Data analysis: Student disadvantage and success at university

Anthony Manny, Zhizhou Yin, Helen Tam, Robert Lipka, Paul Dickins and Graham Sciberras

Table of contents

1 **Executive summary** ... **3**

2 **Introduction** ... **4**

2.1 Definitions ... 4

2.1.1 Socio-economic status (SES) ... 4

2.1.2 Aboriginal and Torres Strait Islander status ... 5

2.1.3 School-based factors ... 5

2.1.4 Higher School Certificate (HSC) ... 5

2.1.5 Australian Tertiary Admission Rank (ATAR) ... 5

2.1.6 Grade point average (GPA) ... 6

2.2 Literature review ... 6

2.2.1 Socio-economic disadvantage and educational outcomes ... 6

2.2.2 Progress in widening participation in disadvantaged groups ... 7

2.2.3 Socio-economic disadvantage, the ATAR and university success ... 8

2.2.4 Equity scholarships and university success ... 10

2.3 Pathway to university ... 10

2.3.1 HSC and ATAR attainment and university application and enrolment by IEO quartile ... 10

2.3.2 Students from regional and remote areas and Aboriginal and Torres Strait Islander students ... 15

2.3.3 Disadvantage and school characteristics ... 20

2.3.4 Disadvantage and HSC subjects ... 23

3 **Analysis** ... **28**

3.1 First-year outcomes ... 28

3.1.1 First-year outcomes by type of disadvantage ... 28

3.1.2 First-year outcomes by school factors ... 34

3.1.3 First-year outcomes by secondary subject selection ... 35

3.2 Exploring the impact of different factors on the ATAR and first-year GPA ... 40

3.2.1 XGBoost predictive model and SHAP value ... 40

3.2.2 Overall effect of disadvantage and related features on the ATAR and first-year GPA ... 41

3.2.3 The effect of disadvantage on the ATAR and first-year GPA ... 48

3.2.4 The effect of high school on the ATAR and first-year GPA ... 51

3.2.5 The effect of subject choice on the ATAR and first-year GPA ... 56

3.2.6 The effect of university, field of study and scholarship on first-year GPA ... 59

3.2.7 The effect of multiple disadvantages on the ATAR and first-year GPA ... 62

4 **Conclusions** ... **64**

5 References 70

6 Further reading 72

7 Appendix 74

7.1 First-year outcomes by school factors 74

7.2 Summary of the machine learning models 75

1 Executive summary

Published literature and our own research have established that inequality exists in educational outcomes between advantaged and disadvantaged groups.

The definition of 'disadvantage' is often determined by the data available, and most research has focused on each disadvantage independently without accounting for the interaction between them.

Compared with their non-disadvantaged peers, students from disadvantaged backgrounds are less likely to progress to Year 12 or to attain an ATAR (on average a lower ATAR) and are less likely to enrol at university. However, this pattern is reversed once ATAR is considered. That is, given the same ATAR, lower-SES students enrol at a higher rate at university and once there, generally slightly outperform their non-disadvantaged peers.

In this analysis, we used machine learning techniques to investigate the complex relationships between three types of disadvantage and their impact on school and university achievement: low SES, Aboriginal and Torres Strait Islander status, and remoteness of residence (plus other related school-based factors).

We examined the average absolute impact of the following factors on the ATAR and GPA (listed in order of importance):

1. a student's academic ability – or proxy measure for ability (eg level of HSC subject)
2. school- or university-related factors (eg high school size and location, university course field of study). These factors can be a proxy measure for ability (and/or family attitude towards education) and may also be affected by other disadvantage factors.
3. gender
4. other factors (eg residential IEO rank, residential remoteness, and Aboriginal and Torres Strait Islander status).

Note: We used senior secondary school and first-year university results in this analysis. The effects of disadvantage likely contribute to a student's academic achievement prior to this period but have not been investigated here. Similarly, disadvantage may prevent students from progressing to Year 12; however, we have not included these students in our data set. Disadvantage may also affect the choice of school or university attended.

Academic ability (or its proxy measures) has the greatest impact on success at high school and university, regardless of disadvantage; this is not to say that disadvantage doesn’t play a major part in a student’s previous academic development. A student makes many choices during education which affect the outcome (eg subjects studied or school attended) and, since disadvantage can limit a student’s options, a range of options and support must be available so students can achieve their potential.

We found limited evidence that disadvantage undermines student success during the transition from senior secondary study to university. Equity scholarships were found to be effective, furthermore, it is assumed that other programs to assist disadvantaged students are also effective – we found that, on average, disadvantaged university students slightly outperform their non-disadvantaged peers with the same academic ability.

The ATAR remains the best measure of academic achievement and predictor of university success, therefore it is the best tool for use in university admissions. However, it is important to recognise that the ATAR summarises a student's senior secondary school achievement and is one of many potential pathways to university. The ATAR and GPA are not the only measures of success, particularly if a student has no desire to attend university.

A full list of policy recommendations can be found in the conclusions section (section 4).

2 Introduction

Most governments around the world aim to increase their population's participation in higher education, and Australia's is no exception. This goal is largely driven by an assumed relationship between education and economic growth – as a population's education level increases, its labour force becomes more skill- and knowledge-based. This increase is considered the driver of innovation and enterprise, both of which generate national wealth (OECD 2010).

In this spirit, the Bradley Review of Australian Education recommended the implementation of a 'demand-driven system' to expand university participation (Bradley Review 2008). Between 2010 and 2017, the Australian Government uncapped limits on the number of government-supported domestic undergraduate university places. Its goal was for 40 per cent of Australia's population to have a bachelor degree or higher by 2025 (Bradley Review 2008).

The ideal that access to higher education should be universal and not obstructed by socio-economic factors (eg household income, location of residence or school attended) is connected to the policy of widening participation, and that only university admission requirements should limit participation. Historically and today, university admission is based on prior academic achievement for most current school leavers (ie those who have just completed secondary schooling). Universities continue to use the ATAR (Australian Tertiary Admission Rank) – developed in 2008 to summarise Year 12 students' academic achievements – as the primary method to determine whether the applicant will likely succeed in, and therefore should be admitted to, a course.

The cumulative impact of socio-economic disadvantage on students' academic performance up to the end of Year 12 creates an equity issue. Universities acknowledge this impact, which has been countered by measures such as ATAR adjustment factors, equity scholarships and access schemes.

This interplay between socio-economic disadvantage, academic achievement in secondary school and university performance forms the premise of our analysis. In this report, we aim to uncover the effects of various disadvantages on student achievement in Year 12 and first-year university. In 'Data analysis: the impact of senior secondary study choices on success at university', we showed the importance of the ATAR in predicting university success and found that university success is largely independent of the specific subject choices opted by HSC students (Manny et al. 2020). Here, we will focus on whether the ATAR – the summary indicator of a student's achievements in secondary schooling – is affected by socio-economic disadvantage and if it contributes to predicting university success independent of this disadvantage.

2.1 Definitions

This section details some of the recurring concepts and measures that will be used in this analysis.

2.1.1 Socio-economic status (SES)

Socio-economic disadvantage comes in many forms and can be measured in many ways. Three main equity groups are commonly identified in Australia: people with lower-SES backgrounds, Aboriginal and Torres Strait Islander people, and people who live in remote areas (Perry 2018).

The first and primary measure of disadvantage used in this analysis is a student's SES, which is assigned based on the Index of Education and Occupation (IEO) ranking of the Statistical Area 1 (SA1) in which the student resides. All SA1 areas across Australia are ranked by the Index of Education and Occupation – part of a suite of estimates called Socio-Economic Index for Areas

(SEIFA)[1] created by the Australian Bureau of Statistics' (ABS) to measure the SES of a locality/region in Australia. Following common practice in existing research, low-SES students here are defined as those residing in an SA1 area which is in the lowest quartile (bottom 25 per cent, referred here as the 1st quartile) of IEO ranking in Australia. (Note: The 1st SES quartile is the bottom 25 per cent of SA1 areas, and not 25 per cent of the Australian population.) Similarly, when citing other research, this definition of low SES is assumed unless otherwise stated.

2.1.2 Aboriginal and Torres Strait Islander status

Aboriginal and Torres Strait Islander status of HSC students' has been obtained from the NSW Education Standards Authority (NESA).

2.1.3 School-based factors

Several school-based factors are included in this analysis: school size, the number of HSC courses offered at the school, school location (remoteness) and school type. School average SES is measured by averaging the IEO index of each student attending that school (ie school average IEO quartiles represent the average of the attending students, not a quarter of schools). The disadvantaged school list used prior to 2019 was updated annually and consisted of schools that were identified as being among the most socio-economically disadvantaged by the NSW Department of Education and Communities or the Catholic Education Commission of NSW.

2.1.4 Higher School Certificate (HSC)

The HSC is a secondary school qualification received by NSW students at the completion of Year 12 and is administered by NESA. Students must satisfactorily complete the required number of HSC courses to be eligible for the qualification. Note: Not all students of the Year 12 age cohort receive the HSC, as not all meet HSC eligibility requirements[2]. These students may receive a Record of School Achievement (RoSA) at the completion of Year 12.

In this report, HSC students are defined as those who have been awarded the HSC qualification in the year immediately before the year of admission to university. These students are also 'current school leavers' (ie there is no time gap between the end of their secondary education and start of their tertiary education).

2.1.5 Australian Tertiary Admission Rank (ATAR)

The ATAR is a rank calculated by the Universities Admissions Centre (UAC) for all students in NSW. Developed for the purpose of university admission, the ATAR ranks students based on their academic achievements. The ATAR ranges from 0.00 to 99.95 with increments of 0.05; ATARs below 30.00 are not reported to students.

The ATAR for each jurisdiction in Australia is calculated by that jurisdiction's tertiary admission centre (TAC). Because all jurisdictions use a common methodology to derive the rank (Harrison and Hyndman 2015), a particular ATAR is considered equal across all jurisdictions, regardless of its issuing authority and is therefore transferrable across Australian states and territories.

In NSW, the ATAR is calculated using exam and moderated school assessment marks achieved by students in their HSC courses; these marks are provided to UAC by NESA. These HSC marks are scaled to remove differences in the average academic ability of candidatures across different HSC courses. Once the marks are scaled, an aggregate based on the student's best 10 units – with at least two units from English and at least eight units of Category A courses – can then be calculated. In turn, this aggregate is used to rank students, producing the ATAR.

[1] https://www.abs.gov.au/ausstats/abs@.nsf/mf/2033.0.55.001

[2] https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/hsc/rules-and-processes/rules-procedures-guide-students

Like the HSC, not all Year 12 students receive the ATAR as not all meet ATAR eligibility requirements[3].

2.1.6 Grade point average (GPA)

In our analysis, the primary measure of success at university is the GPA based on first-year results obtained by current school leavers who have applied through UAC, received an offer, enrolled in a university course in the year immediately following Year 12 and remained enrolled at the course census date. First-year GPA is used due to the data's timeliness and availability to UAC. There is supporting evidence that first-year GPA correlates strongly with completion rates (Norton et al. 2018), which suggests that performance in the first year sets the foundation for the student's overall performance in the remainder of their university course.

The GPA of students who changed courses during first year was weighted by the study load completed for each course. Students with zero study load for a course were not included in the analysis, as they have either deferred or effectively withdrawn from the course.

Other measures of first-year success used include:

- incomplete first year: achieving a GPA of zero with a non-zero study load (recording a fail for all subjects)
- completed first year with fails: recording a non-zero GPA but failing at least one subject
- completed first year with no fails: achieved a pass grade or better in all subjects.

First-year GPA and the other measures of success used here could also be considered leading indicators for first year attrition.

2.2 Literature review

2.2.1 Socio-economic disadvantage and educational outcomes

Most published studies on disadvantage and education are generally limited by the data available, which causes two main research limitations. Firstly, most research focuses on only one disadvantage at a time without accounting for the interaction between different disadvantages. Due to a lack of data, other contributing factors may not have been considered. Secondly, defining the measures of disadvantage is inconsistent. In many cases, the definition of disadvantage is determined by the data available which is inconsistent across the published research.

Inequality in educational outcomes between advantaged and disadvantaged groups in society has been well documented around the world. Generally, participation and achievement outcomes (eg assessment scores, GPAs) are poorer for students from lower socio-economic backgrounds. A meta-analysis of 58 mainly American studies showed that, overall, the relationship between SES and academic performance is medium to strong (Sirin 2005), which suggests that socio-economic effects on educational outcomes have been persistent and substantial (Thomson 2018).

Similarly, educational inequality has a long history in Australia. Comparing studies between 1975 and 1998, Rothman (2003) found that SES (measured by father's occupation) influenced reading comprehension and mathematics scores in 14-year-olds. The impact of socio-economic disadvantage on educational outcomes is clear from early childhood to early adulthood. Disadvantaged groups are behind advantaged groups at all milestones of development (eg primary school readiness, meeting international proficiency standards at Year 7, attaining a

[3] https://www.uac.edu.au/future-applicants/atar/atar-eligibility

Year 12 certificate (or equivalent) at age 19, and full engagement in education, training or work at age 24 (Lamb et al. 2015)).

In educational outcomes, the gap between disadvantaged and advantaged groups continues at the transition between secondary and tertiary education. Dobson and Birrell (1997) found that students from low-SES postcodes were the most underrepresented group in Australian universities, likely because fewer low-SES students completed Year 12 and obtained an ATAR – the most common pathway to accessing higher education. Using ABS census data from 2011, Lamb et al. (2015) found that only 60.6 per cent of young people living in the lowest decile SES areas (measured by SEIFA's Index of Relative Socio-economic Advantage and Disadvantage (IRSAD)) completed Year 12, compared with 89.1 per cent of young people living in the highest decile SES areas. This attainment gap was also apparent in the likelihood of gaining an ATAR – 36.1 per cent of young people from the lowest decile SES areas versus 83.3 per cent for the highest decile (based on data from the Longitudinal Surveys of Australian Youth (LSAY) in 2009). Finally, the effects of disadvantage flowed on to participation rate in higher education – 17.3 per cent of people aged 20 to 24 in the lowest decile SES areas enrolled at university, compared with 47.2 per cent for the highest decile (based on data from the 2014 ABS Survey of Education and Work).

Similar attainment gaps exist between Aboriginal and Torres Strait Islander and non-Aboriginal and Torres Strait Islander groups, and between those living in remote/rural and urban areas. Aboriginal and Torres Strait Islander youth were less likely to complete Year 12 than non-Aboriginal and Torres Strait Islander youth (58.4 per cent compared to 75.2 per cent completion rate). As remoteness of residence increases, the likelihood of completing Year 12 decreases (78.2 per cent for those living in major cities versus 43.4 per cent living in very remote areas); and across Australia, 62.3 of city students received an ATAR, compared with 27.7 per cent for those in remote areas (Lamb et al. 2015).

2.2.2 Progress in widening participation in disadvantaged groups

Given these educational inequalities, increased participation in equity groups previously underrepresented in higher education was inherent in the goal of widening participation (Bradley Review 2008). The Bradley Review set a target that, by 2020, low-SES students would comprise 20 per cent of higher education enrolments.

UAC data on applicants from the 2017 HSC cohort showed that, for students with ATARs below 60, the low-SES group was more likely than other SES groups to apply to, and subsequently enrol at, university, which perhaps reflects the efficacy of the widening participation policy (Manny 2020). Overall, however, low-SES students remained less likely to be ATAR-eligible or to obtain a high ATAR than higher-SES groups.

Recent analysis published by the National Centre for Student Equity in Higher Education (NCSEHE) showed that between 2013 and 2018, the percentage of low-SES student university enrolments across Australia increased from 15.8 to 17.0 – still short of the 2020 target of 20 per cent. The data, sourced from the Australian Government Department of Education, Skills and Employment, showed that higher education participation increased among other disadvantaged groups (eg Aboriginal and Torres Strait Islander students and students with a disability); however, regional and remote student enrolments decreased as a share of total enrolments (Koshy 2019).

Similar conclusions were made by the Productivity Commission (2019) in its 'report card' on the demand-driven system's implementation. Using LSAY data, the commission found increasing low-SES[4] group participation in higher education, but in the Aboriginal and Torres Strait Islander group, the participation gap remained and, in fact, may have widened for people living in remote regions.

[4] Productivity Commission's definition of low SES is inherited from the LSAY. This measure is detailed in Lim and Gemici (2011).

2.2.3 Socio-economic disadvantage, the ATAR and university success

Although the level of participation by equity groups remains lower than that of other groups in society, some progress has been made in achieving equality in access to higher education in Australia.

As the Productivity Commission (2019) report highlighted, the 'additional students' flowing into tertiary education – due to the system's expansion – were more likely to come from the lowest SES quartile compared with other students; however, these additional students had lower ATARs, lower rates of literacy and numeracy, and dropped out at a higher rate compared with other students. Therefore, it appears that socio-economic disadvantages are drivers of academic attainment throughout primary and secondary schooling, and consequently, levels of attainment predicates higher education success.

However, two questions remain: Independent of the ATAR, does the effect of socio-economic disadvantage endure beyond high school to influence university performance? Is university performance determined predominantly by the level of previous academic attainment (of which the ATAR is one measurement)?

Several studies have examined the complex relationships between socio-economic disadvantage and educational outcomes in the transition from secondary to tertiary education.

Birch and Miller (2006) obtained data from University of Western Australia students who commenced in 2001 and graduated from high school the year before. An ordinary least squares (OLS) regression showed a positive correlation between first-year weighted average marks (WAM) and the ATAR's predecessor, the Tertiary Entrance Rank (TER), being female, and attending a government rather than a Catholic or independent school. Using quantile regression techniques they also found that the importance of these factors on WAM varied according to students' performance. Specifically, while these factors did not have significant predictive effects on high-achieving students (those performing above the 85th percentile at university), they had a pronounced impact on the grades of low-achieving students with below-average to average first-year marks. These researchers also found no significant effects of SES on WAM, as measured by SEIFA's Index of Economic Resources (IER).

Messinis and Sheehan (2015) developed a composite measure of SES by combining SEIFA's Index of Socio-economic Advantage and Disadvantage (SAD) and the school type attended by the students in their study. Their research sample consisted of over 55,000 students who attended Victoria University from 2009 to 2013. They found that higher prior achievement (ATAR) was associated with significantly higher first-year marks, although other factors had a significant detrimental effect on first-year performance (eg gender (ie being male), low SES and having a non-English speaking background). The researchers stressed that, despite these findings, a large amount of variance in first-year performance remained unexplained by the variables included in their study. That is, many students with a low ATAR showed that they could still succeed at university. Furthermore, their quantile regression showed that the effect of the ATAR on first-year marks was more impactful for the low-SES than the high-SES group. While an increase in ATAR corresponded with an increment in first-year mark for both SES groups, the increment was greater for low-SES than for high-SES students. Also, when all other factors (eg gender, school) were equal, low-SES students tended to achieve higher first-year marks than high-SES students at a given ATAR, and that school quality had little effect on first-year university performance.

Li and Dockery (2014) provided similar findings concerning the effects of SES and school characteristics on university performance. Using data from over 8,000 students who attended an unnamed university between 2011 and 2013, they found that students from low-SES schools performed marginally better at university than those from higher-SES schools, suggesting that higher-SES schools may somehow 'inflate' their students' ATARs[5].

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[5] Li and Dockery (2014) used ICSEA to define school's SES and university performance was measured by WAM.

Li and Dockery (2014) carried out random-effects models to investigate the effects of SES, other student demographical factors and the ATAR on university performance. In their first set of models, school SES (measured by the Index of Community Socio-Educational Advantage (ICSEA)), student characteristics (eg age, gender, SES as measured by IER and IEO) and other regressors (eg field of study taken at university, school characteristics, school resourcing) were entered incrementally into the model to explain variance in WAM. Because the ATAR was not included as a regressor, the total effects of these factors on WAM would include any intermediary effects these factors may have on ATARs. This set of regressions showed very mild effects of an individual's SES (IER) – as well as modest effects of school characteristics (school sector, co-ed status) and resourcing – on WAM. The factors with the most significant (positive) effects on WAM were gender (female), specific fields of study, and age (older students), with the co-ed status of schools (single-sex) having some moderately positive effect.

Li and Dockery (2014) ran the same models again, including the ATAR as a regressor, and found that the ATAR had very large impacts on WAM. Their models showed that an increase in one standard deviation in the ATAR amounted to an increase of 6 points in WAM. The influence of a school's SES remained statistically significant once the ATAR has been controlled for; that is, low-SES schools were associated with better university performance. However, individual SES did not affect university performance once the ATAR has been accounted for.

Walker-Gibbs et al. (2019) sought to determine the unique contribution of individual SES and the ATAR on university performance, once student characteristics and demographic factors had been accounted for. Their sample consisted of over 7,000 students enrolled in four undergraduate courses at a Victorian university in 2016. They identified the following groups of students as more at risk of failing or dropping out: those with a low or no ATAR, studying part-time and off-campus, and mature age. Importantly, analyses of variance (ANOVAs) examining the effect of individual SES and other factors (eg attendance type, attendance mode and age) on failure and drop-out rates showed little or no main effect of individual SES. That is, individual SES by itself was not an adequate category in predicting the likelihood of failure at university.

Overall, the studies described in this section varied greatly in sample (size, type of cohort), time of study, definitions of disadvantage, types of predictive factors and outcome measurements, statistical methodology, plus other features. Despite these differences, it appeared students' tertiary academic performance was influenced predominantly by:

- their prior academic achievements at secondary school (typically measured by the ATAR), followed by
- other socio-demographic factors, such as age, gender, course-based factors (eg field of study) and institution-based factors (eg part-/full-time study and attendance mode).

An individual's SES appeared to have little impact on university performance[6], although there was some evidence that school-level SES did. Importantly, students from low-SES schools were shown to outperform their peers from high-SES schools when other factors were controlled for (Birch and Miller 2006; Li and Dockery 2014; Messinis and Sheehan 2015).

Similarly, Anderton (2017) found that first-year university students who attended government schools scored a higher GPA compared with those who attended non-government schools; and while secondary school tuition fees correlated positively with the ATAR, they correlated negatively with first-year GPA.

Generally, the outlook appears favourable for students with socio-economic disadvantage provided they were able to complete their university studies, and by age 25 their employment outcomes were as good as those of other students (Productivity Commission 2019).

[6] Where there was some evidence as in Messinis and Sheehan (2015), the individual SES measure used by these authors was a composite of SEIFA's SAD and school type attended by the students.

2.2.4 Equity scholarships and university success

Published research on educational outcomes of need-based scholarships concentrates on describing influences on student enrolments and retention. Few papers contain measures on how these scholarships influence GPAs. The literature indicates that appropriately resourced scholarships increase lower-SES students' enrolment, retention and success rate at university, when they are combined with other support and mentoring services that make up for a deficit of knowledge and cultural capital needed in an unfamiliar and competitive environment.

Equity and equity-merit scholarships awarded at Deakin University, Queensland University of Technology and The University of Sydney were found to be effective at retaining recipients across different demographic groups, universities, and scholarship products (Zacharias and Ryan 2020). The scholarship design element that most influenced effectiveness was a scholarship's eligibility criteria. The authors recommend that multi-factor assessment for scholarship eligibility is needed because existing definitions of equity groups are not sufficient at individual level and should not be used to assess applicants except for disability or a health condition. The authors also emphasise that money alone does not overcome all barriers to educational success and scholarships need to be part of a comprehensive support system.

Macquarie University's equity scholarship program strongly improved retention rates and produced other positive psychological and social outcomes among recipients (Reed and Hurd 2016). The authors point out that lower participation in higher education of students from low-SES backgrounds in Australia is driven by the necessity for families with limited means to provide financial support. The value of this scholarship program varied from one-off payments to larger awards covering on-campus accommodation. Scholarship recipients reported reduced financial anxiety, improved motivation, feelings of inclusion at university, less time required for paid work and more time for study. In turn, these effects led to less stress and more collaboration with peers.

In other countries, equity scholarships have resulted in positive effects on student outcomes in higher education. In Italy, government grants used to pay university fees and cover educational costs improve the beneficiaries' chance of obtaining credits towards their degree, completing their degree on time and decreases the likelihood of dropping out (Sneyers et al. 2016). In Canada, a combination of mentoring and financial support produced the best student outcomes compared with other conditions where only mentoring or no support was given (Angrist et al. 2009). In southern United States, programs waiving tuition fees based on merit led to a significant increase in young people achieving a college degree (Dynarski 2008); however, in both the Canadian and US studies, findings suggested that these equity programs tended to have a more significant effect for women than for men. Dynarski (2008) also concluded that while tuition fees are an important influence on college completion, the main impediment was associated costs.

2.3 Pathway to university

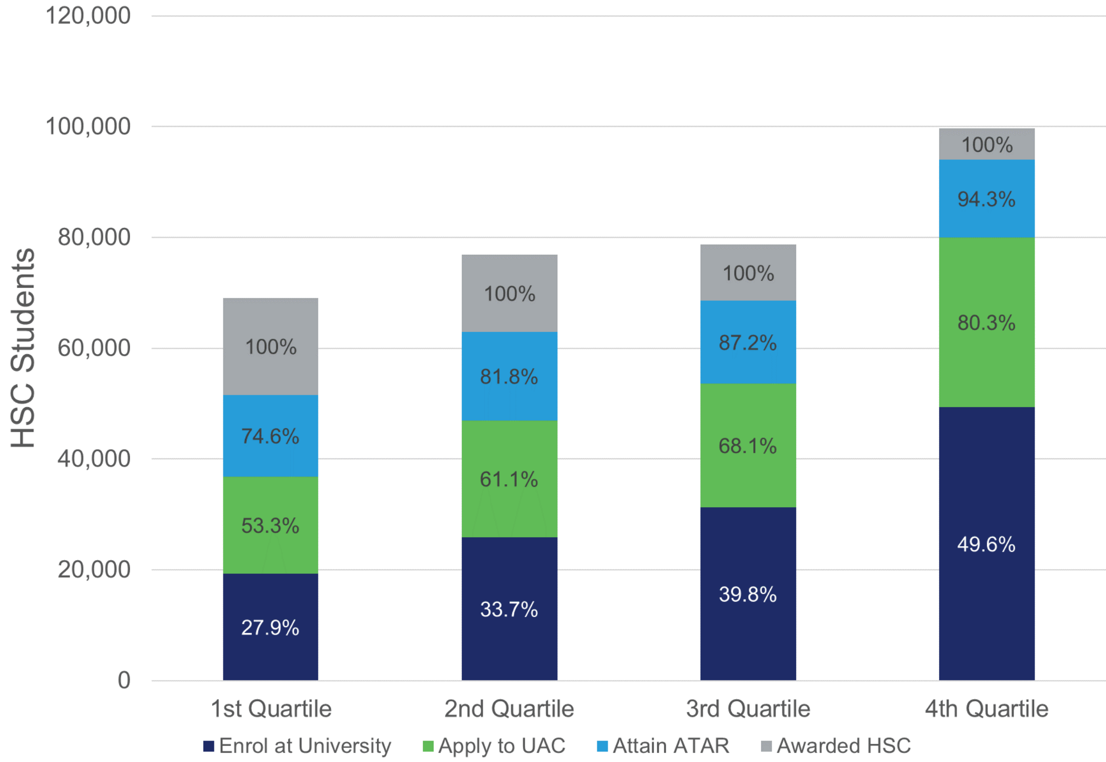
2.3.1 HSC and ATAR attainment and university application and enrolment by IEO quartile

This report focuses on the effects of three types of disadvantages on achievement at school and university: low SES, Aboriginal and Torres Strait Islander status, and regional and remoteness status, along with other related school-based factors. It is important to examine all three in context of each other to get a true picture of the complex relationships between them. We will start with low SES, defined as the 1st quartile of IEO students, as these students represent the largest single disadvantage group.

The Year 12 retention rate, ATAR attainment rate and university application and enrolment rates of low-IEO students are lower than those for high-IEO students – a fact well-documented and discussed above.

As Figure 1 shows, the NSW cohort also demonstrates this pattern. (It is worth repeating that the SA1 quartiles represent 25 per cent of SA1 areas, not 25 per cent of the population; the total population of the 1st IEO quartile SA1 areas is less than the higher quartiles; approximately 21 per cent of the total population live in the 1st IEO quartile SA1 areas, versus 32 per cent for the 4th IEO quartile SA1 areas.) Figure 1 tracks the percentage of 2013 to 2017 HSC students through ATAR attainment, application via UAC, and university enrolment. Of all 4th IEO quartile HSC students, 49.6 per cent progressed to university enrolment. This proportion decreases going down the IEO quartiles, with 27.9 per cent of 1st IEO quartile HSC students enrolling at university.

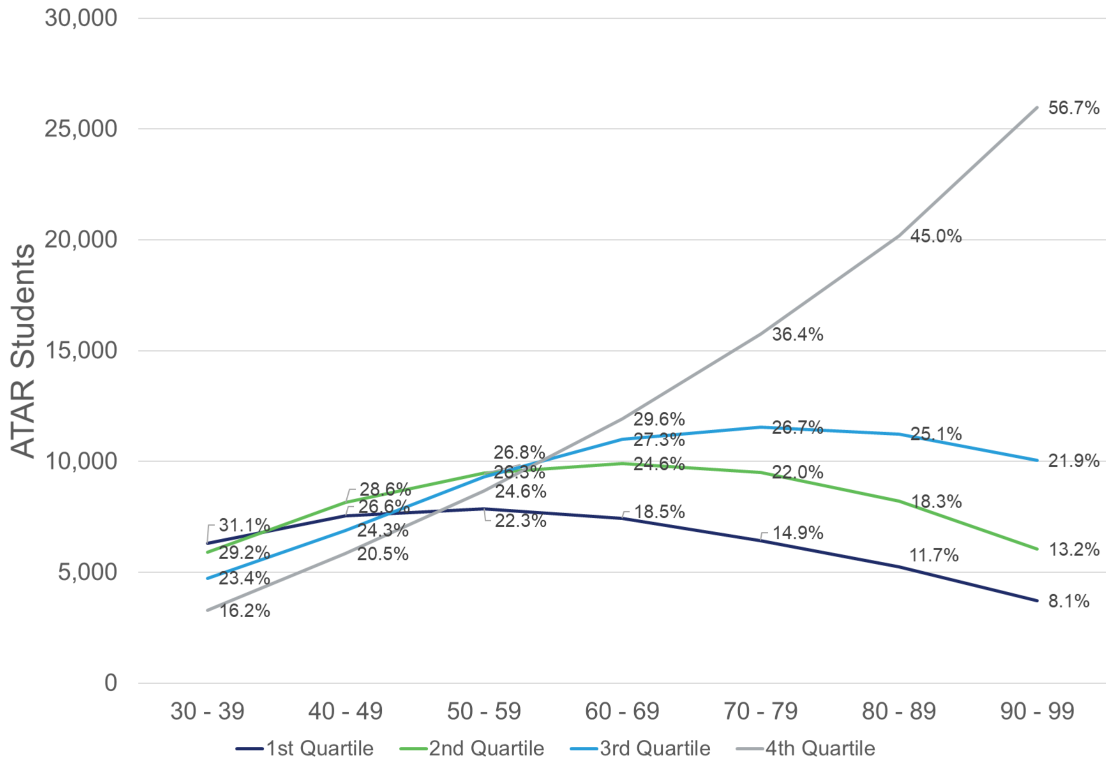
Figure 1: Cumulative progression by IEO quartile (per cent awarded HSC 2013 to 2017).



Note: University enrolment only includes students who enrolled in a course via a UAC application. While UAC represents the single largest market for NSW Year 12 university applications and enrolments, it does not include all. Students can apply directly to a NSW university and participate in higher education interstate or overseas.

The 4th IEO quartile HSC students not only make up a higher proportion of students attaining an ATAR (35.5 per cent compared with 25.1 per cent from the 3rd quartile, 22.1 per cent from the 2nd IEO quartile and 17.3 per cent from the 1st quartile), they also receive, on average, higher ATARs than their lower-IEO peers. Figure 2 clearly demonstrates the dominance of 4th IEO quartile students in ATAR bands of 80 and above. While representing 35.5 per cent of all ATAR students, 4th IEO quartile students make up 56.7 per cent of 90+ ATARs and 45.0 per cent of 80 to 89 ATARs. In contrast, 1st IEO quartile students, who represent 17.3 per cent of all ATAR students, only make up 8.1 per cent of 90+ ATARs and are overrepresented in 30 to 39 ATARs with 31.1 per cent. The 70 to 79 ATAR range is closest to the overall IEO distribution of ATAR-attaining students.

Figure 2: ATAR by IEO quartile (2013 to 2017, ATAR <30 not shown).



Previous research has confirmed that more high-ATAR students tend to apply for and enrol at university than lower-ATAR students (Manny et al. 2020). This holds true across the different IEO quartiles. Within the same IEO quartile, students with higher ATARs were more likely to apply and enrol than students with lower ATARs. Although there are fewer 1st IEO quartile students with high ATARs (Figure 2), Figure 3 shows that, for students with ATARs above 70, there is little difference between IEO quartiles in terms of UAC application rates; however, below ATARs of 70, students from lower-IEO quartiles were more likely than those from higher-IEO quartiles to apply to and enrol at university. In particular, the increased rate of enrolment for lower-IEO students compared with their higher-IEO peers is more pronounced than in the application rate.

The increased enrolment rate of lower-IEO students can be partially explained by the rate at which these students take a gap year (ie they first enrol in university one year after completing school – Figure 4). When the ATAR is considered, there is only a small difference in gap year and enrolment rates between the IEO quartiles. For example, let us compare 1st and 4th IEO quartile students with an ATAR above 90:

- 9.0 per cent of 1st IEO quartile students take a gap year compared to 10.6 per cent of 4th IEO quartile students (1.6 percentage point difference).
- 78.6 per cent of 1st IEO quartile students enrol compared to 73.2 per cent of 4th IEO quartile students (5.4 percentage point difference).

Lower-IEO/lower-ATAR students are more likely to take a gap year at the same or higher rates than higher-IEO students (with ATARs of 30 to 49) and still enrol at higher rates (with no gap year). There is little difference between gap year rates of 1st to 3rd IEO quartile students; however, we still see higher enrolment rates from lower quartile IEO students. Note that there are many reasons to take a gap year which are not necessarily related to SES.

Figure 3: Cumulative progression by IEO quartile and ATAR (per cent ATAR students 2013 to 2017, ATAR <30 not shown).

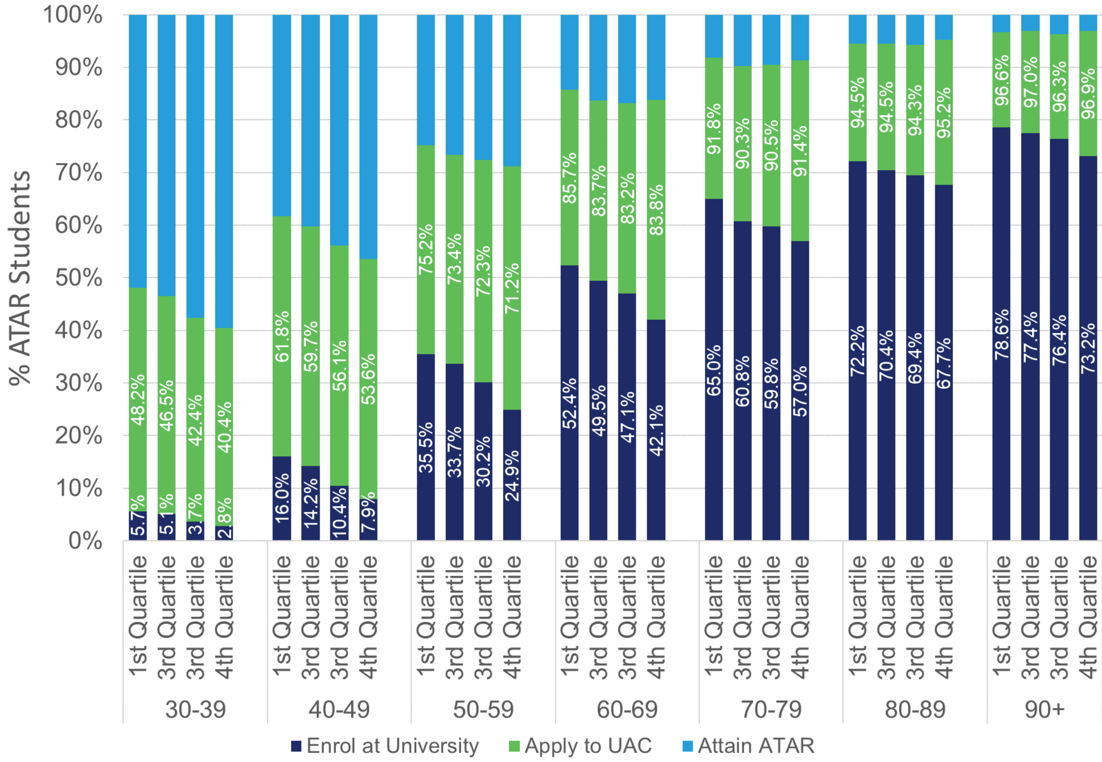


Figure 4: Students taking a gap year by IEO quartile and ATAR (per cent ATAR students 2013 to 2017, ATAR <30 not shown).

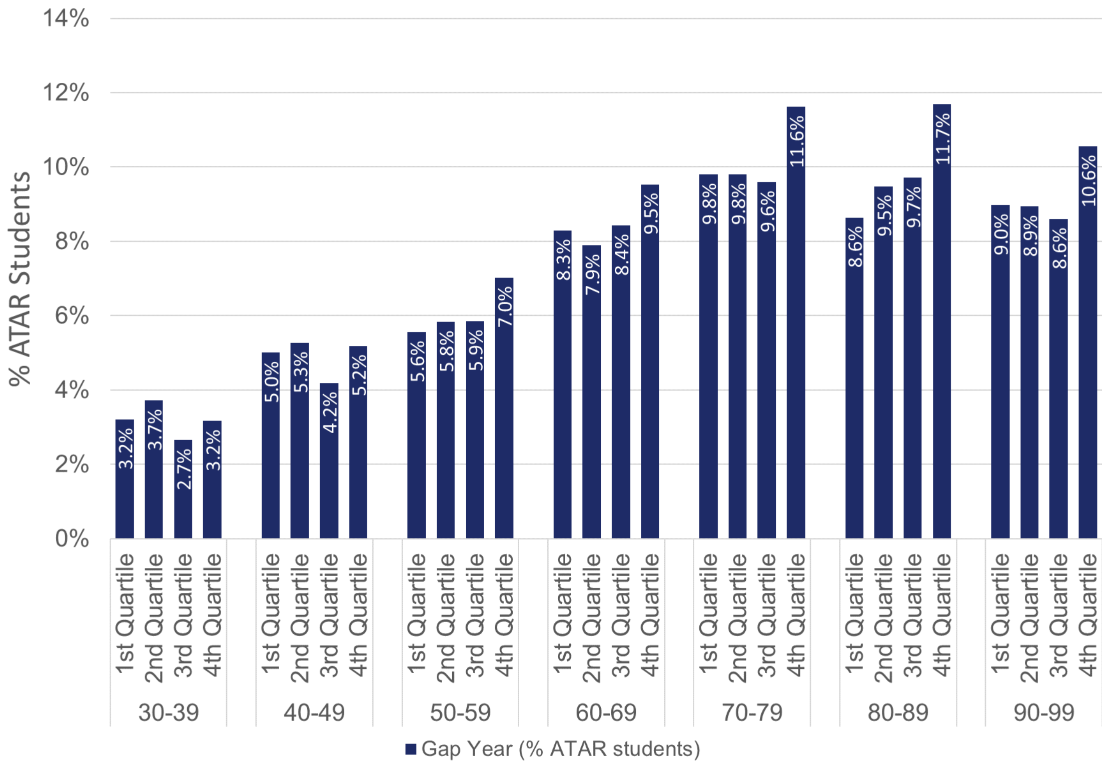


Table 1 shows some distinct field of study enrolment trends for students with different ATARs. Much of this behavior is driven by course selection criteria. There are also some distinct trends related to IEO rank with higher-IEO students having a greater preference for Architecture and Building, Management and Commerce, Society and Culture, and Creative Arts, whereas lower-IEO students have a greater preference for Natural and Physical Sciences (particularly at ATARs below 90), Engineering and Related Technologies, Health and Education.

Table 1: Field of study – Proportion of students enrolled by ATAR and IEO quartile (ATAR 2013 to 2017).

ATAR	IEO Quartile	1 - Natural and Physical Sciences	2 - Information Technology	3 - Engineering and Related Technologies	4 - Architecture and Building	5 - Agriculture, Environmental and Related Studies	6 - Health	7 - Education	8 - Management and Commerce	9 - Society and Culture	10 - Creative Arts
90-99	4th Quartile	15.05%	2.62%	10.72%	2.42%	0.34%	12.05%	1.56%	26.64%	20.98%	7.63%
	3rd Quartile	16.19%	3.03%	11.74%	1.99%	0.34%	15.82%	2.04%	24.55%	17.73%	6.56%
	2nd Quartile	16.89%	2.68%	13.69%	1.71%	0.39%	16.95%	2.43%	23.46%	16.41%	5.40%
	1st Quartile	15.29%	2.09%	13.41%	1.81%	0.34%	20.70%	2.77%	25.04%	14.00%	4.55%
80-89	4th Quartile	15.06%	3.90%	9.08%	4.57%	0.80%	11.52%	3.62%	14.53%	25.75%	11.17%
	3rd Quartile	16.40%	3.35%	10.86%	3.79%	0.97%	15.58%	5.35%	13.21%	21.88%	8.63%
	2nd Quartile	16.94%	3.81%	11.22%	3.60%	0.78%	17.10%	6.21%	12.11%	21.27%	6.96%
	1st Quartile	16.84%	3.94%	12.92%	3.37%	0.60%	15.98%	5.79%	13.93%	20.16%	6.48%
70-79	4th Quartile	12.11%	4.40%	6.08%	4.85%	0.83%	12.77%	4.47%	12.71%	29.94%	11.84%
	3rd Quartile	13.70%	4.01%	7.75%	3.85%	1.08%	15.53%	6.84%	12.19%	25.32%	9.74%
	2nd Quartile	13.52%	4.23%	8.31%	3.70%	0.99%	16.96%	7.80%	11.97%	24.06%	8.44%
	1st Quartile	15.05%	4.89%	9.40%	3.30%	1.12%	15.52%	7.20%	12.07%	24.06%	7.38%
60-69	4th Quartile	9.74%	5.64%	3.97%	4.10%	0.99%	12.99%	7.68%	15.63%	28.74%	10.51%
	3rd Quartile	11.71%	4.66%	4.66%	3.91%	1.29%	13.93%	10.63%	15.81%	24.61%	8.78%
	2nd Quartile	11.57%	4.45%	5.80%	3.98%	1.04%	13.20%	10.07%	14.81%	27.23%	7.83%
	1st Quartile	12.16%	5.58%	5.69%	4.00%	0.74%	13.93%	9.82%	13.74%	27.86%	6.49%
50-59	4th Quartile	9.26%	5.49%	2.40%	4.12%	1.13%	12.89%	7.17%	21.16%	25.99%	10.39%
	3rd Quartile	7.16%	5.31%	3.44%	3.67%	1.41%	13.22%	10.83%	18.65%	26.93%	9.38%
	2nd Quartile	8.73%	5.79%	3.40%	3.51%	1.35%	12.89%	9.90%	16.99%	28.09%	9.35%
	1st Quartile	7.60%	5.92%	3.13%	3.25%	1.50%	13.28%	10.70%	16.23%	29.66%	8.74%

Higher ATAR students tend to enrol in Group of Eight (Go8) universities in higher proportions (Table 2) with regional universities enrolling higher proportions of lower-ATAR and lower-IEO students.

At all ATARs, 4th IEO quartile students enrol in Go8 universities at greater proportions than lower-IEO students. However, 1st IEO quartile students with an ATAR above 80 tend to enrol in Go8 universities at higher rates than 2nd and 3rd IEO quartile students with the same ATAR. 1st IEO quartile students with an ATAR below 80 tend to enrol in Go8 universities at higher rates than 2nd IEO quartile students with the same ATAR.

Table 2: Proportion of students enrolled by university group, by ATAR and IEO quartile (ATAR 2013 to 2017).

		University Group		
ATAR	IEO Quartile	Regional	Metro	Go8
90-99	4th Quartile	0.40%	29.27%	70.33%
	3rd Quartile	0.89%	34.18%	64.94%
	2nd Quartile	1.30%	34.86%	63.84%
	1st Quartile	1.58%	28.82%	69.60%
80-89	4th Quartile	1.03%	56.77%	42.20%
	3rd Quartile	2.77%	61.90%	35.33%
	2nd Quartile	3.36%	63.03%	33.61%
	1st Quartile	3.30%	60.32%	36.38%
70-79	4th Quartile	2.01%	78.43%	19.57%
	3rd Quartile	4.22%	81.90%	13.88%
	2nd Quartile	5.56%	82.09%	12.35%
	1st Quartile	6.07%	80.92%	13.01%
60-69	4th Quartile	3.31%	91.86%	4.82%
	3rd Quartile	6.48%	89.81%	3.71%
	2nd Quartile	7.59%	89.26%	3.15%
	1st Quartile	8.97%	87.44%	3.59%
50-59	4th Quartile	4.29%	92.80%	2.91%
	3rd Quartile	8.29%	89.95%	1.76%
	2nd Quartile	9.79%	88.96%	1.25%
	1st Quartile	11.09%	87.38%	1.53%

Note: Go8 includes USyd, UNSW and ANU, Metro includes UTS, MU, GU, UoN, UoW, ACU, UC and WSU, and Regional includes UTas, CSU, UNE, CQU, SCU and La Trobe.

2.3.2 Students from regional and remote areas and Aboriginal and Torres Strait Islander students

A crosstabulation between Australian Statistical Geography Standard (ASGS) remoteness classification and IEO quartile of our HSC students shows a very clear relationship between these two variables (Table 3). Over three quarters of HSC students (76.7 per cent) reside in major cities and are predominately from higher-IEO groups. In comparison, HSC students who reside in regional and remote areas are predominately from lower-IEO quartiles. It is worth noting that relatively few HSC students live in very remote regions (0.36 per cent); this is mostly due to a low starting population and is exacerbated by the lower Year 12 retention rate in remote areas (Lamb et al. 2015).

Table 3: Proportion of HSC students by remoteness and IEO status (2013 to 2017).

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	Total	Proportion
Very Remote Australia	31.1%	16.9%	50.7%	1.3%	**100%**	**0.1%**
Remote Australia	49.9%	29.9%	17.3%	2.9%	**100%**	**0.3%**
Outer Regional Australia	47.5%	30.9%	19.1%	2.6%	**100%**	**5.1%**
Inner Regional Australia	30.1%	32.9%	28.5%	8.5%	**100%**	**17.8%**
Major Cities of Australia	17.5%	21.1%	23.7%	37.8%	**100%**	**76.7%**
Total	**21.3%**	**23.7%**	**24.3%**	**30.6%**	**100%**	**100%**

Table 4 shows the same residential remoteness by IEO quartile crosstabulation for HSC students of Aboriginal and Torres Strait Islander status (6,849 Aboriginal and Torres Strait Islander HSC students in the data set). Compared with the total HSC cohort, these students are predominantly from lower-IEO quartiles and reside in regional and remote areas. Aboriginal and Torres Strait Islander students represent:

- 2.1 per cent of all HSC students
- 20.8 per cent of all HSC students who live in remote areas
- 28.9 per cent of those living in very remote areas
- 4.4 per cent of all HSC students from the 1st IEO quartile.

Table 4: Proportion of Aboriginal and Torres Strait Islander HSC students by remoteness and IEO status (2013 to 2017).

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	Total	Proportion
Very Remote Australia	66.2%	29.2%	4.6%	0.0%	**100%**	**0.9%**
Remote Australia	54.4%	27.5%	16.6%	1.6%	**100%**	**2.8%**
Outer Regional Australia	64.7%	22.4%	11.6%	1.3%	**100%**	**16.2%**
Inner Regional Australia	47.8%	31.7%	17.7%	2.8%	**100%**	**34.2%**
Major Cities of Australia	34.1%	30.6%	20.8%	14.5%	**100%**	**45.8%**
Total	**44.6%**	**29.5%**	**17.9%**	**7.9%**	**100%**	**100%**

Figure 5 shows the percentages of students who progressed from ATAR attainment to UAC application and university enrolment by Aboriginal and Torres Strait Islander status and ASGS remoteness classification. Figure 6 shows the corresponding percentages for Aboriginal and Torres Strait Islander students by ASGS remoteness classification. Figure 5 shows that progression rates decline as remoteness of residence increases and Figure 6 shows that Aboriginal and Torres Strait Islander students have lower progression rates for the same remoteness status when compared to the total HSC student cohort (Figure 5).

Figure 5: Cumulative progression by Aboriginal and Torres Strait Islander and remoteness status (per cent awarded HSC 2013 to 2017).

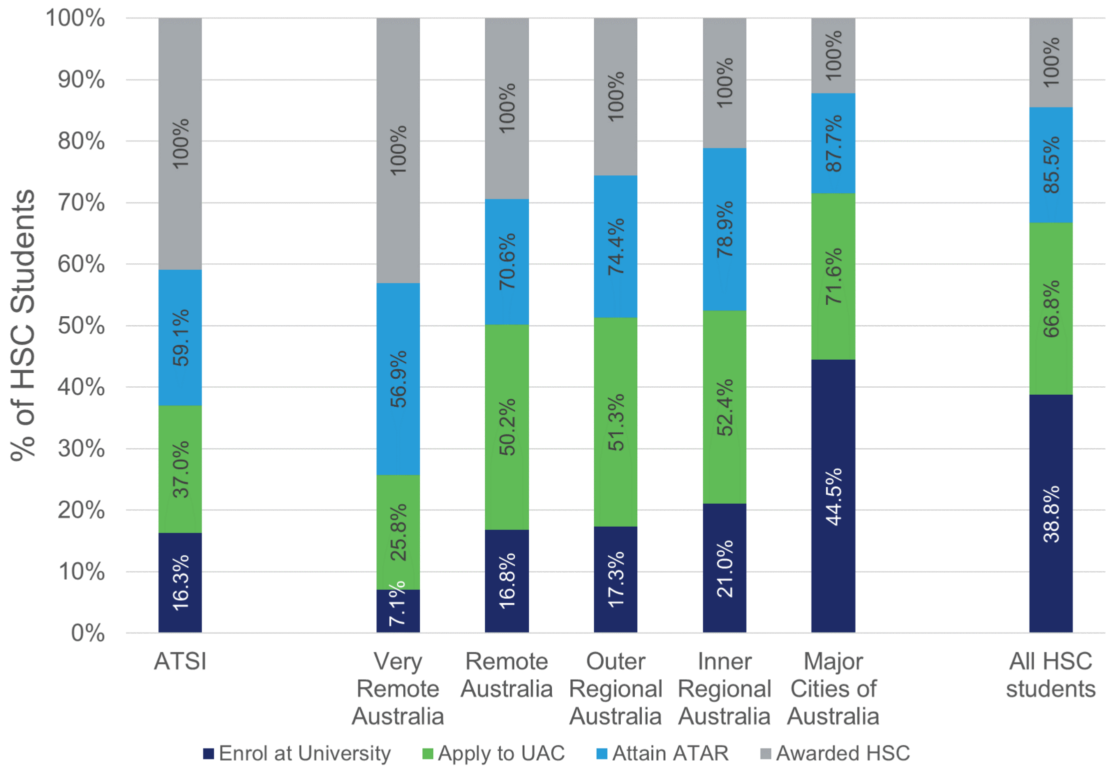
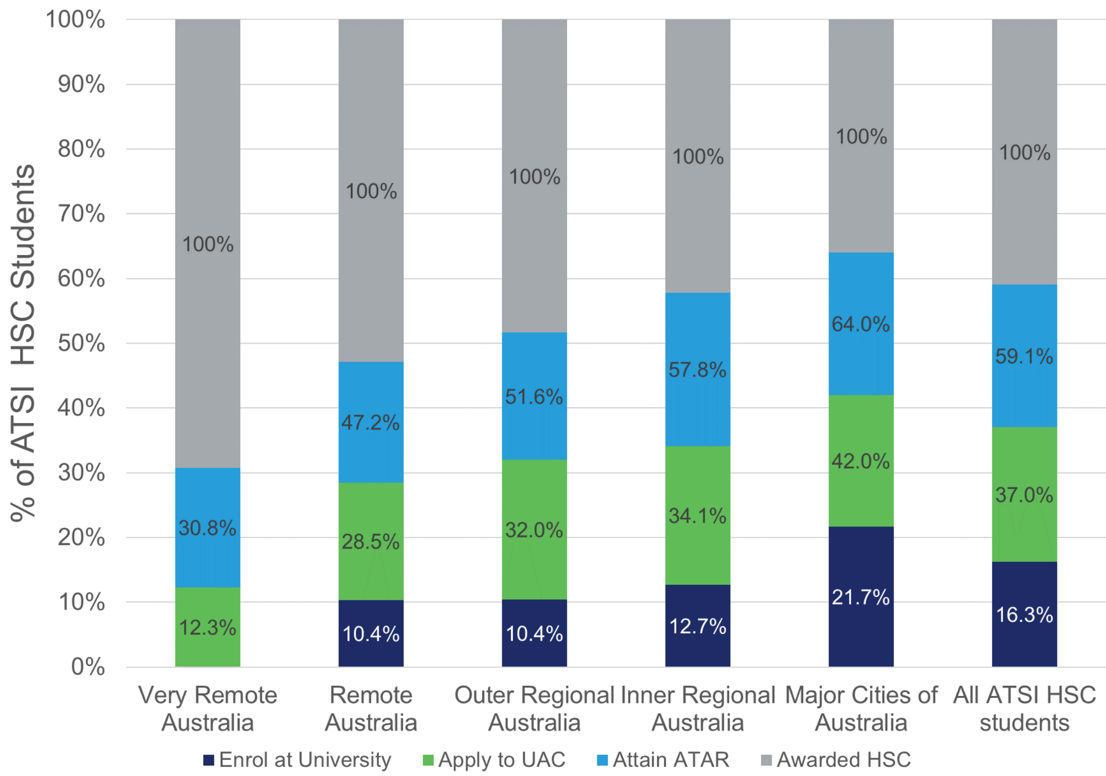


Figure 6: Cumulative progression of Aboriginal and Torres Strait Islander HSC students by remoteness status (per cent awarded HSC 2013 to 2017).



Regional and remote students and Aboriginal and Torres Strait Islander students not only attain ATARs at lower rates than the total cohort average, but generally receive a higher proportion of lower ATARs (Figure 7) – this is also the case for lower-IEO students (Figure 2). It is worth repeating that these disadvantage indicators tend to co-occur; thus, there are higher proportions of lower-IEO students in more remote areas (Table 3) and Aboriginal and Torres Strait Islander students make up higher proportions of both lower-IEO and more remote categories (Table 4).

Figure 7: ATAR by Aboriginal and Torres Strait Islander and remoteness status (2013 to 2017).

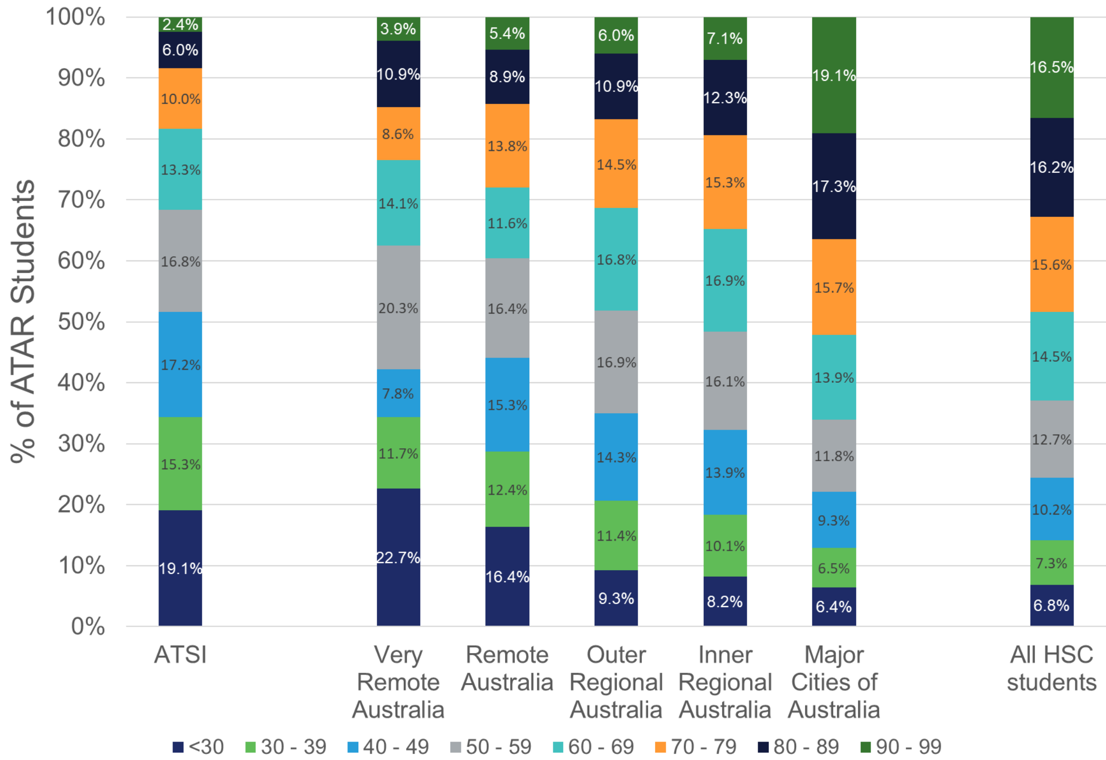
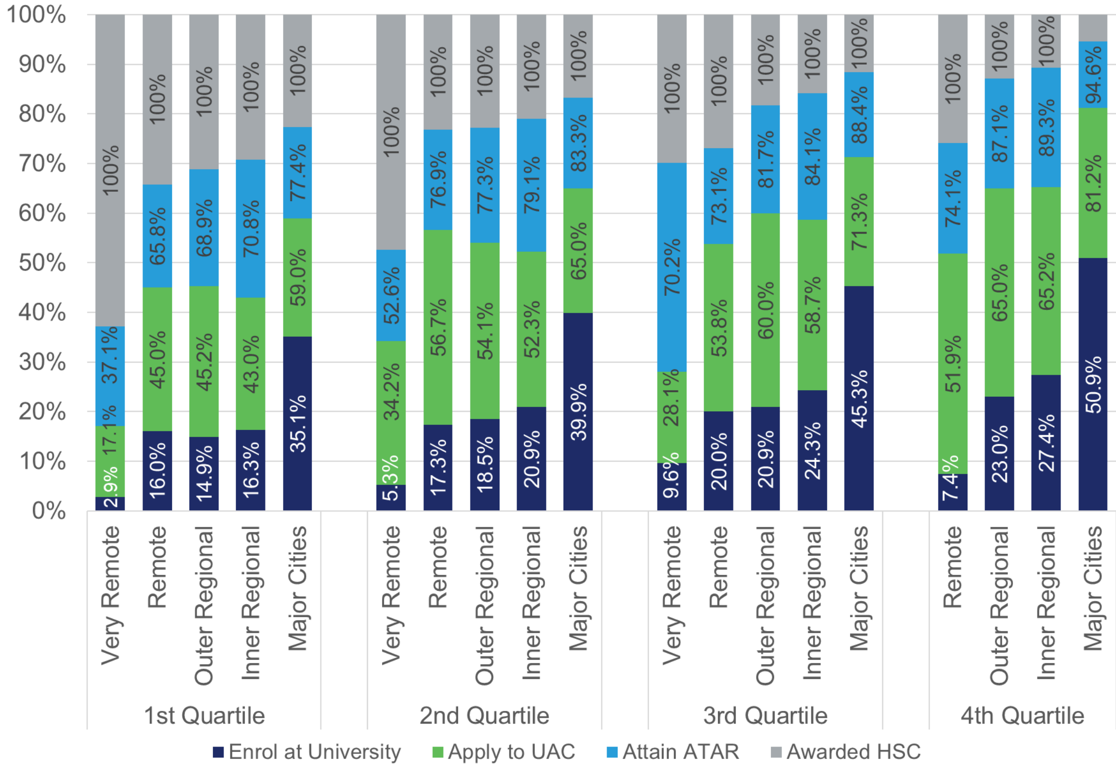


Figure 8 shows a similar progression trend for IEO quartiles as shown in Figure 1 above (ie lower-IEO students attain ATARs, apply through UAC and enrol at lower rates than higher-IEO students). The ATAR attainment rate declines as remoteness increases for the same IEO quartile, and this 'remoteness effect' becomes even more pronounced for application and enrolment rates.

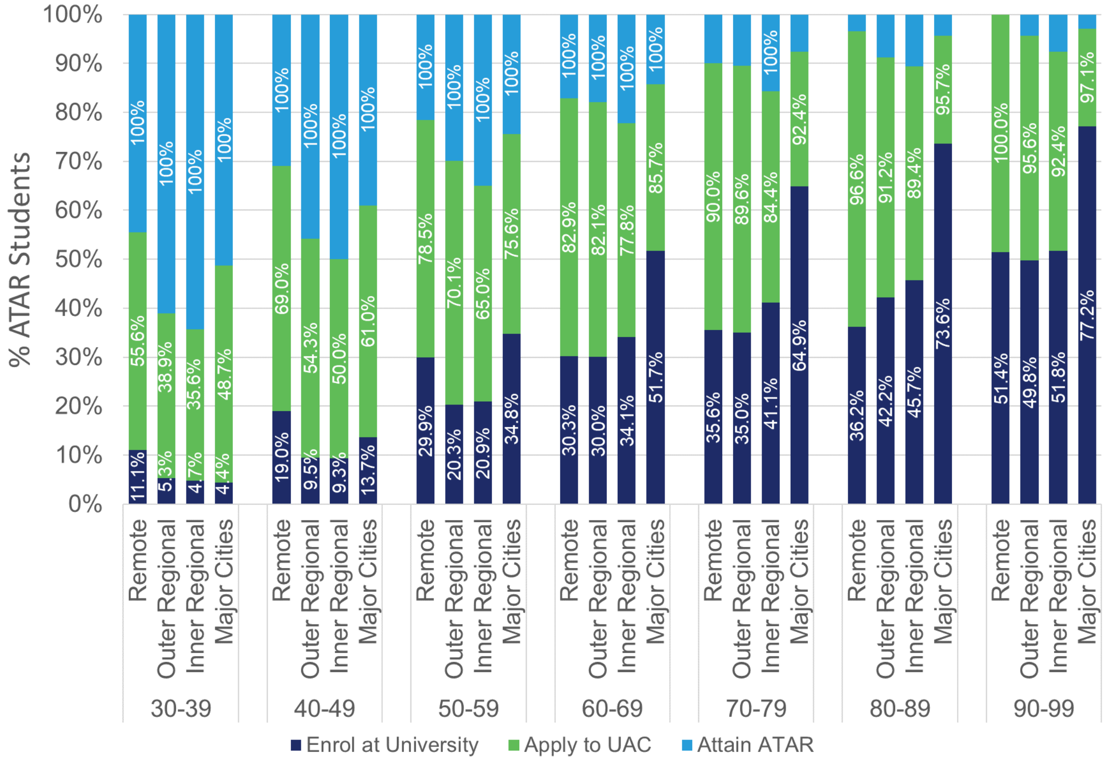
Figure 8: Cumulative progression by remoteness status and IEO quartile (per cent awarded HSC 2013 to 2017 – small sample size removed).



As Figure 9 shows, when comparing progression rates of UAC application and university enrolment by ATAR and remoteness status, remote students typically apply to UAC at the highest rate for their ATAR. This trend does not translate to enrolments for ATARs above 60 but does so for ATARs below 60. Remote students may also apply to and enrol at non-UAC participating interstate universities which, despite being in a different state, may be geographically closer.

For a given ATAR range, students from major cities enrol through UAC applications at significantly higher rates than regional and remote applicants, despite similar application rates. Again, interstate enrolments may explain these lower regional and remote enrolment rates.

Figure 9: Cumulative progression by remoteness status and ATAR (per cent ATAR 2013 to 2017 – very remote students removed due to low sample size by ATAR).



Note: Very remote students have been removed due to the very low sample size when divided by ATAR. Remote and very remote students may apply interstate rather than to UAC as they may be geographically closer to non-UAC participating interstate universities.

2.3.3 Disadvantage and school characteristics

The intricate relationships between the various disadvantage categories discussed so far are further complicated when school characteristics are considered. Schools were classified into five size groups with each group consisting of roughly equal number of HSC students (averaged over five years of HSC data). To gain a greater understanding of the characteristics of very small schools, the smallest classification was then divided in half, and each half contained an equal number of schools (Table 5). Large schools had 168 or more HSC students per year compared to fewer than 30 HSC students per year in the very small schools.

In general, the large and medium/large schools (>133 HSC students) which account for 40 per cent of all HSC students are very similar, as are the very small to small/medium schools (<102 HSC students). The rate of ATAR attainment is approximately 91 per cent in the large and medium/large schools and approximately 80 per cent in the very small to small/medium schools with medium schools in the middle at 86 per cent.

The number of HSC subjects studied in each school size category above 30 students is similar: from 125 to 129 out of the 133 subjects available. In comparison, students in very small schools only studied 106 subjects between them. The average number of subjects studied per school declines with school size; however, the extent to which this trend is due to subject availability or demand by school is not entirely clear. Having fewer students at the school to create demand for subjects and offering niche subjects that are studied by few or no students, may be partly responsible for this trend.

Overall, subject availability does not appear to be a large problem except in very small schools (<30 students) whose students don't study as broad a range of subjects in total (106 of the 133 available subjects) – this indicates a potential problem and may be, partially, a result of the lower proportion of students (3.8 per cent) attending very small schools.

Small schools also offer a significantly lower average number of subjects per school (24.3). The lower number of subjects studied in very small schools does not appear to inhibit the ATAR attainment rate, as it is in line with small and small/medium schools.

It is worth noting that subjects delivered by alternate providers (eg community languages or VET subjects) are counted with subjects offered at the school in which the student is enrolled. While not strictly offered by their school, the student still has access to the subject.

Table 5: School size characteristics summary (HSC 2013 to 2017).

	Large 168+	Med/Large 134 - 167	Medium 102 - 133	Small/Med 70 - 101	Small 30 - 69	Very Small <30	**All Schools**
Number of Schools	59	88	111	154	206	207	**825**
%HSC Students	20.1%	20.1%	20.1%	20.0%	15.8%	3.8%	**100%**
%ATAR students	21.5%	21.5%	20.2%	18.8%	14.4%	3.6%	**100%**
% ATAR attainment	91.4%	91.2%	85.6%	80.5%	78.3%	80.3%	**85.5%**
Subjects studied	126	129	125	127	126	106	**133**
Avg subjects per school	61.2	55.9	53.0	49.1	41.5	24.3	**40.7**

Table 6 shows that students in the 4th IEO quartile predominately attended schools with more than 133 HSC students and students in lower-IEO quartiles attended smaller schools. This table also shows that Aboriginal and Torres Strait Islander students generally attend smaller schools.

Table 6: School size and student IEO quartile (HSC 2013 to 2017).

		Large 168+	Med/Large 134 - 167	Medium 102 - 133	Small/Med 70 - 101	Small 30 - 69	Very Small <30	**All Schools**
% All HSC Students	4th Quartile	29.1%	27.6%	18.0%	17.4%	6.4%	1.5%	**100%**
	3rd Quartile	17.4%	22.0%	23.2%	20.3%	13.5%	3.7%	**100%**
	2nd Quartile	14.6%	16.0%	23.5%	21.5%	20.1%	4.3%	**100%**
	1st Quartile	16.9%	12.4%	16.5%	21.6%	25.9%	6.8%	**100%**
	Total	**20.1%**	**20.1%**	**20.1%**	**20.0%**	**15.8%**	**3.8%**	**100%**
% ATSI HSC Students	4th Quartile	15.9%	26.2%	22.6%	21.1%	9.8%	4.4%	**100%**
	3rd Quartile	11.7%	15.1%	22.6%	22.9%	18.0%	9.7%	**100%**
	2nd Quartile	9.8%	13.1%	20.0%	23.2%	22.9%	10.9%	**100%**
	1st Quartile	5.7%	8.4%	11.4%	23.5%	32.4%	18.7%	**100%**
	Total	**8.8%**	**12.4%**	**16.8%**	**23.1%**	**25.2%**	**13.6%**	**100%**

Table 6 shows the relationship between IEO quartile and school size, and is related to both the relationship between IEO quartiles and remoteness status (Table 3) and the more remote location of smaller schools (Table 7). Table 7 shows that all remote and very remote schools (by ASGS remoteness area) are very small schools (<30 HSC students). In contrast, most major city school students attended a medium to large school (>102 HSC students) and most regional students attended a small to small/medium school (30 to 101 HSC students). This pattern was more pronounced for Aboriginal and Torres Strait Islander students.

Table 7: School size and school ASGS remoteness area code (HSC 2013 to 2017).

		Large 168+	Med/Large 134 - 167	Medium 102 - 133	Small/Med 70 - 101	Small 30 - 69	Very Small <30	**All Schools**
Number of Schools	Major cities of Australia	57	83	88	108	115	78	**529**
	Inner regional Australia	2	5	23	38	69	54	**191**
	Outer regional Australia				8	22	57	**87**
	Remote Australia						13	**13**
	Very remote Australia						5	**5**
	Total	**59**	**88**	**111**	**154**	**206**	**207**	**825**
% All HSC Students	Major cities of Australia	24.9%	24.1%	20.3%	17.8%	11.3%	1.7%	**100%**
	Inner regional Australia	3.4%	6.9%	24.0%	28.5%	30.2%	7.1%	**100%**
	Outer regional Australia				27.7%	44.5%	27.8%	**100%**
	Remote Australia						100.0%	**100%**
	Very remote Australia						100.0%	**100%**
	Total	**20.1%**	**20.1%**	**20.1%**	**20.0%**	**15.8%**	**3.8%**	**100%**
% ATSI HSC Students	Major cities of Australia	16.0%	17.2%	23.1%	22.8%	17.8%	3.1%	**100%**
	Inner regional Australia	2.8%	11.5%	15.8%	27.5%	32.1%	10.2%	**100%**
	Outer regional Australia				17.9%	40.2%	41.9%	**100%**
	Remote Australia						100.0%	**100%**
	Very remote Australia						100.0%	**100%**
	Total	**8.8%**	**12.4%**	**16.8%**	**23.1%**	**25.2%**	**13.6%**	**100%**

Table 8 shows the average ATAR achieved by school size and school ASGS remoteness. Average ATARs generally decline as schools become smaller and more remote. This is related to student ATAR trends from the different IEO quartiles and remoteness status (as discussed and shown in Figures 2 and 7), and the type of school attended (as shown in Tables 6 and 7). It is unclear which factors in this complex relationship cause, and which are results of, these trends.

Table 8: Average ATAR by school size and school ASGS remoteness area code (HSC 2013 to 2017).

		Large 168+	Med/Large 134 - 167	Medium 102 - 133	Small/Med 70 - 101	Small 30 - 69	Very Small <30	**All Schools**
Avg ATAR	Major cities of Australia	74.23	74.64	68.16	66.25	59.92	58.47	**70.14**
	Inner regional Australia	63.84	63.09	63.86	60.32	60.65	56.68	**61.40**
	Outer regional Australia				63.82	56.44	53.26	**57.76**
	Remote Australia						42.35	**42.35**
	Very remote Australia						54.51	**54.51**
	Total	**73.99**	**74.07**	**67.33**	**64.87**	**59.85**	**56.28**	**68.48**

The result of the above trends can be summarised in the schools' average IEO of its students and the size of the school (Table 9). Schools with a higher average student IEO tend to be larger with higher average ATARs, while schools with a lower average student IEO tend to be smaller and have lower average ATARs.

Table 9: School size and average school IEO (HSC 2013 to 2017).

		Large 168+	Med/Large 134 - 167	Medium 102 - 133	Small/Med 70 - 101	Small 30 - 69	Very Small <30	**All Schools**
% All HSC Students	4th Quartile School IEO	8.1%	7.7%	3.9%	4.2%	1.1%	0.3%	**25%**
	3rd Quartile School IEO	5.0%	6.7%	7.0%	5.6%	3.7%	0.8%	**29%**
	2nd Quartile School IEO	5.9%	4.6%	8.6%	8.2%	7.8%	2.0%	**37%**
	1st Quartile School IEO	1.2%	1.2%	0.7%	2.1%	3.1%	0.8%	**9%**
	Total	**20.2%**	**20.2%**	**20.2%**	**20.1%**	**15.6%**	**3.8%**	**100%**
Avg ATAR	4th Quartile School IEO	78.75	79.31	78.30	77.22	70.00	69.16	**78.14**
	3rd Quartile School IEO	76.30	75.52	66.87	65.18	66.24	62.04	**70.33**
	2nd Quartile School IEO	66.15	65.69	62.06	59.02	56.47	54.23	**61.16**
	1st Quartile School IEO	64.59	54.84	58.77	48.78	50.28	49.00	**54.10**
	Total	**73.99**	**74.07**	**67.33**	**64.87**	**59.51**	**56.36**	**68.47**

Note: The average school IEO quartile classification is determined by the average IEO percentile of the students who attend that school and which quartile they belong to, not the rank of the school's average student IEO (ie if the average student IEO percentile for a school is greater than 75 then the school is classed as 4th quartile).

Research suggests that students select subjects according to their ability (Manny et al. 2020); that is, students of high academic ability tend to study particular HSC subjects. Parental influence on school selection may contribute to the above trends in a similar way. Many of these trends are driven by self-selection but, as mentioned, it is unclear which factors in these complex relationships cause these trends, which are results of these trends, and how these factors interact.

2.3.4 Disadvantage and HSC subjects

Higher-ATAR students tend to study particular HSC subjects (Manny et al. 2020), which is generally true across the school and student characteristics used above. Table 10 shows that the rate of study of Category B subjects increases as the ATAR decreases with little variance by school size. The rate of extension subjects studied decreases with the ATAR; however, students in smaller schools tend to study English and Mathematics Extension subjects at higher rates for the same ATAR compared with those in larger schools. This higher study rate in smaller schools does not extend to other extension subjects except for 90+ ATAR students, which suggests that subject availability may be an issue in smaller schools (ie students select English and Mathematics Extension subjects in the absence of other options). As all schools offer English and mathematics, it would be easier for students in smaller schools to access these as extension subjects rather than other less popular subjects that may not be offered.

Table 10: Rate of subjects studied by ATAR and school size (HSC 2013 to 2017, ATAR <30 not shown).

ATAR	School Size	Category B Subjects	English Extension subjects	Maths Extension subjects	Other Extension subjects
90-99	Large 168+	2.4%	21.8%	58.8%	16.5%
	Med/Large 134 - 167	2.1%	24.4%	58.7%	15.3%
	Medium 102 - 133	2.8%	26.2%	46.7%	16.4%
	Small/Med 70 - 101	3.0%	27.8%	42.5%	18.9%
	Small 30 - 69	3.2%	27.1%	47.2%	13.3%
	Very Small <30	2.5%	25.6%	55.8%	27.3%
80-89	Large 168+	6.8%	10.5%	25.2%	10.1%
	Med/Large 134 - 167	7.5%	12.8%	24.1%	11.8%
	Medium 102 - 133	8.6%	13.7%	18.8%	10.6%
	Small/Med 70 - 101	8.0%	15.0%	20.8%	12.9%
	Small 30 - 69	8.7%	17.9%	22.3%	10.0%
	Very Small <30	6.6%	21.9%	30.2%	11.3%
70-79	Large 168+	12.8%	4.9%	11.8%	7.0%
	Med/Large 134 - 167	14.3%	6.6%	10.9%	8.3%
	Medium 102 - 133	14.6%	7.7%	9.4%	7.4%
	Small/Med 70 - 101	14.8%	8.4%	11.6%	10.0%
	Small 30 - 69	14.7%	11.4%	12.3%	8.1%
	Very Small <30	14.8%	13.4%	15.8%	6.4%
60-69	Large 168+	19.8%	1.8%	5.5%	5.3%
	Med/Large 134 - 167	20.9%	3.0%	5.3%	6.3%
	Medium 102 - 133	20.7%	3.7%	4.2%	5.9%
	Small/Med 70 - 101	21.4%	4.2%	5.5%	7.0%
	Small 30 - 69	19.5%	6.0%	6.7%	5.5%
	Very Small <30	20.6%	6.6%	7.2%	4.7%
50-59	Large 168+	27.1%	0.9%	2.8%	4.4%
	Med/Large 134 - 167	27.6%	1.2%	2.6%	5.0%
	Medium 102 - 133	27.9%	1.3%	1.7%	4.9%
	Small/Med 70 - 101	27.2%	1.9%	2.7%	5.5%
	Small 30 - 69	26.3%	2.8%	2.9%	4.1%
	Very Small <30	24.4%	4.3%	3.6%	3.4%
40-49	Large 168+	33.5%	0.5%	1.3%	4.6%
	Med/Large 134 - 167	32.3%	0.8%	0.9%	4.3%
	Medium 102 - 133	32.8%	0.7%	0.9%	4.2%
	Small/Med 70 - 101	31.7%	1.1%	1.4%	4.5%
	Small 30 - 69	31.4%	1.4%	1.1%	3.6%
	Very Small <30	28.4%	1.8%	1.8%	2.4%
30-39	Large 168+	38.9%	0.1%	0.5%	4.0%
	Med/Large 134 - 167	36.0%	0.4%	0.5%	3.8%
	Medium 102 - 133	36.7%	0.2%	0.3%	3.5%
	Small/Med 70 - 101	35.9%	0.4%	0.5%	3.7%
	Small 30 - 69	36.6%	0.6%	0.6%	2.8%
	Very Small <30	33.8%	0.8%	0.5%	1.9%

Consistent trends are evident when examining rates of study of Category B and extension subjects by ATAR and student IEO quartile (Table 11); however, there is some variance by IEO quartile. Lower-IEO students are more likely to study a Category B subject than their higher-IEO peers with the same ATAR. Lower-IEO students studied English Extension subjects and other extension subjects at lower rates than higher-IEO students with the same ATAR, particularly at higher ATARs. In contrast, lower-IEO students studied Mathematics Extension subjects at higher rates than their higher-IEO peers with the same ATAR.

Table 11: Rate of subjects studied by ATAR and student IEO quartile (HSC 2013 to 2017, ATAR <30 not shown).

ATAR	IEO Quartile	Category B Subjects	English Extension subjects	Maths Extension subjects	Other Extension subjects
90-99	4th Quartile	1.8%	26.5%	52.9%	19.8%
	3rd Quartile	3.1%	24.3%	55.2%	13.3%
	2nd Quartile	3.5%	20.4%	53.3%	10.6%
	1st Quartile	4.1%	17.3%	59.0%	9.9%
80-89	4th Quartile	5.9%	13.9%	21.1%	12.9%
	3rd Quartile	8.7%	13.7%	23.2%	10.3%
	2nd Quartile	9.0%	12.8%	23.1%	9.2%
	1st Quartile	10.5%	12.0%	27.2%	8.7%
70-79	4th Quartile	11.2%	7.5%	10.9%	9.1%
	3rd Quartile	14.8%	7.7%	10.6%	8.3%
	2nd Quartile	15.9%	7.7%	10.9%	7.4%
	1st Quartile	17.9%	7.3%	13.6%	6.3%
60-69	4th Quartile	17.0%	3.5%	5.0%	6.4%
	3rd Quartile	21.0%	3.7%	5.1%	6.1%
	2nd Quartile	22.2%	3.7%	5.6%	5.6%
	1st Quartile	23.3%	4.2%	6.2%	5.5%
50-59	4th Quartile	23.7%	1.6%	2.6%	4.8%
	3rd Quartile	26.9%	1.8%	2.4%	4.5%
	2nd Quartile	28.0%	1.7%	2.5%	5.2%
	1st Quartile	30.2%	1.9%	2.8%	4.5%
40-49	4th Quartile	28.4%	1.2%	1.4%	4.3%
	3rd Quartile	31.1%	0.7%	1.0%	4.0%
	2nd Quartile	33.2%	0.9%	0.9%	4.1%
	1st Quartile	34.6%	1.1%	1.3%	4.2%
30-39	4th Quartile	32.1%	0.4%	0.5%	3.3%
	3rd Quartile	35.3%	0.4%	0.5%	3.4%
	2nd Quartile	36.5%	0.3%	0.4%	3.5%
	1st Quartile	39.9%	0.4%	0.5%	3.5%

Examining Category B and extension subject rates of study by ATAR and school average IEO quartile (rather than individual student IEO quartile) shows the same trends (Table 12); however, there are greater differences between IEO quartiles. The school's average IEO tends to drive the study pattern more strongly than the student's individual IEO; that is, students who attended low-average IEO schools were more likely to study Category B subjects than students of comparable individual IEO and ATAR who attended higher-average IEO schools. This is apparent in the difference between rates of study of Category B subjects by individual IEO quartile (1st IEO quartile 90-99 ATAR is 4.1% – Table 11) and corresponding average school IEO quartile (1st quartile avg. school IEO 90-99 ATAR is 5.4% – Table 12).

Table 12: Rate of subjects studied by ATAR and average school IEO quartile (HSC 2013 to 2017, ATAR <30 not shown).

ATAR	Avg School IEO	Category B Subjects	English Extension subjects	Maths Extension subjects	Other Extension subjects
90-99	4th Quartile School IEO	1.8%	27.0%	52.3%	20.3%
	3rd Quartile School IEO	2.3%	24.2%	59.1%	14.0%
	2nd Quartile School IEO	4.6%	17.5%	47.5%	8.8%
	1st Quartile School IEO	5.4%	17.5%	64.1%	10.9%
80-89	4th Quartile School IEO	5.9%	12.9%	20.5%	13.4%
	3rd Quartile School IEO	7.5%	14.9%	24.5%	11.0%
	2nd Quartile School IEO	10.0%	12.2%	21.9%	7.8%
	1st Quartile School IEO	12.7%	13.3%	35.4%	10.3%
70-79	4th Quartile School IEO	10.8%	7.1%	10.0%	8.9%
	3rd Quartile School IEO	13.6%	8.2%	11.9%	8.8%
	2nd Quartile School IEO	17.3%	7.2%	10.6%	6.7%
	1st Quartile School IEO	18.5%	8.4%	18.2%	7.1%
60-69	4th Quartile School IEO	16.3%	3.1%	4.7%	6.1%
	3rd Quartile School IEO	19.8%	4.0%	5.5%	6.8%
	2nd Quartile School IEO	22.7%	3.8%	5.1%	5.2%
	1st Quartile School IEO	26.5%	4.1%	8.7%	5.8%
50-59	4th Quartile School IEO	23.4%	1.5%	2.6%	4.5%
	3rd Quartile School IEO	25.7%	1.6%	2.5%	5.5%
	2nd Quartile School IEO	28.5%	1.8%	2.3%	4.3%
	1st Quartile School IEO	33.2%	2.2%	3.8%	5.3%
40-49	4th Quartile School IEO	28.7%	1.1%	1.5%	3.8%
	3rd Quartile School IEO	30.3%	1.0%	1.1%	4.6%
	2nd Quartile School IEO	33.4%	0.8%	0.9%	3.8%
	1st Quartile School IEO	35.8%	1.4%	1.9%	4.7%
30-39	4th Quartile School IEO	31.5%	0.4%	0.6%	3.1%
	3rd Quartile School IEO	33.7%	0.4%	0.4%	3.7%
	2nd Quartile School IEO	37.2%	0.3%	0.4%	3.3%
	1st Quartile School IEO	43.2%	0.4%	0.6%	3.8%

The tendency for high-ATAR students to specialise by studying more extension subjects (Table 12) is reflected in the lower number of key learning areas (KLAs) they study (Table 13).

In general, the number of KLAs studied is more closely linked to academically-oriented students who specialise than a school's average IEO. And lower-ATAR students tend to have broader study patterns than higher-ATAR students, regardless of a school's average IEO (Table 13).

Table 13: Number of key learning areas studied by ATAR and average school IEO (HSC 2013 to 2017, ATAR <30 not shown).

ATAR	Avg School IEO	2	3	4	5+
90-99	4th Quartile School IEO	1.9%	23.5%	52.8%	21.9%
	3rd Quartile School IEO	2.2%	26.6%	51.9%	19.4%
	2nd Quartile School IEO	2.0%	25.6%	48.3%	24.1%
	1st Quartile School IEO	1.8%	29.0%	51.8%	17.4%
80-89	4th Quartile School IEO	1.4%	16.3%	48.6%	33.7%
	3rd Quartile School IEO	1.4%	16.3%	48.1%	34.2%
	2nd Quartile School IEO	1.6%	15.1%	46.5%	36.8%
	1st Quartile School IEO	1.5%	15.0%	49.4%	34.1%
70-79	4th Quartile School IEO	1.1%	14.2%	45.3%	39.4%
	3rd Quartile School IEO	1.0%	12.4%	45.8%	40.8%
	2nd Quartile School IEO	0.9%	11.4%	42.5%	45.2%
	1st Quartile School IEO	1.1%	12.7%	45.3%	41.0%
60-69	4th Quartile School IEO	1.0%	12.5%	43.7%	42.9%
	3rd Quartile School IEO	0.7%	10.8%	42.3%	46.2%
	2nd Quartile School IEO	0.8%	9.7%	41.6%	48.0%
	1st Quartile School IEO	0.8%	10.2%	40.0%	49.0%
50-59	4th Quartile School IEO	1.2%	10.8%	43.4%	44.7%
	3rd Quartile School IEO	0.6%	9.3%	41.4%	48.7%
	2nd Quartile School IEO	0.7%	8.2%	39.6%	51.6%
	1st Quartile School IEO	0.4%	7.8%	39.5%	52.4%
40-49	4th Quartile School IEO	0.9%	10.0%	42.8%	46.4%
	3rd Quartile School IEO	0.7%	8.9%	39.5%	50.9%
	2nd Quartile School IEO	0.5%	7.6%	38.9%	53.1%
	1st Quartile School IEO	0.5%	6.8%	40.4%	52.3%
30-39	4th Quartile School IEO	0.6%	10.5%	43.7%	45.2%
	3rd Quartile School IEO	0.5%	7.9%	40.3%	51.3%
	2nd Quartile School IEO	0.4%	7.3%	38.0%	54.3%
	1st Quartile School IEO	0.2%	5.6%	36.7%	57.5%

3 Analysis

3.1 First-year outcomes

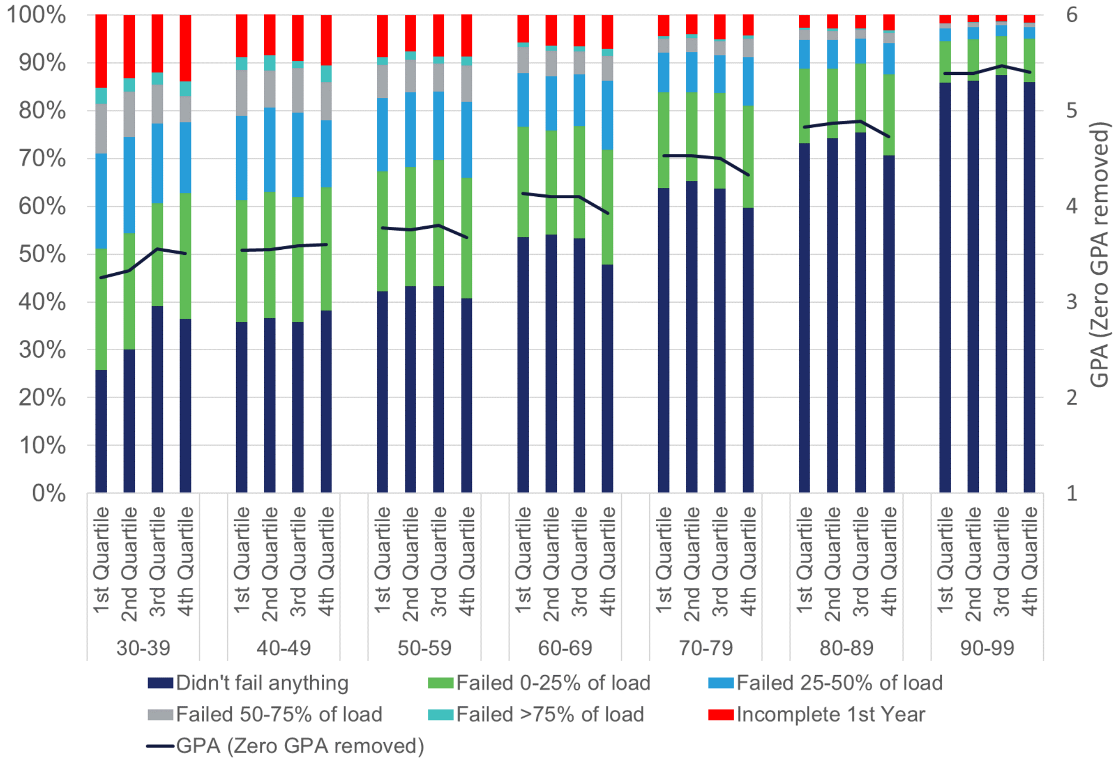
In the following section we provide a summary of first-year university outcomes (as defined in section 2.1) for HSC students (2013 to 2017) enrolling in a bachelor degree through UAC between 2014 and 2018. Prior research shows the ATAR's value in predicting first-year university outcomes and a clear positive relationship with first-year GPA (Manny et al. 2020). As a result, all other factors affecting first-year outcomes discussed in this section will be viewed in conjunction with the students' ATAR.

Throughout this section, it is unclear whether some trends are caused by certain cohorts of students under/overperforming in their ATAR or under/overperforming at university when compared to other cohorts. Other factors may also contribute to these observations, such as differences in resource availability and teaching styles between school and university, and a student's ability to adjust to these differences.

3.1.1 First-year outcomes by type of disadvantage

First-year university students largely perform to the level expected of their ATAR, regardless of their IEO status (Figure 10). For students with ATARs over 90, there is very little difference in pass/fail rates or first-year GPA, regardless of IEO status; however, as ATARs decline, 4th IEO quartile students begin to fail at a slightly higher rate when compared with lower-IEO quartile students with the same ATAR. This contributes to a slight drop in 4th IEO quartile average GPA – an effect that peaks for students with ATARs in the 60s and 70s and reduces at ATARs below 60. It is unclear whether this trend is caused by 4th IEO quartile students overperforming in their ATAR or underperforming at university when compared to lower-IEO quartiles.

Figure 10: First-year outcomes by ATAR and IEO quartile.



First-year university students also largely perform to the expected level of their ATAR, regardless of remoteness status (Figure 11). Again, there is little difference in pass/fail rates or GPA for students with ATARs over 90, regardless of remoteness status; however, as ATARs decline, students from major cities begin to fail at a slightly higher rate when compared with students from regional areas with the same ATAR. This also contributes to a slight drop in the average GPA of students from major cities. This effect is strongest for students with ATARs in the 50s to 80s and becomes weaker at ATARs below 50 – most likely due to the relationship between higher-IEO students residing predominately in major cities (as discussed in section 2.3.2).

Figure 11: First-year outcomes by ATAR and remoteness (remote and very remote removed – small sample size).

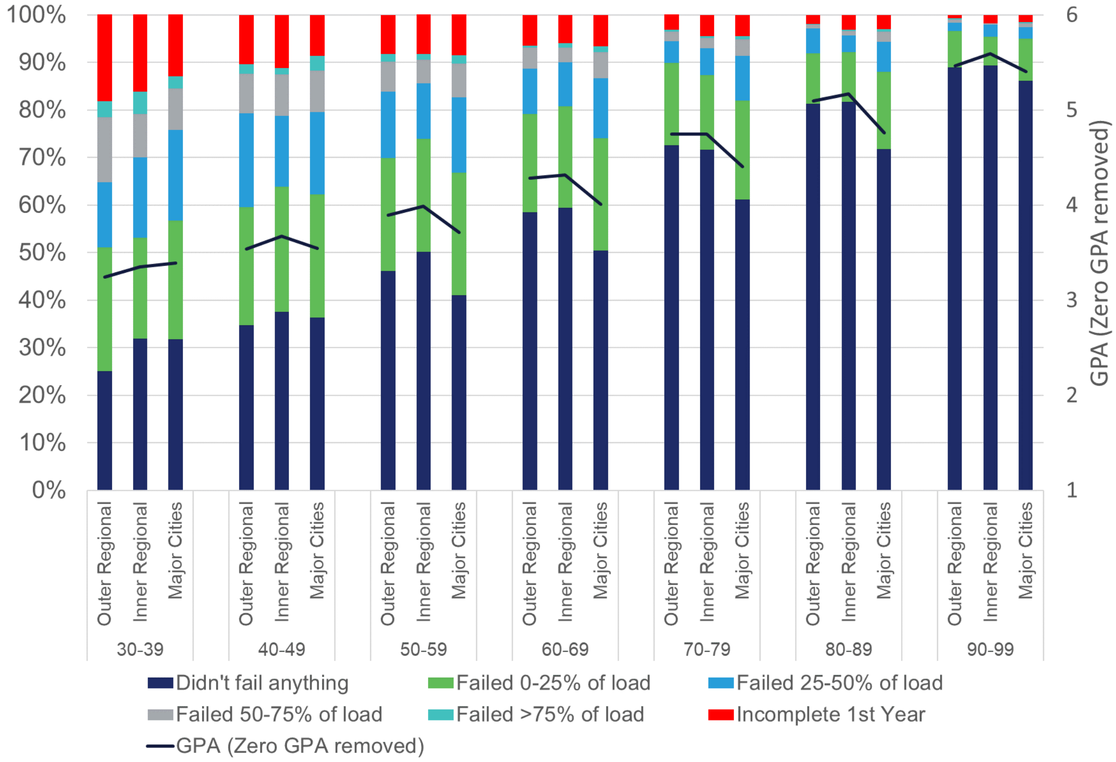


Figure 12 shows that Aboriginal and Torres Strait Islander students in first-year university generally perform to the level expected of their ATAR, but slightly outperform non-Aboriginal and Torres Strait Islander students with the same ATAR – particularly for ATARs above 80. This trend is consistent with Aboriginal and Torres Strait Islander students:

– being more likely to belong to a lower-IEO quartile and have a more remote background (as discussed in section 2.3.2), and

– having a slightly better pass/fail rate and GPA when compared with higher-IEO quartile students and those who reside in major cities (Figures 10 and 11).

At this stage, it is unclear whether Aboriginal and Torres Strait Islander students are underperforming in their ATAR or overperforming at university when compared to non-Aboriginal and Torres Strait Islander students.

Figure 12: First-year outcomes by ATAR and Aboriginal and Torres Strait Islander status.

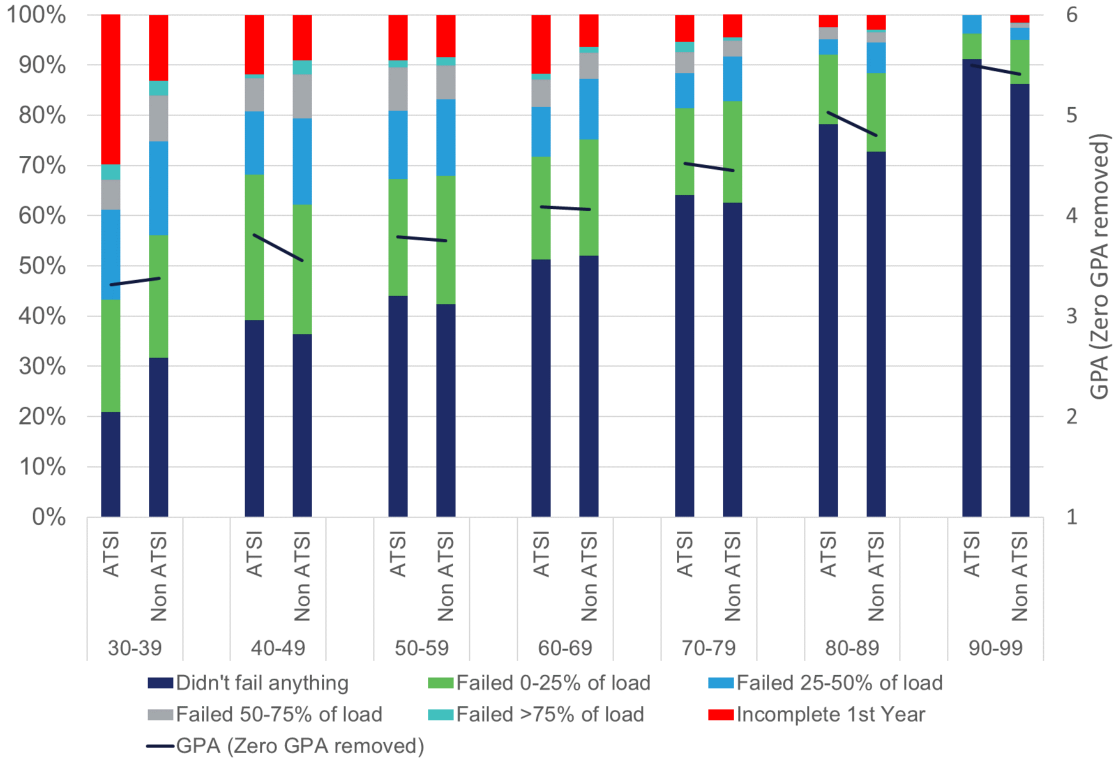


Figure 13 shows first-year outcomes by gender. Both genders display similar trends by ATAR and IEO quartile (as shown in Figure 10) – 4th IEO quartile students fail at slightly higher rates than lower-IEO students with the same ATAR. For ATARs above 90, there is little difference in pass/fail rates and resulting average GPA for the different genders; however, at ATARs below 90, there are distinct differences between the genders.

As ATARs decline, male students fail at higher rates than female students, which also results in a lower average GPA for males. This trend is consistent across IEO quartiles for students with the same ATAR and with other research (Birch and Miller 2006; Li and Dockery 2014; Messinis and Sheehan 2015). Research shows gender has an effect on university performance independent of IEO – females perform better than males when IEO has been accounted for. Further research to uncover the underlying reasons for males' underperformance at university may be of value.

Figure 13: First-year outcomes by ATAR, gender and IEO quartile.

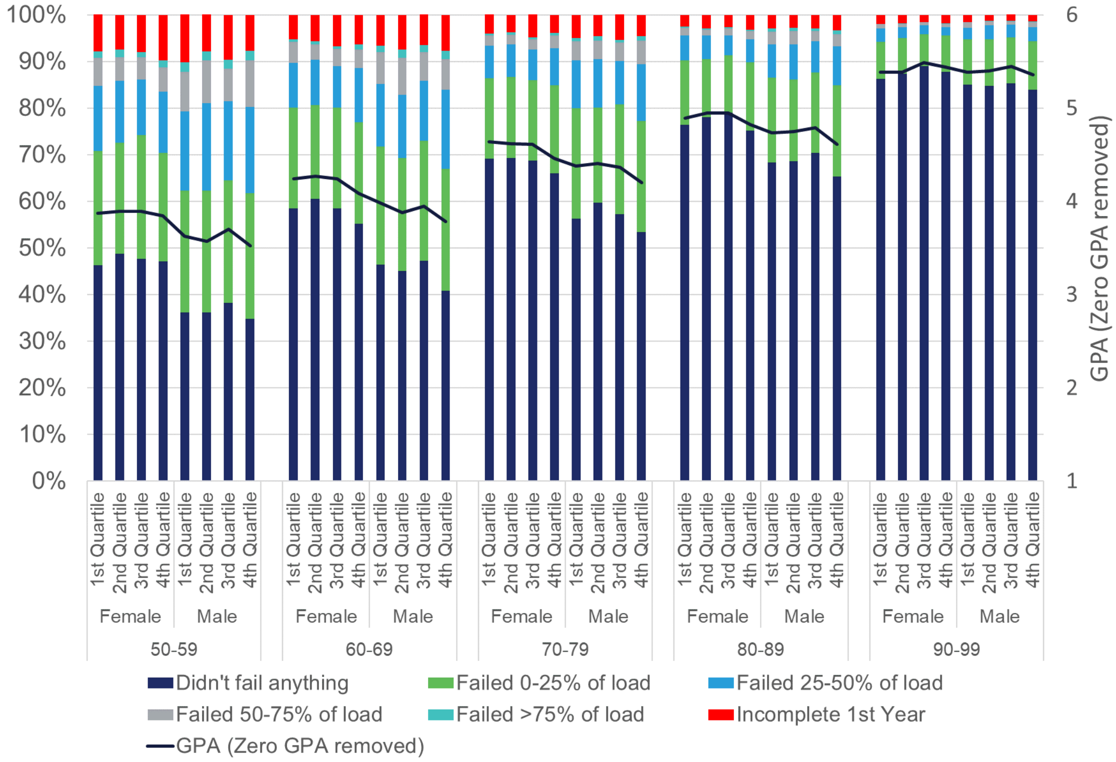


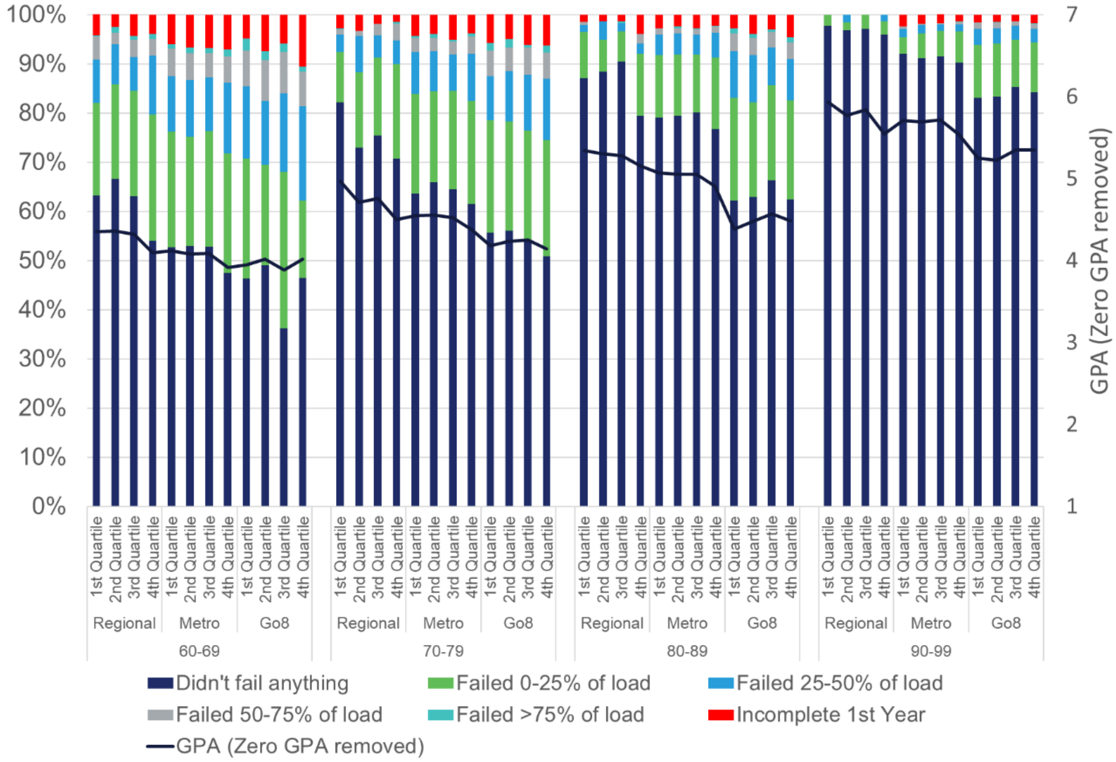
Figure 14 shows first-year outcomes for students enrolled at different types of universities. The trend for 4th IEO quartile students to fail at a slightly higher rate is still present; however, compared to other examples, it is much less pronounced. Students who attend the same type of university still tend to perform at a level expected of their ATAR, regardless of IEO.

For students with the same ATAR, there are differences in pass/fail rates between different university types – Go8 universities have slightly higher fail rates than metro and regional universities. *Note: Go8 includes USyd, UNSW and ANU, Metro includes UTS, MU, GU, UoN, UoW, ACU, UC and WSU, and Regional includes UTas, CSU, UNE, CQU, SCU and La Trobe*.

As Table 2 shows, Go8 universities enrol more students with higher ATARs, while regional universities enrol more students with lower ATARs. If universities deliver courses at a level appropriate to the majority of their students:

- lower-ATAR students would struggle when enrolled in a university where most students have high ATARs, and
- higher-ATAR students would perform better when enrolled in a university where most students have low ATARs.

Figure 14: First-year outcomes by ATAR, university and IEO quartile (ATARs >60).



While students generally perform at a level expected of their ATAR, Figures 10 to 14 show a definite trend: the slight under/overperformance in the ATAR or first-year university outcomes of the various disadvantage groups have:

– the smallest impact for students with ATARs above 90 and below 50, and

– the largest impact for students with ATARs between 50 and 90.

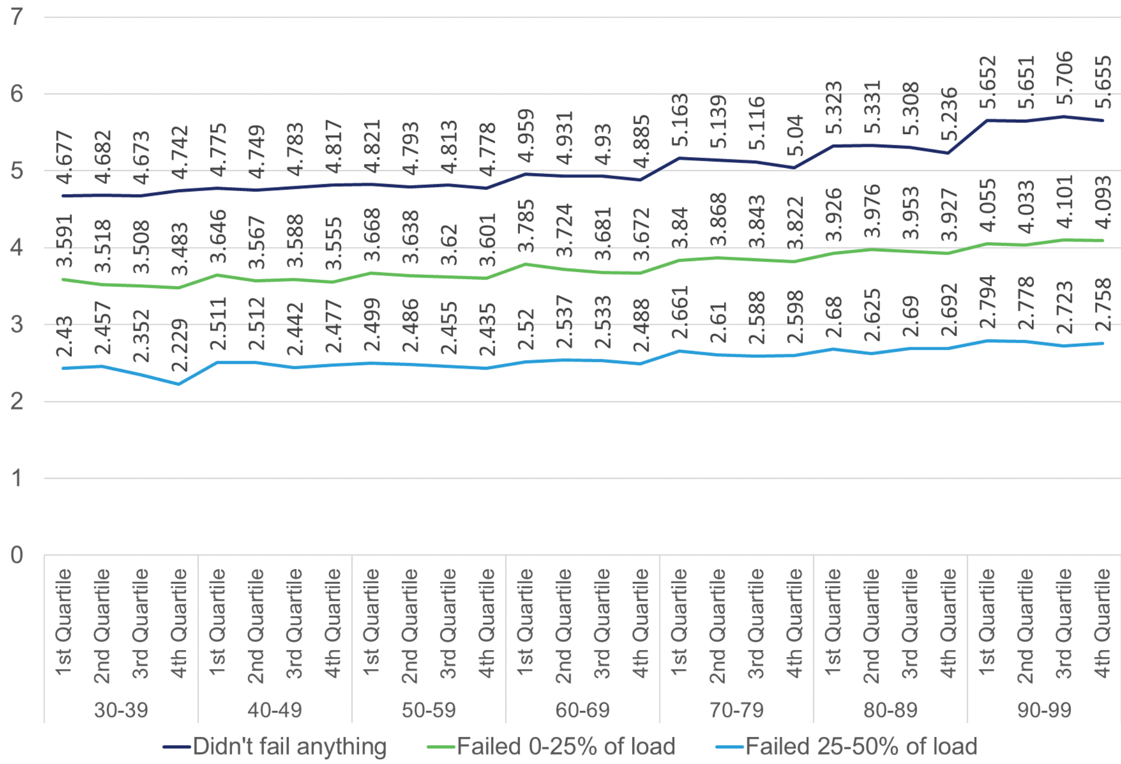
As Table 2 shows, this trend can be partly explained by the different pass/fail rates of the university types, and proportion of students enrolled in the different university types by IEO quartile.

Several other factors may also contribute to this effect. Firstly, the aggregates that underlie ATARs are more clustered in the mid-ATAR ranges between 50 and 90, and – for ATARs above 90 and below 50 – are more spread out. This means that the same magnitude of change in the aggregate, say 1.0, would lead to a larger change in the rank for ATARs between 50 and 90, than it would be for ATARs above 90 or below 50.

Similarly, the difference between passing and failing a subject has a much larger effect on GPA than the difference between a pass and a credit (section 2.1.6). It is unclear why higher-IEO students tend to fail one or more subjects at a slightly higher rate; however, the difference in GPA (shown in the above Figures) is mostly driven by the difference in pass/fail rate. As Figure 15 shows, students from different IEO quartiles with the same ATAR who didn't fail anything have much closer average GPAs.

Also, the ATAR is a snapshot in time. While large changes in performance are unlikely in a single year, the small changes we observe here are possible. As discussed, research has found that disadvantaged groups are behind advantaged groups at all milestones of development (Lamb et al. 2015). It is possible that these students are, on average, catching up at university. It is also likely that, in school, high-IEO students (with greater economic resources) were given more parental and social support and made more use of outside tuition than their low-IEO peers. If this practice does not continue into first-year university, lower-IEO students could close this gap. More research in this area may be of value.

Figure 15: First-year GPA by pass/fail rate, ATAR and IEO quartile.

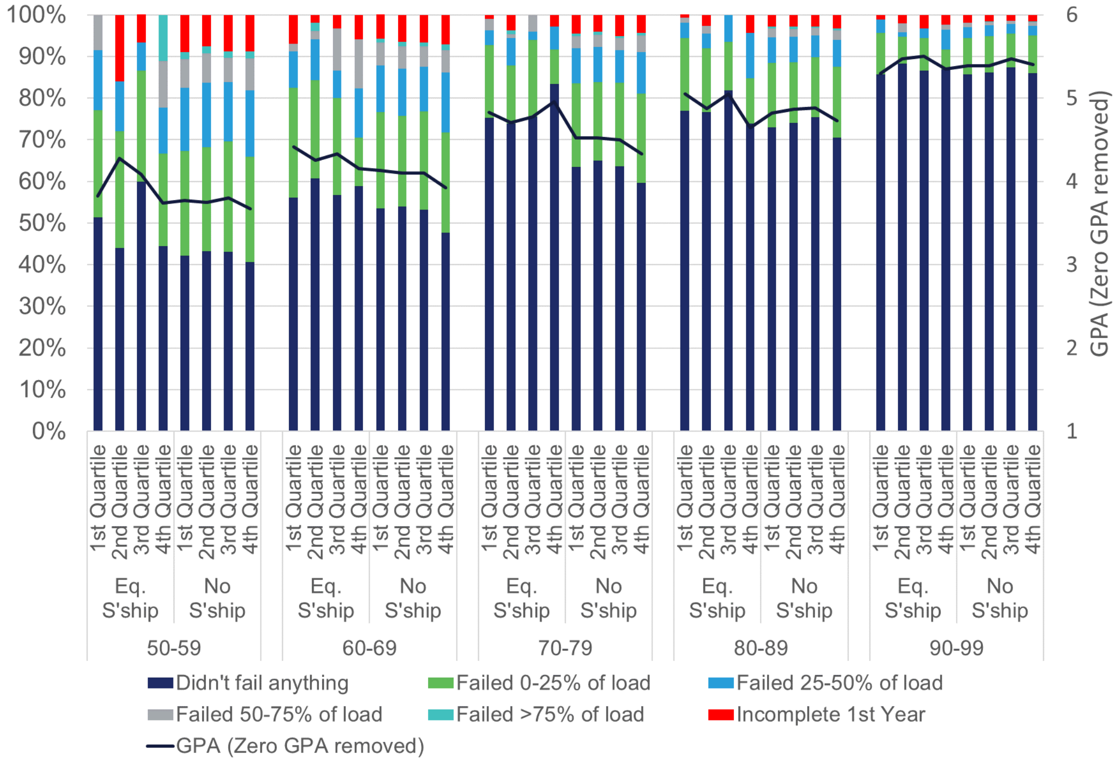


If we consider students with the same ATAR and IEO quartile, those who receive an equity scholarship generally have slightly lower fail rates – and, as a result, slightly higher average GPAs – than those who did not (Figure 16).

Again, this effect is weakest for students with an ATAR above 90 or below 60 and strongest for students with an ATAR in the 70s. As with other factors already discussed, pass/fail rate is the biggest driver in average GPA difference between equity scholarship recipients and non-recipients. For students who do not fail anything, receiving an equity scholarship makes little difference to their average GPA.

If we consider students with the same ATAR, those who receive an equity scholarship record fewer incomplete first-years (ie they fail all subjects) than those who did not. This suggests that while equity scholarship recipients do not necessarily perform above a level expected of their ATAR (in terms of the marks they attain), they appear to be more resilient or motivated in completing first year. This would improve the retention rates of recipients, as first-year results are a good predictor of completion rates.

Figure 16: First-year outcomes by ATAR, equity scholarship and IEO quartile.



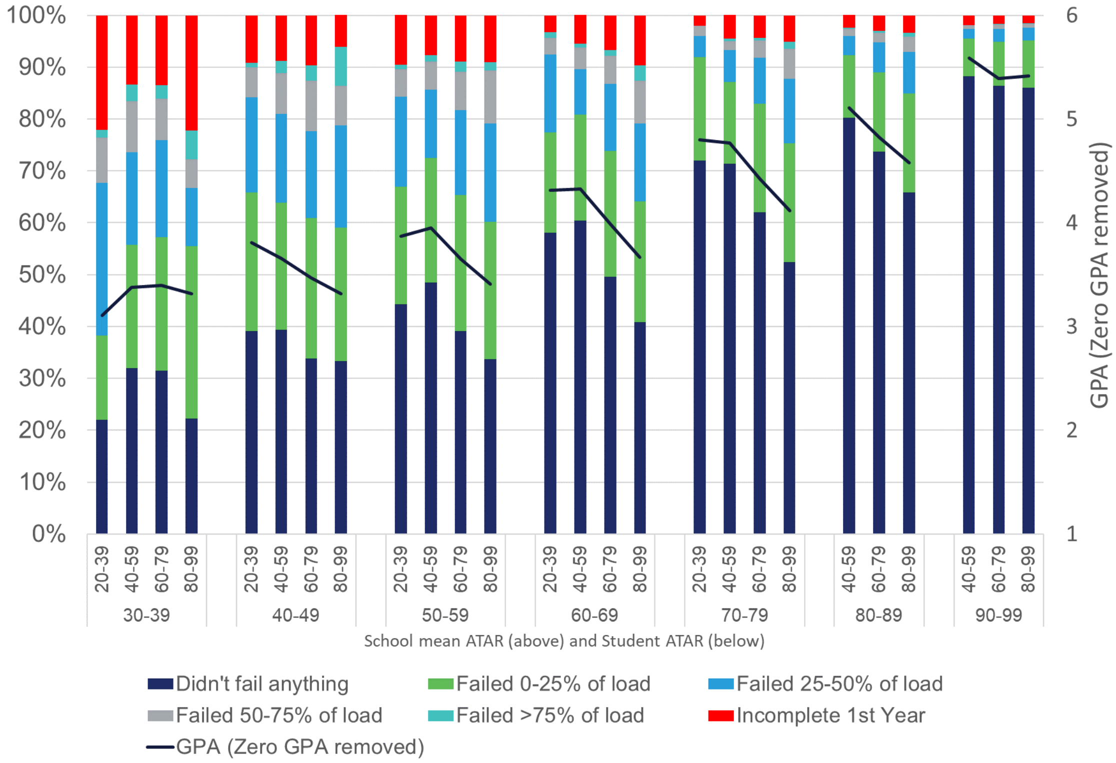
3.1.2 First-year outcomes by school factors

As discussed in section 2.3.3, there is an intricate relationship between the disadvantage categories of students and the characteristics of the school they attended. As a result, and as Figure 17 shows, there is a relationship between the outcomes and disadvantage profiles of students who attend schools with particular characteristics.

For students with an ATAR above 90, school mean ATAR has a small effect on first-year pass/fail rates and GPA (Figure 17). For students with an ATAR below 90 who attended a school with a mean ATAR above 60, there is a distinct increase in the fail rate and resulting reduction in GPA. This effect is more salient for ATARs in the 60s and 70s and less so for ATARs below 50.

As discussed in section 2.3.3, these schools tend to be larger and located in major cities with higher proportions of 4th IEO quartile students. It is unclear whether this represents ATAR overperformance or underperformance during first-year university; however, it is most likely related to the effects discussed in section 3.1.1. This incidence of ATAR overperformance/first-year underperformance is similar for higher-IEO students.

Figure 17: First-year outcomes by ATAR and school mean ATAR (small sample size removed).



To varying degrees, first-year university student outcomes continue this trend for the other school characteristics. The Appendix (section 7.1) shows examined outcomes for other school characteristics without further commentary; however, we will discuss their overall effect on outcomes in section 3.2.4.

3.1.3 First-year outcomes by secondary subject selection

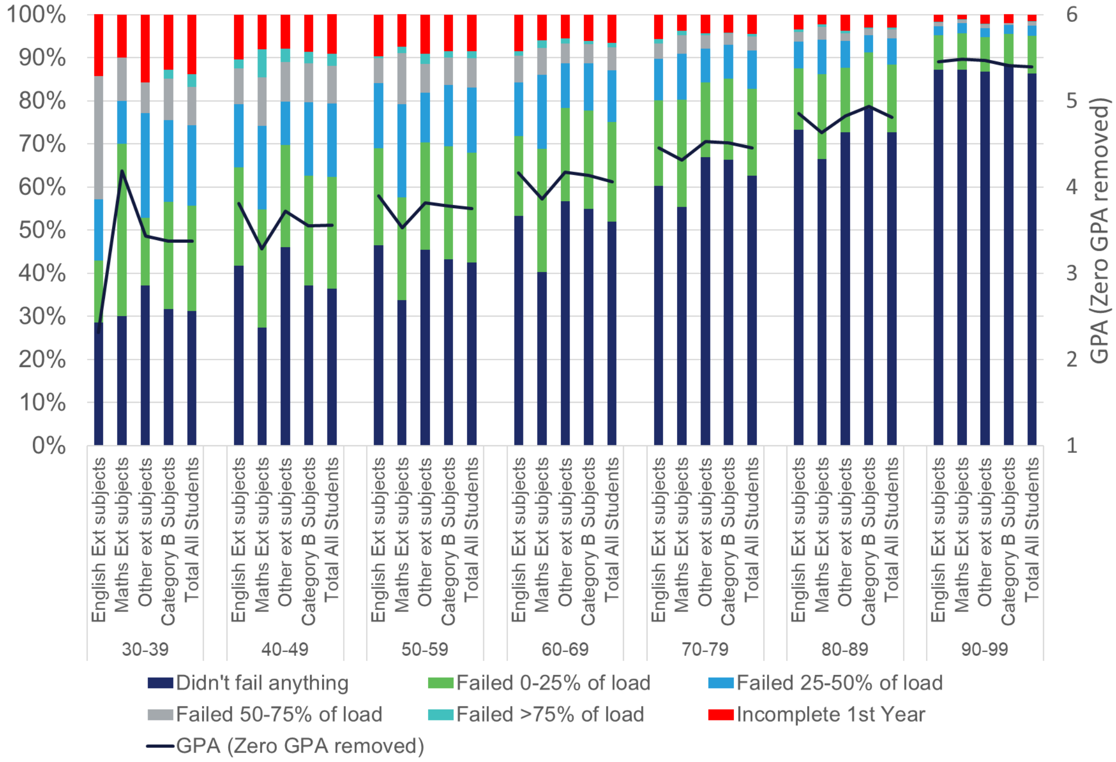
HSC students can select from a wide range of subjects which can count towards their ATAR. These include Board Developed courses and vocational education and training (VET) courses, known as Category B subjects for ATAR purposes. Many Board Developed courses have an extension-level course available in which the student studies one extra unit; these courses are usually more in-depth than the 2-unit course and allows the student to specialise. As mentioned earlier, students tend to select subjects according to their ability (Manny et al. 2020), and this is true for student's studying Category B and extension subjects.

For comparison, subjects have been classed into five groups (Figure 18). The first two are English Extension and Mathematics Extension subjects – the two most common extension subjects. All other extension subjects and all Category B subjects were grouped together. All other Board Developed courses were grouped together, which represents the 'Total All Students' group (as a student must study a number of these courses to qualify for an ATAR). It is possible for a student to be included in more than one of these groups depending on their chosen subjects.

As Figure 18 shows, the outcomes for students with an ATAR above 90 are very similar, regardless of the HSC subject groups studied.

Patterns emerge at lower ATARs. Students with ATARs in the 50s to 80s who studied Category B, English Extension and other extension subjects tend to have a slightly better pass/fail rate and higher GPA than those who studied a Mathematics Extension subject. It is unclear if these students under/overperform in their ATAR or under/overperform during first-year university.

Figure 18: First-year outcomes by ATAR and subject group.



For students with an ATAR above 90 who studied English Extension, Mathematics Extension or Category B subjects, there is little difference in first-year outcomes for the different IEO quartiles (Figures 19, 20 and 21).

For ATARs between 60 and 90, we see a similar outcome pattern (Figure 10): 4th IEO quartile students have slightly higher fail rates and a lower average GPA than lower-IEO students. For ATARs below 60, the pattern is less consistent; however, the proportion of these English Extension or Mathematics Extension students is significantly lower.

Figure 19: First-year outcomes of students who studied English Extension subjects by ATAR and IEO quartile.

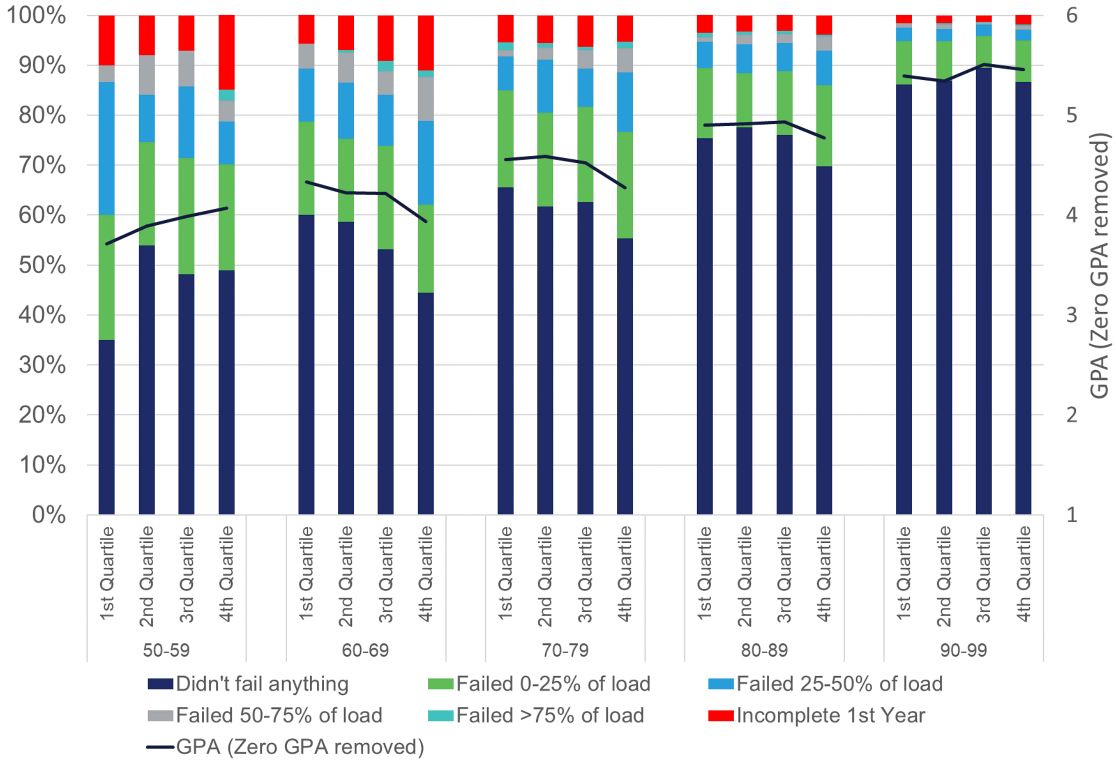


Figure 20: First-year outcomes of students who studied Mathematics Extension subjects by ATAR and IEO quartile.

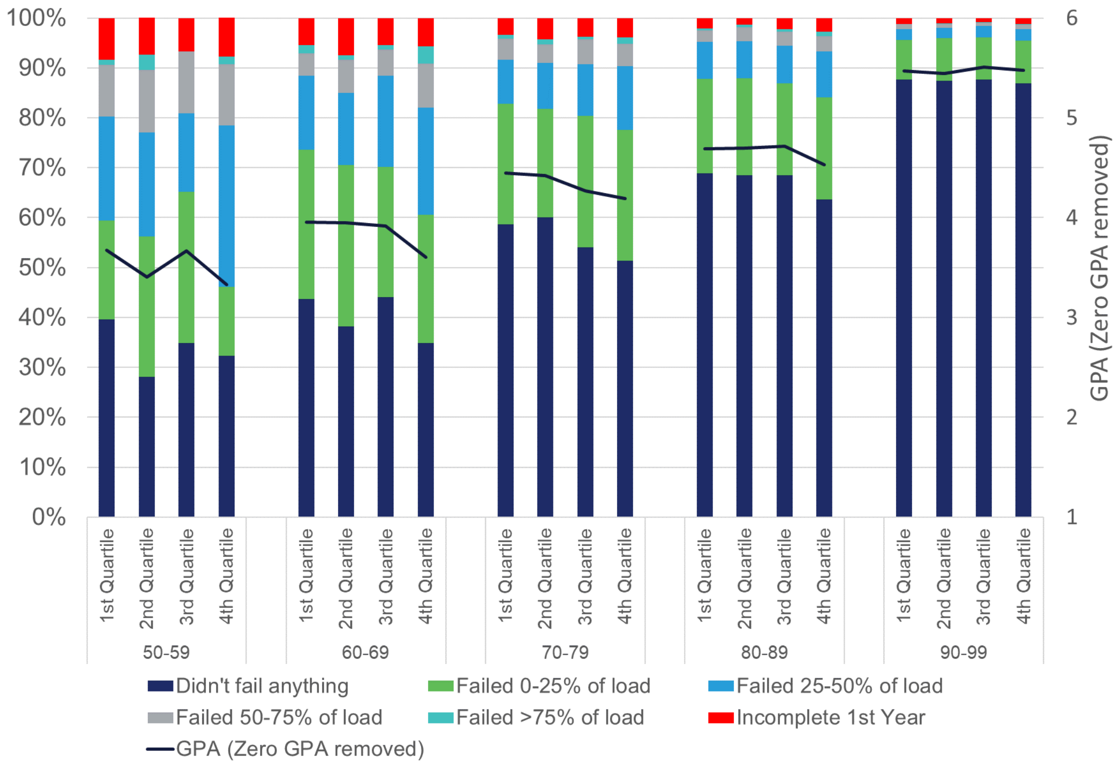
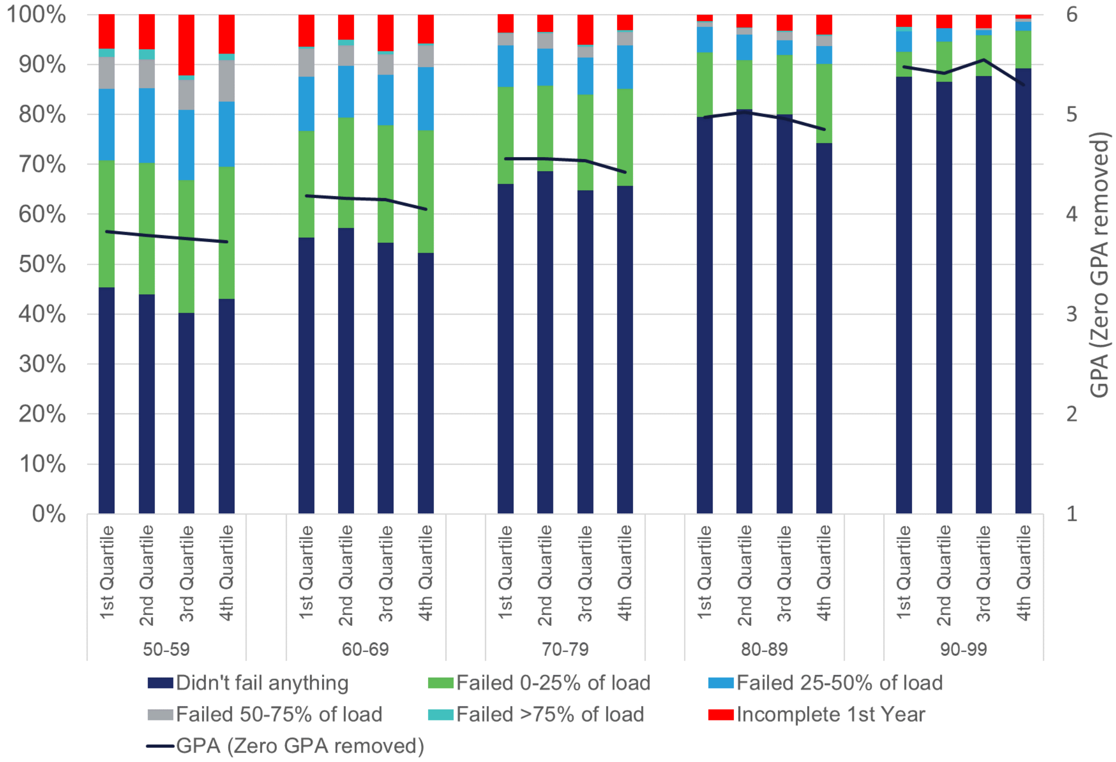
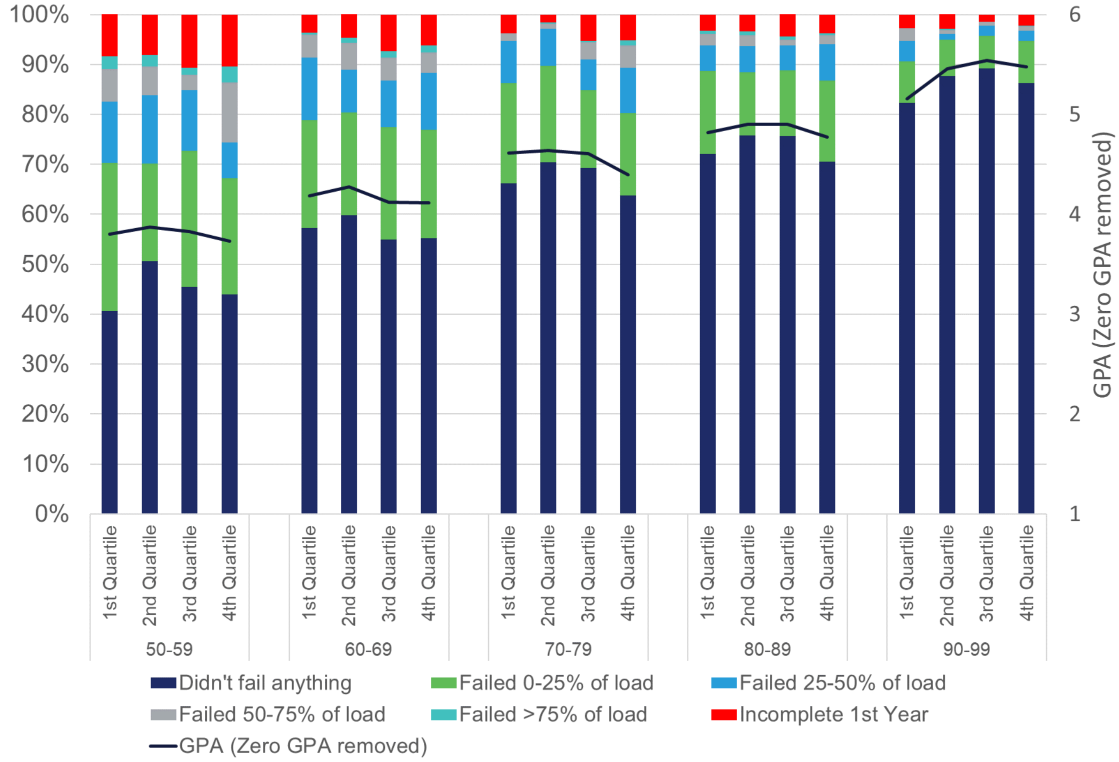


Figure 21: First-year outcomes of students who studied Category B subjects by ATAR and IEO quartile.



1st IEO quartile students who studied other extension subjects (Figure 22) vary slightly from the overall pattern described above. 1st IEO quartile students also fail at slightly higher rates and have a slightly lower-average GPA than their 2nd and 3rd IEO quartile peers – in the same way as 4th IEO quartile students do for all ATARs (including those above 90). The large variation between subjects included in this group may contribute to this observation. Further study in this area may be of value.

Figure 22: First-year outcomes of students who studied other extension subjects by ATAR and IEO quartile.



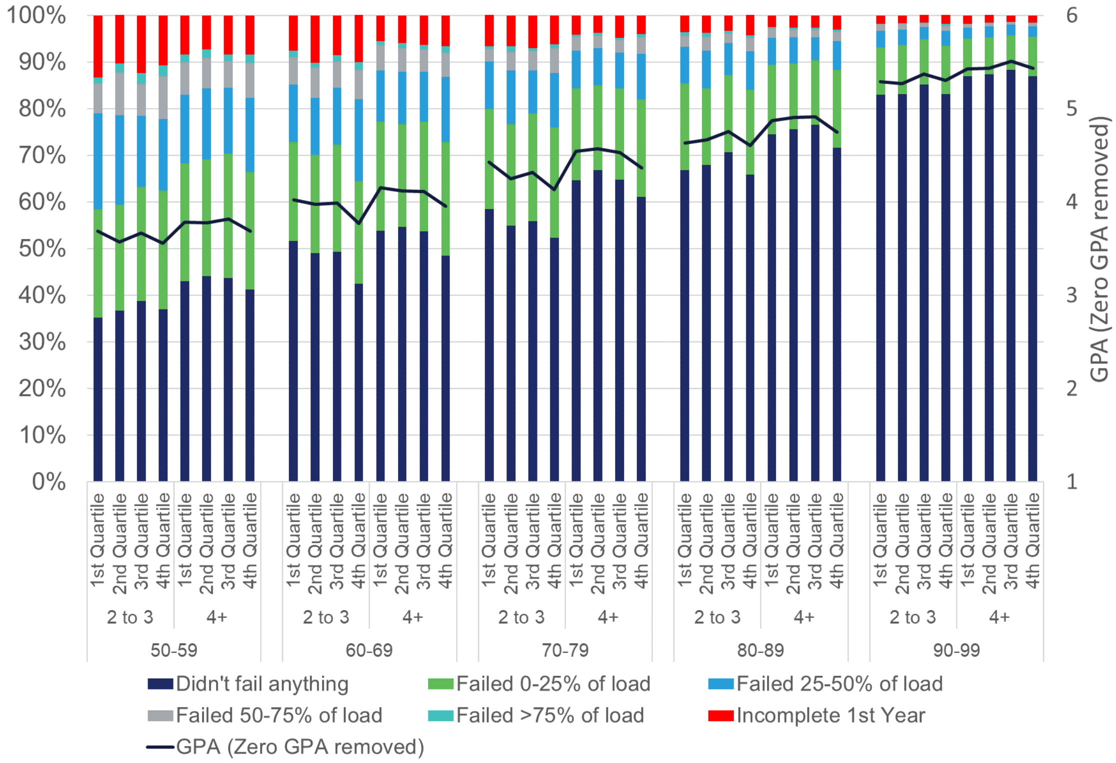
To examine student outcomes by the number of HSC key learning areas (KLAs) studied (Figure 23), students were divided into two groups:

1. those who studied two or three KLAs (defined as specialising students), and
2. those who studied four or more KLAs (defined as students with a broader study pattern).

Both groups exhibit the same general trend shown in Figure 10: 4th IEO quartile students fail at a slightly higher rate than lower-IEO students with the same ATAR. For students with ATARs above 90, there is a small difference in pass/fail rate and resulting average GPA between the two groups; however, for ATARs below 90, there are larger differences between them.

As ATARs decline, specialising students fail at higher rates and have a lower-average GPA than students with a broader study pattern. For students with the same ATAR, this trend is consistent across IEO quartiles. The cause of this trend is not known; however, students studying a broader range of HSC subjects may have an advantage in first-year university (as students are required to study a broad range of first-year subjects). More research in this area may be of value.

Figure 23: First-year outcomes by ATAR, number of key learning areas (KLAs) studied and IEO quartile.



In summary, the first-year outcomes shown in this section are more closely related to the individual students' ATAR and disadvantage profile than any variation caused by any interaction of disadvantage and the choice of subject level studied. Regardless of whether they experience any socio-economic disadvantages, students still generally select subjects according to their ability (as shown in section 2.3.4).

3.2 Exploring the impact of different factors on the ATAR and first-year GPA

3.2.1 XGBoost predictive model and SHAP value

In this section, we describe the machine learning techniques used to explore the impact of different types of disadvantage on students' academic performance in secondary and tertiary contexts. Specifically, ensembles tree predictive models were developed using XGBoost (Chen and Guestrin 2016) to predict students' academic performance using SES indices as features for training.

Decision tree models are classic yet powerful algorithms for solving classification or regression problems in the machine learning domain. This technique partitions the training dataset into subsets with binary splits on all branches according to certain splitting criteria. The partition approach is completed when the model is able to predict the output based on input data with acceptable accuracy. This type of prediction model takes its name from the way that the trained model resembles a tree with the start splitting point as its root.

XGBoost is a machine learning algorithm that is widely applied in machine learning projects. The algorithm implements gradient boosted decision trees. The benefit of using XGBoost is that it produces an importance score for each feature used in the model. The importance score indicates how useful the feature is in the construction of the decision trees within the model.

Thus, in our model, the importance of each SES index on students' academic performance could be inferred by its score.

To further interpret our trained XGBoost models in terms of feature importance and the relationships among its features, we applied the SHapley Additive exPlanations (SHAP), technique (Lundberg and Lee 2017). In this analysis, SHAP values are obtained by incorporating concepts from cooperative game theory. Given a set of players, cooperative game theory defines how to fairly distribute the payoff amongst all the players that are working in coordination. In the game, the independent input features are the players, and the payoff is the difference between the average prediction of the instance minus the average prediction of all instances. With this model design, we are able to calculate the SHAP value for each feature, which represents the change in the expected model prediction when conditioning on that feature. The calculation of SHAP value is a relatively complex process, but intuitively, the SHAP value explains the difference in the model prediction when the given feature was used versus when it was not.

To determine the impact of SES indices on different stages of academic achievement, we built two predictive XGBoost models and analysed them using the SHAP technique. The first model predicted Year 12 students' ATARs based on the following inputs: the students' demographic characteristics, their SES indices, the high school attended and subjects studied at school. The second model predicted these students' first-year university GPA using the same features from the first model, but with added inputs including the students' enrolled institution, field of study of the enrolled university course, students' ATARs and whether a scholarship was taken. The technical details in preparing the data and training these two models are described in section 7.2. The following sections will focus on comparing the importance of various features in the prediction of the ATAR and first-year GPA. We will also discuss the relationships between some of these features and how they contribute to the prediction of students' academic performance in high school and at university.

3.2.2 Overall effect of disadvantage and related features on the ATAR and first-year GPA

After training the XGBoost models, SHAP values for all features were extracted to compare their importance. Figures 24 and 25 show the feature importance measured by the average absolute SHAP values of each feature. Note that a feature may have a positive or negative SHAP value which means it may positively or negatively impact the prediction result (this will be further explained below). Here, the focus is on the importance of features or the size of impact, so the absolute SHAP value of each feature is presented here. Additionally, the same feature would have different levels of impact on different students due to its interaction with other features when predicting students' results. Thus, the average absolute impact on all students is reported here to measure the importance of input features.

As Figure 24 shows, the highest level of English and the highest level of mathematics are the two most important features in predicting a student's ATAR. The values on the bar charts are the average absolute SHAP values. As the ATAR is normalised from its range of 0 to 99.95 to a range of 0 to 0.9995 in this analysis, we can think of the SHAP value as the average change in normalised ATAR as a result of being impacted by a particular feature. For instance, the highest level of English taken by the student at high school was found to affect 0.0754 (or 7.54 per cent) of normalised ATARs on average. Following the highest level of English and mathematics taken by the student, the next most important factor on the ATAR was school mean ATAR, with an average absolute SHAP value of 0.0461. Of the demographic and SES indices, gender and residential IEO rank were the most important features.

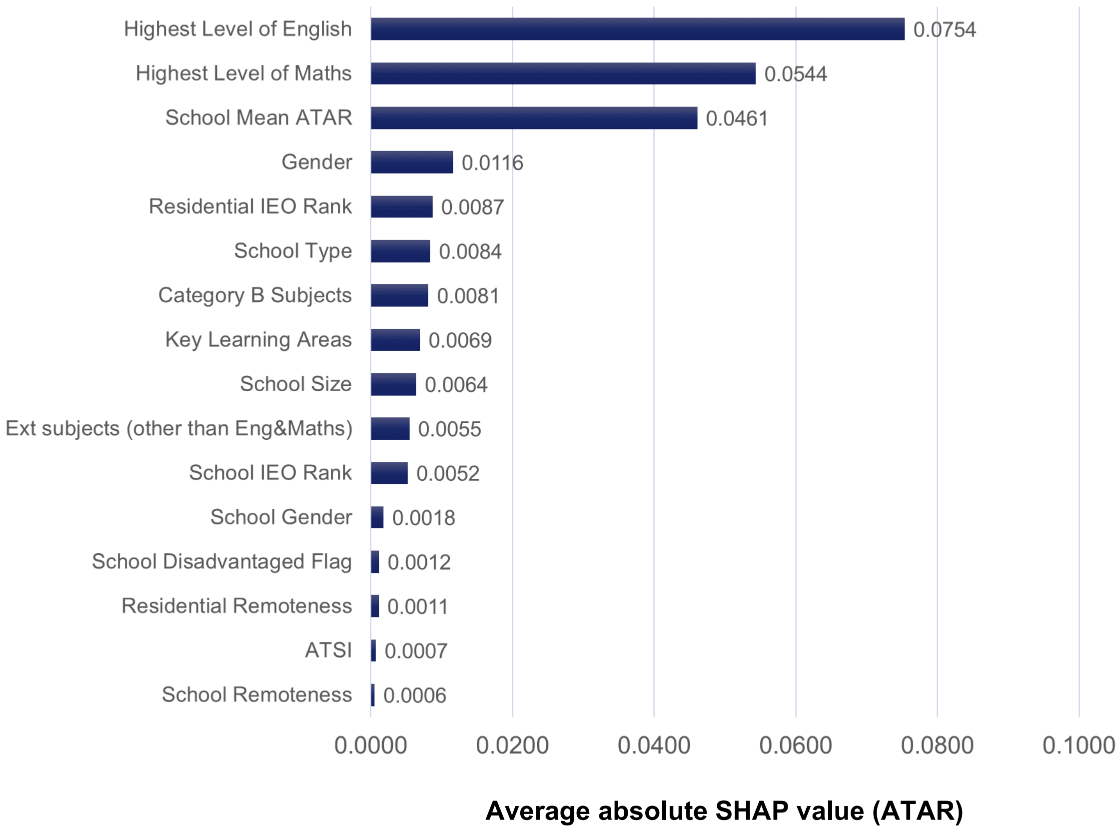
For comparison, the average absolute importance for the ATAR of the highest level of English studied (0.0754) is 6.5 times that of the average absolute importance of gender (0.0116) and 9 times that of residential IEO rank (0.0087). This finding is consistent with previous research showing some influence of SES and student's gender on academic performance in high school.

Other school-based factors (eg school type, school size, school's IEO) and subject-based factors (eg number of key learning areas, Category B subjects and extension subjects taken by the student) had medium impact on the ATAR.

Finally, school gender (ie whether school was single-sex or co-ed), remoteness of student's residence, and other individual's demographic characteristics, such as Aboriginal and Torres Strait Islander status, had the least impact on the ATAR. The effect of these features on the ATAR will be discussed further in later sections.

It is important to remember that studying higher levels of English or mathematics, or attending a school with a high mean ATAR, does not necessarily lead to a higher ATAR for the individual. As discussed in earlier sections and in prior research, students tend to select subjects according to academic ability, which may also extend to school selection. This finding simply reflects that students of higher academic ability tend to choose certain subjects and possibly schools. In the absence of any other available data, it is possible that subject and school selections could be loosely regarded as proxy measures for academic ability and family attitude or expectation towards educational achievement. Similarly, limitations associated with remoteness and resources could affect these choices. Also, these choices are time dependent and represent academic ability in the senior years of high school and first-year university. The effects of disadvantage factors over time have not been investigated here.

Figure 24: The average impact of all features on the ATAR as measured by average absolute SHAP value.



In the model predicting first-year GPA, the ATAR emerged as the dominant feature. In our analysis, first-year GPA was normalised from a range of 0 to 7 to a range of 0 to 1. As Figure 25 shows, the ATAR was found to affect 0.0971 of normalised first-year GPA on average. In this case the ATAR now becomes a more direct measure of academic ability, replacing the proxy highest level of English and Mathematics choice seen previously in Figure 24. Following the ATAR, other features, in order of importance, were field of study of the enrolled university course and the enrolled university group. In our model, the field of study consisted of 12 categories and enrolled universities were classified into three groups: Go8 universities, metro universities and regional universities. Students may also select field of study and university according to their academic ability in the same way HSC students select subjects and schools as previously discussed. These two features will be discussed further in section 3.2.6.

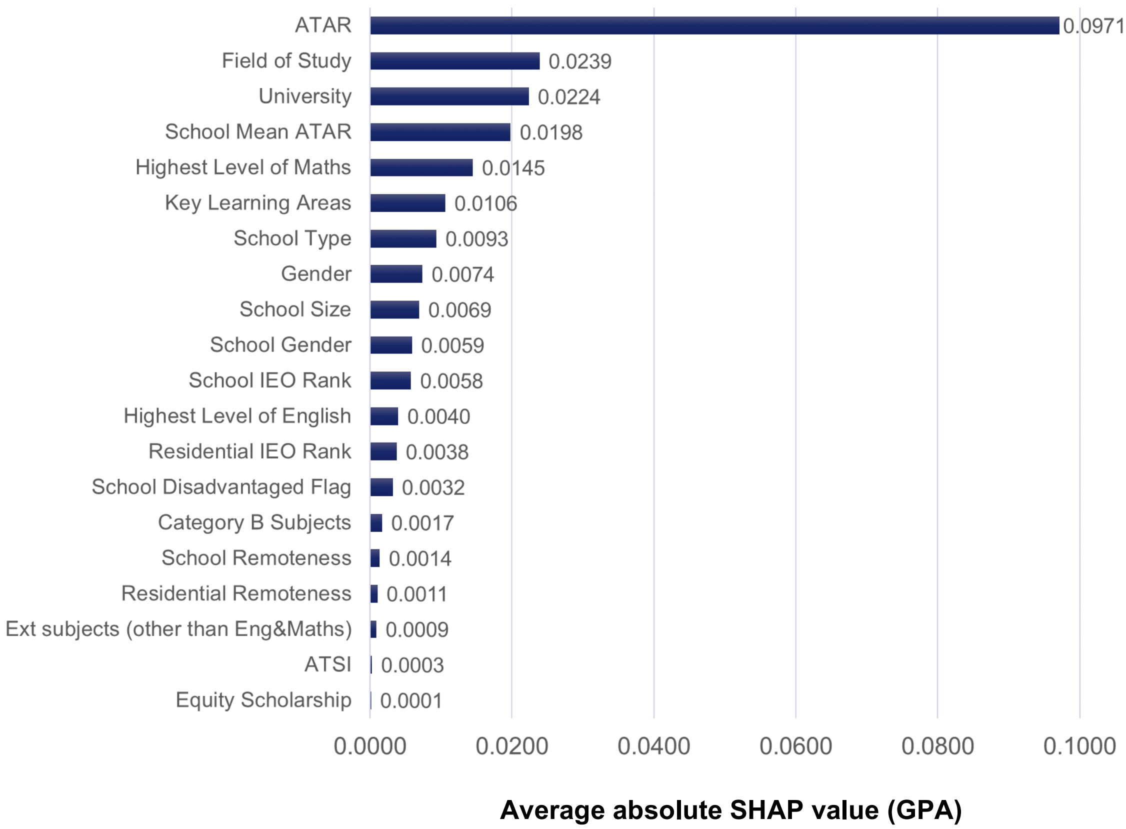
Compared to the model predicting students' ATARs, school mean ATAR and the highest level of mathematics played a less important role on first-year GPA – but still exerted medium impact; however, the highest level of English studied at high school had much less impact on first-year GPA than it had on students' ATARs.

Of the demographic and SES indices, gender and residential IEO rank continued to be the most important features; however, they were further down the rank of average absolute importance than in the ATAR model.

For comparison, the average absolute importance for GPA of the ATAR (0.0971) is 13 times that of gender (0.0074) and 26 times that of residential IEO rank (0.0038). Similar to the model predicting ATARs, other school- and subject-based factors showed medium impact on first-year GPA, while remoteness of student's residence and Aboriginal and Torres Strait Islander status again showed little impact.

Finally, the presence of an equity scholarship had the least impact on first-year GPA, possibly because only a small proportion of students received this scholarship offer. Nonetheless, this group of students is of interest, and patterns identified in minority groups such as Aboriginal and Torres Strait Islander and equity scholarship students will be discussed in later sections.

Figure 25: The average impact of all features on first-year GPA as measured by average absolute SHAP value.



The bar charts above demonstrate the importance of each feature within the predictive model; however, it remains to be seen how the distribution of input features affect the predicted variable, either positively or negatively. To this end, a summary plot of all features for each of the two models are shown in Figures 26 and 27.

On these charts, input features are sorted by their importance. For each feature, each dot represents a single student. The 'blotches' reflect the density of students with that particular SHAP value; that is, blotch thickness represents the number of students with that SHAP value on that feature. The x-axis value of a dot represents the impact of the feature for that student. Note that both positive and negative SHAP values are presented in the plot rather than the absolute values used previously in Figures 24 and 25. Finally, the colour of the dot represents the value of the feature for that student.

As Figure 24 shows, the highest level of English studied by the high school student had the highest importance for the ATAR. In Figure 26, a high value on this feature denotes that the student studied a higher level of English (eg English Extension 1 or 2) while a low value means that they studied a lower level English course (eg English Standard). The summary plot therefore shows a strong relationship between high level of English studied and positive impact on ATARs. The highest level of mathematics studied shows a similar pattern. It is worth noting that for some students, this is the most important feature affecting their ATAR.

School mean ATAR also has a strong positive relationship with the ATAR, although the magnitude of the impact from schools with low-mean ATAR (in the negative direction) appears to be greater than from schools with high-mean ATAR (in the positive direction); however, from the density distribution of this feature, we can see that school mean ATAR has more positive than negative impact on students' ATAR. We can also see that, from the gender feature, being female has a positive impact on ATAR whereas being male has a negative impact (females are denoted by a feature value of 0 (blue) and males by 1 (red)). This is reflected in females attaining higher average ATARs than males during the period that this data covers.

Residential IEO rank also has a positive relationship with the ATAR – higher ATARs corresponding to higher IEO ranks of the students' residences; however, as with school mean ATARs, the low residential IEO rank's impact on the ATAR is greater. Although some features have a low impact on ATARs overall (eg Aboriginal and Torres Strait Islander status or whether extension subjects other than English and mathematics were taken), they produced clear ATAR patterns. For instance, Aboriginal and Torres Strait Islander status has a negative impact on ATARs for most students.

Figure 26: The summary plot of all features on the ATAR (*feature uses categorical values).

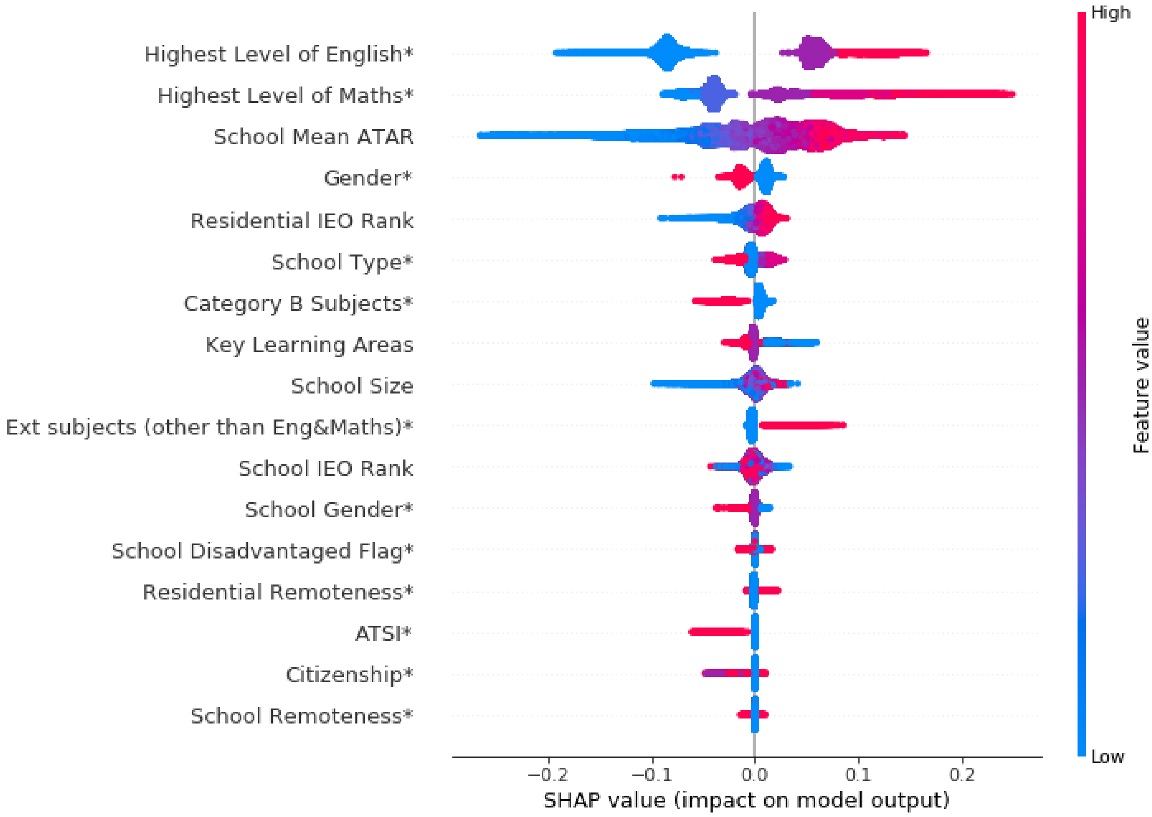
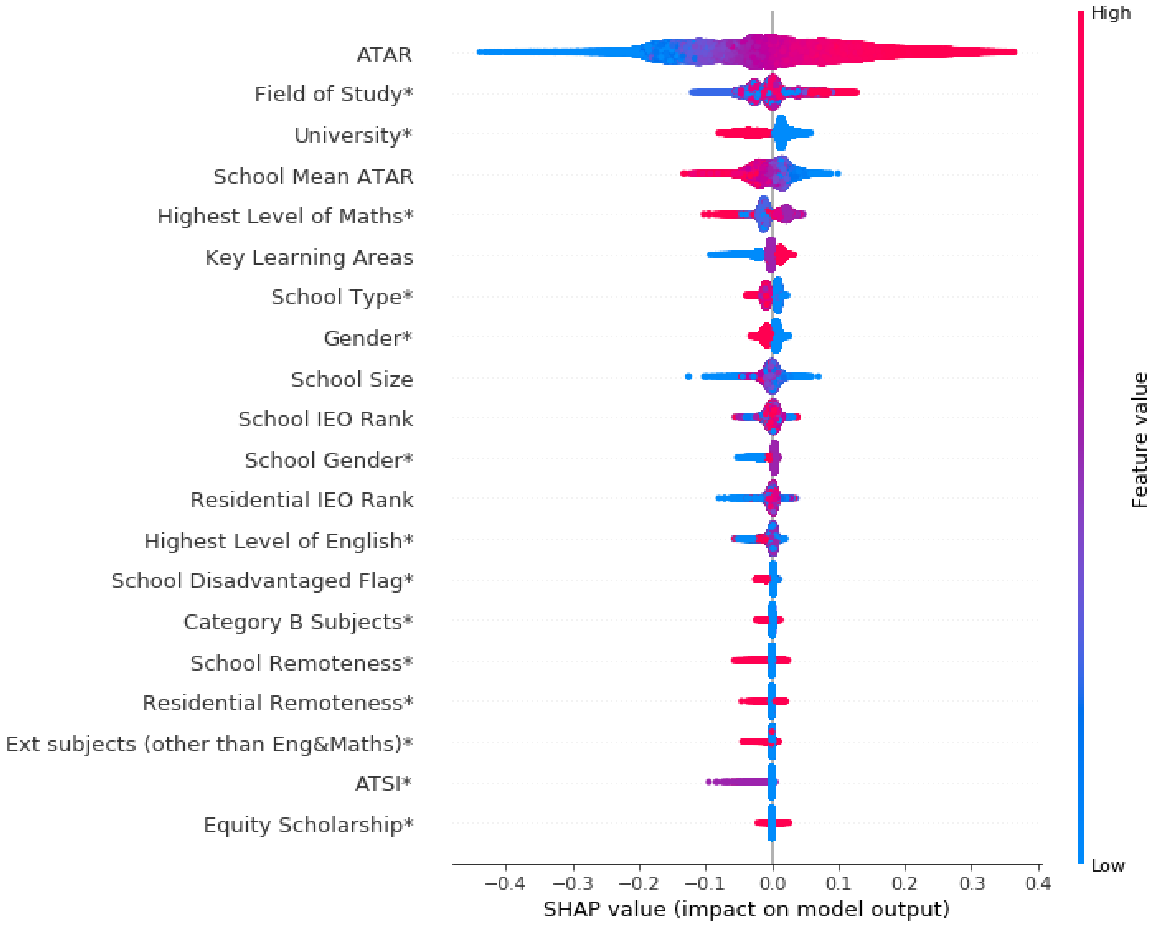


Figure 27 shows the summary plot of the model predicting first-year GPA. There is a strong positive relationship between the ATAR and first-year GPA. The ATAR was found to affect up to 0.4 of the normalised first-year GPA in both positive and negative directions. The next two factors with the largest impacts were the field of study and university group in which the student enrolled. Because these two features use categorical data, we cannot infer here whether they have a positive or negative effect on GPA. We will analyse them in detail in section 3.2.6.

School mean ATAR continues to exert a relatively large influence on first-year GPA; however, it has a negative effect on GPA. We will contrast the impact of school mean ATAR on ATAR and first-year GPA in section 3.2.4. Interestingly, compared with their impact on the ATAR, the highest level of mathematics and the number of KLAs studied have the opposite influence on first-year GPA for some students.

Lastly, although the equity scholarship has the least impact on GPA, the scholarship appears to have either a positive or negative impact, perhaps depending on other factors (eg the ATAR). Similarly, there are other features that have minor impacts on GPA, which we will discuss in the following sections.

Figure 27: The summary plot of all features on first-year GPA (*feature uses categorical values).

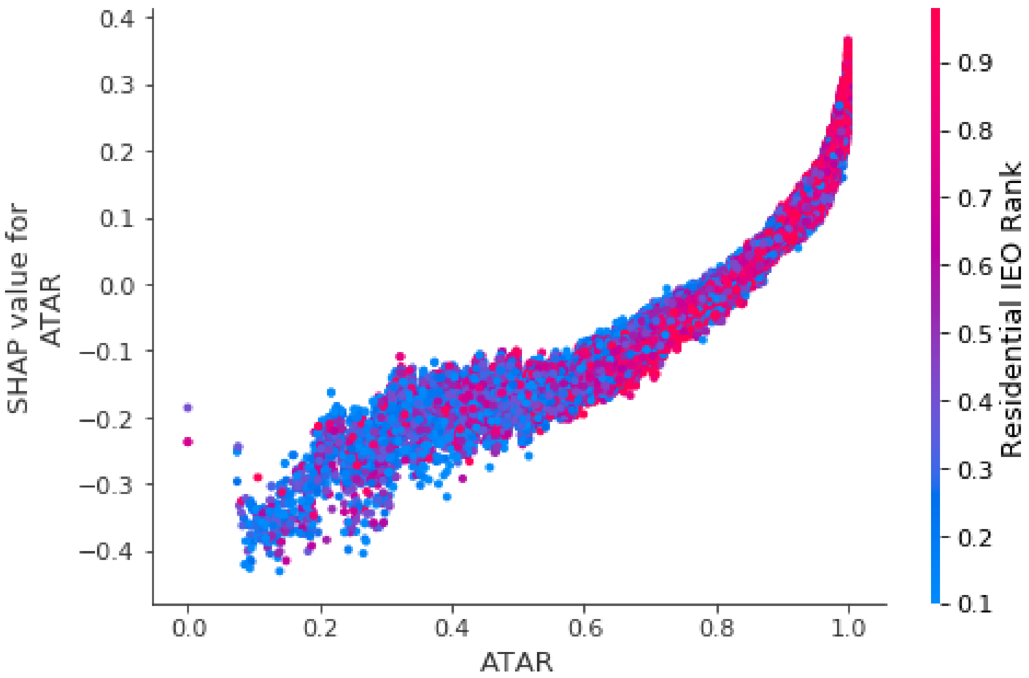


The ATAR is the dominant feature in predicting first-year GPA. A detailed dependence plot of the ATAR predicting first-year GPA is shown in Figure 28. More specifically, this dependence plot also shows the interaction effect between the ATAR and residential IEO rank on GPA. In this plot, each dot represents a first-year university student. The x-axis is their normalised ATAR value from 0 to 0.9995, representing their actual ATARs from 0 to 99.95. The colour of the dot represents the value of the student's residential IEO rank. The y-axis value is the impact of the students' ATAR on their first-year GPA, which is measured by the SHAP value.

The ATAR has a strong impact on GPA, which seems to strengthen as the ATAR increases; its impact increases dramatically when the ATAR is greater than approximately 90 (the normalised ATAR >0.9 on the plot). Depending on other features' contributions, the same ATAR for different students could have a different impact on their first-year GPA. On average, the ATAR has a positive impact on first-year GPA when it is greater than 80 and has a negative impact when it is less than 80. Additionally, the impact on first-year GPA becomes more varied among low-ATAR students, which suggests that, for these students, first-year GPA was affected more by factors other than the ATAR.

Both high and low residential IEO rank students are represented using different colours in the entire range of ATARs; however, there are fewer low residential IEO rank students among high ATARs. In contrast, for ATARs less than 60, low residential IEO rank students become the majority. This interactive effect shows that although the residential IEO has less impact on GPA than it has on the ATAR, through its interaction with the ATAR, it exerts an indirect influence on GPA.

Figure 28: The impact of the ATAR on first-year GPA interacted with residential IEO rank.



In summary, the order of importance for impact on both the ATAR and GPA is:

1. A student's ability (or its proxy measures) and subject/FOS choices have the highest importance for impact on the ATAR and GPA. HSC subject and university FOS choices are inherent in student ability as they are captured in the choices that students make based on their ability.

2. School and university characteristics: these include school mean ATAR, school type, school size, school gender (for both the ATAR and GPA) and the university attended (for GPA only). The school and university attended is also partly influenced by disadvantaged factors.

3. Gender: while not strictly considered a disadvantage, being male has a significant negative impact on ATAR and GPA.

4. Individual student disadvantage factors and average school disadvantage factors: these include residential IEO rank, residential remoteness, Aboriginal and Torres Strait Islander status for the individual, and school IEO rank, school disadvantage status and school remoteness for the school average. These factors are either directly derived from the individual student or are an aggregation of the students attending the school. Some of the average school factors represent school choices that are heavily influenced by a student's individual disadvantage factors or in some cases are completely out of the control of the individual (eg remoteness).

Note: Many of the choices mentioned above are time dependent and represent academic ability in the senior years of high school and first-year university. The effects of disadvantage factors over time has not been investigated here.

3.2.3 The effect of disadvantage on the ATAR and first-year GPA

The following sections contain detailed dependence plots, which show the impact of various factors on ATAR and GPA. The ATAR will be used as the secondary factor for analysis in the detailed dependence plots for impact on GPA, while school mean ATAR will be used for impact on the ATAR. Although the highest level of English and mathematics have a slightly higher impact on the ATAR than school mean ATAR (Figure 24), they are categorical factors with an arbitrary value (unlike a rank, which is continuous). As a result, they were not used as the secondary factor for analysis.

Figure 29a shows the impact of student's IEO rank and school mean ATAR on the student's ATAR with the magnitude of these impacts expressed as SHAP values. There is a clear positive relationship between student's IEO rank and its impact on the ATAR – higher IEO is associated with a positive impact on the ATAR. At the other extreme (IEO rank around 0.0), there is a subset of students whose low-IEO background has affected them more negatively than it has for other students (SHAP value as low as around -0.8).

High-IEO students generally attend schools with high mean ATARs, as high-performing schools (red) are more concentrated towards the top right area of Figure 29a; however, there are students from low-IEO backgrounds (normalised IEO rank below approximately 0.6) who attended high-performing schools. It appears that, for these students, attending a high-performing school has a negative impact on their ATARs, when they are compared with their peers of the same IEO rank who attended a low-performing school.

In contrast, the effect of a student's IEO rank on GPA is less apparent. Figure 29b shows the effects of a student's IEO rank and ATAR on GPA. Here, the differences in residential IEO rank do not appear to have a consistent effect on GPA. There is more variation at both extremes of IEO rank. That is, for students who came from very high- or very low-IEO backgrounds, having a low ATAR affected their GPAs more negatively than it would if they came from a middle-IEO background. This is consistent with the outcomes discussed in section 3.1.1 and shown in Figure 10 – that high-IEO students (particularly those with ATARs below 90) failed at slightly higher rates than lower-IEO students with the same ATAR.

Figure 29a: The impact of residential IEO rank and school mean ATAR on the ATAR.

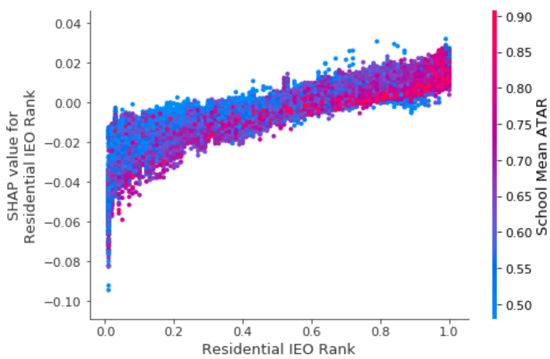


Figure 29b: The impact of residential IEO rank and the ATAR on GPA.

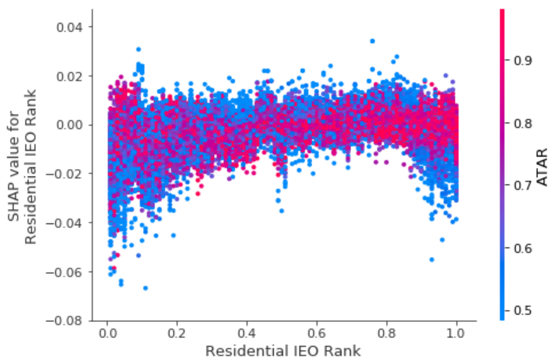


Figure 30a shows the impact of residential remoteness and school mean ATAR on the ATAR. Residing in a major city has little effect on the ATAR, particularly if a student attended a school with a high mean ATAR (red).

As a student's residence becomes more remote, the effect on the ATAR becomes more varied (larger range of SHAP values) and generally more positive – particularly for students who attended schools with a higher mean ATAR. The slight positive impact on ATAR experienced by regional and remote students (Figure 30a) would be more than offset for most students by a stronger negative IEO effect (Figure 29a) due to the relationship between remoteness and lower-IEO status.

Figure 30b shows the impact of residential remoteness (during Year 12) and ATAR on GPA. Remoteness has, on average and by absolute values, a weak impact on ATAR and GPA (Figures 24 and 25); however, remoteness has a less positive impact on GPA than it does on the ATAR. Residing in a major city has a smaller effect on GPA than it does on the ATAR (as shown by the smaller range of SHAP values) and regional and remote students experience similar frequencies of positive and negative impact on GPA, regardless of their ATAR. Here, the regional and remote status is determined by where the student resided during Year 12. Their location of residence at the time of university enrolment has not been considered. Further research on the movement of regional and remote students between Year 12 and enrolling at university may be of value.

Figure 30a: The impact of remoteness and school mean ATAR on the ATAR.

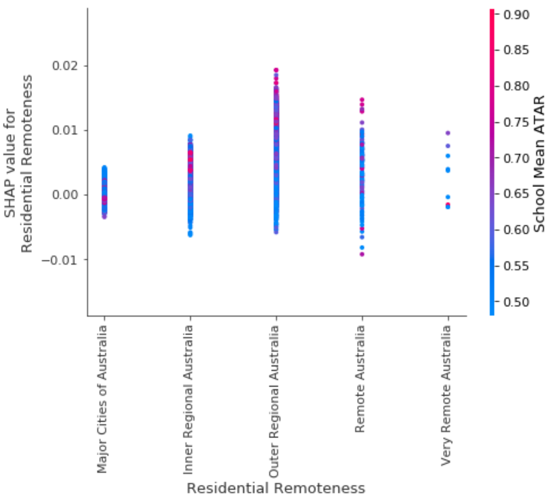
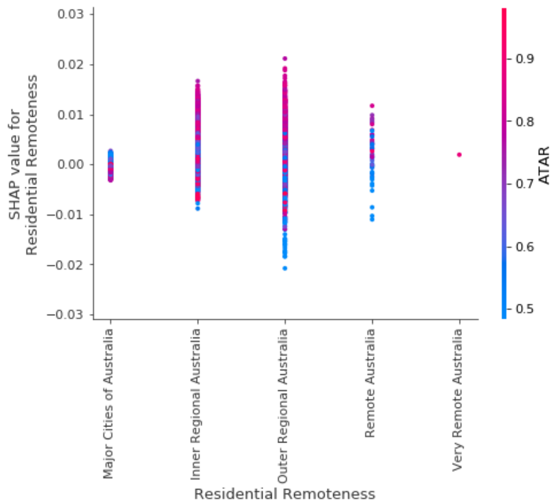


Figure 30b: The impact of remoteness and the ATAR on GPA.



Figures 31a and 31b show similar small negative impacts of Aboriginal and Torres Strait Islander (TSI) status on the ATAR and GPA respectively:

– Figure 31a shows that Aboriginal and Torres Strait Islander students who attend higher mean ATAR schools generally experience a negative impact on their ATAR, whereas

– Figure 31b shows that having a high ATAR has a slight neutral to positive impact on the GPA of Aboriginal and Torres Strait Islander students but a lower ATAR has a negative impact on GPA.

This supports the outcomes shown in Figure 12: high-ATAR Aboriginal and Torres Strait Islander students slightly outperform high-ATAR non-Aboriginal and Torres Strait Islander students; however, this trend diminishes as ATAR declines.

Figure 31a: The impact of Aboriginal and Torres Strait Islander status and school mean ATAR on the ATAR.

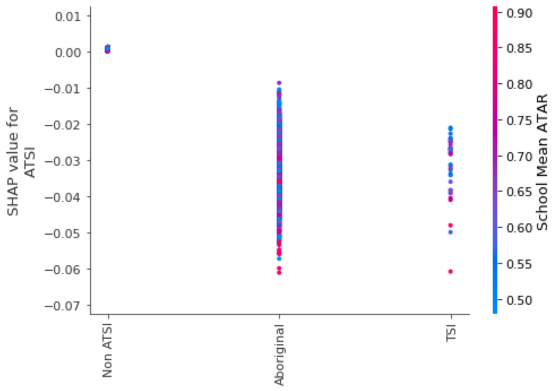


Figure 31b: The impact of Aboriginal and Torres Strait Islander status and ATAR on GPA.

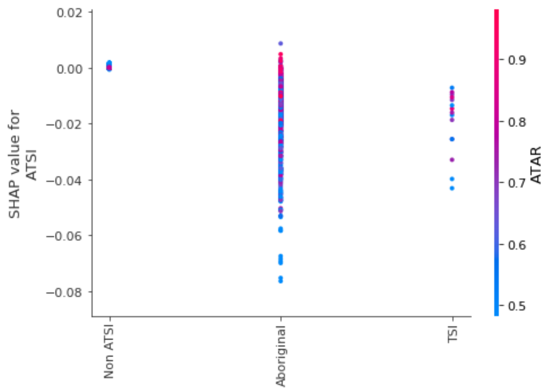


Figure 32a shows the impact of gender and school mean ATAR on the ATAR, and Figure 32b shows the impact of gender and the ATAR on GPA. Being female has a positive impact on both the ATAR and GPA while being male has a negative impact on both the ATAR and GPA. Attending a high mean ATAR school lessens the impact of gender on the ATAR. Similarly, a high ATAR ameliorates the impact of gender on GPA.

Figure 13 in section 3.1.1 shows the outcomes of these trends – there is less difference in GPA between the genders for ATARs above 90; and high ATARs lessen the positive and negative impacts of gender on GPA (Figure 32b).

Figure 13 also shows a widening difference in GPA between the genders at lower ATARs, where the diverging impact on GPA of the different genders (positive for female and negative for male) is more salient.

Figure 32a: The impact of gender and school mean ATAR on the ATAR.

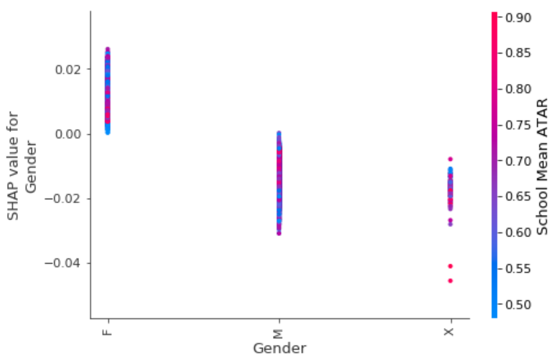
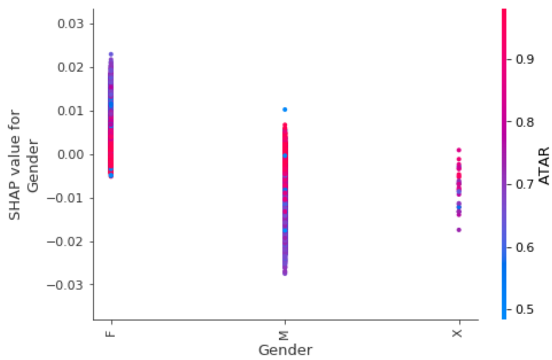


Figure 32b: The impact of gender and the ATAR on GPA.



To summarise:

– Academic ability has a greater impact on both the ATAR and GPA than disadvantage factors. Gender also has a greater impact on both the ATAR and GPA than other disadvantage factors.

– In general, while disadvantage factors impact both the ATAR and GPA, they have less impact on GPA than on the ATAR. Low-ATAR males, Aboriginal and Torres Strait Islander students and outer-regional students, however, continue to experience larger negative impacts on both the ATAR and GPA.

- In effect, the ATAR is a snapshot in time with the impact of disadvantage factors on academic ability summarised in the ATAR.
- First-year university students perform at a level expected of their ATAR and are impacted less by disadvantage factors.

These findings suggest that any action to improve success rates for disadvantaged students should occur well before the end of secondary school.

3.2.4 The effect of high school on the ATAR and first-year GPA

As highlighted in section 2.3.3, there is a complicated relationship between disadvantage factors and the characteristics of the school attended. Figure 33a shows the impact of school mean ATAR on the ATAR and Figure 33b shows the impact of school mean ATAR and the ATAR on GPA.

A school mean ATAR above approximately 70 (0.7 in Figure 33a) has a positive impact on an individual student's ATAR, and, for a school mean ATAR below 40, this impact is both stronger and in a negative direction (Figure 33a).

Figure 33b shows this trend is reversed for GPA: a school mean ATAR above 70 generally has a small negative impact on GPA and a school mean ATAR below 70 has a slight positive impact on GPA. Figure 33b's ATAR colour scale (ie red is more positive than blue) shows that higher ATARs have a significantly more positive impact over and above the school mean ATAR. This is consistent with the outcomes discussed in section 3.1.2 and shown in Figure 17.

The reversal of the impact trend of school mean ATAR from ATAR to GPA may be caused by the similar factors discussed in section 3.1.1. That is, it is likely that, at higher mean ATAR schools, students are pushed harder and make more use of outside tuition. If this practice does not continue into first-year university, the gap would close in the same way that it does between higher- and lower-IEO students (discussed in section 3.1.1). More research in this area may be of value.

Figure 33a: The impact of school mean ATAR on the ATAR.

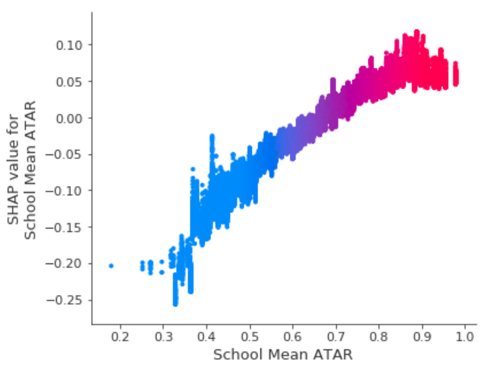
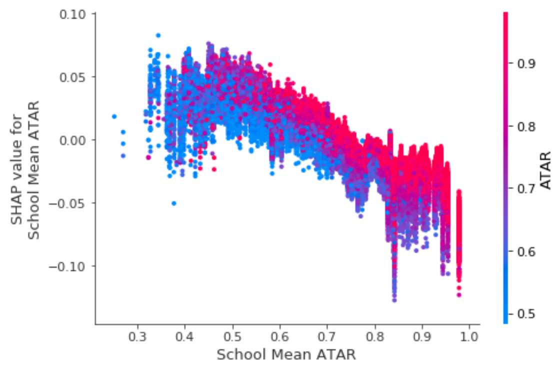


Figure 33b: The impact of school mean ATAR and the ATAR on GPA.



School type presents varying degrees of impact on both ATAR (Figure 34a) and GPA (Figure 34b). School type is a category, not a continuous measure, and, within each category, there is significant diversity of school characteristics which makes interpretation of results difficult.

The largest group (ie number of schools and students) is government non-selective schools (GVNS). GVNS schools tend to have a slight negative impact range on the ATAR and a neutral to slight positive impact range on GPA.

Government selective schools (GVSL) are possibly the most homogenous school category – in this group, all schools are medium to large in size, have high school mean ATARs and most students achieve high ATARs. GVSL is the only school group to have a positive impact range for both ATAR and GPA.

The two non-government catholic school groups – non-government catholic independent (NGCI) and non-government catholic systemic (NGCS) – show a slight positive impact range on ATAR and a slight negative impact range on GPA. The NGCI group has a less positive impact on the ATAR for students who attended a school with a higher mean ATAR and a less negative impact on GPA for higher-ATAR students.

Non-government other (NGOT) is a diverse group of independent schools that includes some very large, high-IEO schools and a significant number of small and/or lower-IEO schools. Unsurprisingly, NGOT has the largest impact ranges on the ATAR and GPA, both of which generally range from slightly positive to negative. The negative impact on the ATAR is stronger for low mean ATAR schools and slightly positive for high mean ATAR schools.

Figure 34a: The impact of school type* and school mean ATAR on the ATAR.

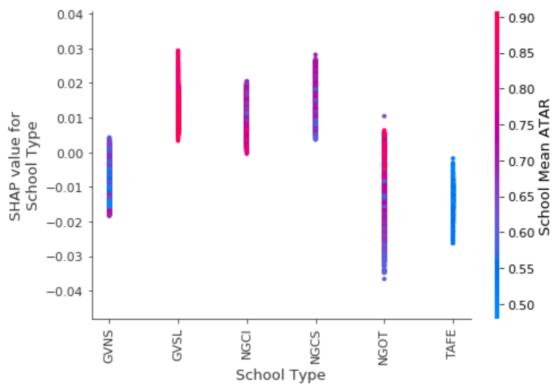
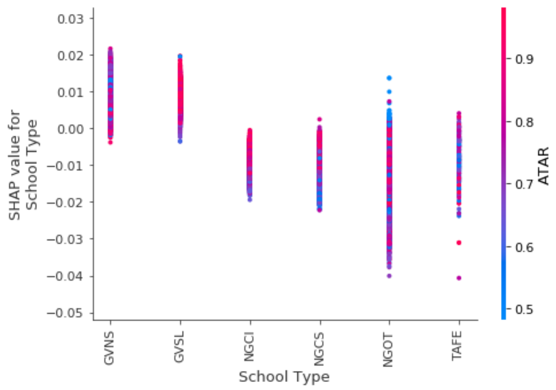


Figure 34b: The impact of school type* and the ATAR on GPA.



*School types: GVNS = Government non-selective; GVSL = Government selective; NGCI = Non-government Catholic independent; NGCS = Non-government Catholic systemic; NGOT = Non-government other; TAFE = TAFE.

School size has a varying impact on both ATAR (Figure 35a) and GPA (Figure 35b). Schools vary in size from 1 to 455 HSC students per year. In this plot, school size has been normalised to a range from 0 to 1. Most school sizes tend to have a slight positive to negative range of impact on both ATAR and GPA, which varies depending on the student. The smallest schools tend to have a more negative impact range on both the ATAR and GPA. School mean ATAR appears to have an inconsistent effect on the impact of school size on the ATAR (Figure 35a), which suggests that other individual school characteristics may be having an effect.

Figure 35a: The impact of school size and school mean ATAR on the ATAR.

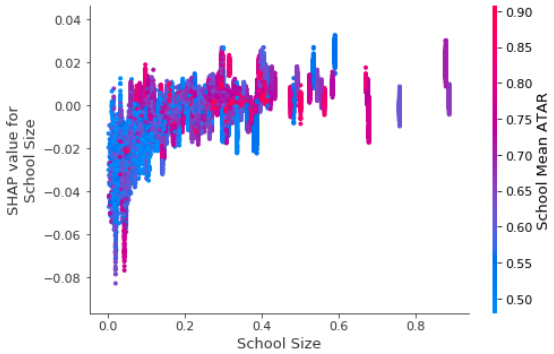
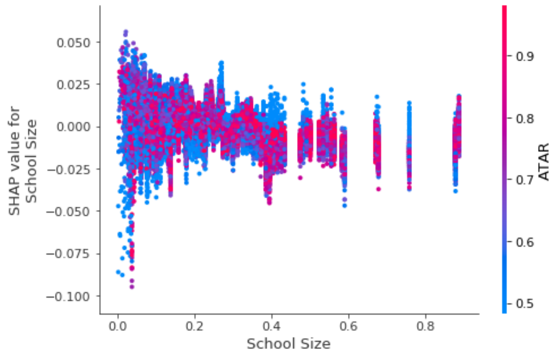


Figure 35b: The impact of school size and the ATAR on GPA.



Figures 36a and 36b show the impact of school gender on the ATAR and GPA respectively. Co-ed schools (C) were found to have the smallest impact range on both the ATAR and GPA. The impact range on the ATAR is:

– slightly negative for higher mean ATAR co-ed schools
– very slightly positive for lower mean ATAR co-ed schools.

The impact range on GPA was slightly positive for all ATARs in this group.

The boys' school group (B) shows a net neutral impact range on the ATAR. The impact range on the ATAR is:

– slightly negative for higher mean ATAR boys' schools
– slightly positive for lower mean ATAR boys' schools.

The impact range on GPA was negative for all ATARs in this group.

In contrast, the girls' school group (G) shows broader impact ranges on the ATAR. The impact range on the ATAR is:

– slightly positive for higher mean ATAR girls' schools
– slightly more negative for lower mean ATAR girls' schools.

Overall, a girls' school has a slightly positive to negative impact range on an individual's ATAR and a neutral to negative impact range on GPAs for all ATARs; however, in general, the impact of school's gender on GPA is not as negative for girls' schools as it is for the boys' schools.

It is worth noting that over half of the schools with a mean ATAR over 80 are single gender schools with a majority of higher-IEO students. The school gender trends above are largely a product of the profile of the students that attend them.

Figure 36a: The impact of school gender and school mean ATAR on the ATAR.

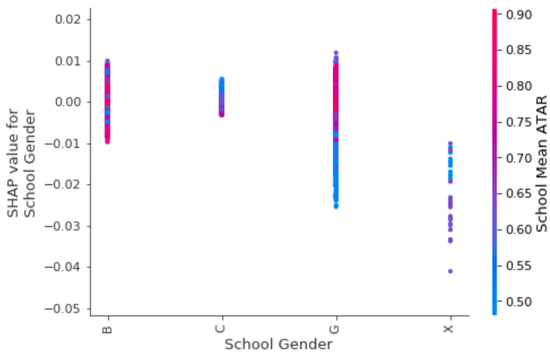
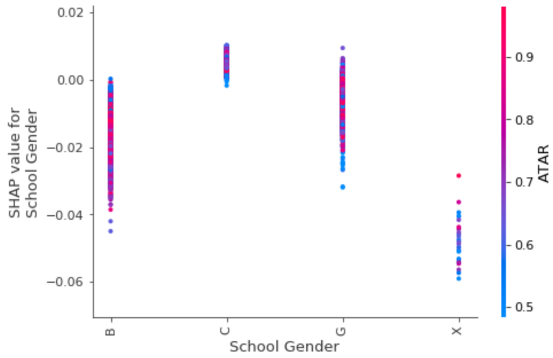


Figure 36b: The impact of school gender and the ATAR on GPA.



School IEO rank (the average of attending students' IEO) has a small range of both positive and negative impacts on ATAR (Figure 37a). High IEO ranked schools (schools with average student IEO above approximately 65 (0.65 normalised)) tend to have high school mean ATARs which have no additional impact on the ATAR, whereas students who attended lower IEO ranked schools with high school mean ATARs experience a positive impact on their ATAR. This suggests that schools with an average student IEO rank below 65 and a higher mean ATAR have a more positive impact on the ATAR.

The impact of school IEO rank on GPA (Figure 37b) has a similarly small range of impacts that are in both positive and negative directions. The secondary impact of the ATAR on GPA is less clear – higher and lower ATARs have positive and negative impacts at different school IEO ranks, sometimes inverting the usual trend with higher ATARs having a negative impact on GPA.

In these plots, each school, represented by a vertical line of dots show the impact ranges experienced by students who attended that school. (All students who attend the same school are represented by a vertical line because they all have the same school IEO rank.) The impact range variations across schools suggest that other school characteristics may be having an effect.

Figure 37a: The impact of school IEO rank and school mean ATAR on the ATAR.

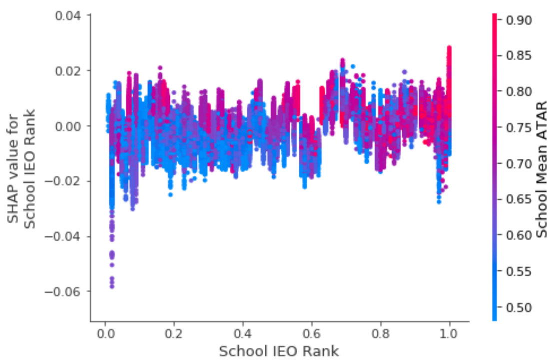
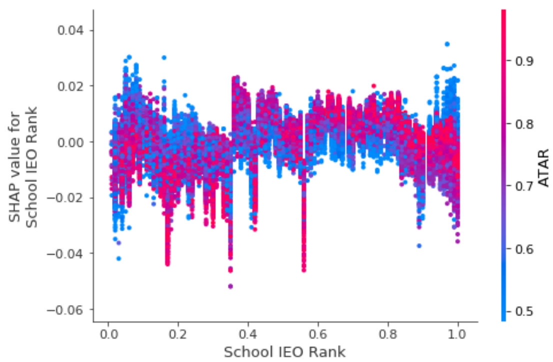


Figure 37b: The impact of school IEO rank and the ATAR on GPA.



Attending a school on the disadvantaged schools list (school disadvantage flag = yes) has an approximately equal positive and negative impact range on the ATAR (Figure 38a), regardless of school mean ATAR. In contrast, the impact on GPA (Figure 38b) ranges from neutral to negative – higher-ATAR students experience a more negative impact.

It is worth noting that during the period covered by this dataset, UAC awarded 'ATAR adjustments' (previously referred to as 'bonus points') to applicants who attended schools on the disadvantaged schools list (as part of the Educational Access Schemes). From 2019, with the availability of new data, this was changed so that students in the bottom quartile of residential IEO are now awarded ATAR adjustments. This change was introduced because it was recognised that not all students who attend disadvantaged schools are disadvantaged. Conversely, some disadvantaged students also attend non-disadvantaged schools. This decision is supported by the net neutral impact on the ATAR of attending a disadvantaged school (Figure 38a) and the negative impact on the ATAR for the lowest IEO quartile (Figure 29a).

Figure 38a: The impact of school disadvantage code and school mean ATAR on the ATAR.

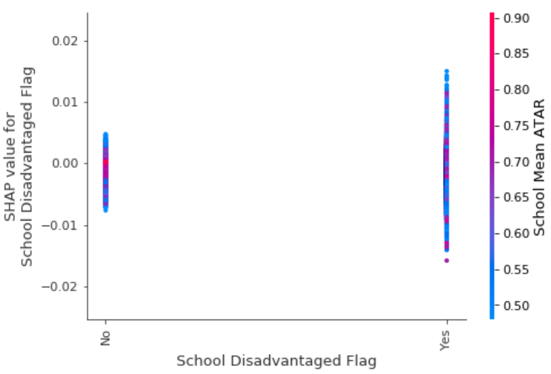
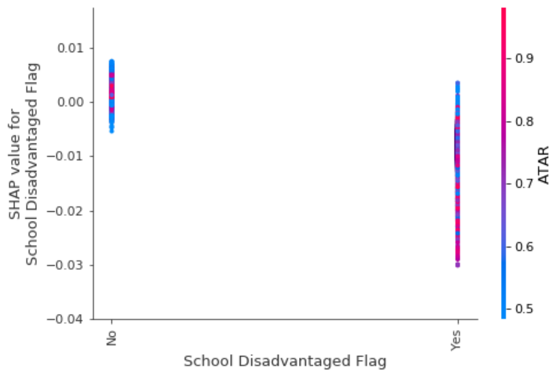


Figure 38b: The impact of school disadvantage code and the ATAR on GPA.



Unsurprisingly, the impact of school remoteness on the ATAR (Figure 39a) and GPA (Figure 39b) are similar to the impacts of residential remoteness.

Attending a school in a major city has little impact on either the ATAR or GPA. Attending a regional or remote school tends to have a more positive impact range on students' ATAR but has a more negative impact range on students' GPA.

Attending a high mean ATAR school tends to have a narrower impact range on the ATAR than attending a lower mean ATAR school.

Attending a metropolitan school in combination with a higher ATAR affected students' GPA both slightly and negatively; whereas, for metropolitan school students with lower ATARs, GPA was impacted both slightly and positively.

Attending a regional/remote school in combination with a higher ATARs affected GPA positively, and for lower ATAR students, negatively.

Figure 39a: The impact of school remoteness and school mean ATAR on the ATAR.

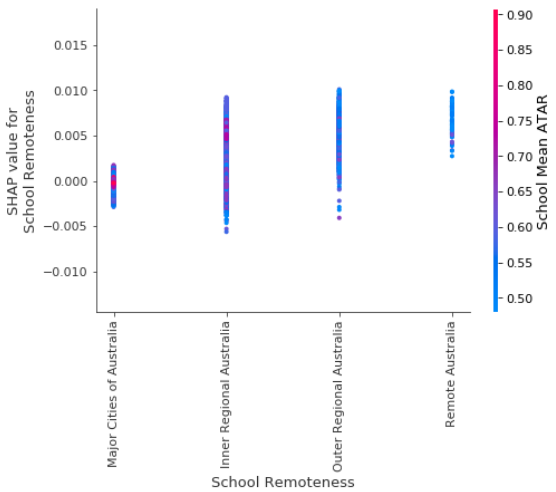
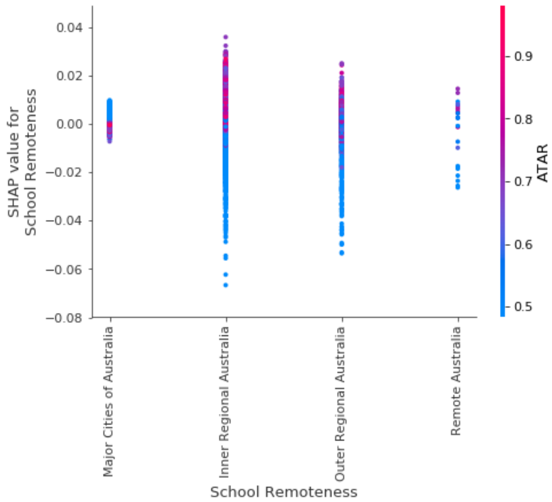


Figure 39b: The impact of school remoteness and the ATAR on GPA.



In summary, most school factors (besides school mean ATAR) have a small impact on GPA and an even smaller impact on ATAR; however, there are a few minor factors (eg small school size) that have a larger, mostly negative, impact range on both ATAR and GPA. Attending a small school negatively affected some students, but not all.

Attending a regional/remote or disadvantaged school has a minor, persistent and negative impact on a student's GPA whereas average school IEO has no consistent impact on GPA. This suggests that the school's individual characteristics (eg school mean ATAR, size and school gender) have a greater impact on a student's ATAR and GPA than the average disadvantage characteristics of the students that attended the school (eg school mean IEO).

As discussed earlier, parents and guardians select schools for the student in their care; however, attending a school with a high mean ATAR does not guarantee a higher ATAR for the student. The diverse results of this analysis of school factors highlights the need to attend a school that suits the student. Although we use the ATAR and GPA as measures of student success, it is important to recognise that there are others, particularly if a student has no desire to progress to university. This highlights the need for a range of schooling options to fit students' needs.

3.2.5 The effect of subject choice on the ATAR and first-year GPA

The impact of studying the highest level of English (Figure 40a) and mathematics (Figure 41a) on a student's ATAR shows similar trends. Lower subject levels have a strong negative impact range, while higher subject levels have a strong positive impact range on the ATAR.

Attending a higher mean ATAR school reduced both the positive and negative impact the subject level had on a student's ATAR. This suggests that students attending lower mean ATAR schools gain a greater benefit by studying higher levels of English and mathematics than students attending high mean ATAR schools.

The impact of studying the highest level of English (Figure 40b) and mathematics (Figure 41b) on a student's university GPA shows similar trends. Research (Manny et al. 2020) shows that once the ATAR has been accounted for, the level of HSC English or mathematics studied has little effect on GPA. This is also evident in this analysis; that is, the impact that studying the highest level of English and mathematics has is much weaker on GPA than on the ATAR. This is also shown by the range of SHAP value scales on the ATAR and GPA plots, which is much larger for the former than the latter.

At higher subject levels, higher ATARs tend to have a more positive impact on GPA. For the same subject levels, lower ATARs have a more negative impact; however, for lower levels of English and mathematics, this is a) less clear and b) reverses for English as a Second Language where higher ATARs tend to have a more negative impact on GPA.

Figure 40a: The impact of the highest level of English and school mean ATAR on the ATAR.

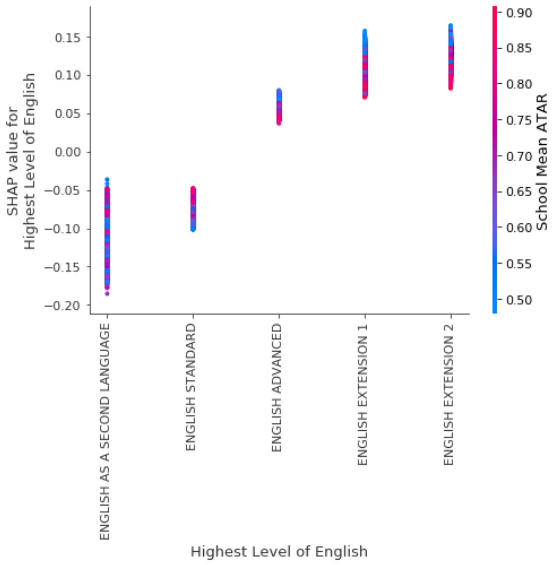


Figure 40b: The impact of the highest level of English and the ATAR on GPA.

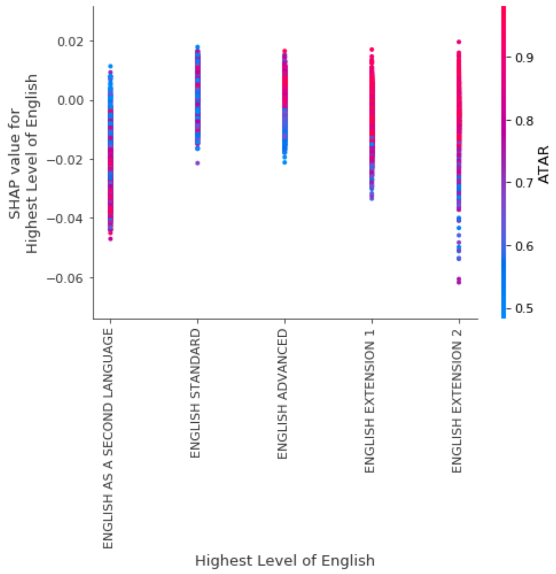


Figure 41a: The impact of the highest level of mathematics and school mean ATAR on the ATAR.

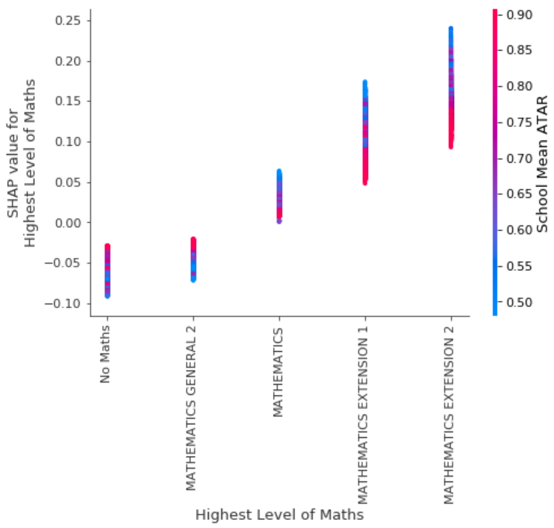


Figure 41b: The impact of the highest level of mathematics and the ATAR on GPA.

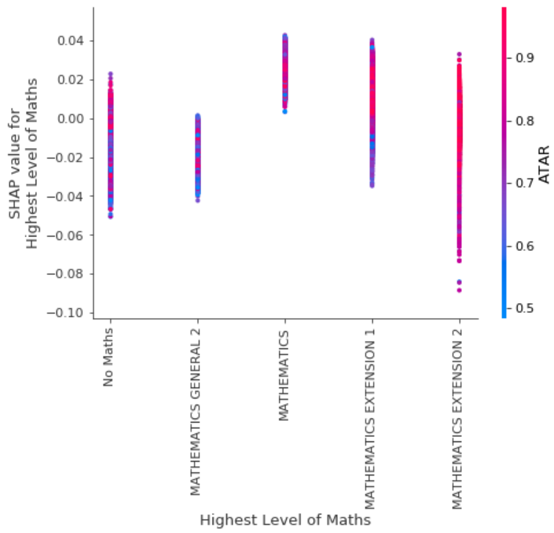


Figure 42a shows the impact of HSC key learning areas (KLAs) on the ATAR. As discussed in section 3.1.3, studying subjects from two to three KLAs is considered as specialising, and studying subjects from four or more KLAs is considered as having a broader HSC study pattern.

As Figure 42a shows, specialising has a positive impact range on the ATAR while studying four to five KLAs has a narrower neutral to slightly negative impact range on the ATAR. Studying six KLAs has a broader impact range and students who attended a school with a lower mean ATAR experience a more positive impact.

Figure 42b shows the impact of the number of KLAs studied on GPA. The impact range clearly decreases and becomes more positive as the number of KLAs studied increases and the study pattern broadens – studying four KLAs has a narrow and neutral impact range. Figure 23 (section 3.1.3) reflects this trend and shows that students who specialise for the HSC tend to fail first-year subjects at a slightly higher rate, and as a result, have a lower GPA than students who studied more KLAs.

Figure 42a: The impact of KLAs and school mean ATAR on the ATAR.

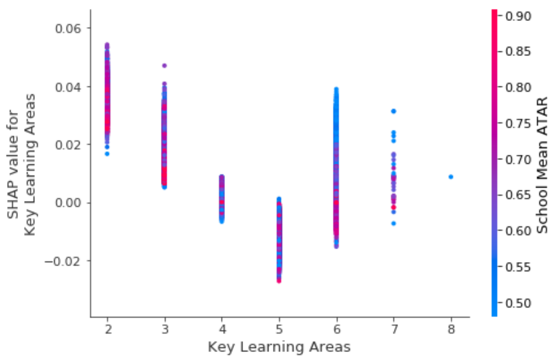
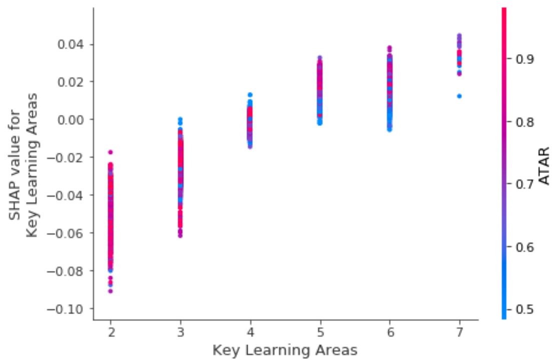


Figure 42b: The impact of KLAs and the ATAR on GPA.



Students who studied Category B subjects experienced a negative impact range on their ATAR (Figure 43a), as opposed to students who did not. For these students, school mean ATAR made little difference to the impact range; however, for students who attended a low mean ATAR rather than a high mean ATAR school, not studying a Category B subject had a slightly more positive impact on their ATAR.

Students who did not study a Category B subject experienced a very narrow, neutral impact range on GPA (Figure 43b), particularly if they had a higher ATAR. Students who studied a Category B subject experienced a wider, neutral to slightly negative impact range on GPA, regardless of the ATAR.

Figure 43a: The impact of studying Category B subjects and school mean ATAR on the ATAR.

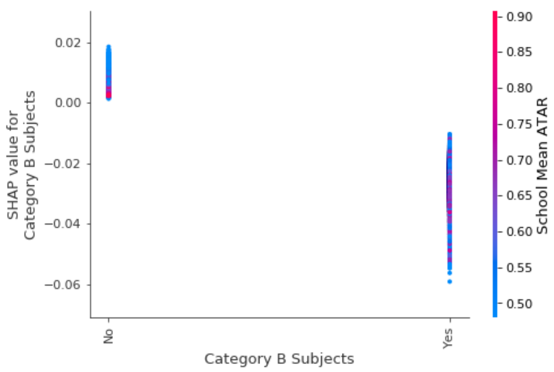
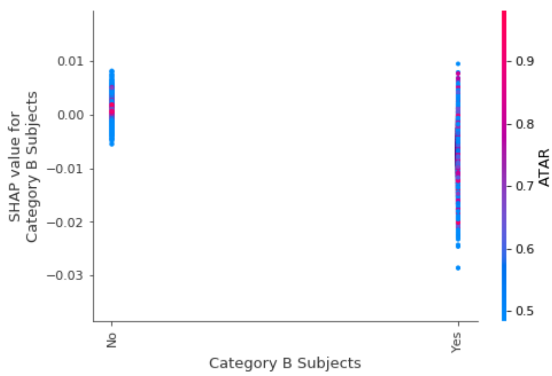


Figure 43b: The impact of studying Category B subjects and the ATAR on GPA.



Studying extension subjects – except for those in English and mathematics – shows a broad, positive impact range on the ATAR (Figure 44a), particularly for students who attended a lower mean ATAR school. This observation is consistent with the following finding: students achieve better results by studying HSC subjects that they are good at and are engaged with. For GPA, however, this impact tends to reverse (Figure 44b) – these students, especially those with a lower ATAR, experience a neutral to negative impact.

Figure 44a: The impact of studying other extension subjects and school mean ATAR on the ATAR.

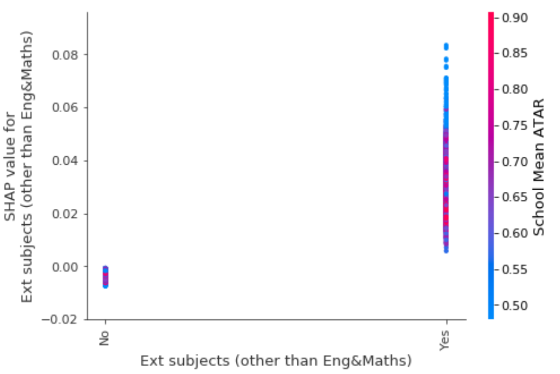
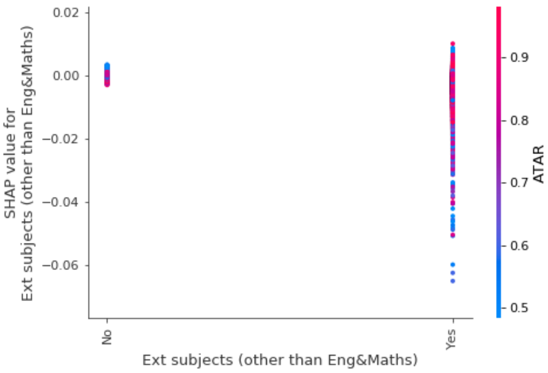


Figure 44b: The impact of studying other extension subjects and the ATAR on GPA.



In summary, specialising for the HSC (ie studying two or three KLAs, often including extension subjects) generally has a positive impact range on a student's ATAR, but a negative impact range on GPA.

In contrast, a broader HSC study pattern (ie studying four or more KLAs) has a slight negative impact on the ATAR but a more positive impact on GPA. Presumably, students who specialise, study subjects they are good at or more engaged with, and as a result, expect better marks. Conversely, studying a broader range of HSC subjects may provide an advantage in first-year university, as these students may have a prior introduction to more first-year subjects.

Studying a Category B subject, which by default increases the number of KLAs studied, has a negative impact on the ATAR; however, it does not appear to provide the same positive impact range on GPA as choosing a broader study pattern. Category B subjects are vocationally-oriented and bear little relation to university subjects, so they would not provide the same introduction to first-year subjects as academically-oriented Category A subjects.

As discussed in section 2.3.4, the number of KLAs studied is more closely linked to the tendency for more academically-oriented students to specialise than it is to any disadvantage factors. As such, this should not adversely affect disadvantaged students if they have access to the required subjects, so they can specialise if desired. Limited access to subjects appears to be an issue only for students who attend small schools (discussed in section 2.3.3), that is, lower-IEO, Aboriginal and Torres Strait Islander, and regional and remote students.

It is important to remember that, for the individual, studying certain subjects does not necessarily lead to a higher ATAR or GPA. As discussed in earlier sections and in prior research, students, including those with higher academic ability, tend to select subjects according to their academic level (Manny et al. 2020).

3.2.6 The effect of university, field of study and scholarship on first-year GPA

After the ATAR, a university course's field of study (FOS) was found to have the largest average absolute SHAP value for impact on GPA (Figure 25). Figure 45 shows the variance in impact range that FOS and ATAR have on GPA. Architecture, Education and Creative Arts have positive impact ranges on GPA, while Engineering, and Management and Commerce have negative impact ranges. On average, Science, IT, Agriculture, Health, and Society and Culture have neutral impacts on GPA (with roughly equal positive and negative impact ranges).

Generally, a higher ATAR has a more positive impact on GPA than a lower ATAR, with some exceptions – for Creative Arts, Society and Culture, and Health, the trend appears to be reversed. Prior research has found that, while the ATAR is a good measure for academic ability, it is not the best measure for creativity. Compared with other FOS, Creative Arts students have the lowest correlation between ATAR and GPA (Manny et al. 2020). High-ATAR Health, and Society and Culture FOS students would most likely enrol in more competitive degrees (eg medicine and law). Consequently, these competitive degrees would, in terms of academic ability, have homogenous candidatures, thus masking any impacts ATAR might have on GPA. There does not appear to be any significant relationship between FOS preferences of the different IEO quartiles discussed in section 2.3.1 (Table 1) and impact on GPA by FOS.

Figure 45: The impact of field of study and the ATAR on GPA.

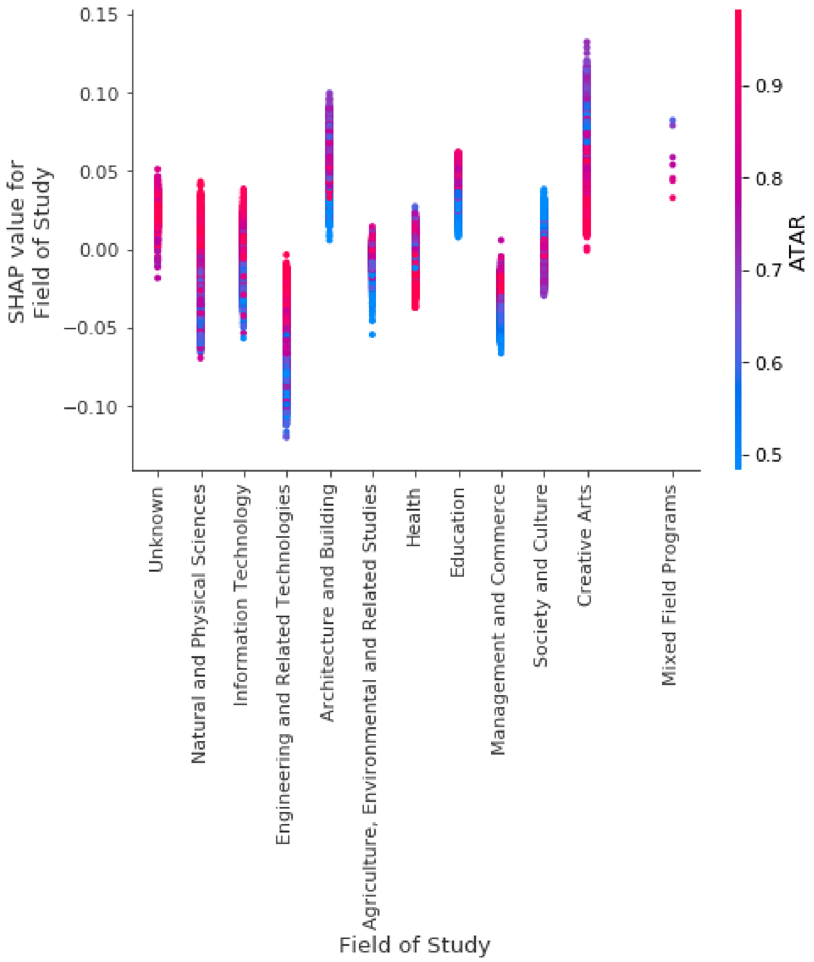


Figure 46 shows the impact range on a student's GPA by university attended:

– regional universities: slightly negative to moderately positive

– metro universities: neutral to moderately positive

– Go8 universities: neutral to moderately negative.

For all university types, a higher ATAR has a more positive impact on GPA than a lower ATAR, which is consistent with the student outcomes shown in Figure 14. This may relate to the average ATAR of students to which certain types of universities offer a place (as discussed in section 3.1.1).

As discussed, students' selection of school and HSC subjects is largely based on academic ability and personal preference – this likely continues into selection of university, degree and FOS. Students with higher ATARs tend to enrol in universities and degrees with higher entry requirements, often referred to as 'spending' an ATAR. Just as parents or guardians select schools, students select universities with a 'good reputation'.

Figure 46: The impact of university and the ATAR on GPA.

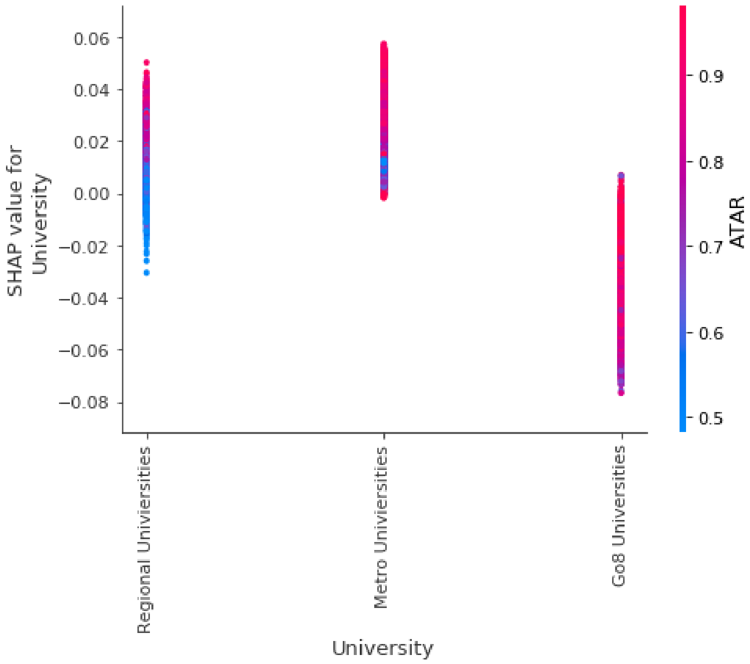


Figure 47 shows the impact of receiving an equity scholarship and the ATAR on GPA. Equity scholarships tend to have impacts that range from moderately positive to slightly negative.

Generally, receiving an equity scholarship has a more positive than negative impact on GPA, and, particularly when benefit is measured by pass/fail rates, for lower-ATAR students than high-ATAR students (Figure 16 in section 3.1.1). Equity scholarship details were unavailable so further investigation was not possible; however, it may be of value.

Figure 47: The impact of equity scholarships and the ATAR on GPA.

3.2.7 The effect of multiple disadvantages on the ATAR and first-year GPA

Some students experience multiple co-existing disadvantages. Figure 48a shows the impact of residential IEO on the ATAR with interaction effects for Aboriginal or Torres Strait Islander status. The colour of each dot represents the Aboriginal and Torres Strait Islander status (purple and pink) of the student.

There are two distinct groups of Aboriginal and Torres Strait Islander students at the upper and lower extremities of the impact ranges for each residential IEO (Figure 48a). Residential IEO rank has a lower impact on the group predominately scattered along the top of the plot than most non-Aboriginal and Torres Strait Islanders of the same residential IEO rank.

The second group is particularly evident in the bottom left corner and is found along the plot's lower extremity. Residential IEO rank has a stronger negative impact on the ATAR for these low-SES, Aboriginal and Torres Strait Islander students than most non-Aboriginal or Torres Strait Islanders of the same rank.

Figure 48b shows the impact of residential IEO and Aboriginal and Torres Strait Islander status on GPA. In this case, the impact for Aboriginal and Torres Strait Islander students is not as polarised because this group is far more evenly dispersed than in Figure 48a. It is possible that university support programs, which are aimed at mid-range residential IEO and Aboriginal and Torres Strait Islander students, have a slight positive impact on GPA. It appears that many of the Aboriginal and Torres Strait Islander ATAR students in the bottom left corner of Figure 48a did not progress to university as there are less of these students in Figure 48b's corresponding vertical range.

The polarisation trend shown in Figure 48a suggests that there is at least one other influential factor involved (possibly remoteness) that has an impact on the ATAR of Aboriginal and Torres Strait Islander students. More research into these effects may be of value.

Figure 48a: The impact of residential IEO and Aboriginal and Torres Strait Islander status on the ATAR.

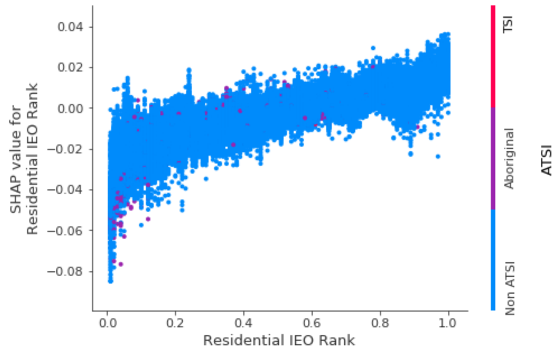
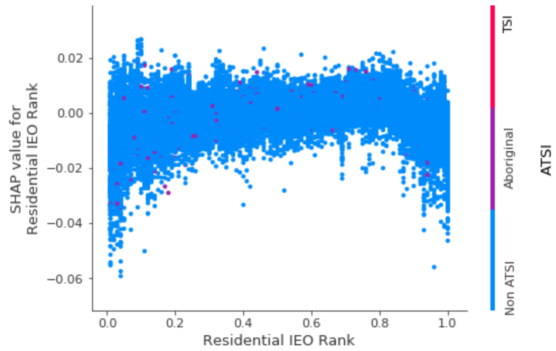


Figure 48b: The impact of residential IEO and Aboriginal and Torres Strait Islander status on GPA.



Figures 49a and 49b show the impact of residential IEO on the ATAR and GPA respectively. In this plot, residential IEO rank has been normalised from a range of 1 to 100, to 0.01 to 1.00; the colour of the dots represent residential remoteness status. The impact of residential IEO by remoteness status on the ATAR is much less polarised in Figure 49a than in Figure 48a (by Aboriginal or Torres Strait Islander status); however, Figure 49a still shows small impact range clusters along the upper and lower extremities at some residential IEO ranks.

In contrast, Figure 49b shows that residential IEO rank has a stronger negative impact on GPA for lower-SES, more remote students than metropolitan students (bottom left corner).

Figure 49a: The impact of residential IEO and remoteness on the ATAR.

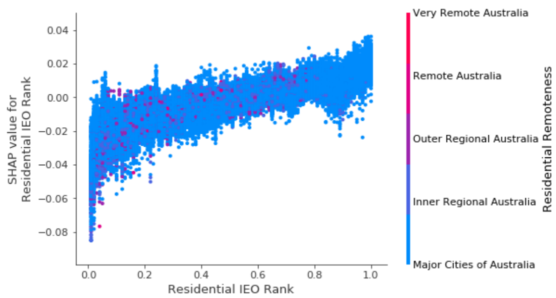


Figure 49b: The impact of residential IEO and remoteness on GPA.

4 Conclusions

Inequality in educational outcomes between advantaged and disadvantaged groups has been well documented; however, much of the published literature on disadvantage and education is limited by the data available.

The definition of 'disadvantage' is often determined by available data and is therefore inconsistent across different studies. Furthermore, most research has focused on each disadvantage independently without accounting for the interactions between them.

In this analysis, we have investigated the complex relationships between three types of disadvantage and their impact on school and university achievement: low SES, Aboriginal and Torres Strait Islander status, and remoteness of residence (plus other related school-based factors).

Although we use the ATAR and GPA as measures of a student's success, it is important to recognise that there are others, particularly if a student has no desire to progress to university.

As published literature and our data clearly show, students from disadvantaged backgrounds who progress to Year 12 attain (on average) a lower ATAR and enrol at university at lower rates than students from non-disadvantaged backgrounds. However, we need to consider the dominant factor in university success – the ATAR. As prior research shows, once we consider the ATAR these progression trends reverse – lower SES students enrol at higher rates than higher SES students with the same ATAR. Furthermore, university students from a disadvantaged background generally slightly outperform those from a non-disadvantaged background with the same ATAR.

Note: The ATAR's dominance as a predictor of university success is unsurprising and it remains the best measure of academic ability available for use in university admissions. It is important to recognise that the ATAR is only a snapshot in time and that there are many other potential pathways to university.

Disadvantage factors often co-exist. Students who experience one form of disadvantage are likely to experience others (eg compared with metropolitan students, a higher proportion of remote students are also Aboriginal and Torres Strait Islander and/or of low SES). We used machine learning techniques to determine the degree to which the various forms of disadvantage and related factors impact both the ATAR and GPA.

We examined the average absolute impact of the following factors on the ATAR and GPA (listed in order of importance):

1. academic ability – or proxy measure for ability (eg level of HSC subject)
2. school- or university-related factors (eg high school size and location, university course field of study). These factors (or choices) can be a proxy measure for ability and/or family attitude towards education, and may also be affected by other disadvantage factors.
3. gender
4. other factors (eg residential IEO rank, residential remoteness, and Aboriginal and Torres Strait Islander status).

Note: We used senior secondary school and first-year university results in this analysis. While disadvantages likely contribute to a student's academic achievement prior to this period, they have not been investigated here. Similarly, disadvantages may prevent students from progressing to Year 12; however, we have not included these students in our data set. Disadvantages may also affect the choice of school or university attended.

The highest level of English and mathematics studied and school mean ATAR have the greatest impact on a student's ATAR. Other factors, including disadvantage measures, have significantly less impact. Subject and school choice can be considered a proxy measure for academic ability and the expectations that a student's family or support network have of education. (Other factors such as remoteness and limited social/economic resources may also affect these choices.)

In our analysis of university success as measured by GPA, we found that the ATAR has the greatest impact, while all other factors have relatively smaller impacts. Gender impacts both the ATAR and GPA more than other disadvantage factors. Figures 24 and 25 (section 3.2.2) show the absolute impact that all disadvantage factors have on the ATAR and GPA.

The impact and implications of disadvantage on university outcomes are summarised below:

- **Socio-economic status**
  - **University outcomes:** First-year university students largely perform to a level expected of their ATAR, regardless of SES. For students with ATARs over 90, there is very little difference in pass/fail rates or first-year GPA, regardless of IEO status; however, as ATARs decline, 4th IEO quartile students begin to fail at a slightly higher rate when compared with lower-IEO quartile students with the same ATAR. This effect peaks for students with ATARs in the 60s and 70s and reduces at ATARs below 60.
  - **Impacts:** Socio-economic status has a relatively small impact on ATAR and GPA. On average, the ATAR is impacted less by SES than by proxy factors related to academic ability (eg subject choice). SES impacts GPA less than it does the ATAR.
  - **Implications:** Students perform to a level expected of their ATAR and disadvantage has relatively little impact, which suggests that disadvantage adversely affects the student prior to senior secondary school and university. Therefore, programs and policies to improve outcomes for disadvantaged students would be beneficial if implemented prior to senior secondary schooling. Lower-SES students tend to slightly outperform their higher-SES peers with the same ATAR, so it appears that equity programs are of value.

- **Remoteness of residence**
  - **University outcomes:** First-year university students largely perform to a level expected of their ATAR, regardless of remoteness status; however, as ATARs decline, students from major cities fail subjects at a slightly higher rate than regional students with the same ATAR. This is most likely influenced by the greater proportion of higher-SES students who reside in major cities.
  - **Impacts:** Remoteness of residence has a relatively small impact on the ATAR and GPA.
  - **Implications:** Remoteness of residence has the strongest effect on choice of school and university, and possibly HSC subjects. Most remote students attend small schools so it is essential that adequate resources are available to cater for a wide range of subject choices. Remote areas have a higher proportion of low-SES and Aboriginal and Torres Strait Islander students so the effects of disadvantage can be magnified and should be considered in policy formulation.

- **Aboriginal and Torres Strait Islander status**
  - **University outcomes:** In first-year university, Aboriginal and Torres Strait Islander students generally perform to a level expected of their ATAR, but slightly outperform non-Aboriginal and Torres Strait Islander students with the same ATAR. This is related to Aboriginal and Torres Strait Islander students being more likely to belong to lower SES-quartiles and live in more remote regions, as the latter two groups were also found to slightly outperform their higher SES and metro region counterparts.
  - **Impacts:** Aboriginal and Torres Strait Islander status has a relatively small impact on the ATAR and GPA.
  - **Implications:** Positive university outcomes for Aboriginal and Torres Strait Islander students suggest that current measures taken to assist this group are having the desired impact. A high proportion of Aboriginal and Torres Strait Islander students are also lower SES and live in remote regions so would benefit from policies that improve success for low-SES and remote students.

- **Gender**
  - **University outcomes:** Both genders display similar trends by ATAR and SES quartile; however, as ATARs decline, male students fail at higher rates than female students with the same ATAR.
  - **Impacts:** Gender has a higher impact on the ATAR and GPA than any other disadvantage. Gender status negatively impacts male students and positively impacts female students in both the ATAR and GPA.
  - **Implications:** Progression rates and outcomes are consistently lower for males than for females in both the ATAR and GPA, so male gender status could be considered an educational disadvantage. Further investigation into the causes of gender-related differences in educational outcomes may be beneficial.

- **Equity scholarships**
  - **University outcomes:** Equity scholarship recipients do not necessarily perform to a level above that is expected of their ATAR; however, they fail fewer subjects than non-recipients, so it appears they are more resilient or motivated to complete first-year university.
  - **Impacts:** Equity scholarships generally have a more positive impact on GPA for recipients with lower ATARs than higher ATARs.
  - **Implications:** Equity scholarships appear to have a positive effect on recipients' outcomes, particularly for students with an ATAR between 60 and 90. Providing more scholarships that target students in, for example, fields of study or courses within this ATAR range, could improve outcomes. Generally, equity scholarships appear to have a positive effect on pass/fail rates, which should lead to shorter completion times and, presumably, lower student debt on completion.

- **School factors**

  - **University outcomes:** First-year university outcomes are largely driven by the ATAR and disadvantage profile of the student rather than the disadvantage profile of the school they attended.

  - **Impacts:** School mean ATAR has a strong impact on the ATAR and a moderate impact on GPA. All other school factors have small impacts on the ATAR and GPA. A small school's size, however, has a greater negative impact on ATAR and GPA than medium or larger schools, and regional or remote schools' locations have a slight negative impact on GPA. Other school characteristics (eg school mean ATAR, size and student gender) have a greater impact on a student's ATAR and GPA than the average SES of its students (school's mean IEO).

  - **Implications:** Selecting a school to suit the student is important; however, a school's high mean ATAR does not guarantee a high ATAR for each student. Disadvantage factors may also influence a student's choice of school, which may in turn impact outcomes.

- **Subject choice at secondary school**

  - **University outcomes:** Students tend to select HSC subjects according to their ability, regardless of any disadvantage they may have. First-year university outcomes are more closely related to the students' ATAR and disadvantage profile than any interaction between disadvantage and the subject level studied.

  - **Impacts:** Any advantage that a student's subject level selection has on the ATAR is reversed in the GPA. This is not the case for selection of Category B subjects.

  - **Implications:** Subject choice has little effect on a student's success provided a student has access to their choice of appropriate HSC subjects. That is, students choose subjects that they are good at and are engaged with and are at the highest level they can comfortably attempt. Studying a particular subject does not guarantee a higher ATAR but may prepare a student for university. School's limited capacity to offer certain subjects does not appear to be a substantial issue generally; however, this may be an issue for some small schools.

- **University and FOS**

  - **University outcomes:** Students who attend the same type of university tend to perform at the same level expected of their ATAR, regardless of disadvantage; however, that level is dependent on university type (as discussed in section 3.1.1).

  - **Impacts:** University choice and FOS have a moderate impact on GPA.

  - **Implications:** Similar to HSC subject selection, students tend to select university and FOS based on their academic ability – disadvantage factors have little influence. Ensuring students have adequate choice in university and FOS appropriate to their academic ability is important in achieving educational success. This includes pathway courses to prepare lower ATAR students for a bachelor degree if required.

– Other factors not considered

We have not considered the following factors in this analysis because there was no data or method of measurement available. These factors, some loosely related to proxy measures, may be heavily influenced, both positively and negatively, by the student's co-existing disadvantages. These include:

- **Cognitive ability:** We used the ATAR and GPA as measures of academic ability. In educational psychology, it is widely acknowledged that a student's cognitive ability underpins academic performance (eg Rohde and Thompson (2007)). Here, cognitive ability refers to the mental capabilities required in reasoning, problem solving and the processing and manipulation of information, and encompasses mental functions including memory, attention and perception. The effect of disadvantage on cognitive or academic ability in the years prior to senior secondary school is outside our research scope.

- **Non-cognitive factors:** These include a student's resilience, motivation, learning style and attitudes towards learning. Although it is assumed that the ATAR and GPA capture these factors, we have not measured them directly in this study. Additionally, each student's situation is unique and some face personal hardships that we have not measured (eg illness, relationship difficulties etc). Presumably, students require high levels of resilience and motivation to counteract these setbacks, but these topics are beyond the scope of this analysis.

- **The extent to which the student and their support network values education and the weight of expectation to succeed:** These factors are closely related to resilience and motivation and can have both a positive and negative effect (eg ranges from 'your education is the most valuable thing you have' and 'I want you to have more opportunity than I had' to 'I didn't go to uni and I turned out fine' and 'none of my friends are going to uni'). The attitude of a student's support network (whether stated explicitly or not) can lead to expectations of success. For some students, the transition from school is marked by an expectation that they will work to their academic ability, and, once at university, students are given more personal responsibility for their own outcomes. Having to repay an equity scholarship if they fail may create a weight of expectation on the recipient. It is unclear how these issues interact with disadvantages.

Academic ability is the biggest influence on success at university, regardless of disadvantage. Students, their caregivers and support networks make many choices as they navigate education. Because each student is unique, support and a range of options (eg subjects they wish to study or a school they'd like to attend) is essential so that students can achieve their potential.

Disadvantage can limit a student's options and these limitations have, sometimes negative, impacts on their educational outcomes. However, it is worth emphasising that some factors examined in this analysis are at the aggregated level (eg school characteristics are made up of data from individual students); therefore, the impact of these factors on educational outcomes may not accurately reflect an individual's characteristics. A school or subject *must* be selected to suit the student.

We have focused only on the period from senior secondary school to first-year university in this analysis and have excluded any prior effects of disadvantage. Fortunately, only limited evidence suggests that disadvantage factors undermine success for students during this transitional period. On average, disadvantaged students achieve slightly better outcomes than their non-disadvantaged peers with the same academic ability and it appears that programs that assist disadvantaged students facilitate these successful outcomes.

– **Policy recommendations**

- The effects of disadvantage on academic ability are entrenched by Year 12 with only minimal further influence at university (Sections 3.1.1 and 3.2.3). Policies that target improving academic outcomes at earlier stages of education would flow through to better outcomes for disadvantaged students in Year 12 and at university.
- The ATAR, as a summary measure of academic achievement, is the most accurate predictor for success at university. The ATAR (or a proxy measure for academic ability) should continue to be used for university admissions, including for disadvantaged students (Sections 3.1.1 and 3.2.2). Greater use of pathway courses to facilitate the successful transition to university would improve outcomes for disadvantaged students.
- Expansion of equity scholarship programs would improve retention and completion rates for a greater number of disadvantaged university students. Targeting courses that attract students with ATARs between 60 and 90 would provide the best results (Sections 3.1.1 and 3.2.6). This could be extended to the provision of equity scholarships for pathway courses. Equity programs in general appear to have a positive effect on the outcomes of students and so should be expanded.
- The average underperformance of male students at both Year 12 and university levels needs further investigation to determine the cause and possible actions (Section 3.1.1 and 3.2.3).
- The complex interaction of the different disadvantages needs to be considered when formulating policy (eg policy to improve the outcomes of Aboriginal and Torres Strait Islander students should also consider their varying SES and regional status and be tailored accordingly – Section 3.2.7).
- Subject availability needs to be ensured for students, especially those who attend small schools (this mostly affects regional and remote students – Section 3.2.5).

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7 Appendix

7.1 First-year outcomes by school factors

Figure 50: First-year outcomes by ATAR and school size.

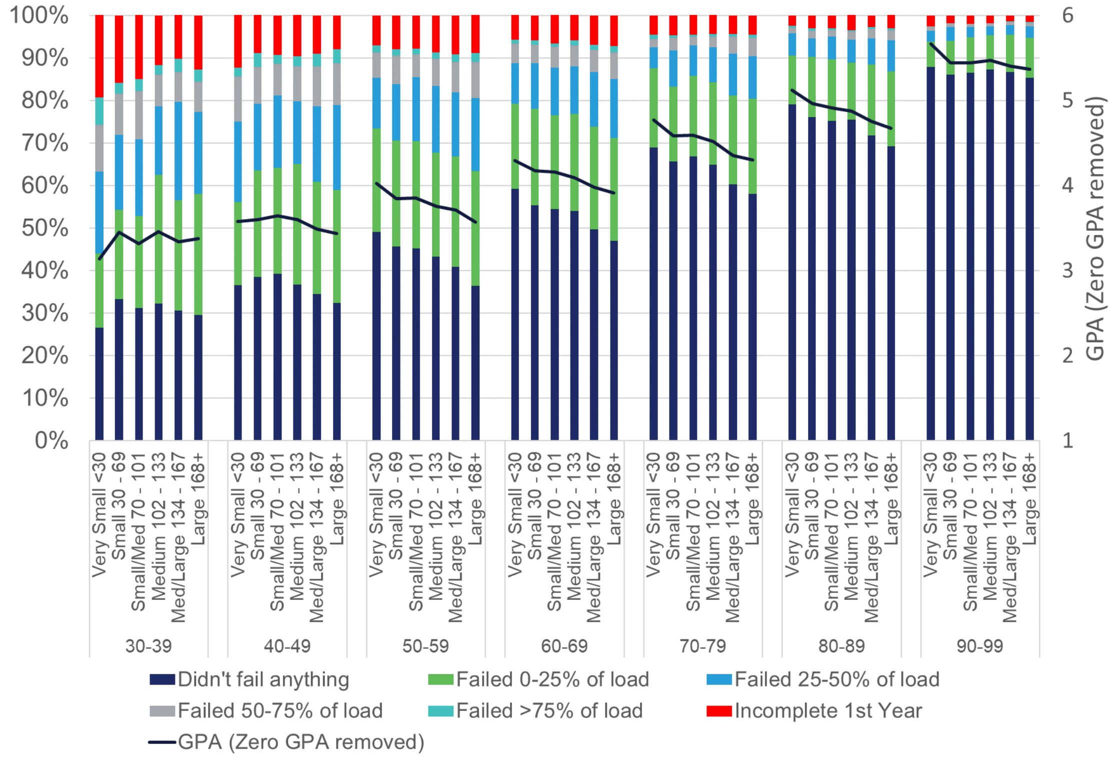


Figure 51: First-year outcomes by ATAR and school average IEO.

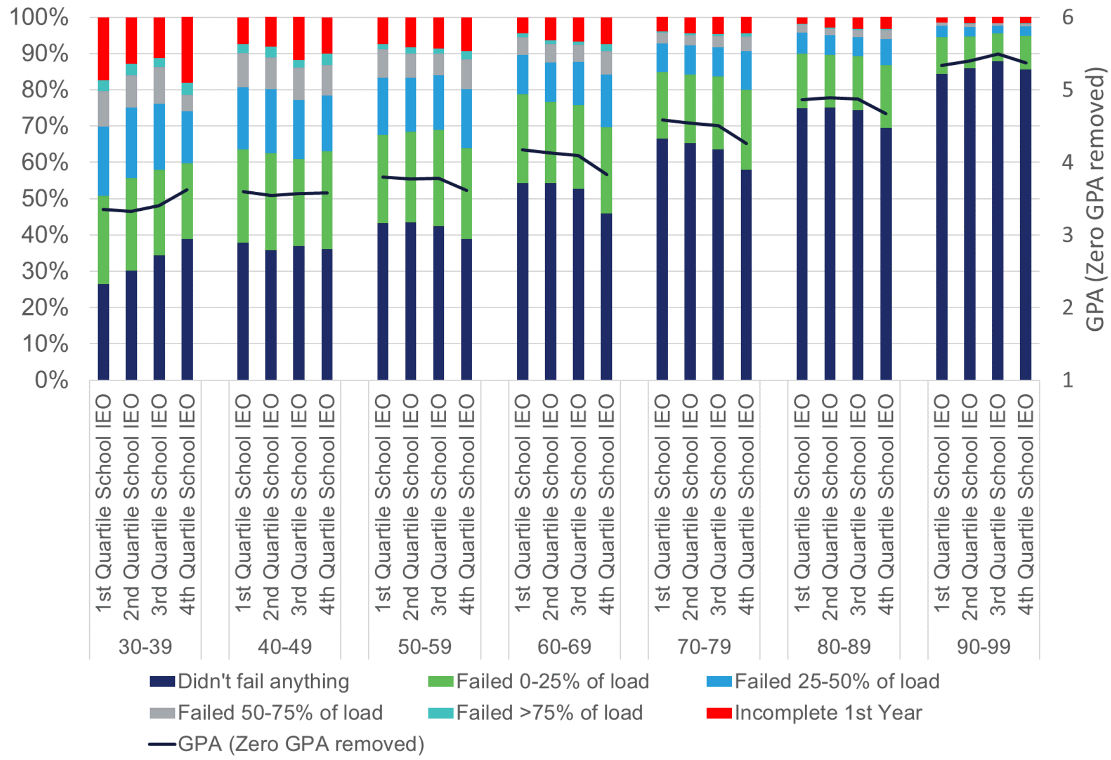
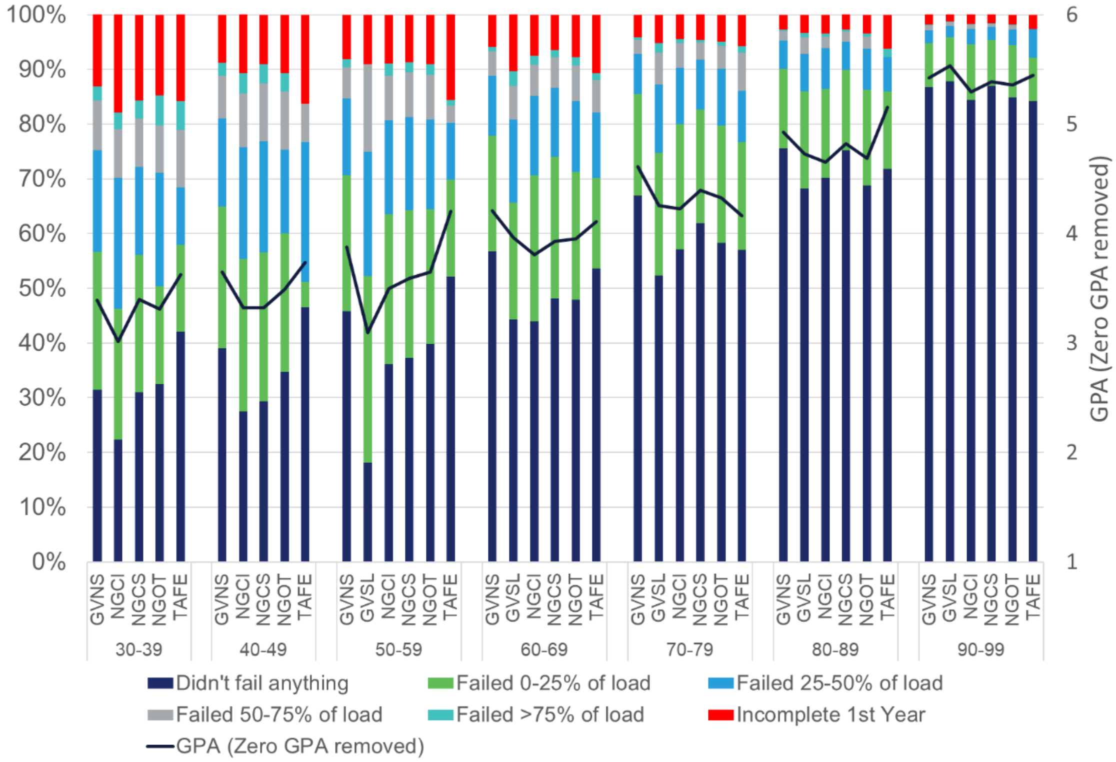


Figure 52: First year outcomes by ATAR and school type* (small samples removed).



*School types: GVNS = Government non-selective; GVSL = Government selective; NGCI = Non-government Catholic independent; NGCS = Non-government Catholic systemic; NGOT = Non-government other; TAFE = TAFE.

7.2 Summary of the machine learning models

The two predictive models are built using the ensembles tree model. We trained two XGBoost models based on the five years of Year 12 students' data (2014 to 2018) and the following year's first-year university students. The first model tries to predict students' ATAR based on 17 features from Year 12 students. The second model is developed to predict the first-year GPA and is based on 20 features from first-year university students.

The ATAR prediction model considers the following features from a Year 12 student (the classifications for categorical variables follow):

- residential IEO rank
- residential remoteness ('0: major cities of Australia', '1: inner regional Australia', '2: outer regional Australia', '3: remote Australia', '4: very remote Australia')
- gender ('0: F', '1: M', '2: X')
- Aboriginal and Torres Strait Islander ('0: Non ATSI', '1: Aboriginal', '2: TSI')
- school size
- school mean ATAR
- school IEO rank

- school disadvantaged flag ('0: no', '1: yes')
- school remoteness ('0: major cities of Australia', '1: inner regional Australia', '2: outer regional Australia', '3: remote Australia', '4: very remote Australia')
- school type ('0: GVNS', '1: GVSL', '2: NGCI', '3: NGCS', '4: NGOT', '5: TAFE')
- school gender ('0: B', '1: C', '2: G', '3: X')
- key learning areas
- highest level of mathematics ('0: no mathematics', '1: Mathematics General 2', '2: Mathematics', '3: Mathematics Extension 1', '4: Mathematics Extension 2')
- highest level of English ('0: English as a Second Language', '1: English Standard', '2: English Advanced', '3: English Extension 1', '4: English Extension 2')
- Category B subjects ('0: no', '1: yes')
- extension subjects (other than English and Mathematics) ('0: no', '1: yes')

The first-year GPA prediction model considers the following features from a first-year university student (the classifications for categorical variables follow):

- residential IEO rank
- residential remoteness ('0: major cities of Australia', '1: inner regional Australia', '2: outer regional Australia', '3: remote Australia', '4: very remote Australia')
- gender ('0: F', '1: M', '2: X')
- Aboriginal and Torres Strait Islander ('0: Non ATSI', '1: Aboriginal', '2: TSI')
- school size
- school mean ATAR
- school IEO rank
- school disadvantaged flag ('0: no', '1: yes')
- school remoteness ('0: major cities of Australia', '1: inner regional Australia', '2: outer regional Australia', '3: remote Australia', '4: very remote Australia')
- school type ('0: GVNS', '1: GVSL', '2: NGCI', '3: NGCS', '4: NGOT', '5: TAFE')
- school gender ('0: B', '1: C', '2: G', '3: X')
- key learning areas
- highest level of mathematics ('0: no mathematics', '1: Mathematics General 2', '2: Mathematics', '3: Mathematics Extension 1', '4: Mathematics Extension 2')
- highest level of English ('0: English as a Second Language', '1: English Standard', '2: English Advanced,'3: English Extension 1', '4: English Extension 2')
- Category B subjects ('0: no', '1: yes')
- extension subjects (other than English and Mathematics) ('0: no', '1: yes')

- ATAR
- university ('0: regional universities', '1: metro universities', '2: Go8 universities')
- field of study ('0: unknown', '1: Natural and Physical Sciences', '2: Information Technology', '3: Engineering and Related Technologies', '4: Architecture and Building', '5: Agriculture, Environmental and Related Studies', '6: Health', '7: Education', '8: Management and Commerce', '9: Society and Culture', '10: Creative Arts', '11: Food, Hospitality and Personal Services', '12: Mixed Field Programs')
- equity scholarship ('0: no', '1: yes').

Overall, these features could be grouped into six categories: demographic and SES indices, high school features, subjects studied in Year 12, in which university and fields of study the students enrolled, the ATAR and scholarship. Some of these features are loaded from different data tables from our database and some are derived based on our data. For instance, both the residence IEO rank and school IEO rank are derived based on the students' residential address. We developed a service to match a given address to the Statistical Areas Level 1 (SA1) code of the address and the corresponding IEO rank from the 2016 SEIFA data set.

For both the ATAR and GPA models, we used the same dataset described earlier (2013 to 2017 HSC students who applied to and enrolled in a bachelor degree through UAC the following year (2014 to 2018)); however, we have removed some student samples during the data cleaning approach due to missing data, invalid data or other data problems. As a result, we have 195,906 training samples for the ATAR model and 121,673 training samples for the GPA model. The cleaned data was split into two parts – 90 per cent of the data was used for training the model, while the other 10 per cent was kept for testing purpose.

The training process builds two XGBoost models for predicting the ATAR and first-year GPA separately. The inputs of the models are the features generated from the original dataset as described above, whereas the prediction target is the normalised ATAR value (from 0 to 0.9995) for the ATAR model and normalised GPA value (from 0 to 1) for the GPA model. The models are built with the XGBoost package and analysed with a SHAP package in a Python environment. The two models are fine-tuned separately, but share the following major settings:

- number of estimators: 2000
- maximum depth of trees: 6
- evaluation metric: logloss.

These two models are evaluated on 10 per cent of their student data separately. The GPA model has a 0.1241 squared mean error and the GPA model has a 0.1770 squared mean error on test data set separately. We did not include some features that are directly relevant to student's academic performance. For instance, subject scores for predicting ATAR and university course scores for predicting GPA. We did not use these features as they are not the focus of this work. Instead, we explored different SES indices as model input and analysed their impact on students' academic performance.

There are some limitations on this work, which could be improved in the future. Firstly, the students' records with no ATAR are removed for training the ATAR model and records with no GPA are removed for training the GPA model. As a result, these students are neglected in this work. Future work could analyse the difference of SES impact on these student groups.

Secondly, the address match uses an Elasticsearch-based approach which may cause some addresses to either not match or match incorrectly. We currently use postcode for IEO rank for those unmatched addresses, which may not be as accurate as SA1. Future work could improve the scoring algorithm of the address match service to generate a more accurate IEO rank. In this study we analysed the compound effect of multiple features, such as the impact of both IEO rank and remoteness features on ATAR and GPA. Future research could extend this approach on other feature combinations.