Benchmarking Cost Efficiency and Productivity in Universities

Research for the Universities Accord

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Benchmarking

Cost Efficiency and Productivity

in Universities

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Synopsis

Australian universities are important both to our economy and community. They play a pivotal role, including supporting the development of the nation's human capital through the delivery of higher education and in the creation of knowledge through research and innovation.

These and other contributions made by universities should not be underestimated.

These benefits are significant, but they do come at a cost. The cost is shared among a range of stakeholders. The total expenditure by the Australian public university sector in 2021 was in excess of $A32 billion, down from its peak in 2019 prior to the pandemic.

Using analyses based on empirical data, the overarching finding is that Australian public universities display a relatively wide range of cost efficiency outcomes. Some universities show evidence of comparative cost efficiencies in respect of education. Others exhibit evidence that they have comparative cost efficiencies in research. Many exhibit a balance between these two.

What explains these comparative cost efficiencies is a key question. Three factors thought to affect university cost efficiency and productivity are examined here.

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Summary

Australian universities are a crucial part of the economy and contribute significantly to society. They support the development of the nation's human capital, provide places of research and innovation and build engagement with countries in our region and beyond.

These and other contributions made by universities should not be underestimated and must not be taken for granted.

These benefits are significant, but they do come at a cost. The total expenditure of the Australian public university sector in 2021 was in excess of $A32 billion, down from its pre-pandemic peak in 2019.

One key question is: Is this investment 'good value-for-money'? This value-for-money question in public institutions has been the driving force behind the use of what are known as 'Performance Audits' by Auditors-General – both state and federal. Performance audits, referred to also as 'value-for-money' audits, have been a centrepiece in government accountability for some decades. There is, however, no example of a performance audit of a public university known. That is not to say that the universities, both collectively and individually, would not show impressive results from such audits, but the outcomes are untested and unknown.

The task for the research team in this investigation is, in some ways, a first step in examining the cost-effectiveness of Australia's public universities. It does not parallel a full performance audit, but it does, however, provide a framework for examining key questions on the cost efficiency of these public institutions. It does not seek to examine the benefits of the outcomes of either or both research and education. But it does look at costs and cost efficiencies in our public universities in the creation of research and delivery of higher education.

Our examination takes the perspective that a preferred way to examine these issues is to look at real-world outcomes. Thus, measurements are based on empirical data, and there is no use of surveys, focus groups and the like as part of the research methods adopted. Inexorably, the use of empirical data requires the application of assumptions and the use of proxies, bringing with them certain limitations that apply to the conclusions made. Other than where express caveats apply – often as a consequence of the absence of more granular data – the general conclusions drawn are, we would argue, robust and based on a research approach that has been subjected to peer review.

This research was tasked to inquire into three specific questions relevant to the university sector – each of which addresses the issue of cost efficiency. Put succinctly, these three issues are:

What is the impact, if any, on the cost efficiency of universities in respect of –

(a) regional compared with metropolitan universities,
(b) single campus compared with multi-campus universities, and
(c) specialised institutions compared with comprehensive institutions?

In some instances, the findings are not as expected. In other cases, they are as one might have anticipated.

The first question posed regarding the cost efficiency differential between regional and metropolitan universities is of importance as existing policy provides for a relatively modest level of supplemental funding in respect of the education of university students in campuses deemed as 'regional'. The results show a statistically (weakly) significant difference between regional universities and those in metropolitan locations. Somewhat unexpectedly, the nature of this difference points to regional universities facing incremental costs in research rather than education. We discuss a limited range of factors relevant here and suggest the strengthening of support for the research efforts of regional universities. One option noted is the potential existence of a 'hub and spoke' research network system.

The existence of multiple campuses is often seen by individuals who work in such universities as the cause of many inefficiencies. The impact on cost efficiency of multi-campus institutions compared with universities that are, largely, single-campus based is the second question posed. While this oft-cited observational evidence seems compelling, the countervailing view is that secondary campuses will only continue to exist if and when they are economically sustainable in the medium or longer-term. If they are not, they will likely face closure.

It is this second perspective that is supported by empirical evidence. While there are some instances of differences between the relative efficiencies/inefficiencies of teaching and research, there is no statistically significant evidence that multi-campus universities suffer from teaching or education cost inefficiencies or overall cost efficiency deficits.

The third question seeks to examine cost efficiency issues as they relate to specialist institutions compared with 'comprehensive' universities. For this question, we turn to data from the United Kingdom. The analysis shows that two of that country's four most productive institutions of higher education are designated by Universities UK as specialists. Both specialise in the medical field, and both show high levels of research rather than teaching efficiency. Stepping back and looking at the specialist group as a whole means that we reach the conclusion that, in general, there is no compelling evidence that specialist higher education institutions are more cost-efficient than their 'comprehensive' counterparts. The evidence is that the efficiency performance observed is related directly to their Field of Education (FoE) / Field of Research (FoR). Institutions with a specialisation in fields that show high levels of efficiency appear to be standout 'winners'. There is a range of consequences of this result discussed in the report, including the potential importance of the university college provider category.

While acknowledging a range of limitations and caveats to this research, the work does point to the possibility of researching related and, arguably, important questions using an empirical approach. Some of the questions might include:

What is the cost of education within Australia's public universities?

Are there some universities that have a comparative cost advantage in the provision of education?

What is the cost of research within Australia's public universities?

Are there some universities that have a comparative cost advantage in conducting research?

Perhaps more controversially, is there a cross-subsidy between the revenues of education and the costs of research?

What explains the costs in higher education and research, and a series of related questions around the most cost-efficient and most productive use of the investments made in the university sector, are potentially important questions to be asked and answered.

Table of Acronyms

ABS	Australian Bureau of Statistics
ARC	Australian Research Council
AACSB	Association for the Advancement of Collegiate Schools of Business
ATN	Australian Technology Network
EFTSL	Equivalent Full-Time Student Load
ERA	Excellence in Research for Australia
FoE	Field of Education
FoR	Field of Research
Go8	Group of Eight Universities
IRU	Innovative Research Universities
HERG	Higher Education and Research Group
HESA	Higher Education Statistics Agency
NTRO	Non-traditional Research Outputs
RBA	Reserve Bank of Australia
REEF	Research and Education Efficiency Frontier
RUN	Regional Universities Network
TEQSA	Tertiary Quality and Standards Agency

Benchmarking Cost Efficiency and Productivity in Universities

Section 1.0 Introduction and Background

The investigation of costs within higher education is important not just for the effective internal management of universities but also for public policy decisions.

This first section of the report is designed to provide an introduction to costings within higher education, in particular for the 37 major public universities in Australia. The focus is on full costs (as opposed to other costs, including marginal costs), as it is generally full costs that are the most crucial for the determination of public policy matters.

The report relates to the research contract to support the work of the Universities Accord Review as requested (Reference ATM Reference ID: ESE23/488) and answers individually each of the three questions asked.

These early sections are designed to describe the approach and methodology employed. The descriptions include the overall research design approach, the data used, and the analytic techniques employed. The specific research designs used for the three questions are described in the relevant sections below.

The approach is empirical and does not rely on surveys, questionnaires, focus groups and the like. Essentially, this research uses real-world outcomes and data that apply to the university sector.

1.1 Defining and Measuring Efficiency and Productivity

Efficiency is the relationship between inputs and outputs. The Cambridge Dictionary defines it as: "the quality of achieving the largest amount of useful work using as little energy…. as possible".

Efficiency in education, including higher education, has many parallels with efficiency in health care. Both have aspects of the 'invisibility' of costing and significant public good and public policy implications.

Palmer and Torgerson[1], in published work on defining efficiency in health care, noted that "Efficiency is concerned with the relation between resource inputs (costs, in the form of labour, capital, or equipment) and either intermediate outputs (numbers treated, waiting time, etc.) or final health outcomes (lives saved, life years gained, quality-adjusted life years)".

In respect of outputs in higher education, the equivalent outputs are:

> 'Intermediate products': students taught, and research published; and
>
> 'Final Products': the economic and social 'uplift' in graduates and the utility and/ or impact of research.

[1] See Palmer, S. and D Torgerson, BMJ. 1999 Apr 24; 318(7191): 1136. doi: 10.1136/bmj.318.7191.1136. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1115526/

The task of measuring the final products is beyond the scope of the present project. The focus is on the 'intermediate products', the two primary (and arguably dominant) outputs of universities: students taught and research published.

The approach is to measure cost efficiency in respect of these two outputs. This approach is not to ignore that universities may undertake other activities. Examples of these other outputs include the provision of (a) community law centres, (b) innovation and incubation hubs for new entrepreneurs and inventions, (c) centres for Indigenous Australians, or (d) research facilities for domestic or foreign public entities, and the like. We acknowledge that by excluding the measuring of these activities, the full cost estimates may be inflated compared to other more comprehensive measurements of cost. We would argue, however, that the activities of teaching students and engaging in publishable research are the key activities of academic endeavour and dominate in respect of the full costs of a university.

Efficiency can be measured in a variety of ways. The key focus here is on cost efficiency. That is to say, the production of the two key outputs: teaching (or education) and research. One can, however, measure efficiency in respect of the use of academic staff. An example is the number of hours taken in supervision to support a research student (typically a PhD candidate) to successful completion. Indeed, one can measure overall university efficiency by using cost efficiency and academic staff efficiency. This approach provides the added advantage that the ***difference*** between the two measures assists university management in identifying opportunities for enhanced productivity. As stated, the focus of this report is on cost efficiency.

Together with others, we observe that there are three components of efficiency. These are: total or overall efficiency and two components being 'sector-wide' efficiency (such as some new technology that can improve the efficiency of all participants in the sector) or individual institution efficiency (where, say, astute management policies drive an efficiency improvement). As noted below, these matters are more profitably discussed in the context of intertemporal productivity growth.

1.2 Efficiency and Productivity

The terms' efficiency' and 'productivity' are often used interchangeably. This usage is understandable but technically inaccurate. Efficiency is a measure at a point in time: the measurement of inputs and outputs. It is a static measure. Productivity is an intertemporal measure. It is, in effect, the ***change*** in efficiency over time. So, if it costs $100,000 on average to complete and publish a research paper in 2011 and, a decade later, in 2020, it costs $90,000 (deflated to 2010 dollar terms), then one can say that there is a productivity gain of 10% in the cost of published research.

The Australian Bureau of Statistics (ABS) is one of several authorities that define productivity but discuss it in terms of being a static measure. The ABS states that it is: "the ratio of a volume measure of output to a volume measure of input; that is, output per unit of input"[2]. They also note that productivity can be measured "for an individual entity, for an industry or sector of the economy, or for the economy as a whole." They add that positive productivity growth is where "an increase in output, a decrease in inputs or a combination of both" occur.

[2] See: ABS Release 5260.0.55.002 - Estimates of Industry Multifactor Productivity, 2016-17

Some might argue that Australia's principal authority on productivity is the Federal Government's Productivity Commission. They state that: "productivity is the efficiency with which firms, organisations, industry, and the economy as a whole convert inputs (labour, capital, and raw materials) into output. Productivity grows when output grows faster than inputs, which makes the existing inputs more productively efficient"[3]. Interestingly, the Commission recognises that efficiency at a point in time and productivity over time can be measured at individual organisational (firm) level, sector (or industry) level or for the nation as a whole.

The Reserve Bank of Australia (RBA) also defines productivity along similar lines, stating: "Productivity increases when more output is produced with the same amount of inputs or when the same amount of output is produced with less inputs"[4]. Consistent with the Productivity Commission, the RBA describes productivity in terms of change. Consistent with others, the RBA focuses on the relationship of multiple inputs (principally labour and capital) with a single output. Further, and like certain others, the RBA uses multifactor productivity [MFP], stating that: "…businesses produce output using a combination of labour and capital inputs. MFP is calculated as a measure of output divided by a measure of combined inputs."

While there have been some efforts in the scholarly literature to examine university or, more broadly, higher education productivity, there are only rare instances where government agencies have attempted this task. In part, this is because of the complexity of the analysis, particularly because there are multiple outputs (not just multiple inputs as recognised under MFP) in higher education. Thus, collecting, curating, measuring and integrating relevant data, including multiple outputs, is important for reasons of validity.

A key factor in measuring efficiency and productivity is the availability of valid and reliable data. Australia is relatively fortunate as there are generally excellent data sources where they are made available.

In some jurisdictions, in particular the United States (US), there is relatively little consistent data across all states (and in the US, data is largely a state matter); no overarching federal agency collects higher education data, curates it and makes it public. The data largely, if not exclusively, reside at the state level. The data collected appear to vary significantly state by state, and due to its heterogeneous nature and variations in definitions used, considerable complexity is added.

There is far less variability in the nature of the 37 major public Australian universities. None has a narrow specialisation, and all claim, in one form or another, to be comprehensive in nature. Indeed, all the universities with names including 'technology' teach and research in a wide variety of fields in the social sciences and humanities. All teach business, and many teach law.

1.3 Measuring the Full Cost of Teaching

As part of considering a range of public policy matters, one might reasonably ask: Can we find one cost that is representative of the sector or does every university have its own individual full cost?

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3 See Productivity Commission 'What is productivity and how is it measured?' May 2015.

4 See Reserve Bank of Australia Explainer 'Productivity' undated, https://www.rba.gov.au/education/resources/explainers/pdf/productivity.pdf.

In Australia, the challenges relating to the significant heterogeneity of institutions in terms of discipline mix are not the issue they may be elsewhere. This heterogeneity does not mean to say there is not variability between the characteristics and nature of Australian universities and even between individual campuses of universities. At whole-of-university level, there is, in Australia, well-documented variability in research intensity and teaching focus. This variability will be discussed later.

The issue of quality differentiation, which is routinely referred to by university management and 'peak' bodies, also exists both intertemporally and between universities at a point in time. There is research evidence that variability in quality, in particular research publication quality, gives rise to variability in the measurement of full costs. As this project is focused on cost efficiency at one point in time, the issue of changing quality over time does not apply. There is some evidence from Excellence in Research for Australia (ERA) 2018 that research quality is correlated with institutional research intensity. Research intensity is included in the modelling used below.

In respect to the issue of the presence of a dollar cost of teaching, the short answer is that all universities have differing cost structures. This difference is depicted in Chart 1, presented later in this report. Some universities are more cost-efficient in their research endeavours; others are cost-efficient in teaching outcomes. Others still exhibit a mix of cost efficiencies. From the perspective of government policy, there is, however, a centrally determined dollar value that applies universally to public universities. So, while there exists variability in full cost levels between universities, and these differ both between universities and in the same university over time, there is also a need to determine a 'fair average cost for teaching' where the quality of education provided is at least at an adequate level.

Note that the focus here is on full cost. There is a range of other cost measures that apply in higher education and elsewhere. The most significant of these is the concept of 'marginal cost'. There are many sources for the definition of costs.

Full costs are defined as being: 'all relevant variable costs and a full share of overhead and other costs attributable to the output'. There are many similar definitions in the literature. The key characteristic is that 'full' cost recognises and captures all of the costs, including costs that may be fixed in nature. To be sustainable, the revenue received by a university must cover not only the costs of academic staff undertaking the teaching and research but must, in the medium and long-term, cover the non-academic costs. Non-academic costs include costs such as salary 'on costs' (payroll tax and superannuation expenses, etc.), infrastructure (laboratories, offices, campus facilities, etc.), libraries and IT, university executive costs, human resources and finance department costs and a range of similar costs. A university simply cannot survive if the costs covered in teaching and research are only the academic time and costs associated with that.

In the context of teaching, the marginal cost might be best thought of as the cost of admitting one more student into a program. This cost is likely very low. It is much like adding a passenger to the manifest of a flight. The marginal cost (so long as there is an empty seat on the plane) is very low – some incremental cost in aviation spirit and (perhaps) the cost of a snack. Similarly, so long as there is a spare seat in the classroom, the marginal cost of teaching is very low. The lecturer will deliver the lecture whether or not that student is present.

To emphasise the point, universities can prosper – in the short term - by adding students so long as they are paid the full cost and incur only a margin cost. But this is not universally possible and, in the medium to longer-term, can reveal financial challenges if that growth results in medium to longer-term additional fixed costs. Those challenges can also exist where a university takes on these students and applies the surplus (defined here as the difference between the revenue received and the marginal cost) to other useful university endeavours, such as scholarships or research.

This research focuses on the need to measure full cost. It does so in respect of (a) individual universities, (b) groupings of universities, and (c) the sector as a whole or a representative sample[5] of the sector, depending on the question being addressed.

1.4 The Research Approach

As indicated above, the approach is to use real-world empirical data to investigate the full costs of the two key university outputs – teaching and research.

There are three elements to the data required to undertake the proposed analysis. All of these data are empirical, and while more granular analyses may be possible, the unit of analysis is the whole of institution. Therefore, the measurements are for all research, education and total expenditure. The analysis is, therefore, not at a granular level where measurements might be made at individual Field of Education (FoE) or Field of Research (FoR) levels.

1.4.1 Expenditure Data

There are two sources of university expenditure data. One is to obtain and use the financial information presented to the Parliaments relevant to the 37 public universities in Australia. This includes all Parliaments of the Australian States and Territories and the Federal Parliament. The advantage of this source is that these expenditure data are audited by the respective Auditors-General. This group, known in Australia as the 'Supreme Audit Institutions', have responsibility for independently verifying the financial reports provided by universities to ensure they are in accordance with the requirements of Australian Accounting Standards.

The second set of data comes from the Federal Government's Department of Education. These financial data are based on the aforementioned records but may include adjustments agreed between the Department and the universities. These data are said to include adjustments especially required to reflect the special circumstances of Australian universities not adequately covered by the Australian Accounting Standards. An example is research grant income, where Accounting Standards require it to be shown as revenue in the financial year the grant is received even if the expenditure (and research effort involved) occurs in a subsequent financial year.

There are advantages and disadvantages to each of these two sets of data. The decision was taken to employ the data file on university expenditure held by the Department of Education, given that it is a set of financial rules accepted by the sector. The key adjustment to these data is the exclusion of expenses disclosed as being in respect of investment losses and asset impairments (where known), given that these do not relate

[5] Or a proxy of the Australian sector as is required when investigating the issue of institutional specialisation in the third question addressed.

to academic effort (and therefore 'cloud' the cost of the academic effort whether it be research or education).

1.4.2 Education Data

To be valid and reliable, the data relating to teaching outputs must involve data measured in a consistent way across all institutions. As a consequence of individual circumstances that vary between higher education institutions, individual institutions make public their data in a variety of ways with a variety of measures. Additionally, this is often done without a comprehensive definition of the measures used. The Federal Government Department of Education collects a comprehensive (and granular) set of data in respect of education delivered by public universities and a range of data from other institutions, including private universities and non-university private providers. Other than for Section 4 below, the education data used in this research is also from the Department of Education. Specifically, data in respect of the Equivalent Full-Time Student Load (EFTSL) data is used.

1.4.3 Research Data

The data in respect of research could plausibly come from a number of sources. In earlier years, the Federal Government kept data on the key outcome of research – research publications – in a data file known as the Higher Education Research Data file. The collection of research publications data was an important source of data as it included detailed material on such matters as author affiliation and, importantly, author apportionment of the research publication. Regrettably, this collection was discontinued almost a decade ago and is not available for this study.

There is a range of privately sourced research datasets. Well-known ones include those by Scopus and Clarivate (Web of Science). Others also exist. Comparing the ERA data with other private sources shows that the ERA, with few exceptions amongst the 37 public universities, reports a lesser number of publications than shown in other sources. Multiple explanations for this discrepancy exist, some relating to the ERA data collection process, which allows, or in some instances, requires publications not to be included.

Another Government endorsed source of data on research is available via the Australian Research Council (ARC) in the form of the ERA. While there is a current round of ERA, the most recent data available is the ERA in 2018. Other than where noted (including Sections 1.7 and 4.0), these data are used for this project. Note that one limitation is that the apportionment of authors' contributions is not included in the data. Thus, the measure for research outputs involves some duplication. An advantage of this data is that its characteristics are known and agreed upon between universities and the ARC. Other than where noted in this report, the analysis that is described here uses ERA 2018 data.

1.5 The Analytic Approach Employed.

For certain aspects of the research, the approach uses an analytic technique known as the Research and Education Efficiency Frontier (REEF) methodology.

REEF is a specialist application of a form of frontier analysis and is designed specifically for the university sector. This is because universities have dual missions of education and research and the costs incurred are not separated into independent entities. The application involves the collection and curation of data directly relevant to these dual key functions of universities – education and research.

Frontier analysis has its origins partly in the work of Nobel Prize winner Harry Markowitz, which describes the optimal mix of risk and reward in investment. However, it is commonly applied where the search is for the efficient mix of two or more output measures. That is to say, where there is more than one desired outcome. Further complexity occurs because there is not a fixed or given relationship between these two or more outcomes.

If there was only one activity and the only motive was profit, then the efficient choice is the one that maximises profit. There would be no need for a 'frontier'. But in organisations with more than one activity or more than one measure of success, using frontier analysis enables us to see where each measure is maximised in relation to the other measure.

As noted above, we argue that universities have two crucial outcomes – teaching and research – and the proportional relationship or mix between these outcomes is not fixed across universities at a single point in time nor across time for a given university. Solving for cost efficiency or productivity optimisation, as classically defined, is not possible. It is, however, possible to provide a multivariate analysis of the inputs – expenditure as well as, when relevant, academic labour – in supporting the chosen mix of output -research and education.

This solution is complex and might be best thought of as a 'line of best fit' through the empirical data.

The application of the REEF methodology used here provides a way of seeing where each university stands in relation to others in the sector or those with which it normally compares itself. So, at its heart, it measures the relative efficiency (and, over time, productivity) performance of universities against others in the same sector at the same time. It also provides a picture of where their ***actual*** use of resources is taking them in terms of output at a point in time.

The technique can also be applied within an institution; for example, at department or FoE / FoR levels. This requires granular data and is not part of the current project.

As illustrated briefly below, a second application is where REEF can be used to track productivity – change in efficiency over time. While beyond this project's specific terms of reference, this report does include some material on this matter to help illustrate the productivity improvement Australian universities have made over many years[6].

1.6 The REEF Methodology

The basics of REEF are best illustrated by graphical representation.

As noted, REEF assumes two dominant outputs of universities – education and research – and that these outputs are funded via the total expenditure of each university. As with other frontier analysis approaches, the REEF model displays the universities across the two-dimensional space of outcomes in research and outcomes in education.

[6] Note this analysis is not able to use data exclusively from the sources listed above. Research outputs come from a private collection of research dataset and the financial expenditure data come from the published reports of universities as audited by the relevant Auditor-General. The teaching data come from the Department of Education.

In the graphs below, the horizontal axis is the measure of education – based on EFTSL per million dollars. The vertical axis is the measure of research outputs (as measured in the 2018 ERA program, the most recent research data being 2016). The 37 public universities appear as points across this graph, reflecting their actual expenditure relative to these two sets of outputs.

Note that the universities are shown with their university groups or affiliations at the time. The Group of Eight (Go8) universities (shown in orange) are all clustered towards the research-intensive area of the graph (top left). The universities which were members of the Australian Technology Network (ATN) group in 2016 (shown in red) are mostly clustered in the mid-range of the graph. The members of the Innovative Research Group (IRU) (shown in black) and the Regional Universities Network (RUN) (shown in green) are distributed across a wider range within the graph. Universities that were, at the time, not aligned with an alliance group are shown in yellow.

The frontier, which represents the strongest combination of research and education outcomes per million dollars of total expenditure, is represented by the institutions at the outer edge of the performance outcomes. This frontier is shown with a blue line.

The efficiency of an individual university is measured by reference to the distance to the frontier closest to that institution. So, if a university is more teaching-focused, it is not compared with the performance of a highly research-intensive university. The efficiency score is calibrated by reference to the distance to the closest point on the frontier. Thus, a university far from the frontier might have a score of 0.50. This score means that this institution is halfway between the origin and the closest point of the frontier.

Other dimensions can be added beyond education and research (such as community engagement or impact, where relevant data are available) by adding further dimensions. Aspects of quality can be added via weights and/ or filters. The results for 2016 are shown in a graphical representation in Chart 1 on the next page.

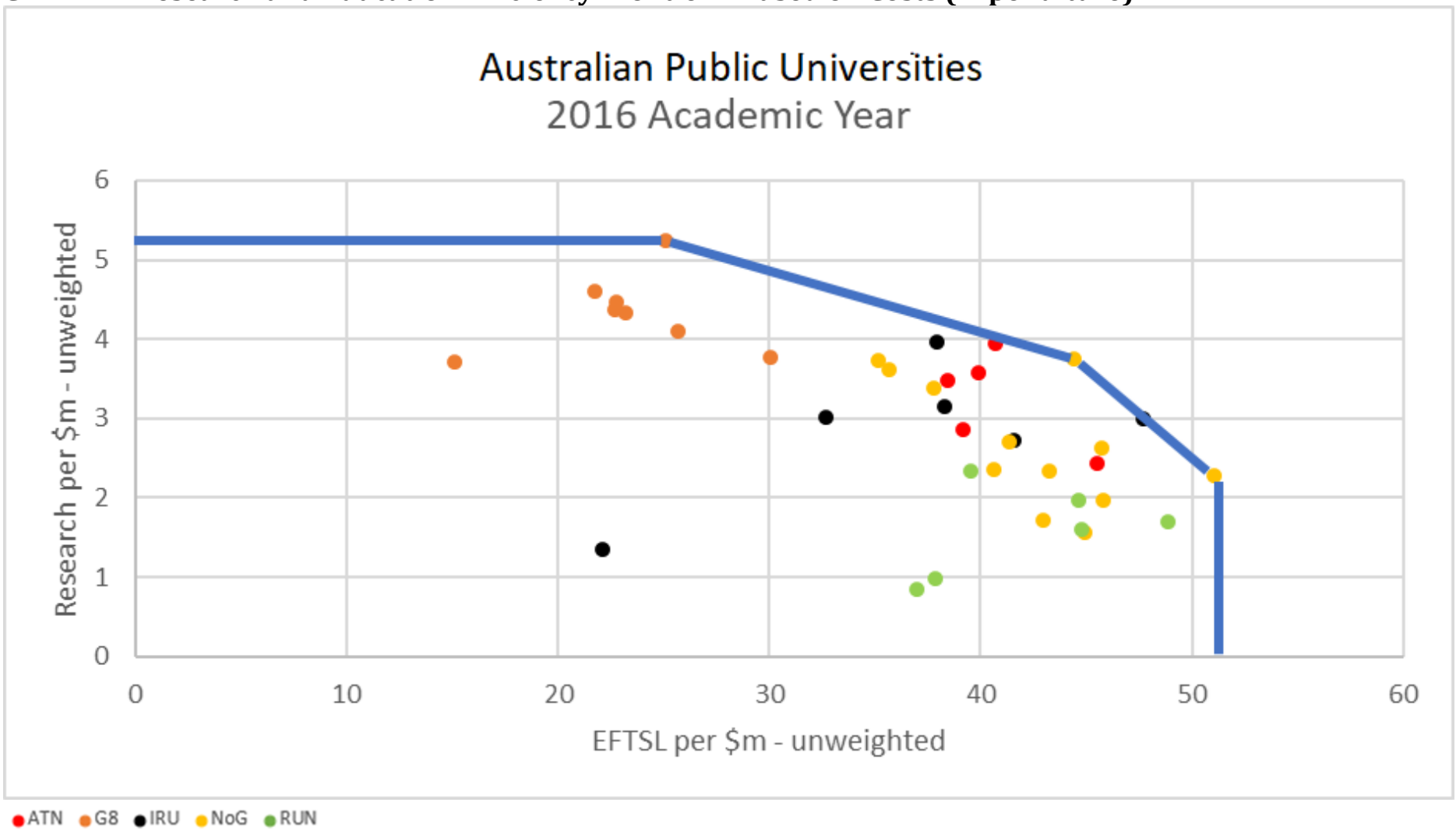
As is apparent in Chart 1, three universities define the efficiency frontier, with a fourth university less than one per cent from the frontier.

In Chart 1, no weightings are used in measurement of the outputs – research and education. A book is counted as one output, and all students (measured in EFTSL) are unweighted – that is, they are weighted equally. Thus, a full-time undergraduate student is treated the same as a coursework graduate student, as is a full-time research student (say, for example, a PhD candidate). This assumed equality of all education activities is relaxed in subsequent analyses where varied weights are used.

Additionally, whole of institution cost efficiencies are not adjusted for differing intensities of particular Fields of Education or Fields of Research.[7] Further analyses which include

[7]. Differences in cost efficiencies exist across different FoEs and FoRs. Empirical evidence consistent with is reported in Section 4.0 below in respect of specialist U.K. institutions which shows that some fields are particularly cost efficient / inefficient relative to others. Where certain conditions exist, this may translate into an impact on overall cost efficiency for more 'comprehensive' universities. One could argue that, where universities with elevated intensities in certain FoEs/FoRs with particularly low/high levels of cost efficiency relative to the institution that defines the frontier closest to the university in question, an overall institutional cost efficiency effect may occur. The direction and extent of any impact on total cost efficiency is not known empirically and is highly dependent on the relative intensities of fields between the university in question and the closest university that is on the frontier. Research on this is feasible and may be of value particularly in countries with high levels of diversity in institutional FoE/FoR intensity.

CHART 1: Research and Education Efficiency Frontier – Based on Costs (Expenditure)



relative intensities of FoEs and FoRs is feasible but outside the scope of this project[8]. Differing intensities of particular fields will likely drive differential total costs (including in education), however, potentially this may not lead to whole-of-institution cost efficiencies given the efficiency score is measured relative to the efficiency frontier[9,10].

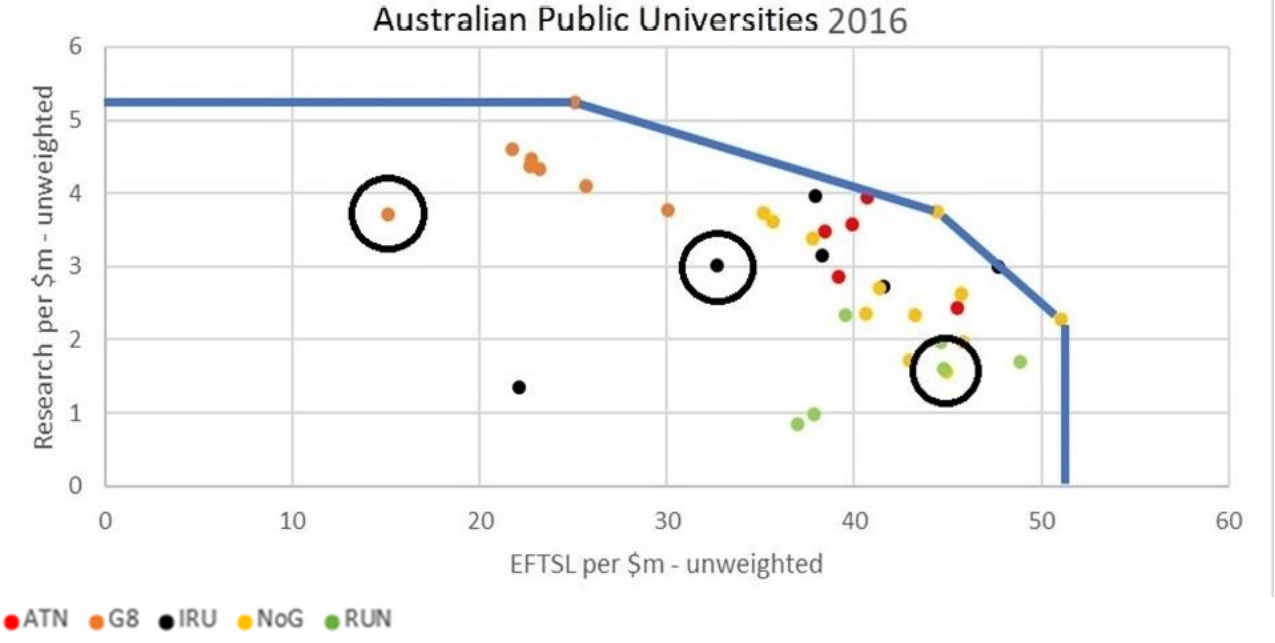
Given the approach, this analysis is agnostic as to the 'importance' or worth of research and education outcomes. A university can provide service to society and the economy by being research-intensive or education-intensive, or a combination of the two. This choice is entirely in the hands of the universities themselves. There is no preference or relative weighting given to the importance of either output.

Chart 2 is identical to Chart 1 other than for four highlighted universities (black circle).

It is evident from the Chart below that the four universities show, to some extent at least, evidence of differentiated outcomes in respect of research and education. They are, however, all approximately the same distance from the frontier. There is one Group of Eight university scored at around 0.87 (or 87%) towards the top left of the Chart, an IRU institution in the centre of the Chart with a score of around 0.86 and two universities with a stronger teaching intensity towards the lower right of the Chart, one of which is the in the RUN grouping and one that is unaligned (partly obscured by the green dot of the RUN member institution) also scored at around 0.87.

All these four universities are regarded as having been approximately equal in cost efficiency in their individually chosen research/ education intensities.

CHART 2: Equally Cost-Efficient Universities – highlighted



[8] The scale of the additional work is potentially significant and applicability in Australia may be limited.
[9] The calculation of cost efficiency is calibrated relative to other institutions of like education/research intensity.
[10] For there to be a marked impact on overall institutional cost efficiency, it is likely that the scale of the difference in FoE/FoR intensities (between the university in question and the university on the frontier that is closest) would need to be significant. While this is true for the UK higher education sector (see Section 4), it may not presently apply in the Australian university sector. This is, however, testable empirically.

1.7 Changes in Cost Efficiency: Measuring Productivity

While relevant for that point in time, cost efficiency can and does change over time. This change is correctly described as productivity and can be examined at individual institutional level or whole of sector level.

1.7.1 Individual University Productivity

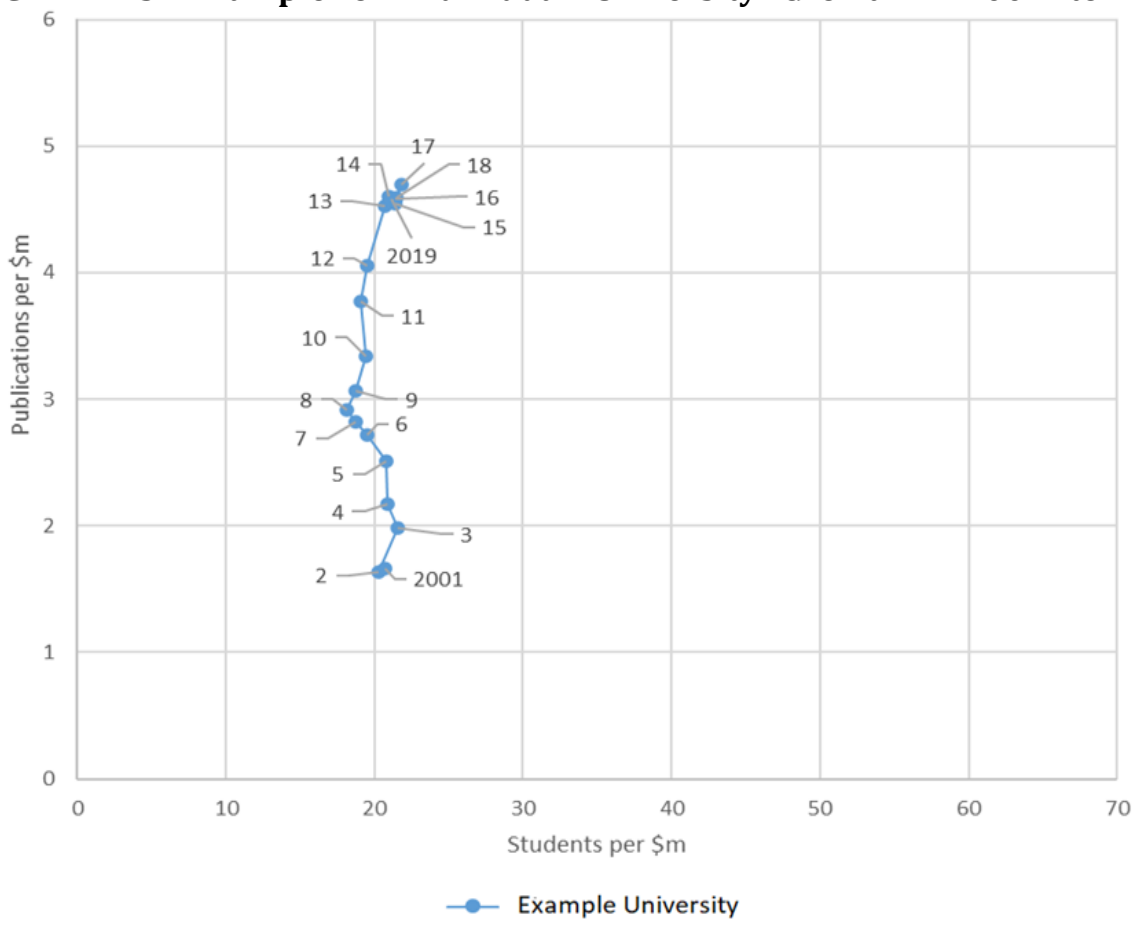
An example of productivity growth at individual university level can be seen in Chart 3 below for the period from 2001 to 2019. The year 2019 is used as the end point so as not to include the effects of the pandemic that commenced in the following year[11].

This Chart shows the change in education and research productivity for an anonymised Australian public university over the period 2001 to 2019 in 2019 dollar terms[12].

As is evident, this university is strongly research-intensive and has shown significant productivity growth over the period 2001 to 2019 (commencing in the year that HERG keeps Australian data from) to the year prior to the effects of the pandemic.

Note that almost all of this productivity growth has been in respect of its research activities. This focus is apparent when one sees that the productivity growth has been largely upwards – the vertical axis relates to research. Some, but comparatively little, productivity growth is seen in education productivity.

CHART 3: Example of Individual University Growth – 2001 to 2019



[11] Given the period involved is beyond that of the ERA 2018 dataset, REEF publications data was used.
[12] The pre-2019 dollar figures are adjusted for inflation using the ABS index applicable to education.

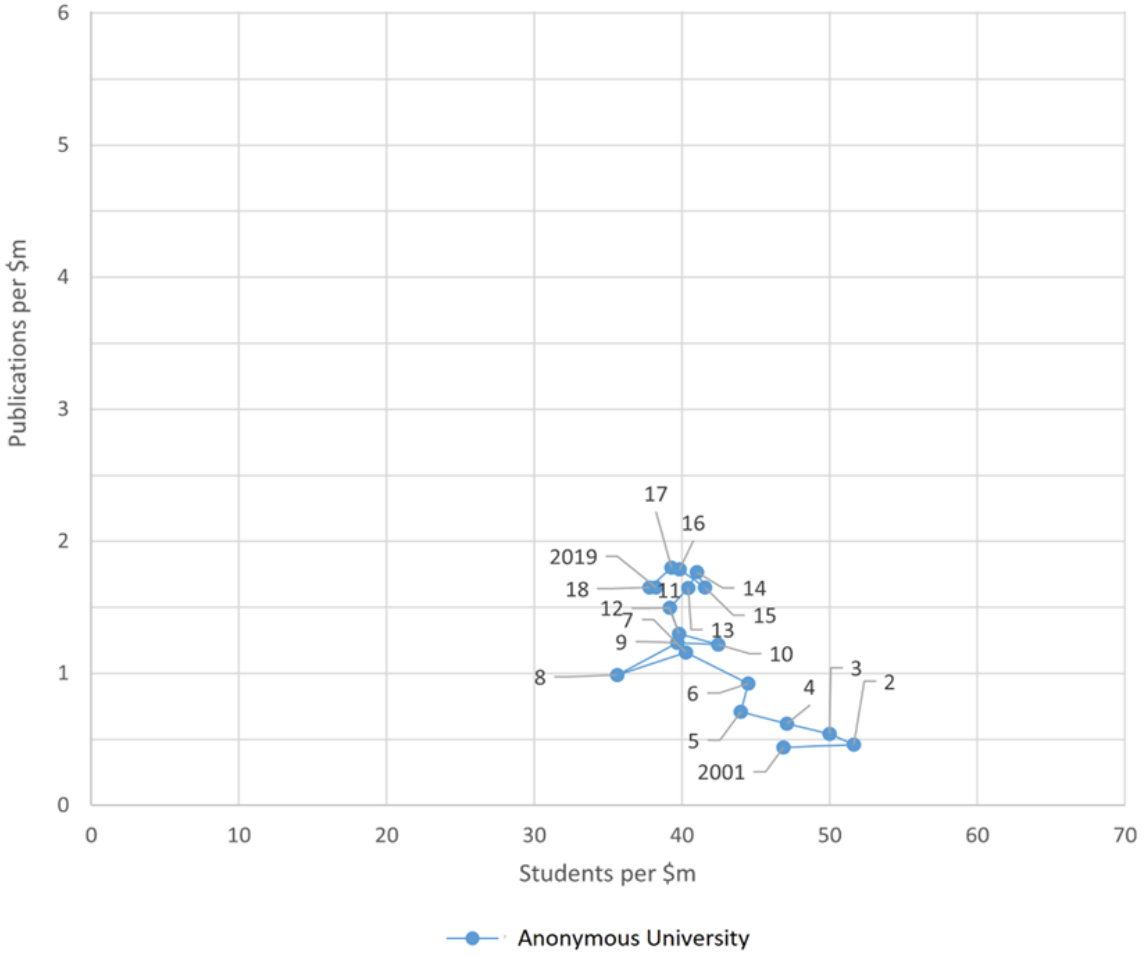
Also apparent is that the university has paused its productivity growth in more recent years. One of several explanations for this pause is that these years represent a period of consolidation over the period 2014 to 2019. Other explanations exist also.

A second example showing productivity changes for another Australian university over the same period (2001 to 2019) can be seen in Chart 4 below.

This Chart illustrates that, while there are many examples of positive productivity growth over this extended period, such productivity growth is not universal in the sector. The example in Chart 4 shows mixed results in productivity growth in the period 2001 to 2019. The result in 2019 is further from the frontier than the university was in 2001. That is to say that, after correcting for inflation, the university is showing lower levels of cost efficiency in 2019 than in 2001.

The analysis does not posit a reason for this finding, it simply provides the empirically-based evidence of the productivity outcome over time.

CHART 4: Example of Individual University Productivity Change – 2001 to 2019



1.7.2 Whole of Sector Productivity Performance

Chart 5 below shows university productivity growth with comparisons between 2009 and the last year prior to the pandemic – 2019. Also shown are two intermediate years, 2012 and 2016. The analysis covers all 37 major public universities in Australia. The estimates are calibrated using 2019 dollar values.

The results for the period are impressive. Some of which might be reasonably attributable to whole of sector improvements, others are gains solely within an institution.

Between 2009 and 2019:

- All universities improved in either or both education and research productivity;
- Productivity growth in research was stronger than for education; and
- There is far greater variability in university productivity in 2019 than in 2009.

The 'frontier' shown in Chart 5 is calibrated as earlier, with research on the vertical axis and education activities on the horizontal axis. Universities with the highest levels of cost efficiency with a mix of research and education intensity calibrate the frontier.

It is on the public record that in 2019, the universities on the 'frontier' were: the University of Western Australia (with a stronger research emphasis), Victoria University (more strongly teaching-focused) and the University of Wollongong (with a balance between research and education intensity).

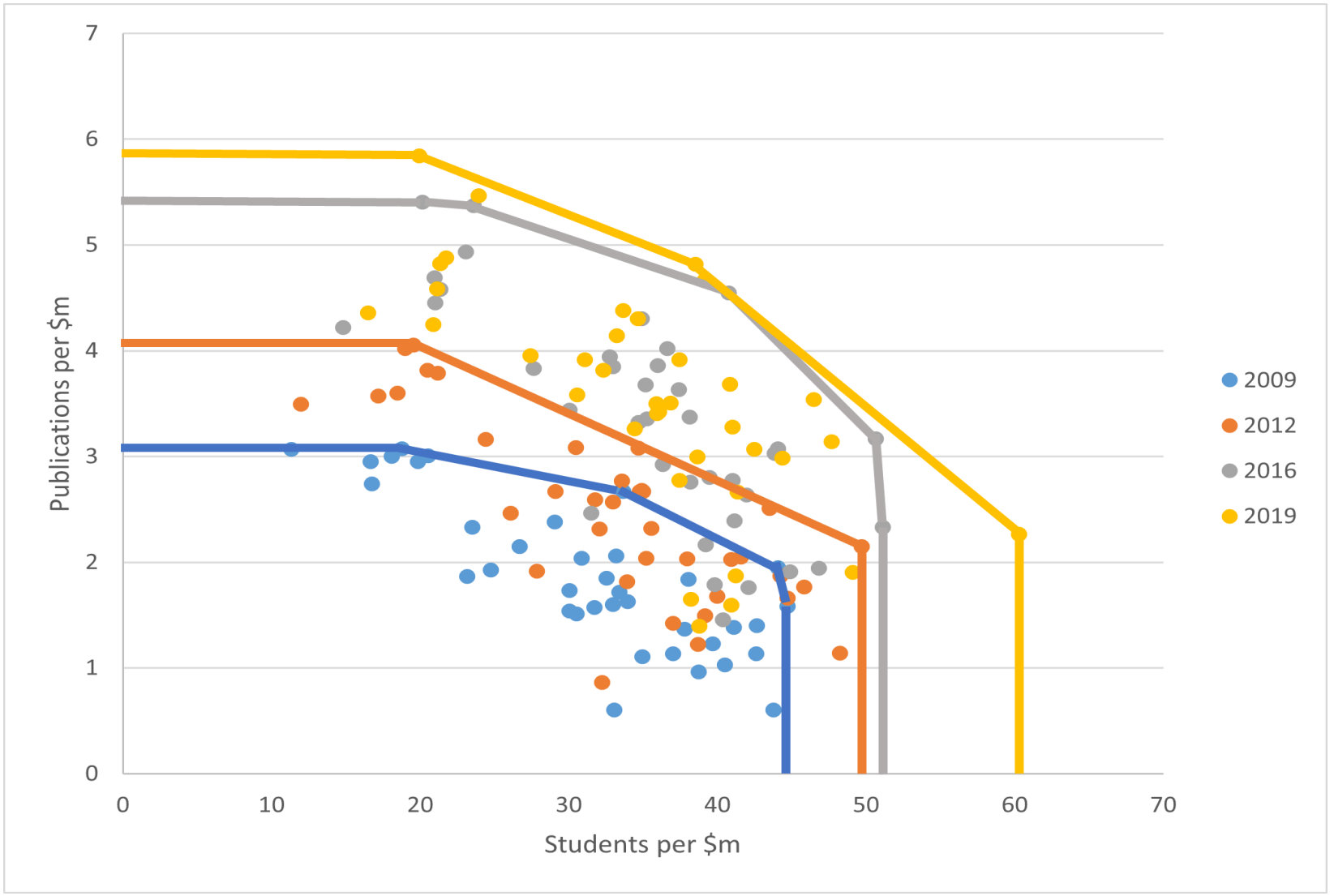
Average annual productivity growth between 2009 and 2019 was in excess of 3%, with some extraordinarily strong outcomes for individual universities occurred.

There are several items of interest in Chart 5. Note that the change in the cost efficiency frontier does not progress in a linear fashion over the period. There is more limited productivity growth between 2016 and 2019 compared with the earlier period, 2012 to 2016, where productivity growth was substantial. In work published at the time, we conclude that the significant change in the period after 2012 is likely linked, in part, to the 'uncapping' of domestic undergraduate places. In further analysis, we report that this gain appears to be consolidated into university operations; that is to say, there was no 'back sliding'[13].

A second factor of interest is that, while the frontiers have moved substantially between 2009 and 2019 both in respect of teaching and research, the number of universities that markedly improved their education efficiency was noticeably lower that those that achieved substantial gains in their research productivity. This can be observed by examining the number of universities closer to the education intensive area of the frontier in 2019 (and 2016) compared with the number closer to the research-intensive part of the frontier. Put simply, there is more significant change in research productivity over the period 2009 to 2019 than in teaching productivity.

[13] See: Houghton, K. and M. Clisby Uncapping University Efficiency. *The Australian*, March 20, 2019.

CHART 5: Change in Cost Efficiency – Productivity in Australian Universities between 2009 and 2019



1.8 What Explains Productivity Change in Universities?

A key question for university management, those in university governance roles, such as members of university councils, and those with responsibilities for public policy decision-making, is: What are the principal factors that explain efficiency and, ultimately, productivity?

While more is needed, this report makes some contribution to answering this question. Some factors that explain productivity are policy determinations. Some are about sector-wide characteristics and behaviours. Others still are institution specific.

Some sector-wide characteristics relate to policy settings by government; others involve student demographics and other matters, including national and regional economic factors. For a few institutions, the role of the Tertiary Quality and Standards Agency (TEQSA) may also be important.

Take the following hypothetical example away from higher education to illustrate some key points. The example uses the aviation industry in a country with 37 airlines. In this hypothetical country, a new model of plane becomes available. It has a technologically improved and more efficient wing design. Some airlines buy this new technology and use it on routes for which the wing design is optimised, producing an efficient and low-cost outcome for those airlines. As expected, productivity increases. Other airlines are disinterested in this innovation. Still others buy the plane but use it on routes that might be too short and do not suit the technology. As noted earlier, there are econometric ways to unpick the productivity attributable to the new industry-wide technology changes, and this can be separated from the effects attaching to the airlines' utilisation or non-utilisation of the technology. That is, there are industry-wide effects separable from those of the individual airlines in this market.

The same approach is applicable to the 37 universities tracked using REEF. Overall cost efficiency and productivity can be partitioned between sector-wide efficiency effects and institution-specific effects. The net of the two is the overall efficiency score. They are netted as all institution-specific factors are under the university's direct control. The sector-wide factors reflect the extent to which institutions take advantage of sector-wide settings to their own institution's advantage. This second factor is much like how an airline does or does not use newly available technology to its best advantage.

The sector-wide factors include but are clearly not limited to government policy settings, funding rules, potential student demographics and student markets, changes to education and learning technology, and national and regional economic factors, including labour markets.

What are the productivity drivers at individual institutional level? Is research intensity a factor affecting productivity? What is the impact of being a dual-sector institution? Does having sizable international student populations or separate international campuses affect productivity? There is an argument that location in a regional area involves greater cost and that this elevated cost impacts the cost of both education and research. This question is examined later in this report. There is also a school of thought that institutions with a specialist focus will likely be more efficient as they are forced to develop a range of expertise in a variety of Fields of Education or Research. This specialisation, too, is a question addressed later in this report.

Another important question that has implications both for public policy as well as for individual universities and their management is: Do economies or diseconomies of scale impact cost efficiency?

It is the case that Australia has, on average, large universities. Potential mergers and/or restructuring within states will likely need to deal with this question. Some argue that this is affected by funding policy choices. The size of universities in Australia, as measured by EFTSL, is large by world standards. The key question is: Are there potential economies or diseconomies of scale?

1.9 The specific questions addressed.

The general question noted above is: What explains the variability in cost efficiency in Australian universities? As acknowledged above, there may be a significant number of factors that come into play. There are three factors we have been asked to address in this research report.

Put succinctly, these factors are:

a) Do regional universities face cost inefficiencies compared with metropolitan universities?
b) Do multi-campus universities face cost efficiencies or cost inefficiencies compared with single or largely single-campus universities? And,
c) Do universities with a limited specialist focus show greater cost efficiencies or greater cost inefficiencies compared with comprehensive universities?

These three issues are dealt with in the following three sections, respectively:

Section 2: Question 1 - Cost Efficiencies and Regional v Metropolitan Universities

Section 3: Question 2 - Cost Efficiency and Single v Multiple Campuses

Section 4: Question 3 - Cost Efficiencies and Field Specialisation

Section 2: Question 1- Cost Efficiencies - Regional v Metropolitan Universities

The first of the specific questions relates to a question that is crucially important for higher education in Australia, given the geography of the country. That is the cost consequences of campuses in regional (and remote) Australia compared with campuses located in metropolitan locations.

There is a range of subsidiary questions relevant here, including: are there cost consequences for education, research or both? Given the long-term presence of additional Commonwealth funding for regional campuses, there is a presumption that there are cost consequences (inefficiencies) in respect of education. But are these added cost issues restricted only to education, or do regional researchers also face cost disadvantages? That is to say, are the cost efficiencies and inefficiencies related to education or research or both? If there are cost inefficiencies in both research and education in respect of regional campuses, what is the balance between these in respect of education and research?

It is of some importance to note that the additional Commonwealth regional funding is not directed at individual universities *per se* but to specific campuses of universities. Those which are defined as 'regional'. Given that the primary education and expenditure data kept by the Commonwealth and used in this research are largely focused at 'whole-of-university' level (that is, the unit of analysis is at 'whole of institution'), certain classification decisions in respect of which universities are 'regional' and which are not must be taken.

2.1 Approach Used in Examining this Issue.

Consistent with the discussion above, the data used to examine this question are largely drawn from the Department of Education and ERA 2018. These data relate to education (in the form of EFTSL) and total expenditure (net of asset impairments and investment losses as they do not relate to academic activity). The research data are drawn from the most recent data in the ERA 2018 round. The most recent research data in ERA 2018 is research published in the academic year 2016. As is explained below, both weighted and unweighted research and education data are included in the analyses.

2.2 Defining Regional and Non-regional Institutions.

In respect of the issue of identifying 'regional' universities as distinct from 'non-regional' (or metropolitan) universities, several possible criteria might be employed.

One option is to use self-identification or self-classification. For example, as at 2016, the membership of the Regional Universities Network (RUN) was:

Central Queensland University
Federation University Australia
Southern Cross University
University of New England
University of Southern Queensland
University of the Sunshine Coast

In 2019, Charles Sturt University also joined RUN. This classification is one option in respect of the identification of 'regional' universities.

Additionally and importantly, the Federal Government provides universities with campuses designated as 'regional' with supplemental funding based on an assumption of additional costs.

In 2016, the following universities received some level of funding under a program to support regional higher education:

Australian Catholic University
Central Queensland University
Charles Darwin University
Charles Sturt University
Curtin University
Deakin University
Edith Cowan University
Federation University Australia
Flinders University
James Cook University
La Trobe University
Monash University
Southern Cross University
The University of Newcastle
University of Adelaide
University of Melbourne
University of New England
University of Queensland
University of South Australia
University of Southern Queensland
University of Tasmania
University of the Sunshine Coast
University of Western Australia
University of Wollongong

This funding is based on campuses rather than institutions. Reviewing the list above reveals that more than half of Australia's public universities received some level of regional funding. This substantial list was further extended under the 'Jobs Ready Graduates' package (commencing in January 2021) with the addition of all South Australian university campuses, both metropolitan and regional.

Given that the expenditure data is at whole of institution level and not campus level, there is a need to provide an adequate proxy to partition universities with material regional funding compared with more limited or no regional funding. For 2016, the following are classified as universities with a material level of activities (and expenditure) that might reasonably be linked to the presence of regional activities – both education and research. They are:

Central Queensland University
Charles Darwin University
Charles Sturt University
Federation University Australia
James Cook University
Southern Cross University
University of New England
University of Southern Queensland
University of Tasmania

This list includes all universities that were members of RUN at the time, plus Charles Sturt University, which was to join that network soon thereafter. The two exceptions are James Cook University and the University of Tasmania. Both James Cook University and the University of Tasmania are older established universities with long track records in research. Both do, however, have a significant regional presence.

Given the presence of material regional funding to these two universities, the classification used to define 'regional universities' is the one noted immediately above, with a total of nine institutions.

So as to provide a clear distinction between regional and non-regional universities, the dataset used in this component of the study excludes all universities that received some, but largely insubstantial, regional funding in 2016. That is to say, the dataset included universities with substantial regional funding and universities that received none. In all, 23 are included in the sample. Thus, the analysis involves a comparison of the cost efficiency of the nine universities listed above and the 14 universities receiving no regional funding listed below.

The universities designated as 'metropolitan' (or, more precisely, non-regional) are:

Australian National University
Griffith University
Macquarie University
Murdoch University
Queensland University of Technology
RMIT University
Swinburne University of Technology
University of Canberra
University of Melbourne
University of New South Wales
University of Sydney
University of Technology Sydney
Victoria University
Western Sydney University

Implicit in this research design is an assumption that these two differ only in respect of cost efficiencies. This assumption is potentially contestable given that, for example, no Group of Eight university is identified with substantial regional funding (although some, such as the Universities of Adelaide, Melbourne, Queensland, and Western Australia, all received some regional funding in the period). Other differences also apply. Given the limited population of universities, it was not possible to establish a research design that involved a matched pair sampling approach.

As is described below, a further sensitivity test, removing all Group of Eight universities from the non-regional group of institutions, is also undertaken.

The cost efficiency modelling follows the principles described and illustrated above. Efficiency scores are calculated for each university, and the analysis is agnostic as to research intensity or education focus. This approach means a university that is more education-focused and close to the efficiency frontier is scored identically to one that is research-focused and equally close to the frontier relevant for such an institution.

The analysis is executed with two alternative measures used for research and education. In respect of research, the ERA data for the academic year 2016 is measured without any weights. That is, a journal article is given the same value as, say, a book chapter or a conference paper included in the ERA data. There are no explicit weights for either the scale of the work or its quality. There is an assumption that these are all scholarly contributions of substance and of (at least) adequate quality.

In respect of education, the data held by the Department of Education provide some degree of granularity. For the purposes of the research here, the education variable is broken into three broad groups: undergraduate education, graduate coursework and research. Some smaller student numbers in, for instance, pathway programs were included in undergraduate education.

The cost efficiency analysis is undertaken in two ways. First, the efficiency score is calculated without weights attached to the education or research variables. That is to say, an EFTSL in undergraduate education is considered the same as one in graduate coursework, which is the same as a research candidate. The assumption is that the aggregate effort is the same for all categories of EFT students. This assumption is changed in the second analysis, which does include weights.

In the second analysis, a variety of weights are applied – in particular, weights in respect of education.

The weights considered for education involve multiple options ranging from undergraduate education of 1.0, graduate coursework of 1.5 and research students of 3.0 to undergraduate education of 1.0, graduate coursework of 5.0 and research students of 10.0.

The results reported below show a model with an excellent fit where the weights for education are: undergraduate education of 1.0, graduate coursework of 2.0 and research students of 4.0. Other weights were used but not reported here. We discounted any analysis beyond research EFTSL being weighted at greater than 5.0 as the models became increasingly poor in explaining overall total university expenditure.

In respect of research, in addition to an unweighted measure of research, we used weight used by the ARC relating to the scale of scholarly contribution. For one aspect of the ERA, a weight of 5.0 was attached to books, with all others as one.

Therefore, two analyses are reported. One is unweighted, and the other is weighted, where the weights applied are: Research: books – 5.0 and other – 1.0; and Education: undergraduate – 1.0, graduate coursework – 2.0 and research students – 4.0.

2.3 Results: Cost Efficiency in Regional v Metropolitan Universities

Chart 6 (shown on page 22) below shows the efficiency graph for the unweighted results and Chart 7 (page 23) for the weighted results.

The results for the unweighted measures of education and research reveal that the regional universities are more prominently located toward the education-intensive area of the graph, with non-regional universities used as the comparison group spread across the graph, including in the more research-intensive area of the graph.

As might be expected, one can observe a somewhat larger proportion of universities classified as non-regional at or near the cost efficiency frontier than regional universities. Both groups have at least one university some distance from the frontier.

A similar pattern can be observed for the weighted research and education outputs shown in Chart 7.

Thus, one might reasonably conclude that regional universities appear to be facing a cost disadvantage relative to their non-regional counterparts.

In part, this cost disadvantage may be systemic. This observation is so because regional campuses of universities have specific funding to support the (presumed) cost disadvantages of their location. Given that these institutions have been provided with this funding, it is reasonable to presume that this funding is included in their reported total expenditure (net of asset impairments and investment losses). Put another way, it is largely axiomatic that if funding is provided to a university, that university will likely spend it.

Looking specifically at the results using the weighted measures for education and research, the mean cost efficiency score for the regional and non-regional universities is 0.825 and 0.904, respectively. This difference is appreciable and in the expected direction – that is, non-regional universities have a noticeable cost efficiency advantage over their regional counterparts. The average for the non-regional universities' changes only marginally (to 0.905) with the removal of the Go8 universities from the non-regional group.

Despite these differences, given the small sample sizes, it is not surprising that these differences in cost efficiency are not significantly different statistically (Mann-Whitney U = 53 p=0.33). Removing the Go8 universities does not alter this result.

Further analysis of the source of any difference may provide some insights into cost behaviours. While the overall efficiency score of the regional universities is not statistically different from their non-regional university counterparts, the overall efficiency level can be disaggregated into efficiencies that relate to education and those that relate to research.

Despite the small sample sizes, there is a (weakly) significant difference between the regional and non-regional universities in respect of the cost efficiency relating to research (Mann-Whitney U = 91, p=0.092) – but not education (Mann-Whitney U = 83, p=0.205).

Thus, it is not unreasonable to conclude that, despite small sample sizes, there is an appreciable cost differential between universities with a marked regional presence compared with their counterparts exclusively in non-regional locations. It would seem that this cost differential is manifested in respect of the costs of research.

Chart 6: Cost Efficiency Australian Universities 2016 – Regional and Non-Regional – Unweighted Outputs

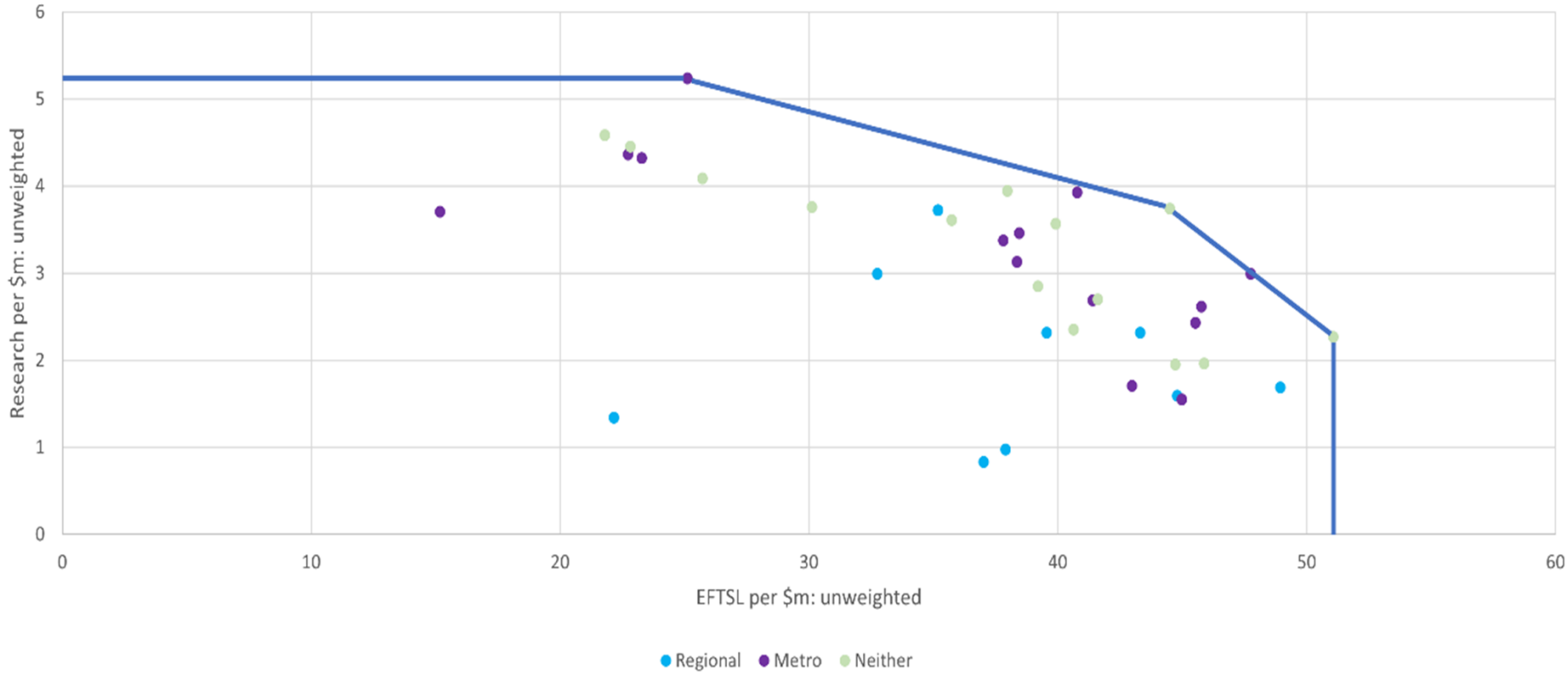
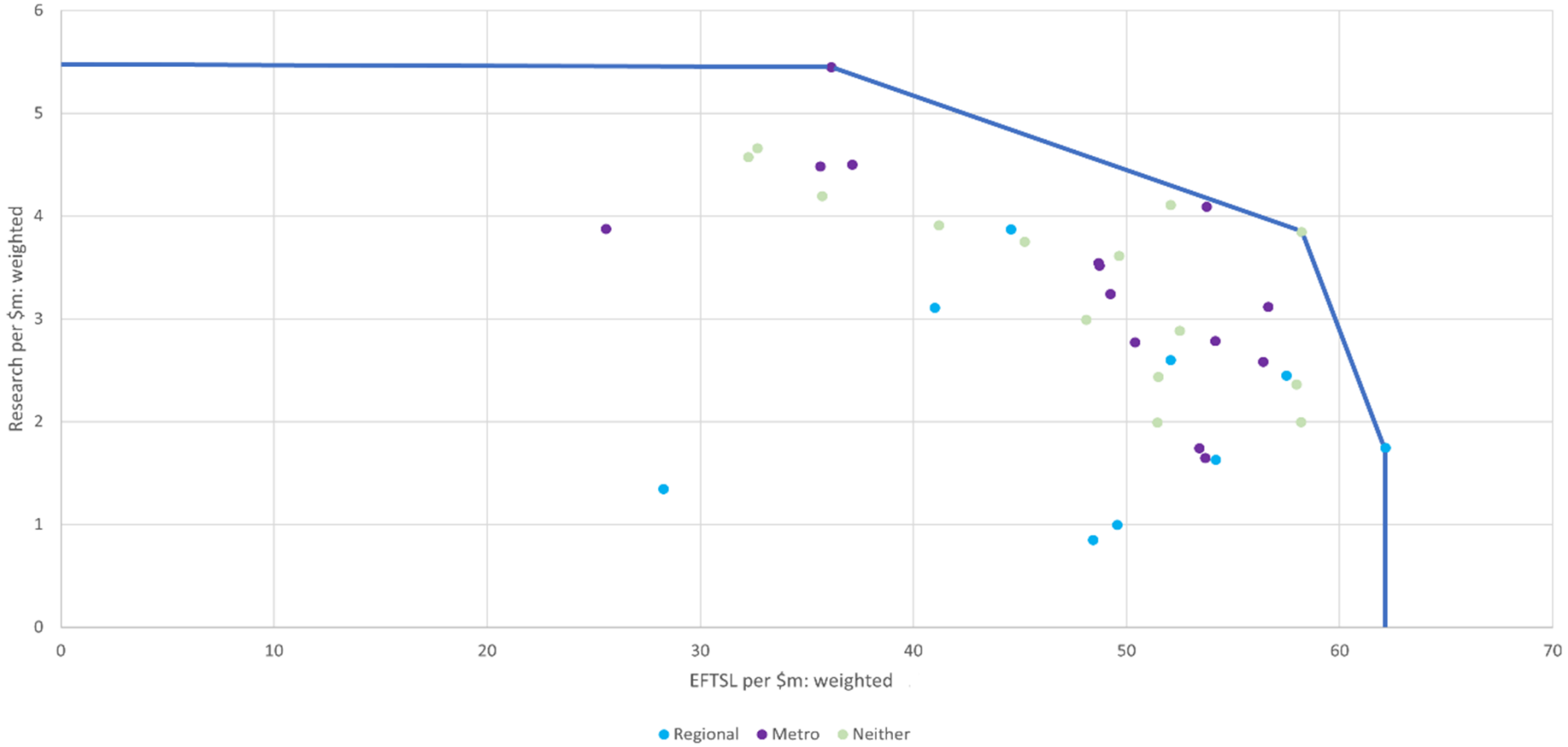


Chart 7: Cost Efficiency Australian Universities 2016 – Regional and Non-Regional – Weighted Outputs



2.4 Final remarks in respect of Regional and Non-regional

Despite the statistically marginal result, there are potentially noteworthy policy implications accompanying this result.

While there is explicit funding to support added education costs, competitive research funding does not, as far as is known by the present writers, include a 'regional loading'. This may be captured in the form of research block grants. Investigation of the presence and extent of regional research funding seems warranted. Given that all universities, regional and otherwise, are obliged to undertake research to 'earn' the title 'university', one might argue the cost differentials present should be corrected by some mechanism.

However, other solutions may also be possible. It may be that innovative structural arrangements might be considered. This arrangement might include what is referred to in aviation circles as a 'hub and spoke' system. For universities, this might operate where a highly research-active university would be a research 'hub' for others. As just one hypothetical example, perhaps researchers at Charles Stuart University might more strongly collaborate with researchers at the reasonably proximate Australian National University (ANU) to help support their research efforts in some FoRs. This could be competitive or non-competitive incentivised collaboration.

Section 3: Question 2 - Cost Efficiency and Single v Multiple Campuses

The second question relates to an increasing presence of institutions with multiple substantive campuses. The presence of multiple-campus institutions became more common after a flurry of mergers in the sector in the 1980 and 1990s. This merger activity largely removed the presence of institutions focused on a single or narrow set of Fields of Education (see Section 4 below for a fuller discussion of this).

While there have been many changes to campus arrangements in recent years, including several campus closures and other rationalisations, there remain a large number of universities in Australia with multiple campuses.

The question posed here is, in essence: Are universities with multiple campuses less cost-efficient than universities with a single campus?

The reality is that no Australian public university has only a single campus, and all 37 public universities have at least one, often many more than a single campus. Some of these are, however, relatively immaterial in terms of their size and effect on cost efficiency. As is discussed below, an objective definition of single versus multiple-campus university is one of the issues to be resolved in answering this question.

There are two opposing schools of thought on this matter. There is a relatively simple proposition that a single campus (or largely single campus) entity is likely to be more cost-efficient (as well as more efficient in terms of staff time utilisation). Classes could all be scheduled at the same location, staff could be more efficiently located within the institution, infrastructure is likely more able to be utilised more efficiently, and the like.

The alternative view is that a university might well take the opportunity to develop a secondary campus (or multiple secondary campuses) where there is an opportunity to establish an economically viable education (or research) program. Granular data on university campuses from the Department of Education shows well over one hundred campuses across the 37 public universities, with a small number of universities supporting over ten campuses each. This number excludes external study mode facilities and overseas campuses.

Consistent with the research analyses described above, data are for the 2016 academic year. Rationalisation since then is acknowledged; however, the validity of the question remains.

3.1 Approach Used in Examining this Issue.

Consistent with the previous section, the data used to examine this question are largely drawn from Department of Education datasets and ERA 2018. These data relate to education (in the form of EFTSL) and total expenditure (net of asset impairments and investment losses as they do not relate to academic activity). As explained below, both weighted and unweighted research and education data are included in the analyses.

3.2 Defining Single and Multiple Campus Universities.

As evident from the preceding discussion, in a technical sense, no Australian university has only one geographic location within its portfolio of real estate. Some come close to having a single campus. One example is the Australian National University, but even it has astrophysics facilities at Siding Springs in New South Wales and in the Canberra suburb of Stromlo. A further facility is known as the Kioloa Coastal Campus on the southern coast

of New South Wales. These facilities are, however, insignificant compared with the main campus at Acton near Canberra's central business district.

The Department of Education requires universities to provide data in respect of the scale of activities on their campuses. Specifically, it requires EFTSL data by campus and mode of study. These data are needed for a variety of reasons, including but not limited to measuring the extent of funding due under regional support programs.

These data are used to define the key variable here and partition the universities between what might be thought of as substantively single universities compared with multiple campus institutions.

For the purpose of this study, a single campus university is so classified if the institution has greater than 80% of its student enrolment (as measured by EFTSL in the academic year 2016) located in one geographic location and not more than 10% of its enrolment in any other location. In other words, if the principal campus is dominant and no other campus is material in terms of its presence, it is deemed a single-campus university.

Enrolments in overseas campuses are excluded as it is assumed these campuses are stand-alone and economically viable. It is also assumed that 'external mode' students are serviced from the principal campus.

Applying this definition, the following 16 universities are, for the year in question, classified as single-campus universities:

Australian National University
Charles Darwin University
Curtin University
Flinders University
Macquarie University
Murdoch University
Swinburne University of Technology
University of Adelaide
University of Melbourne
University of New England
University of New South Wales
University of Queensland
University of Sydney
University of the Sunshine Coast[14]
University of Western Australia
University of Wollongong

The remaining 21 of the 37 universities are defined as being multi-campus institutions.

As with the research design described in the previous section, there is an assumption that these two groups of universities differ only in respect of cost efficiencies. Unlike the analysis described in the previous section, a number of Go8 universities can be found in

[14] A suggestion was made by a member of the Universities Accord Secretariat that University of the Sunshine Coast might not be validly classified as a single campus university. A careful review of the data provided confirms that, for the year in question, the single campus classification is valid. However, we did re-examine the question with USC classified as a multiple campus university. The result of this further test shows no significant difference to the results reported.

each group, and universities classified as regional are also in each group. Other characteristics, including average size measured by EFTSL, are also spread between the groups. Indeed, one might reasonably assume that the groups are similar other than the presence of the campus structure.

The cost efficiency modelling follows the principles described and illustrated above. The efficiency scores are calculated for each university. As before, the efficiency score is agnostic to research intensity or education focus. That is, a university that is more education-focused and close to the efficiency frontier is scored identically to a university that is research-focused and equally close to the nearest point of the frontier.

As with the test reported in the previous section, the analysis is executed with two alternative measures used for research and education. In respect of research, the ERA data for the academic year 2016 is measured in ERA without any weights. Once again, the two tests involve the use of unweighted and weighted education and research data.

3. 3 Results: Cost Efficiency in Single and Multiple Campus Universities.

The results of the analysis for this second question are reported below. The model appears to be an excellent fit. Chart 8 below shows the efficiency graph for the unweighted results, and Chart 9 the weighted results.

In respect of the results for the unweighted measures of education and research, one can observe that the multi-campus universities are more located across the entire graph, with some emphasis toward the education-intensive area of the graph. Single-campus universities are also spread across the entire graph. Two of the least cost-efficient are in this latter group.

A similar pattern can be observed in respect of the analysis using the weighted outputs of research and education shown in Chart 9.

Thus, one might reasonably conclude that there are differences between the two groups but that these differences do not represent a consistent pattern of cost efficiency or inefficiency.

Chart 8: Cost Efficiency Australian Universities 2016 – Single and Multi-campus Universities – Unweighted Outputs

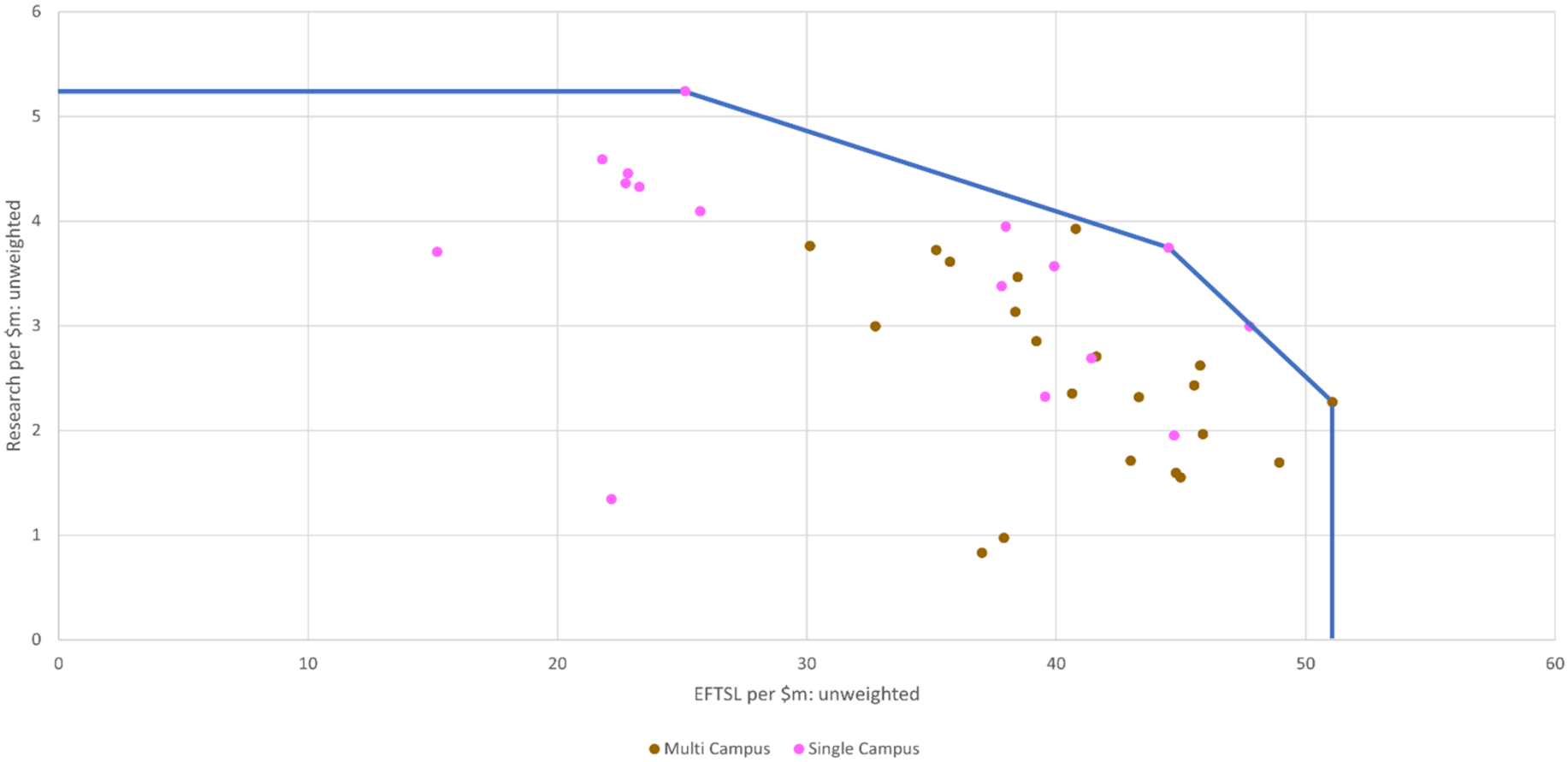
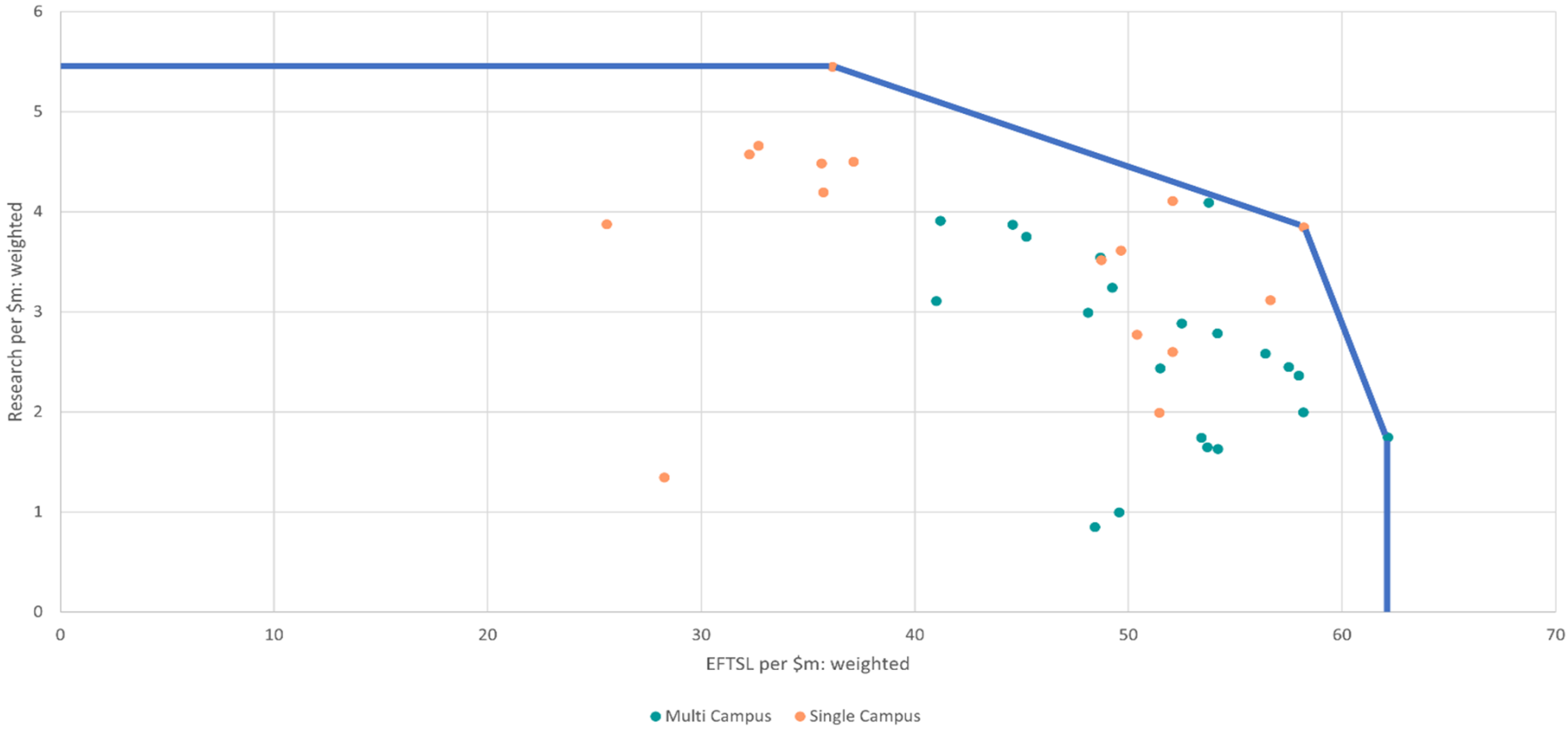


Chart 9: Cost Efficiency Australian Universities 2016 – Single and Multi-campus Universities – Weighted Outputs



One is tempted to conclude that there is no systemic cost disadvantage to having a multiple-campus structure. This is consistent with the idea that university management does not open and/or operate secondary campuses unless they are cost-effective.

Looking at the cost efficiency results; for the unweighted analysis, the single-campus group has a mean efficiency score of 0.862, and for the multiple-campus universities, the mean is 0.874. This difference is not significant (Mann-Whitney U =161, p=0.842).

The results for the weighted measures are similar. Again, there is no statistically significant difference between the two groups (Mann-Whitney U =179, p=0.747).

Thus, it is not unreasonable to conclude that there is no substantive cost efficiency differential between universities with a (largely) single-campus structure and those universities with multiple campuses.

When testing for relative cost efficiencies and inefficiencies between education and research, there was little difference between the two groups of universities.

3.4 Final remarks in respect of Single and Multiple Campus Structures

The presence of multiple campus universities has been a feature of Australian public universities for some decades. The findings are consistent with the view that universities only retain secondary campuses when there is an adequate case to support a cost-efficient operation. An alternative view is that, even with a single campus, there can be significant cost inefficiencies. As just one example, some universities have multiple operations from a single campus. This includes the teaching of programs for Open Universities Australia or for 'external mode' students as two of a large range of possibilities. That is to say, even with a single campus, universities can experience inefficiencies because of what might be thought of as 'multiple duties'.

In respect of the potential effects of 'multiple duties', one can see the possibility of cost inefficiencies being created in situations where the work environment involves responsibilities across multiple and diverse activities. This issue is, in part, dealt with in the analysis examining the third question on universities with a specialist focus. This question is examined in the section that follows.

Section 4: Question 3 - Cost Efficiencies and Field Specialisation

The third issue examined is the issue of Field of Education/Field of Research specialisation and the impact, if any, that is observable in respect of cost efficiency outcomes.

A significant challenge in examining this issue within the Australian context is the absence of public institutions with limited fields of specialisation. While many such institutions did exist in Australia prior to the 1980s, they have been merged with or, in other ways, incorporated into larger comprehensive public universities.

While a range of private providers might reasonably be described as specialist institutions, that is, the entire institution is focused on one or a limited range of Fields of Education (and, potentially, Fields of Research), the data available for these institutions are incomplete. Thus, it is not possible to complete a cost efficiency and/or productivity analysis using this section of the higher education sector in Australia.

Within public universities, there are instances of specialist organisations with a continued separate identity. These include, for example, the Victoria College of the Arts (within the University of Melbourne) and the Western Australian Academy of the Performing Arts (an academic unit of Edith Cowan University).

Other examples of specialist institutions have, subsequent to their merger, lost their clearly visible individual identity. An example of this might be the Lincoln Institute of Health Sciences which was incorporated within La Trobe University some decades ago. In either event, there is no separate or sufficiently granular data on these institutions, rendering a cost efficiency analysis impossible.

As is evidenced in advanced economies, there exists a rationale for specialist organisations to exist. We see the presence of specialist law firms (in, for example, corporate law or family law), engineering consulting entities (in construction or mining) and the like. It is plausible, even likely, that an educational institution that is specialist in its focus may prove to be especially cost-efficient in delivering its chosen mix of education and research.

There is, therefore, an argument that there may be cost efficiency differences between specialist and comprehensive higher education institutions. One school of thought is that higher education institutions focused on serving a specific field and a community that relates to that field may benefit by being more able to achieve cost efficiency. That is to say, a narrower scope could, it is argued, provide an environment where cost efficiencies are achievable. There is less 'distraction' with an array of activities that have multiple complexities. Given this, there is a presumption that specialist institutions will achieve a lower cost structure, all other things being equal, and that, therefore, will show a higher cost efficiency score.

A competing hypothesis is that comprehensive institutions may be of a sufficient scale to provide cost efficiencies.

Thus, to some extent, the issue of scale and specialisation may be conflated. Given this, an attempt is made to separate out these issues as far as possible. In this regard, certain methodological choices are made, as discussed below.

4.1 Approach Used in Examining this Issue.

As discussed and agreed with the Universities Accord Review Secretariat, a pragmatic approach to shed some light on this question is to turn to the United Kingdom (UK) higher education sector, where there are several specialist institutions in various fields. Universities UK lists a total of 17 institutions across seven Fields of Education/research as institutions classified as 'specialist'.

The data come from the UK's institutions of higher education for the academic year 2018 to 2019.

The student data are drawn from the Higher Education Statistics Agency (HESA). HESA reports that, for this academic year in question, there were 277 higher education providers. Of these, 114 are reported to have small student cohorts (of less than 1000 students). These smaller institutions, in some instances, are as small as less than 20 students to something greater than that. These are not included in the analysis, given that their small size may give rise to significant diseconomies of scale, potentially impacting the results.

The expenditure data are also drawn from HESA.

All research publication data come from research published with an affiliation to one (or more) of the institutions listed by HESA. The unit of measurement is affiliations. Each publication is included where an academic staff member nominates an affiliation. In such a case, this will count as one publication attributable to the university or other higher education institution. Note there is no correction for multiple authorships. That is to say, if the publication is sole-authored, it counts as one publication for the university. If there are several authors, it still counts as one full publication for any university listed as an affiliated institution by an author or co-author. Thus, a publication with more than one author will be counted more than once. Unfortunately, the ability to correct for this duplication to arrive at a unique authored publication is not practically feasible given the data.

Note also that the research data are collected for the calendar years 2018 and 2019, with the mean used to measure for one academic year. Data specifically relating to the UK academic year were not available. Expenditure data also relates to the 2018 to 2019 academic year. These data are also drawn from the HESA dataset.

4.2 Defining Specialised Institutions

Specialist institutions are defined by reference to the list of 'specialist universities' provided by Universities UK. This list includes 17 institutions across seven Fields of Education/research (the list is to be found in the Appendix on page 47). Note that two of these 17 are eliminated due to the scale of the student cohort (less than 1000 students).

Of the 163 higher education providers with 1000 students or more, a further 14 are eliminated because of the non-availability of required data for one or more of the three elements (education, research and expenditure). This results in a sample of 149 institutions included in the following cost efficiency analysis.

Using the Research and Education Efficiency Frontier (REEF) analysis methodology described earlier, the relative cost efficiency is calculated for these 149 institutions for the academic year 2018-19.

4.3 Results of the Analysis

Chart 10 below shows the results of this analysis for all 149 institutions included in the analysis. No further exclusions for reasons of outliers or related outcomes were needed.

The efficiency' frontier" (the most cost-efficient institutions in their chosen mix of education and research intensity) is calibrated by reference to four institutions. These institutions define the 'efficiency frontier' – the highest level of cost efficiency within this cohort of institutions for the academic year in question. These four institutions are the London School of Tropical Medicine and Hygiene, St Georges, University of London, the Liverpool, John Moores University and Buckinghamshire New University (also known as the University of Buckinghamshire). It is noteworthy that Universities UK classifies two of these four institutions at the cost efficiency frontier as 'specialist' institutions. It is also noteworthy to observe that these two specialist institutions on the efficiency frontier specialise in one FoE/FoR; Medicine.

All other institutions designated as 'specialist' are some distance from the efficiency frontier. Many of these are involved in education and research in music and/ or the performing arts. It is important to keep in mind that the measurement of the research outcomes of these institutions is routinely problematic. There are challenges in validly measuring (or even capturing) what might be seen as non-traditional research outputs in these fields.

Calculating the mean efficiency score for each category of institution (specialist and non-specialist) shows no cost benefit achieved by specialist institutions. Indeed, there is a statistically significant difference between the cost efficiency scores of the two types of institutions (Mann-Whitney U test, U = >400, p =0.011). That is, specialist institutions are less efficient than comprehensive ones.

That said, it is apparent that the efficiency score directly reflects the outcomes relating to the fields of specialisation. The organisational structure, specialised or comprehensive, seems not to be a dominant factor.

Further refining the analysis, we re-calibrated the efficiency frontier removing Buckinghamshire New University since this institution is different in character. This institution is a private university, established as one of the first such institutions in the UK in the 1970s. Data for what might be thought of as similar Australian private institutions have not been routinely available.

With a re-estimation of the cost efficiency frontier, one can observe that the Norwich University of the Arts is estimated to be close to the efficiency frontier with a strong intensity in education rather than research. This finding does not markedly alter the results of the Mann-Whitney U Test.

Given these outcomes, one is drawn to the conclusion that specialist institutions' cost efficiency level likely reflects the level of cost efficiency performance of the discipline areas of their core activities[15]. That is, just as it is known from publicly available data that academic units focusing on Medicine have high publication rates relative to many other

[15] Note that, unlike Australia where the 37 public universities are all, to a large extent 'comprehensive', the UK has a mixture of specialist and comprehensive institutions This makes for more challenges in defining the efficiency frontier. Universities used to determine the frontier are assumed to be reasonably representative of that part of the frontier where they are located.

fields (both per million dollars of expenditure and per academic researcher). It is also known that publication rates in Science and Technology are higher than in several other fields. Publication rates in the Humanities, Business, and, as conventionally measured, Music in the Performing Arts are lower than in areas such as Medicine, Science, and Technology.

Note also a potential anomaly in respect of the outcome for the London Business School (number 138). Based on this estimate, this institution is closest to the origin (furthest from the efficiency frontier). This result seems counterintuitive as publicly available data in Australia suggests that while publication rates in business are lower than in many other fields, teaching or education efficiency is routinely high. A possible explanation is that London Business School has a substantial professional education portfolio of activities. The size of this portfolio is, based on the available evidence, considerable. This education activity is likely not included in the HESA data used in this research. This absence may mean that much of the expenditure captured within the modelling is devoted towards its non-award education portfolio. Therefore, the positioning of this institution is potentially miscalibrated.

4.4 Final Remarks in respect of Specialisation.

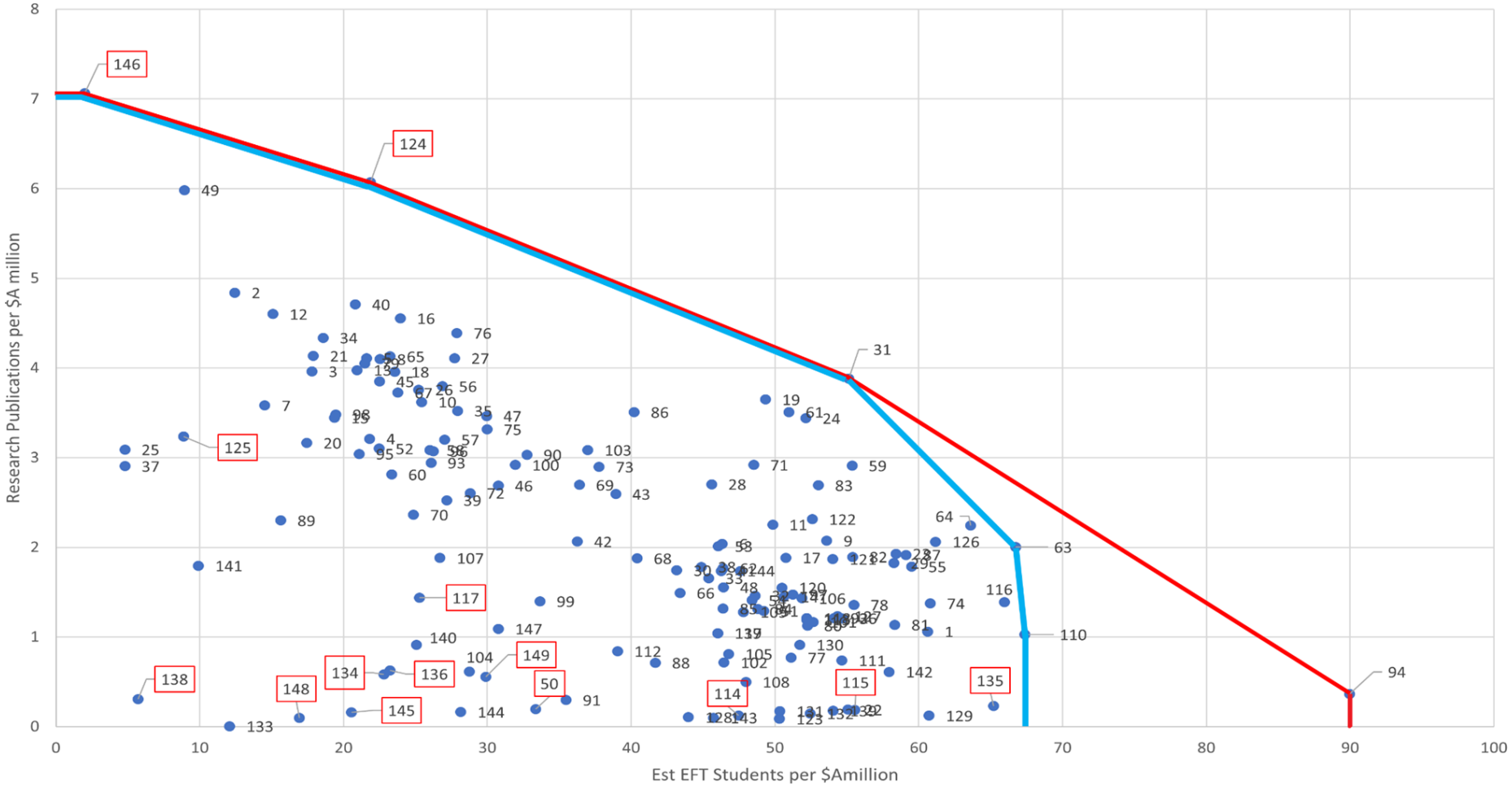
In respect of the question: 'Do comprehensive universities or specialist institutions provide a more cost-efficient portfolio of education and research?', we are drawn to the outcome that the evidence points to 'specialist' institutions reflecting the research and education productivity outcomes that reflect their core disciplines. That is, specialist institutions do not routinely show signs of being more cost-efficient than 'comprehensive' institutions. Put another way, the evidence is that neither 'comprehensive' nor 'specialist' institutions are routinely more cost-efficient than the other. The level of cost efficiencies described in the UK data is consistent with the fact that some Fields of Education/Fields of Research provide different productivity levels compared with others. That is, institutions heavily weighted towards Medicine, Science and Technology will likely show much higher levels of research productivity than institutions focused on fields such as Music and Performing arts, among others.

In some respects, this is borne out by looking at Institution 49. This university is close to the efficiency frontier in the research-intensive component of the graph. The institution is the Imperial College of Science, Technology, and Medicine. While this institution is not listed among the specialist universities as determined by Universities UK, it is, nonetheless, an institution with a relatively strong focus on FoEs/FoRs that have higher, rather than lower, publication rates. These include Science, Technology and Medicine.

The conclusion that cost efficiency is likely driven in large part by the particular FoE/FoR of the specialist institution is a new empirical contribution. While there may not be a significant difference in cost efficiency, it is an unanswered question whether there are qualitative differences between, for example, educational offerings of specialised and comprehensive higher education institutions. It is unlikely to be possible to undo the mergers between specialist institutions that existed in earlier decades; perhaps the role of specialist higher education institutions is now to be left in the hands of the 'university college' higher education providers.

In conclusion, and bearing in mind the limitations involved, there is no compelling evidence supporting the conclusion that specialist institutions are more cost-efficient than comprehensive institutions.

Chart 10: UK Higher Education Institutions (>1,000 students only) 2018-19 Academic Year



Highlighted: **Red**- Frontier 1 **Blue** - Frontier 2
Red Block Highlight: Universities UK classification: 'Specialist'

SOAS University of London	**117**
Solent University	**102**
SRUC	**141**
St George's, University of London	**124**
St Mary's University, Twickenham	**118**
Staffordshire University	**74**
Stranmillis University College	**142**
Swansea University	**39**
Teesside University	**55**
The Arts University Bournemouth	**128**
The Manchester Metropolitan University	**11**
The Nottingham Trent University	**9**
The Open University	**1**
The Royal Central School of Speech and Drama	**149**
The Royal Veterinary College	**133**
The University of Aberdeen	**76**
The University of Bath	**56**
The University of Birmingham	**5**
The University of Bolton	**112**
The University of Bradford	**103**
The University of Brighton	**41**
The University of Bristol	**21**
The University of Cambridge	**37**
The University of Central Lancashire	**33**
The University of Chichester	**119**
The University of Dundee	**70**
The University of East Anglia	**58**
The University of East London	**84**
The University of Edinburgh	**7**
The University of Essex	**72**
The University of Exeter	**26**
The University of Glasgow	**13**
The University of Greenwich	**53**
The University of Huddersfield	**61**
The University of Hull	**69**
The University of Kent	**46**
The University of Lancaster	**79**
The University of Leeds	**4**
The University of Leicester	**65**
The University of Lincoln	**71**
The University of Liverpool	**16**
The University of Manchester	**3**
The University of Northampton	**88**
The University of Oxford	**25**
The University of Portsmouth	**24**
The University of Reading	**60**
The University of Salford	**38**
The University of Sheffield	**15**
The University of Southampton	**34**
The University of St Andrews	**98**
The University of Stirling	**86**
The University of Strathclyde	**35**
The University of Sunderland	**77**
The University of Surrey	**67**
The University of Sussex	**47**
The University of the West of Scotland	**63**
The University of Warwick	**20**
The University of West London	**92**
The University of Westminster	**54**
The University of Winchester	**109**
The University of Wolverhampton	**51**
The University of York	**45**

Trinity Laban Conservatoire of Music and Dance	**145**
Ulster University	**28**
University College Birmingham	**123**
University College London	**2**
University College of Estate Management	**131**
University for the Creative Arts	**114**
University of Bedfordshire	**81**
University of Chester	**78**
University of Cumbria	**111**
University of Derby	**48**
University of Durham	**52**
University of Gloucestershire	**106**
University of Hertfordshire	**30**
University of Northumbria at Newcastle	**19**
University of Nottingham	**8**
University of Plymouth	**43**
University of South Wales	**36**
University of St Mark and St John	**130**
University of Suffolk	**110**
University of the Arts, London	**50**
University of the Highlands and Islands	**104**
University of the West of England, Bristol	**17**
University of Wales Trinity Saint David	**91**
University of Worcester	**101**
York St John University .	**113**

Section 5: Concluding Remarks

The measurement of costs, efficiency and productivity has significant implications that go beyond the management of individual universities. There are implications for a range of stakeholders including, but not limited to: students, university staff, clients and other beneficiaries of research, philanthropic organisations, governments and the wider community.

Additionally and importantly, there is also considerable relevance of these issues for those with responsibilities pertaining to policy-making as it relates to higher education. This includes not only those in political office but also those in the management of government business and those with regulatory responsibilities.

The research reported here relates to three specific questions. In essence, they are:

What is the impact, if any, on the cost efficiency of universities in respect of –

Regional compared with metropolitan universities,

Single campus compared with multi-campus universities, and

Specialised institutions compared with comprehensive institutions.

Certain of the results are inconsistent with some conventional intuition in the sector.

Perhaps one of the more important observations that might accompany this work is that using an empirical research method, questions of cost and cost efficiency (and productivity) are testable.

There are two obvious extensions to this work that warrant consideration. They are put as two questions:

Is there a comprehensive model that can support our understanding of cost efficiency in universities?

We have seen some examples of other factors that may impact university costs and cost efficiency; can this be crafted into a more comprehensive model?

Perhaps more importantly:

Can this research approach provide an *empirically determined evidence base* of the costs of education and research?

Noted early are other questions worthy of consideration:

Do some universities have a comparative cost advantage in education?

Do some universities have a comparative cost advantage in research? And,

Are there cross-subsidies between the revenues earned from education activities to support the costs of research?

There are important policy considerations for each of these questions.

There is a range of limitations and caveats to this work described in the text and Appendix to this report.

There is a large array of other matters directly and indirectly relevant to cost efficiency that might also be worthy of future investigation. One issue applicable in the near term is the impact of the size of institutions. The average size (mean EFTSL) of Australia's public universities is, by world standards, large. Some argue that this circumstance is directly related to policy decisions of previous years. There are other explanations also, including the need to attract and retain significant numbers of international students to provide a secure revenue base to support large research programs.

The research team would like to express its appreciation for the opportunity to work on these issues for the Universities Accord Review.

Contributors and Acknowledgments

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APPENDIX – DATA

The description provided in Section 1 gives an overview of the data used in much of the analyses that followed in Sections 2 to 4. This Appendix provides greater detail and further insights into the data and the decisions made around the data that can be used in modelling higher education productivity.

Input Data - Expenditure

A prime consideration in modelling higher education productivity is the identification and measurement of what it is that is 'consumed' to achieve the prime outputs of higher education. As described earlier, these are primarily (1) education (for almost all institutions in higher education other than institutions focused only on research and research students) and (2) research.

An example of an institution almost void of an education role – other than research training - would be the Australian National University prior to its merger with the Canberra campus of the University of Melbourne (known as the Canberra University College) in 1960. There are, however, no other Australian examples and few internationally.

There are a large number of higher education institutions with little to no research outputs. Virtually all of the non-university private providers in Australia have either no identified research outputs or very few. Internationally, there are many examples of institutions, both with and without the title 'university' that have little to no research output. Further, there are many universities internationally that do not identify as having research as part of their mission statement. A study examining academic productivity published in an Australian scholarly journal in 2021 but based on US data found that around one-half of all AACSB[16] accredited business schools in the US have no research outputs.

In Australia, the regulatory requirements currently call for an entity that uses the title 'university' to have a substantive research profile in addition to one in education. This is a requirement of TEQSA[17].

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[16] Association for the Accreditation of Collegiate Schools of Business (AACSB) is an internationally recognized entity that accredits business schools globally.

[17] Specifically the TEQSA requirements are stated to be: " In accordance with the Tertiary Education Quality and Standards Agency Act 2011 (TEQSA Act) s59A(1), the quality of research undertaken by a provider must be considered by TEQSA if the provider is: ……..in the Australian University category.
Standards B1.3.16-19 of the Higher Education Standards Framework (Threshold Standards) 2021 (Threshold Standards), set threshold levels for the breadth of research and the quality of research for a provider in the Australian University category.
The 'benchmark standards' for research quality are:

- research that is World Standard measured using best practice indicators, and/or
- research of National Standing in fields specific to Australia, in the case of research that is not easily captured by existing standard indicators (B1.3.19).

Existing Australian Universities of ten or more years must undertake research that meets one or both benchmark standards set out above and leads to the creation of new knowledge and original creative endeavour in:

- 50 per cent, or at least three, broad Fields of Education in which the university delivers courses of study (whichever is greater), or for universities with a specialised focus, all broad fields of education for which the university has authority to self-accredit (B1.3.16).

The data required for meaningful cost efficiency and productivity includes, therefore, data on expenditure, output measures of education and output measures of research. There is a range of options in respect of all three measures. These are explained in more detail below.

Additionally, efficiency and productivity can be measured not in financial cost or expenditure terms but in the utilisation of academic staff. This form of analysis looks specifically at the utilisation of the academic workforce within higher education. The data requirement here is measures of this workforce. Further, an interesting extension of efficiency and productivity analyses is the comparison of outcomes between academic staff efficiency and productivity and cost efficiency and productivity. These differences can provide some direction to see where gains might be more easily or successfully made – in the academic component of a university or the non-academic component (in functions such as administration, finance, infrastructure, policies and procedures and the like).

Expenditure Data

In respect of expenditure data, the earlier discussion stated that there are two sources of university expenditure data. One is to obtain and use the formal financial reports presented to the relevant Parliament and audited by the appropriate Auditor-General. The advantage here is that this data is independently verified and must be consistent with Australian Accounting Standards. The principal alternative is the financial data available from the Federal Government's Department of Education. This second set of data is likely based on the former data and may and does include adjustments agreed between the Department of Education and the university sector. The university sector has, in the past, expressed concerns in respect of the applicability of some Accounting Standards. In particular, there have been concerns over what is known as 'revenue recognition'.

These issues here revolve around the receipt of research grant income. Under Accounting Standards, such income is required to be brought to account in the financial year the research funding is received despite the fact that there may be a mismatch with the effort used to 'earn' the grant, which can be in future financial years. This mismatch can be substantial in situations where there is significant volatility in the dollar value of grants received in successive years. The mismatch is largely inconsequential when the income stream for grant receipts is largely consistent from year to year.

For the purposes of the analysis included in the report, the Department of Education data are used.

Two further points are pertinent. First, the data are adjusted to reflect the total expenditure that might be reasonably seen as being toward the ***academic*** effort of the

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For providers entering the 'Australian University' category from 1 July 2021 or have been established as an 'Australian University' for less ten years (and are yet to meet the standard in B1.3.16), the university must undertake research that meets one or both benchmark standards for research quality in:

- 30 per cent, or at least three, broad Fields of Education in which the university delivers courses of study (whichever is greater), or
- for universities with a specialised focus, all Fields of Education for which the university has the authority to self-accredit (B1.3.17).

However, within ten years of entry into the 'Australian University' category, these providers must meet the requirements outlined in B1.3.16. Once a university has met the requirements of B1.3.16 it must maintain that standard.

university. Therefore, any reported expenditure related to investment losses is excluded from the measure of total expenditure. This exclusion is on the basis that such costs do not directly relate to academic effort.

In respect of expenditure relating to capital works, analyses can both include and exclude such costs. The argument for excluding is based on the fact that such expenditure is 'lumpy', and so, year-on-year comparisons may be miscalibrated. The counter-argument is that this expenditure is, at some point in time, related to the academic effort (including where such expenditure is related to expenditure on administration and only indirectly related to academic effort).

A further type of analysis is to use a 'smoothed' measure of total expenditure where the three-year moving average of total expenditure (after excluding investment losses) is adopted. In the present analysis, there appears to be little need for using a smoothed total expenditure measure.

The primary total expenditure measure used in this report is total expenditure as reported by the Department of Education, excluding investment losses[18].

Research Data

Optimally, the research data reflects the successful academic outcomes as they relate to the research effort. In their work on measuring productivity in universities, the ABS used two components of research outcomes: (a) research candidates (primarily PhD graduations and research grant income). These, we would argue, ignore the primary outcome of research, which, for many FoRs is through publication. These measures, we would argue, have validity challenges. First, the use of grant oncome is an input, not output, measure. The key to measuring efficiency and productivity is to compare inputs with outputs. Secondly, the measure using the number of research students graduating is linked strongly with the training element in universities and is not independent of any measure of education.

Rather than using the measures employed by the ABS, we look at more direct measures of outputs. Specifically, we choose to measure the most commonly employed measure of research outputs – publications. The publication of research is routinely seen as a measure of the successful completion of research or a key component in the research program. This measure is, however, not without limitations.

There are serious issues with the use of publications in modelling efficiency and productivity. These are discussed in detail below.

First, there are some FoRs where research outcomes are imperfectly measured via publication. These include FoRs such as music and the creative arts more generally. They can also include some other FoRs, such as information technology, where conference presentations are seen as equal to conventional publications. Further, publication varies between other FoRs. From some FoRs, journal publications are the dominant mechanism for publication; in other FoRs, it is via book publication. A measure that captures as much of this variety of outlets will have greater validity than a measure that is partial.

[18] Note, as part of the data validation process these Department of Education data were checked against other sources and one correction in respect of investment losses was made. These corrections include a material investment loss and were included in our calculations.

The existence of the variety of publication outlets points to a further measurement issue. This issue relates to calibrating the scale of academic effort to produce a publication. Is the effort to publish a journal paper equal to that to complete a book chapter, for example? Is this the same as a conference paper or a book?

Importantly the ARC in the ERA did observe in one part of the 'rules' of the 2018 ERA round that books should be calibrated with a weight of 5 compared with other research outputs, which were all calibrated as one.

A further issue is the quality of research. While this issue is of lesser relevance when looking only at the productivity growth of the same university over time (there is little evidence that research quality changes so dramatically over shorter periods of time), the potential existence of differential quality between universities in cross-institutional analyses can be an issue that warrants further analyses.

A further matter is the intensity within a university of particular FoRs. An example of this is shown in section 4 of this report, where there is a significant difference between research outcomes for specialist institutions with differing FoR intensities. Institutions with a strong presence in Medicine are seen as more productive compared with those in music and the creative arts. These two groups can also differ in cost efficiency levels in comprehensive universities. So, even if a university is reasonably seen as comprehensive but has a large medical school (often with the presence of associated medical research institutes), that university can be seen as being particularly research-active and cost-efficient in research.

The final limitation relates to timing. While the costs associated with education are, to a large degree, linked to the same time period as the output measure of education (students taught), the same is likely not true of research. There are examples where the time period taken from the submission of a journal article to publication is measured in years rather than months or weeks. There are some FoRs where the elapsed time between submission and publication is a matter of weeks. There are other FoRs where this is years. Further, this does not include any measurement of the period between the conception and execution of the research and its ultimate submission to a publication outlet. There is, in short, a measurement issue in respect of the time period where the costs of research are expended and where the research outcomes are measured. There is no known way to deal with this. It is assumed that, over time, there is some degree of smoothing of this and that, ultimately, the trends will reflect this changing cost efficiency and productivity. The empirical results tracked by HERG support this conclusion. For example, we have seen that, in some instances, a change in university leadership can and does impact cost efficiency, including research outcomes, with a lead time of up to approximately two years from the date of the leadership change.

Despite the presence of these limitations, the decision has been taken to use publications as the key measure of research output.

There are multiple sources from which research data can be acquired. In an earlier period, the Federal Government kept data on the key outcome of research – research publications – in a data file known as the Higher Education Research Data file. The collection of research publications data was an important source of data as it included detailed material on such matters as author affiliation and, importantly, author apportionment of the research publication. Regrettably, this collection was discontinued almost a decade ago and is not available for this study.

There is a range of privately sourced research datasets. Well-known private sources include Scopus and Clarivate (Web of Science). Others also exist. All of these private datasets rely, in part, at least, on the observable presence of research via web-based sources.

Another Government endorsed source of data on research is available via the ARC in the form of the ERA. While there is a current round of ERA, the most recent data available is the ERA in 2018. A major advantage of the use of ERA data is that the parameters of these data are well understood, and the Department of Education and the university sector have largely agreed that it is a valid measure of research over the relevant period. Importantly ERA includes agreed measures of what is referred to as 'Non-traditional Research Outputs (NTROs). For some universities, NTROs are of importance.

There are some limitations with ERA. For example, the data do not include instances where a four-digit FoR includes publications totalling less than 50. Other limitations of this type also apply.

Comparing the ERA data with private sources shows that the ERA, with few exceptions amongst the 37 public universities, reports a lesser number of publications than is shown in other sources. There are multiple explanations for this, some of which relate to the ERA data collection process that allowed, or in some cases required, some publications not to be included. For example, the ERA process does not collect data where the number of researchers within a FoR is less than ten. Nor does the ERA data include publications where the number of publications within a FoR is less than a total of 50. Comparing the number of publications reported in ERA to one private research data collection shows that the discrepancy between the ERA data and private data sources can be significant. The total number of publications reported in ERA for the year 2016 was a little over 98,000 publications. The equivalent number reported in one private source is around 20,000 more. There were some universities where the discrepancy was significant (where the ERA is around two-thirds of the private collection data), and others where the differences are close to zero.

ERA data are used for this project. Note one limitation is that the apportionment of authors' contributions is not included in the data. Thus, the measure for research outputs involves some duplication. An advantage of this data is that the characteristics of the data are known and agreed between the universities and the ARC.

Education Data

As noted earlier, all Australian higher education institutions provide data to the Federal Government Department of Education. With some delay, this is made public via the Department's data portal. These data are subject to the definitions of the Department and, in recent years, are granular. The data is now disaggregated by level of award, origin of student (domestic or international, FoE), and there is data on graduation and attrition rates, among other things.

Some of these factors impact on cost efficiency and productivity. For example, policies that strengthen the educational experience that result in lowering student attrition have been shown to significantly increase education cost efficiency. Two universities have introduced the 'block mode' teaching model and have seen productivity gains as a consequence.

In respect of choices, the analysis might proceed on the basis of using student headcount data or EFT student measures. While there are some reasons to examine head count (some administrative costs are linked to individual enrolments, for example), on balance, the bulk of the academic effort is more validly measured using a measure that is linked to EFT students present. The measure used in the analyses reported here is EFTSL, as defined by the Department of Education.

A further refinement, outside the scope of the current project, is to model cost efficiency in respect of education in particular, which is discipline specific. For example, is the cost of undergraduate education in medicine five times the cost of undergraduate education in, say, management and commerce or law? Or is it only twice the cost? Cost and cost efficiency analyses may be an important next step in refining cost efficiency and productivity analyses.

Final Remarks on Data and Data Limitations

As with all research, there are limitations. We acknowledge these – in particular as they apply to the measure of research. The science of cost efficiency and productivity research is imperfect. Where possible, the analysis includes sensitivity analyses to test the possible impact of these data limitations.

We include this Appendix on data in the interest of making full disclosure about many of the caveats and limitations involved in the analyses described in this report.

APPENDIX to Section 4

Members of Universities UK designated as Specialist

Performing and visual arts

The Courtauld Institute of Art
Falmouth University
Glasgow School of Art
Guildhall School of Music and Drama
Norwich University of the Arts
The Royal Central School of Speech and Drama
Royal College of Art
Royal College of Music
Trinity Laban Conservatoire of Music and Dance
University of Creative Arts
University of the Arts London

Medical

St George's, University of London
London School of Hygiene and Tropical Medicine
Science and technology
Cranfield University

Humanities and business

London Business School
School of Oriental and African Studies (SOAS), University of London

Veterinary

Royal Veterinary College