HIGHER EDUCATION AND RESEARCH GROUP
HERG

Australian Parliament Senate Inquiry: Higher Education Support Amendment (Job-Ready Graduates and Supporting Regional and Remote Students) Bill 2020

Cost Allocation and Productivity in Australian Higher Education: An Evidence-based Approach.

Submission by the Higher Education and Research Group (HERG)

Introduction and Structure of this Submission

Much of this submission focuses on certain aspects of the Bill as set out in the "Explanatory Memoranda" to the Bill. The memoranda state that the Bill seeks to: "…redesign the Commonwealth Grant Scheme (CGS) funding clusters and the Commonwealth contribution amounts (CCAs) to better align CGS funding to the cost of delivering higher education…" Thus, a pivotal issue is the measurement of the cost of education in universities. In this submission, we provide empirical evidence of potentially significant flaws in the cost estimations used to frame the Bill. We also propose a way to support a stronger and more valid measurement regime that will lead to benefits for the Australian higher education sector in general and student tuition contributions in particular.

After the Executive Summary, we introduce a taxonomy revealing ways in which and why funding arrangements in the Australian higher education sector can be thought of and analysed, then follows a section focused on the nature of the cost allocation problem (with supplementary material in Appendix A). Next is a description of the nature of the evidence produced to support the cost estimations used by the Department of Education, Skills and Employment (DESE), and then a description of the underlying flaws in the approach used by DESE follows. A section analysing the costs and efficiencies in the Australian university sector and a description of the partitioning of the costs of research from the costs of education is next. The final section describes the policy implications of taking an evidence-based approach to cost allocations.

The analytic tool used in some of the analysis, the Research and Education Efficiency Index (REEF Index), is described in Appendix B in the form of a narrated guide using PowerPoint.

1.0 Executive Summary

This submission argues that the basis on which the Bill is premised is flawed in several ways. First, it is inadvisable to create policy or legislation dealing with the funding of education in the absence of a clear policy indicating the government's position on the funding of research in universities. To treat these two issues sequentially in Bills will mean that important interrelationships between the two are missed.

Second, treating all 37 Australian major public universities as though they are identical in the efficiency with which they deliver either or both education and research is simplistic and ignores the 'joint or common cost' dilemma represented by the teaching-research cost interrelationship.

Third, there are techniques that may be able to partition education and research costs. This partitioning will support a stronger evidence base for policymaking. However, as at the time

of writing, the Department of Education, Skills and Employment (DESE) has yet to make available this data. This data resource, known as Datamart, has the required granular level that may make a more rigorous analysis possible.

Fourth, what evidence is available based on the work of the Higher Education Research Group using its Research and Education Efficiency (REEF) Index suggests that material misspecification of the cost of education in each Field of Education may occur if funding is based, as the Bill suggests it is, on the 2019 costing work of the consultant to DESE. This work is based on incomplete survey data that is unlikely to be capable of providing the true cost of education, as is acknowledged by the consultants involved in the numerous caveats concerning research-intensive universities that accompany the cost of teaching estimate. More specifically, using the methodology adopted, the cost of research is likely to be underestimated, and the cost of education overestimated.

Fifth, the REEF Index suggests that some Australian universities are not operating at or near the 'efficiency frontier'. Including the costs of inefficient operations in estimates of the cost of education sector-wide for funding purposes means that more efficient and productive universities are not rewarded, and funding is potentially mis-specified.

Sixth, in the absence of available Australian data, the use of publicly available data for AACSB accredited business schools in the USA can assist to inform us about the relative costs of education in research-intensive and non-research-intensive institutions in one Field of Education (FOE). These point to possible cost estimate mis-specifications in Australia for this FOE.

Seventh, using the REEF Index methodology, it is possible to provide evidence of the incremental costs faced by regional educational institutions and more accurately assess the costs attributable to the lack of economies of scale these institutions may face.

In summary, with available data, certain statistical techniques may be able to provide an evidence base for policymaking on education costing. Before the Bill can safely proceed, there will need to be an analysis of the relevant data (currently held by DESE) so that a sound evidence-based approach can be made for funding either or both education and/or research.

The Australian community clearly benefit from a strong and appropriately funded higher education sector. This Committee of Inquiry can support the Australians who avail themselves of the education and research created by and provided in Australian universities by requiring that this Bill be recast using costing and efficiency information relevant to the task. In essence, we recommend that the Committee see that policy direction be supported by an evidence-based approach using the relevant data.

While there are many compelling arguments in respect of the direction described in the policy statements of the Minister, our conclusion is that the evidence base needed to progress this Bill in its current form is not yet in place.

2.0 Identification of the Issues Addressed and Structure of the Approach.

That university funding will be partitioned between funding that relates to research and funding that relates to teaching or education activities describes the overarching framework adopted within current government policy and, more specifically, by this Bill.

This submission is based on the premise that the two key outputs of universities in Australia are research and education. Thus, partitioning funding between these two key activities can be seen as a reasonable and defensible approach. It is, however, not common in funding regimes around the world. While such an approach is used, more common methods include: block funding models and funding models that have in place explicit cross-subsidies where the revenue from education is used to support the costs of research.

A key difficulty is that these two activities involve what is known in finance circles as 'joint and common' costs. If one is to have a funding regime where funding for teaching is related to the true costs associated with the provision of educating students and this is separated from the funding regime for research that reflects the true costs associated with all aspects of research, an absolute need exists to find a reliable and valid means of separating the costs of research from the costs of education.

While the need for this partitioning is obvious, it is, in fact, problematic as it involves the well-documented 'joint and common cost problem'. To illustrate, the single biggest expense in universities in Australia and around the world is staff salaries. The salary of a lecturer, for example, will need to be partitioned between activities associated with teaching and activities associated with research. This partitioning is not easily achieved. More on this later, under the heading the "Joint and Common Cost Problem" and a more detailed explanation in Appendix A.

Assuming that one can unambiguously determine the aggregate level of funding for education, then this funding pool will need to be partitioned further between 'disciplines' or 'fields of education' (FOE) to obtain costs for funding clusters. This is explicitly the method adopted in the Bill. These include such fields as agricultural science, medicine, nursing, teacher education, commerce, law, arts and humanities and the like. Within these FOEs, there is a further partitioning that can occur between levels of education, for example, undergraduate education, graduate diplomas, and the like. As currently operationalised, there is funding substitution between undergraduate and graduate coursework education, rendering this issue of levels largely moot to the minds of some. As will be shown below, this substitutability may not provide the incentives needed to deliver graduate coursework education at the highest quality levels to the Australian community. This issue is largely peripheral to the focus of the current Bill but is relevant to higher education policymaking.

For some institutions, there is also a need to partition between higher education and technical and further education costs. However, while relevant for a limited number of institutions, this complexity is not addressed further in this submission. Another complication is the funding for research training (predominantly PhDs). For the sake of simplicity, this submission treats the cost of this training as a component of education funding; in reality, a more sophisticated analysis would be needed to separate these costs.

Given this taxonomy of funding, each of these components of the funding model must be calibrated correctly as the introduction of one funding mechanism (such as undergraduate education) impacts subsequent funding mechanisms given that the overall funding envelope is said to be largely budget neutral. Thus as we understand it, the announced increase in student numbers is, by and large, to be funded only from student contributions (HECS payments).

The first challenge is that the overall funding regime is being introduced into Parliament on a sequential basis. The current Bill is focused on education, and while the funding framework for research has been signalled, the details of the research funding mechanisms are largely unknown. This approach results in significant uncertainties and, because there is a major variation in the higher education sector in respect of research intensity, the integrity of overall university funding is not able to be judged with reasonable clarity and certainty. There remains the possibility that research-intensive universities will have grave concerns over their ability to continue research activity at current levels. For reasons explained below, there are, in our view, serious risks that might see a significant component of the costs associated with research activity either being potentially unfunded or, unintentionally and unknowingly, passed onto students as fees for education. That is to say, student tuition (HECS) payments may be larger than can be reasonably justified given the true underlying costs of their education.

3.0 The Nature of Funding and How the Data used in this submission are Analysed.

DESE has approached the issue of the costing of education by employing consultants to survey universities asking for university representatives their thoughts on and estimates of the costs underlying the education programs that they provide. The consultant's report published in November 2019 describes the sampling and measurement techniques employed. It also describes several significant caveats to the cost estimates. Some of these caveats warrant further consideration given their use in funding estimates. The consultant points to a number of important limitations on how its work can and should be used.

It is noted that the DESE consultant's approach involves data drawn from only a sample within the sector and not the sector as a whole.

The consultant's approach to data gathering is appropriate, given the parameters placed on the task. However, given the purpose for which the data are used in the Bill, the resulting cost estimates are potentially invalid. Put directly, it is possible, even likely, that these costings are mis-specified as valid education cost estimates usable to underpin a university funding mechanism.

Given the 'zero-sum' approach to budgetary outlays as described above, the survey technique for gathering costing data, while valid in specific contexts, is not an approach that can provide the level of precision needed. As indicated elsewhere, it is likely to result in an underestimate for research costs (and therefore funding), and potentially an overestimate for education costs.

In Appendix A to this submission, an explanation of why the process used in gathering data employed by the consultants to DESE is not optimal. We argue that the cost estimates produced are not likely to provide valid and reliable results for the purpose for which they are now used. As we understand it, the Bill relies on these estimates.

The description in Appendix A is written in a way to avoid 'jargon' and is intended as a document to introduce critically important concepts in an easily accessible way.

The Higher Education and Research Group (HERG) is an organisation that has focused on supporting the higher education sector in a number of ways, including providing information to help enhance efficiency in both education and research. By necessity, to

measure efficiency, a deep understanding of the costs of education and the costs of research is needed.

Certain of the conclusions discussed and representations made in this submission include facts discovered, and conclusions reached based on client data. For reasons of client confidentiality, no individual institutions are identified other than where the data are publicly available. That is, the conclusions are based on this client data and publicly available data. In a number of instances, this is a non-random sample from within the population of higher education providers in Australia.

4.0 University Expenditure Efficiency and Analytic Approach Taken

At the Australian Financial Review Higher Education Summits in 2017 and 2018, the HERG was invited to present findings in respect of the analytic tool - the Research and Education Efficiency Frontier Index (REEF Index). The REEF Index has been described by the previous Federal Minister of Education (Senator Simon Birmingham) as a "… ground-breaking measure" (*Australian Financial Review*, August 28, 2017).

Much of the data used in this submission relates to the Australian university sector-wide education and research productivity from 2001 until 2018 (the most recent publicly available data). We have been seeking more detailed and more contemporary data from the Department of Education and, at the time of writing, are awaiting access.

The REEF Index shows very significant differences in the level of efficiency between individual Australian universities. See Figure 1. That is to say, markedly different cost regimes exist between the 37 major public universities that we include in our database.

An explanatory set of PowerPoint slides, useful to understand the structure and applications of the REEF Index, are shown in Appendix B of this submission (this appendix is a narrated set of slides).

As of 2018, we can observe that several universities are at the "efficiency frontier" in that they produce the largest nominal 'value' for the Australian taxpayer and other stakeholders per million dollars of expenditure. That is to say, the outputs achieved are at a lower cost than found at other universities in the sector. Not included here are a range of more advanced analyses that include weights and filters of a variety of factors in inputs or outputs. These can allow for time lags, quality differences and a number of other factors.

As is apparent, the cost of education at one university is not the same as another university. Further, some universities provide quality education at a lower cost than others, while other universities publish quality research at a lower cost than others.

This cost differential is also true within university groupings. An example is the Australian National University and The University of NSW, which are historically at or near the 'efficiency frontier'. These two research-intensive universities, both reported to be amongst the world's elite by global ranking agencies, historicaly produce their chosen mix of teaching and research outcomes at a more efficient rate than some others in the Group of Eight alliance. One of the Group of Eight produced teaching and research outcomes at a markedly higher overall cost than the remaining seven.

Within the REEF Index analysis, universities measured as being closer to the frontier provide a greater level of their chosen mix of education and research outcomes relative to expenditure on these academic activities. Universities further from the frontier provide lower levels of outcomes per dollar of expenditure. Universities that are toward the upper left quartile represent more research-intensive profiles; universities toward the lower right quartile show signs of a stronger education focus.

The colour codes show the university groupings (Go8 – orange; ATN – red, RUN – green; IRG – black; unaligned – yellow). As might be expected, the Group of Eight universities tend to be placed in the upper left component of the graph. There is variation between their individual outcomes of research and education per million dollars of expenditure, including funding from HECS payments and CGS.

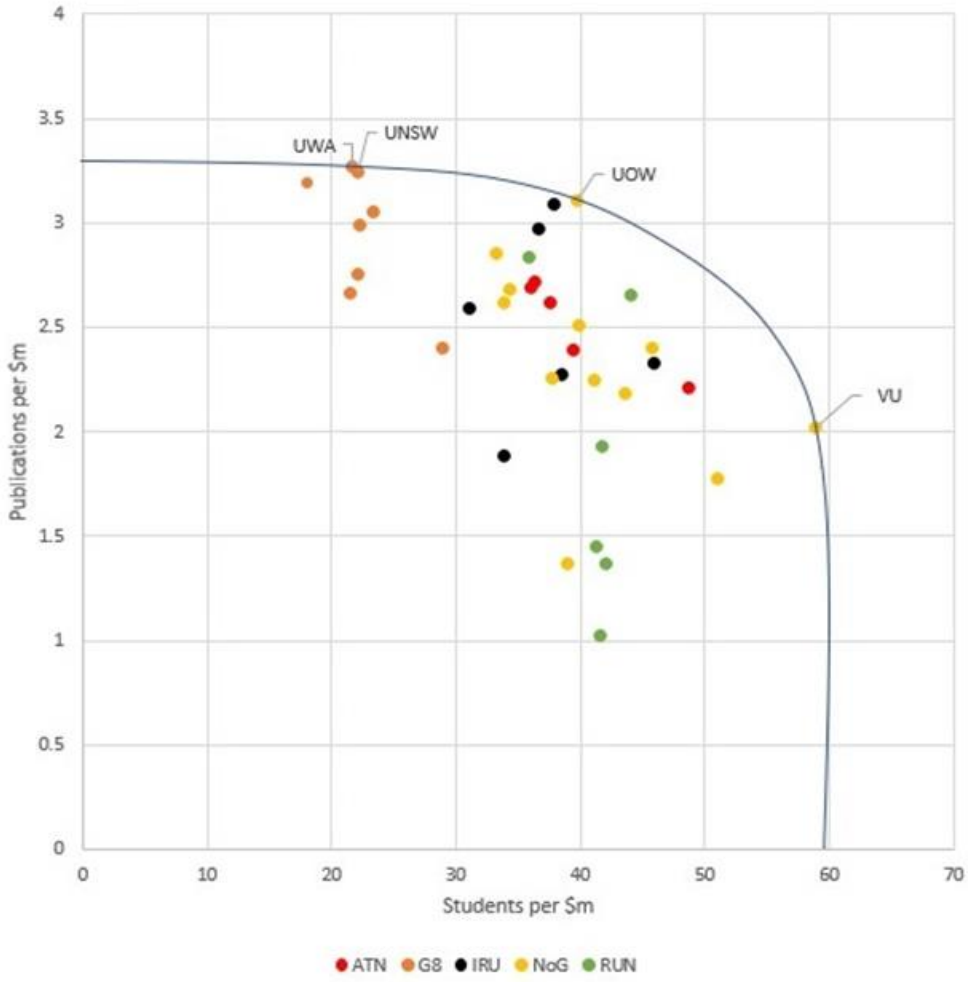

Figure 1: 2018 University Efficiency Frontier
Universites on Frontier identified

Those universities that are at or close to the frontier in 2018 are the University of New South Wales, the University of Western Australia, the University of Wollongong, and Victoria University. While they all represent the strongest efficiency outcomes in respect of expenditure in the sector, the intensity of the research/education mix varies with the first two being more strongly research-focused, the last-named being more strongly education-focused and the third named university having a balance between education and research. In 2018, several other universities were close to the frontier, and several some distance away. This last group exhibit higher cost outcomes in either education or research or both.

Many variations to the REEF Index analysis can be employed (while these are not shown, some are available on request). Because the REEF Index has been designed to be agnostic as to the mix that an academic institution might adopt in respect of the research/education intensity level, the REEF Index has no weighting or bias in respect of the relative importance of research or education. It remains unbiased as to an institution's own choice on this matter.

5.0 Historical Pattern of University Efficiency and Productivity

Over the last several years, universities that have been on the cost efficiency frontier or very near to it include the Australian National University, University of New South Wales, University of Western Australia, University of Wollongong, RMIT University, and Victoria University. As can be observed, these universities have differing profiles in respect of education and research intensity. Some of these universities contribute strongly to the Australian community with research, others contribute with education, and all have some mix between these two.

A substantial number of universities are not close to the 'efficiency frontier'. This distance means that the cost to provide teaching and research outcomes is more at these universities than others nearer the frontier. Indeed, some universities operate at approximately 60% of the level of efficiency that other institutions achieve. In some instances, this can be explained and justified by reference to particular circumstances. For example, regional location inevitably involves added cost, but there are other instances where obvious explanations are not present. The costs involved in regional insitutions is noted below in a separate section.

Of interest is that a large number of universities improve their efficiency year after year. This improvement results in lower average costs for their outcomes in research or education or both. Depending on the period chosen, over several five-year intervals, a small number of universities are declining in productivity. That is to say, the cost incurred in providing education and research has increased. There are examples were these cost 'blowouts' are reversed in subsequent years. On occasion, these reversals are after a change in university leadership.

The REEF Index can be used to assess the productivity performance at 'whole of institution' level. By way of illustration, analysis for 2001 to 2008 for two universities is shown in Figures 2 and 3. The data used come from public sources. Between 2001 to 2008, the University of Sydney (Figure 2) progressed its productivity growth for both education and research. From 2008, when the current vice-chancellor was appointed, we see very significant progress in terms of research productivity, but less growth in education

productivity until approximately 2014. Since then, there has been less productivity growth in either education or research. Some will see this as a period of consolidation; others may see it in other ways.

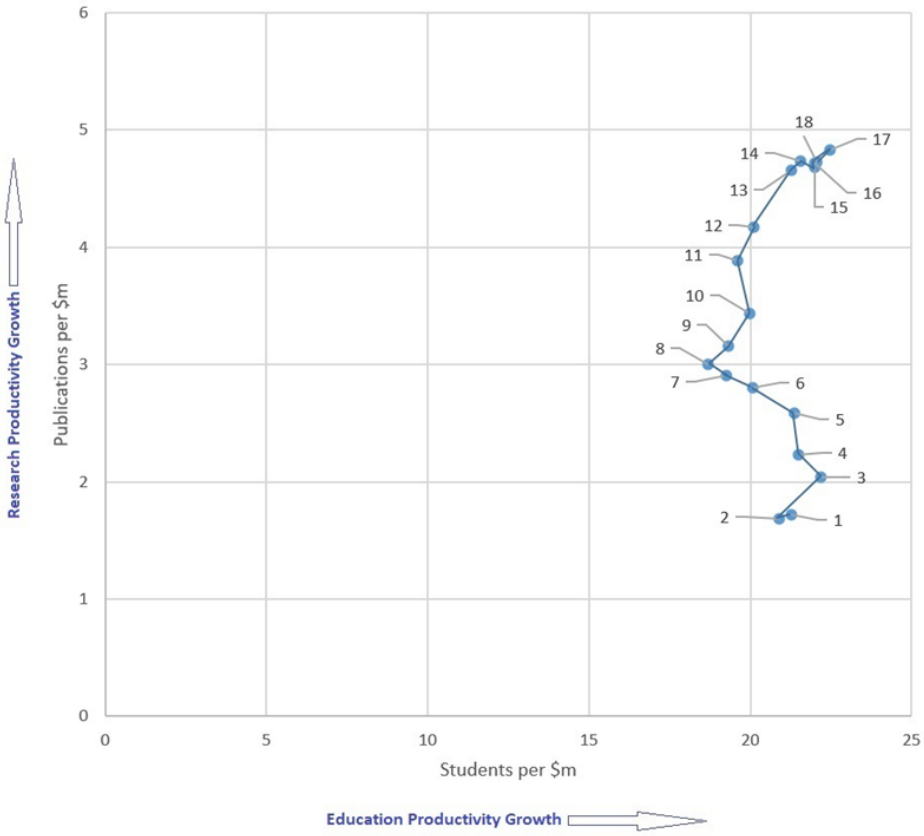

Figure 2: Productivity Growth 2001 to 2018 - University of Sydney

The university shown in Figure 3 is not a member of the Group of Eight universities and is around the mid-point of Australian universities in terms of size (as measured by reference to student population).

In Figure 3, one can observe the productivity change between 2001 and 2018. Some would describe the pattern of change as 'non-strategic'. The result for 2018 compared with 2001 shows an overall decline in education productivity – that is a cost increase in delivering education to each student at that university. We have not been able to locate any evidence that there was a simultaneous increase in teaching quality. Some will question whether the underlying costs reflected this productivity outcome represent acceptable value for money – either for students' HECS contributions or for taxpayer funding support.

Both universities shown in Figures 2 and 3 will, under the proposed arrangements, be funded on the same basis as each other. We contend that the university represented in Figure 2 has provided much stronger outcomes for students and a range of other stakeholders compared with those for the university in Figure 3.

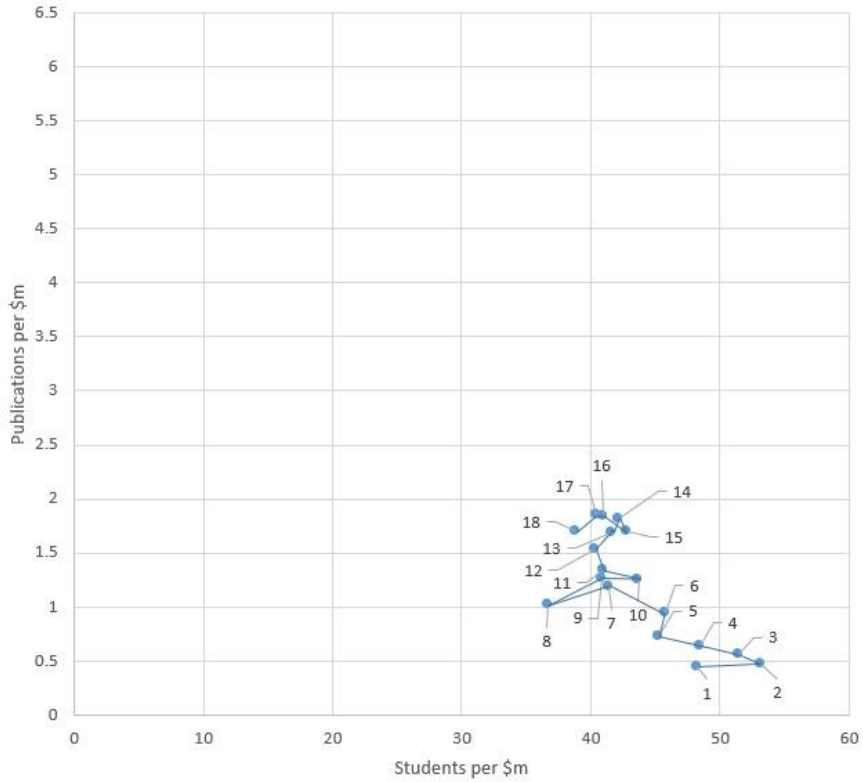

Figure 3: Productivity Growth 2001 to 2018: University X

Two observations flow from the comparison between the universities in Figures 2 and 3. First, the DESE consultant has captured in its estimates the cost 'escalation' in institutions like the one shown in Figure 3. This inclusion may render the funding levels to universities larger than would otherwise be the case. In the context of some FOEs and subject clusters, this means that HECS contributions will be greater than might otherwise be justified. That is, student costs and fees will be larger than might be justified if one were to use genuine 'reasonable' costs. Second, the proposed funding arrangements provide no incentive or reward for efficient and highly productive universities such as the university shown in Figure 2 and many others.

The Australian National Audit Office (ANAO) has the power and remit to perform what are known as 'performance audits' (also referred to as 'value for money' audits) of Australian budget allocations. There is no evidence that the ANAO has undertaken a 'performance audit' on any individual Australian public university, nor on the sector as a whole, in respect of the delivery of overall education and research outcomes funded from Commonwealth sources.

6.0 Productivity Growth in Australian Universities

Australian universities have, by and large, been able to deal with changes in funding arrangements and have responded strongly to specific incentives where they have been offered. Over the period 2001 to 2018, the productivity growth in the sector as a whole, averages more than 2% per year compound.

The vast majority of the productivity growth has been in respect of research activity, with a markedly lesser amount in education productivity. Figure 4 below is drawn from HERG's work quoted in the KPMG report on the sector issued in 2018 and illustrates the significant move by the most efficient in the sector (that is, the institutions on the 'efficiency frontier').

As can be seen, much of the growth is upward (recall that the vertical axis relates to research). Further analysis, not reported here, shows this upward trajectory in research productivity is also to be found when one of several research quality filters (such as journal impact or citations) is used. This outcome represents strong evidence that, at least until 2016 and indeed beyond, the sector, on average, has been in a lengthy, high productivity growth period.

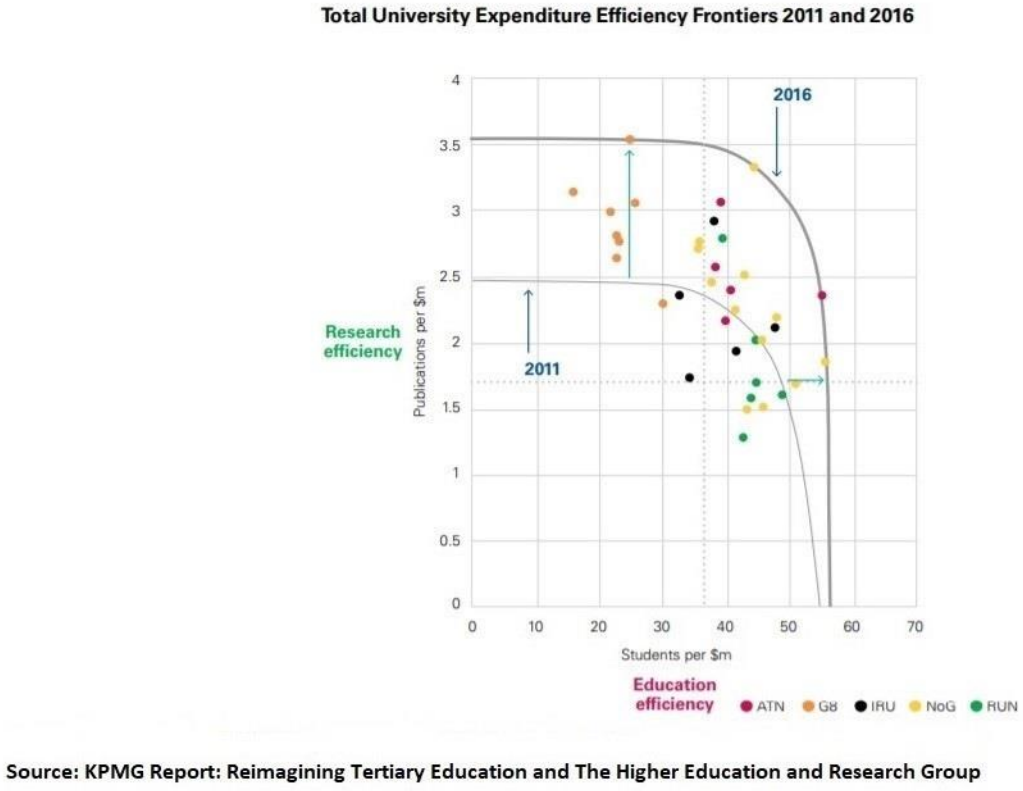

Figure 4: Australian University Productivity: 2011 compared with 2016.

7.0 Evidence of Costs in one Field of Education (FOE)

The most significant known study of costs within one FOE, a study based on several hundred business schools in the United States (USA) with certification from the global accreditation agency AACSB, using academic year data for 2016-17, shows the level of costs varies by reference to (1) the self-nominated focus (an education focus only or a focus on research), and (2) the status of the business school being private or publicly funded. There were 365 business schools in the dataset, of which 267 (73%) were public universities, and 98 (27%) were private institutions.

The data here are costs, not tuition fees, which are invariably higher in private institutions. Tuition fees in public (state institutions) were often low for 'in-state' students and markedly higher for 'out-of-state' students. These costs do not include costs such as accommodation, often a significant part of overall costs for students or their families.

The study addressed the research question: Holding all other things equal, what is the cost of a full-time undergraduate student's education over one academic year? Note that, the highest cost undergraduate education was in private, research-focused schools (around $A9,700 per EFTLS) and the lowest cost was in public, non-research focused business schools (at less than $A5,000 per EFTLS). It is important to note that, given the estimation approach used, this cost excludes the overhead costs of running a business school (e.g. the costs of buildings, the office of the Dean and the like) or overheads incurred at the university level (e.g. the cost of the library or central university administration). Thus, this estimate might be best thought of as the direct costs of the education of these business students. That said, the difference between the direct cost of less than $A5,000 in the US and the Australian cost-based funding level of $15,600 (the total student HECS contribution for the same type of student of $14,500 per year, plus $1,100 from the Commonwealth) is large. The extent of this difference leads to questions on the reasonableness of Australian costs or 'overheads' that might be used to explain this substantial cost differential.

The study also estimated the time spent by academic staff (referred to in the US context as faculty members). For public non-research schools, this cost was around 2.1% per faculty member's time per EFTLS per year. For public research-focused universities, it was less than that at around 1.6% per year. Private business schools were significantly more. In public business schools, both research-focused and non-research focused schools used between 3% and 3.5% of an academic staff member's time in supporting each full-time equivalent coursework master's degree student. That is to say, the cost in faculty time associated with teaching graduate courses was markedly higher than undergraduate education.

For coursework master's degrees students (often, in the US context, MBA degrees), holding all other things equal, the cost for public non-research focused schools was estimated at around $A6,000 and for research-focused schools, at around $A9,000. For private schools, again the cost was more, as much as $A20,000 per student per year.

Given this evidence, one might question the potential negative effect on the quality of master's coursework education in Australia given the substitutability of bachelor and master's degree funding.

8.0 Using Surveys to Collect Data on Costs

Over the years, costing exercises have involved academic staff in universities completing questionnaires developed by those seeking to know the amount of time spent on these two broad categories of activities.

It is our observation that the use of survey methodologies does not support the production of valid and reliable estimates of costs. Our experience in the field is that academic staff systemically underestimate the time spent on research and related and correlated activities. This second group of activities includes the costs associated with, amongst other things, research that fails and remains unpublished, supporting the research activities of others

(e.g. the time spent in reading and comments on draft papers of colleagues, providing referee reports for scholarly journals, writing research grant applications, providing referee comments on the research applications of others, conference attendance and a myriad of other activities – not immediately seen directly as 'research'). This systemic underestimate of time spent on activities is understandable. Acknowledging the time 'wasted' on activities, such as perusing research that yields no publishable results, is not easy to acknowledge.

Importantly, the errors in these estimates are not random, but likely to underestimate the cost of research and overestimate the cost of education activities.

9.0 Funding for Campuses that are Regional

The Bill, as presented, provides for greater funding for universities that have regional physical campuses. Based on systemwide data and using the REEF Index methodology measuring productivity, there is compelling evidence that higher education institutions that provide educational offerings in regional locations face higher cost frameworks than those in larger city locations.

We would speculate that a portion of these costs relates to economies of scale. All institutions that are seen as 'regional', including those in the Rural Universities Network and some others, exhibit higher cost regimes. Further, by and large, most of these campuses are within universities with smaller total student populations. With rare exceptions, universities with a total student population under around of 25,000 EFTSL are not at or near the 'efficiency frontier'. That is to say that, other than in rare cases, these institutions face cost pressures that do not enable them to deliver at or near-optimal levels of research and education outcomes per dollar.

Thus, additional financial support in these cases, from a costing point of view, can be justified from the empirical evidence at hand.

A further aspect of higher education delivery relevant to regional and remote Australians not explicitly acknowledged in the Bill is the presence of digitally delivered education.

10.0 Limitations and Caveats

As explained, while we have publicly available sector-wide data until 2018, the more granular data have not, as at the time of writing, been made available from DESE. Thus, the data we can discuss are largely only at the sector-wide level and not disaggregated into FOEs or clusters as is central to the Bill. This ability to access granular data is essential to take this measurement accuracy process further.

11.0 Concluding Remarks

Higher education throughout the world can and is funded in various ways using a variety of funding mechanisms.

It is common for universities and other higher education institutions to be funded via block grants and other mechanisms. It is also common for universities and colleges to be funded based on tuition fees, which then go to fund both the costs of teaching and the costs of

research; that is, there is an explicit cross-subsidy from the revenues of education to the costs of research. Other funding mechanisms also exist.

Given the Australian policy framework that requires separating the costs of education from the costs of research, a detailed and precise costing framework needs to be established. If there is measurement error or serious imprecision, and these costs are used as the basis for student contributions, then considerable negative consequences may occur.

With access to sector-wide but granular data, estimates may be possible to help support this evidence-based approach to the funding of universities and other higher education providers.

Australia has shown that its universities are highly productive and provide students, the community and the broader society with valuable outcomes including both the creation of knowledge (research) and the distribution of knowledge (teaching). These two activities feed off each other and are synergistic. Adequately and appropriately funding both of these activities is important.

Those that are assessing this Bill and the policies and procedures that underlie it will need to make a judgement as to whether the measures used in determining the HECS and CGS components to fund education are adequately precise in their calculation.

Given that this is only one part of a suite of funding mechanisms, that this first step is as accurate as is possible is important because of the potential downstream consequences. Australian universities deserve support that allows them to continue to provide quality education and create leading-edge research.

While there are many compelling arguments in respect of the direction described in the policy statements of the Minister, our conclusion is that the evidence base needed to progress this Bill in its current form is not yet in place.

12.0 Recommendations

The following are suggested recommendations that come from this submission:

1. That the Bill be petitioned between those aspects that relate to higher education affecting Australians in remote and regional settings and the remainder of the Bill with the former group of provisions being enacted with no further delay.
2. That a comprehensive plan for the funding of both education and research be developed and in place prior to substantial changes to the education funding component of the sector.
3. That the plan referred to in Recommendation 2 only proceed after a valid and reliable evidence base is established in respect of the costs involved in the delivery of education in the sector.
4. That DESE be requested to make available, in a timely fashion, relevant data for legitimate research purposes.
5. That future funding policies recognise and create incentives for universities to provide education and research outcomes for Australia with an agreed level of efficiency at an agreed and measured level of quality.

APPENDIX A: Description of the 'Joint and Common Cost' issue in Higher Education

Oil Wells and Butchers' Shops: How do help understand University Funding?

The US Federal Government Energy Information Administration (EIA) tells us that more than half of all drilling in the extractive industry involves wells that produce both oil and natural gas. Of the remaining wells, a little more than half exclusively produce oil, and the remainder produces only natural gas. In the situation of a single output – such as the production of oil only - the cost of the product is easily calculated. One can simply assign all the costs of production to that one product.

Contrast that to where both oil and natural gas are being disgorged from a single well. The products can be separated in a physical sense, but how do you separate the costs between the two products? This dilemma is not a hypothetical question and has been a question that has arisen in legal proceedings where a producer has separate commercial agreements – one for oil and one for gas – with different commercial partners where the cost of production is central to such things as cost-sharing, investment funding, revenue and profit calculations.

You could make a variety of arbitrary decisions to allocate costs; perhaps you could allocate the costs between the oil and gas based on the volume of output; or perhaps relative weight or even retail value of each product. Whichever method is used, a producer will only be able to observe the costs from a narrow perspective and decisions as to how to allocate costs are, invariably, largely arbitrary. The nature of this costing issue has parallels with estimating the costs of education and research in universities. Please bear with the analogy, which takes time to unpack.

Compare the oil and gas cost allocation example to that of a local butcher's shop. The butcher might purchase a beef carcass for around $2000, and from that carcass, she or he may be able to extract 200 kg of saleable meat. For simplifying purposes, let's assume that there are two types of meat on the carcass. One is premium tenderloin, or in some communities, fillet steak – that is a premium cut of beef. The other meat is suitable for hamburgers – not such a premium cut. Let us assume half the carcass comprises premium meat, and the other half is meat for hamburgers. Now ask that butcher 'what is the cost per unit of weight of each type of meat?' Is there a clear-cut answer?

One might be tempted to say $10 per kilo being $2000 divided by 200kgs. The arithmetic is precise enough, but immediately one becomes uneasy that this is not the 'right' answer. Some butchers might want to 'adjust' their answer to allow for the differential selling price – but how much of an 'adjust' should be made? What about if different levels of time, skill or effort are involved in cutting each type from the carcass, or there is more wastage with one type than the other? Any single butcher is going to introduce a fair element of guesswork if she or he was to estimate the 'cost' per kilo of hamburger meat as opposed to fillet steak. The key issue here is that both types of meat are what in finance circles is known as a 'joint and common cost' problem. The core cost – the beef carcass - is a joint cost of both types of meat. There is no natural or obvious logical way of separating the cost of one type of meat or the other when one is 'up close' to the issue. It is, of course, possible for a butcher to estimate the costs when she or he has multiple carcasses, but it is a numbers game – the more observations one has, the more precise the answer – the view is better taken at a sector-wide level. This issue is the same as that encountered in the oil and gas industry.

If one were to then survey butchers across the city, they would all face the same difficulty in responding to the survey with any degree of precision. The survey involves a range of 'up close' observations. Any allocation would include a significant element of arbitrary allocation or

intuition - otherwise known as 'guesswork'. Allocating joint and common costs is a known challenge.

Is there a solution? Let us assume that there are 40 butchers across the city. Butcher A purchases a carcass for $2000 and extracts 50% of premium meat and 50% of lower-grade meat. Butcher B purchases the same weight of carcass, but instead of producing 100 kg of premium meat and 100 kg hamburger meat, the carcass she has produced 80 kg of premium meat and 120 kg of hamburger meat. With different characteristics, the price for this carcass is $1800.

On the other side of town are Butchers C, D and E, who all purchase carcasses with slightly different relative proportions of tenderloin and hamburger meat. They all pay varying prices depending on the quality of what is purchased. There are several simplifying assumptions here – but stay with the example for a moment longer.

By looking at the variability between the intensity of tenderloin and hamburger meat and comparing that with variations in the cost of carcasses, one can impute an individual cost of tenderloin and of hamburger meat. This estimate will be differentiated between the two types of meat because we can use the variability of the original cost of the carcass to estimate the relative costs of the two types of meat.

Note that we can only do this if we have multiple carcasses across multiple butcher shops; as opposed to an individual butcher simply observing one carcass. While one butcher's shop might have several carcasses, as said before, it is a numbers game – the more observations, the more accurate the cost estimation. In effect, the estimate can be best made at one level above the individual butchers' shop. To obtain an estimate of the cost of fillet steak – if you really want to know that cost for the industry – it is best done by some peak body, association or regulator that can collect data from across the entire sector.

How does this apply to university funding? Well, to begin with, we know that many individual academic staff members both produce research and teach courses; their salaries, the biggest single cost in a university, are a classic example of a naturally occurring joint cost. So, the separation of types of costs – research versus teaching or teaching one education program versus another, must – by definition – involve finding a solution to the university joint cost program.

Given the Canberra funding mechanisms, there is a need to estimate the costs of research and education across the university sector. Further, we are in the midst of an active debate on education and research cost-estimated funding.

Inevitably, there will be others who say that separating out costs cannot be done – and there is a mountain of theory to support this. There is also a mountain of empirical evidence that supports the reality that, in other contexts and with large datasets, estimates can be calculated– albeit with some degree of measurement error. This is where econometrics meets accounting – theory and empirics collide.

If you ask a typical university spokesperson: What is the cost of research at the university? - that person may find it difficult to answer with any degree of precision and without making a range of explicit or implicit allocation decisions. Included in these decisions are assumptions about such things as the proportion of time that academic staff might use in the creation of research. However, these representatives would not be able to see the variability across the sector as a whole. They will each see only 'their world'.

When one takes a "helicopter" view of the university sector, we can see that some universities are highly education-focused with some research, others are highly research-focused with some education, and others have a balance between education and research. This variability is crucial in making estimates of university costs.

Surveying individual universities, like surveying butcher shops – is not a great solution. Indeed, worse still, if it is done – and assumed to be valid and credible – then we might generate a range of estimates that regulators, governments and others might treat as 'correct' estimates without fully appreciating the range of largely arbitrary allocation decisions and assumptions involved in these measures.

One of the major worries, for those who ponder these things, are attempts to estimate the separate costs of research and teaching. Over many decades, it has been a personal experience that academics, well-intended and not wishing to make errors, will dramatically underestimate the time spent on, and therefore cost of, research.

The cost of research is not just what you receive from a grant – one estimate showed that the monies spent by Go8 universities equalled $1.20 for every $1.00 received from grants. This 'over'-spending is rational because there is prestige in holding major competitive grants – such as from the ARC – so researchers, either formally or informally, are willing to find a little more to support those research projects.

There is some anecdotal evidence that, in arriving at estimating the costs of research, an individual academic will tend to focus on the costs of *successful* research. Understandably they might tend to push to the back of mind the unsuccessful projects. The reality is that the 'true' full cost of research includes a wide range of research activities. It includes the cost of research that does not get published. Also included are activities such as supporting other researchers; commenting on the draft work of colleagues, supporting the editorial process of research journals, and reviewing work for the ARC and NHMRC. These are all part of the full cost of research too. The funding of Australia's research must include all these costs – failure to fund the full range of research activities will see research in Australian universities wither. Under-estimating this cost will have a huge and even intergenerational impact on Australia – the clever country. If this occurs, what will happen to our hard-fought global university rankings?

We are facing policy settings leading the Federal Department of Education to need defensible separation of the costs of research and education – as well as differentiating the costs of individual fields of education. For some years now, the Department has funded consultants to estimate the cost of education within the university sector. The survey technique used is well understood and has its advantages, but the inherent limitations in respect of the joint cost problem impact on the validity of the results for the purposes of cost estimation. It is little different to surveying butchers' shops as described above.

However, by moving up one level and collecting data across the whole sector, we might yet obtain an informed, empirical-evidence-based view of what is the cost of education, including individual fields of education. We might also obtain an estimate of the *full* cost of research.

The joint cost estimation problem is not new, and the mechanisms we can use to achieve greater precision in cost allocation in such challenging situations, are not unknown. The Federal Government, through its Datamart dataset, has the base information to help support the creation of usable cost estimates. Here is an opportunity for bringing evidence-based thinking to what is a complex set of questions.

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APPENDIX B: PowerPoint Slide Show Describing the Research and Efficiency Frontier Index (REEF Index)

[Note this is a narrated PowerPoint slides show – go to 'Slideshow' and click 'From Beginning']

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