Review of ACT University Admission Index calculation

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1. Background

In this report, I review the calculation of University Admission Indexes (UAIs) in the ACT and the procedures used to relate ACT UAIs with NSW UAIs. In particular, I review the claims of Mr Mark Drummond about the fairness of these procedures.

In conducting this review, I had access to the following documentation:

- “Certification 2005”, ACT Board of Senior Secondary Studies. Single sheet giving data concerning Year 12 certificates, tertiary entrance statements and vocational certificates from 20 ACT schools.
- CD containing “ACT Year 12 Study” and “ACT Vocational Education Study” and other information.
- “ITI calculation report – NSW 2005”. Report by Professor George Cooney, Chair, NSW Technical Committee on Scaling, NSW University Admission Centre.
- Many emails from Mr Mark Drummond sent between 28 November 2005 and 1 February 2006.

2. How the ACT UAIs are calculated

In 2005, there were 4055 students who completed the ACT Year 12 certificate, and 2504 of these met the requirements to receive a Tertiary Entrance Statement (TES) and receive a UAI. I shall call these “UAI-eligible students”. (An additional 15 mature age students and 155 students from overseas schools also received a UAI but these students were handled separately.)

For the 2504 UAI-eligible students, the following procedure was followed:

1. Each college calculates a score for each student completing a “T course”.

2. The BSSS scales the college course scores using the ACT Scaling Test results to give statistically moderated scores known as “scaled scores”.
3. For each student, the aggregate score is equal to the sum of their best three scaled scores plus 0.6 of the next best scaled score. (All scaled scores must be from T courses.)

4. Students who have completed the ACT year 12 certificate and at least one tertiary subject, but who have not received an aggregate score, are given a notional aggregate score.

5. Students with aggregate scores or notional aggregate scores are given a percentile rank based on their scores.

6. For eligible students, these percentile ranks are converted to UAIs using the same conversion table as for NSW TERs to UAIs.

The criticisms surrounding the calculation of the ACT UAIs primarily concern Step 6 above, and so this step is the focus of the rest of my report. I do not consider Steps 1–5 further.

**The UAI**

The percentile rank of a student based on their aggregate (or nominal aggregate) score is a measure of their achievement relative to all students who received such a score. This is known as the “participation rank” or TER. (It is sometimes called the adjusted TER due to the inclusion of students with nominal aggregate scores.) However, the UAI is intended to represent the percentile achievement of a student against their full age cohort. That is, it is relative to all persons of the same age as those finishing Year 12. This is known as the “population rank”. So a UAI of 92 means the student has performed better than 92% of the population eligible to be in year 12, including those who did not attempt year 12.

It is important to include the full age cohort in this calculation in order for the UAI (or its equivalent) to be comparable between Australian states. Such comparisons assume equal distributions of ability of the full age cohorts in each state.

Because there is no performance data for those not attempting year 12, some statistical procedures must be used to estimate the appropriate percentiles.
The NSW conversion process

In NSW, the performance of the year 12 students in the School Certificate examinations two years earlier is used to determine the relationship between the participation rank and the population rank or UAI. This process assumes that the full age-cohort undertakes the School Certificate examinations in year 10.

The Year 10 achievement score (namely the total score on the School Certificate Examinations in English, Mathematics, Science, and Australian History, Geography, Civics & Citizenship) is used as a measure of the achievement of the full age cohort.

Let $p(x) =$ percentile rank of Year 10 achievement score $x$ in the full age cohort.

$q(x) =$ percentile rank of Year 10 achievement score $x$ amongst those eligible for a UAI.

Then the relation between $q$ and $p$ gives the relationship between UAI and the NSW TER. Specifically,

$$UAI = p(q^{-1}(TER)).$$

(1)

Figure 1 shows how this calculation works graphically.

Because there are no comparable Year 10 results available for the ACT, the TER-UAI conversion in the ACT is the same as that for NSW, where the percentile rank (TER in the above equation) is based on students with aggregate scores and those with notional aggregate scores.

By using the NSW conversion table based on equation (1), the following implicit assumptions have been made:

1. the age cohort in the ACT has the same distribution of ability as the age cohort in NSW; and

2. the Year 12 students receiving an aggregate or notional aggregate score have the same distribution of ability as the students receiving a UAI in NSW.

It is these assumptions that Mr Drummond is questioning. In his various emails, he alleges either that the age cohort in the ACT is different from the age cohort in NSW, or that the population of the ACT receiving either an aggregate or nominal aggregate score is different from the population of NSW who receive a UAI.
The inclusion of the group of students with notional aggregate scores when computing ACT percentile ranks is intended to provide comparability with the group of NSW students receiving a UAI. This reflects the situation in the ACT where fewer students receive a UAI than in NSW due to the available of several other options to students completing year 12. If these students were omitted, the UAI's of ACT students would be considerably lower.

3. Comparing ACT and NSW age cohorts and UAIs

The ACT experiences greater immigration of students in years 11 and 12 than do other states. So the age cohort of students is trickier to define than it is in states with more stable residential populations. Nevertheless, there is some statistical evidence that the age cohort in the ACT is relatively similar to that in NSW.

The “participation rate” (the proportion of the age cohort receiving a UAI) in the ACT for 2005 is 55.7%. The participation rate in NSW was 57.0%. In comparison, the only other state
Government colleges cater for years 11 and 12 only. Non government schools are continuous from years 9 to 12. This may account for the difference in correlations between the two groups although the plots of the two groups in Chart 2 shows little difference apart from more outlying scores in the government sector.

**Chart 2.** UAI and Literacy Numeracy for Government and Non-Government schools

\[
UAI = -12.191 + .106 \times \text{Lit-Num}; R^2 = .374 \quad \text{(G)}
\]

\[
UAI = -19.945 + .117 \times \text{Lit-Num}; R^2 = .46 \quad \text{(NG)}
\]

The relationship between median literacy numeracy scores and median UAI for each school including the NSW school is illustrated in Chart 3. The position of the NSW school relative to ACT schools does not support the proposition that ACT schools are being disadvantaged by current procedures.

**Figure 2:** Chart 3 from Edwards (2006) showing the median UAI\(^{s}\) and the median literacy/numeracy scores for each ACT school. The NSW school year 12 students completed the NSW HSC. All other schools completed the ACT year 12 certificate.

with a participation rate between 50 and 60\% was South Australia with 53.3\%. Victoria had a participation rate of 65.5\% in 2005. The differing participation rates between states has been shown (Hyndman, 2005, 2006) as the major contributing factor to the different state conversion tables. This suggests that the NSW age cohort is quite similar to the ACT age cohort in terms of their propensity to undertake preparation for tertiary education.

Edwards (2006) provides some analysis of 2005 UAI results in ACT compared to 2002 literacy/numeracy results for the same cohort. There is one school where the students completed the NSW HSC and so received a UAI using the NSW conversion procedure. All other schools involved students receiving the UAI using the ACT conversion procedure. Figure 2 is taken from Edwards (2006) and shows the median UAI\(^{s}\) and the median literacy/numeracy scores for each ACT school. Clearly, the median UAI at the NSW school is very similar to what would be expected if the UAI\(^{s}\) were calculated using the ACT procedure.

It would be interesting to look at other aspects of the UAI\(^{s}\) distributions, to see if this result is true for higher percentiles as well as the median.

It would also be interesting to explore the use of the literacy/numeracy scores to construct an ACT TER-UAI conversion in much the same way that NSW uses the year 10 achievement scores. This would allow a conversion process without assuming any equivalences with NSW.
4. Hyndman’s model using participation rates

Each state has their own conversion process for computing UAI scores (also known as ENTERs and ITIs), depending on what data are available to the state authorities. In Hyndman (2005, 2006), it was shown that the differences between the state conversion functions are largely due to the different participation rates between states. In particular, it was shown that the cumulative percentage of students above a specific UAI value in state $j$ could be expressed as

$$y_j(UAI) \approx a(UAI) + b(UAI)r_j$$

where $r_j$ is the participation rate in state $j$ and $a(UAI)$ and $b(UAI)$ are smooth functions of the UAI value such that $a(100) = b(100) = 0$, $a(0) = 100$ and $b(0) = 0$. These constraints reflect the following facts:

- all students receive a UAI of at least 0 regardless of participation rate;
- no student receives a UAI of 100 regardless of participation rate.

(Note that NSW and the ACT actually do give UAI scores of 100. These are comparable to ITI values of 99.95 elsewhere in Australia.)

**Figure 3:** Constrained regression spline curves fitted to the intercept and slope parameters for robust regressions modelling the cumulative percentage against participation rate for different ITI values. Take from Hyndman (2006).
Now $\text{TER} = 100 - y_j(UAI)$, and so from equation (2)

$$\text{TER} = 100 - a(UAI) - b(UAI)r_j. \quad (3)$$

The functions $a(UAI)$ and $b(UAI)$ are shown in Figure 3 based on the TER-UAI conversions used in all Australian states and New Zealand. The inverse of the relationship (3) provides an alternative method for converting TERs to UAIs. (This is what is now used in Victoria.)

Figure 4 shows the resulting conversion graphically (in black), using a participation rate of 55.7%. For comparison, the current ACT (2005) conversion is shown in blue. This suggests that the current ACT (2005) conversion is probably too generous, especially for lower TERs. However, it should be noted that the definition of participation rate in the ACT is somewhat unclear due to the changing cohort, and it has variously been estimated between 50.0% and 55.7% for 2005 (Edwards, 2006). Therefore, the conversion based on (3) and a participation rate of 50% is also shown (in red). This suggests that the current ACT conversion is about right for TERs above 70, but probably too generous for lower TERs.

![Figure 4: TER-UAI conversions based on: (1) Hyndman (2006) model using participation rate of 55.7% – black; (2) Hyndman (2006) model using participation rate of 50.0% – red; (3) ACT 2005 method – blue.](image)
5. Comments from Mr Mark Drummond

Much is said in the emails from Mark Drummond, but there appears to be only three specific points made in support of his argument against the assumptions behind the ACT UAI conversion process. These points are summarized (in my words) in bold below, and some brief comments are made.

1. The ACT age cohort is more similar to the cohort from Sydney's North Shore than the age cohort from the whole of NSW.

   The only evidence presented (in the material available to me) in support of this assertion concerned the percentage of people aged 15 and over who possessed a bachelor’s degree or higher. Other imaginary graphs and figures were presented, but these don’t seem to have been based on any data.

   While the educational attainment of parents is a useful predictor of a child’s educational performance, it is only one of many such predictors. This one demographic characteristic alone should not determine the relevant age cohort to be used in the conversion process.

   In fact, Mr Drummond suggests that for one other demographic characteristic (namely the proportion of the age cohort who achieve a UAI), the ACT is closer to NSW as a whole than it is for Sydney’s North shore. Mr Drummond gives the ACT proportion as 51%, the NSW proportion as 60% and estimates the North Shore proportion as 70–80%. (The 2005 figures are 55.7% for the ACT and 55.0% for NSW.) On this characteristic, the ACT is less similar to Sydney’s North Shore than it is to the whole of NSW.

2. ACT UAI outcomes are below the NSW average when the Narrabundah, Radford and Girls’ Grammar results are omitted.

   This may be true, but it is not a fair comparison. To make it fairer (although probably not completely comparable), a similar proportion of top performing schools in NSW would also have to be omitted.

   When all ACT UAI outcomes are compared to all NSW UAI outcomes, it is seen that the
ACT has a higher median UAI than NSW (in 2004, the ACT median was 77 compared to NSW with 67). This difference arises because of the inclusion of the students with nominal aggregate scores when ACT participation percentile ranks are computed. If these students were omitted, the median UAI in ACT and NSW would be identical.

3. A higher proportion of UAIs above 99.0 is expected at the following schools: CIT, Lake Ginninderra, MacKillop, Orana, St Francis Xavier and Lake Tuggeranong. [Other emails list a different set of schools.]

Mr Drummond bases this claim on an assumed year 12 population at these schools of 1000 students, and a result (which I have not confirmed) that no student from these schools obtained a UAI above 99. He then uses a binomial distribution to compute the probability of less than 1 in 20,000.

This probability calculation assumes that the student population at these schools is a random selection of all year 12 students. As this is not the case, the probability calculation is incorrect. However, without any data on the student population of these schools, it is not possible to take the analysis further.

Mr Drummond refers to the socio-economic status of the areas in which the schools are based. However, the performance of a school is affected by numerous factors, including but not limited to socio-economic status of the area.

To substantiate this claim, some evidence of the distribution of ability of the students at these schools would need to be provided.
6. Conclusions

No evidence has been presented in the material made available to me that supports the contention that ACT students are disadvantaged by the UAI conversion process. Some evidence (the analysis of literacy/numeracy results) suggests that the current ACT UAI conversion process gives results that are consistent with NSW UAI results. Other evidence (the application of the Hyndman model) suggests that the ACT UAI values are slightly higher than what is to be expected using Australia-wide data. None of the material produced by Mr Drummond provides a persuasive case for the disadvantage of ACT students.

The use of the NSW conversion table by the ACT BSSS is not ideal as it rests on some assumptions that have not been tested. But the evidence available to date suggests that the conversion process is producing adequate results that are consistent with NSW UAI s. This should continue to be monitored.

I encourage the BSSS to further analyse the year 9 literacy/numeracy results, in particular looking at whether the upper percentiles of the distributions also show consistency with the NSW results.

I also encourage the BSSS to investigate the potential use of the year 9 literacy/numeracy test as a means of computing an ACT UAI conversion table without reference to NSW data. However, it is recognized that the student migration in the ACT, and the relatively small numbers of students in the ACT, will make this more difficult than the use of the year 10 achievement score in NSW.
7. References

