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Abstract

Administrative data from a New Zealand university are used to validate the National Certificate of Educational Achievement (NCEA) Rank Score used in university admissions and scholarship decisions. We find no statistical evidence to corroborate the specific weighting scheme used in this index. For example, our regression analysis suggests that too much weight is attached to the lowest category of credits in predicting both successful completion outcomes and letter grades. To show the potential importance of this validated measure of high school achievement, we run several simulations on these first-year student outcomes at this university. We show that the use of an alternative, empirically-validated measure of NCEA results to select students would lead to only slight improvements in course completion rates and letter grades. These higher entry standards would lead to declines in the proportions of Pacifica students, but minimal impacts on the proportion of Māori students enrolled at this university.

Keywords: Academic At-Risk Students, Academic Performance, Academic Success, Econometrics, Economics of Education

1. Introduction

There has been a recent marked acceleration in worldwide enrolments in post-secondary education. Between 1970 and 1990, the World Bank estimates that these enrolments, as a percentage of the five-year age group following the completion of high school, increased by one-third (from 10.2% to 13.6%).[1] Between 1990 and 2010, however, this percentage more than doubled (from 13.6% to 29.3%). Using similar measures, tertiary enrolments in New Zealand have increased at a steadier but faster rate over this entire period, with participation increasing five-fold since 1970.[2]

Such substantial increases in higher educational participation suggest that less able or academically prepared individuals may be enrolling at university. This relates to concerns by individuals and families in other countries over rising rates of academic failure, as well as the fiscal implications for the governments that subsidize these activities (e.g., see related discussions in Murray 2008, Johnson 2012, Raisman 2013 and Duncan 2015). As a result, empirical evidence on factors that are predictive of university failure may be particularly useful in both screening applicants and providing early interventions to improve academic outcomes. Yet, such predictive risk analysis on university academic performance that focuses on the overall predictive power of these tools has been relatively rare (e.g., see Engler (2010a and 2010b), and Jia and Maloney (2015) for recent exceptions).

The purpose of this study is to analyze a key summary measure of academic achievement from New Zealand high schools commonly used by universities in both screening applicants and providing student scholarships (commonly referred to as the 'NCEA Rank Score'). Our concern is that this weighted index of academic achievement at school was arbitrarily constructed, and never empirically validated as to its efficacy in predicting relevant university academic outcomes. We use regression analysis on administrative data from a large urban university in this country to show that alternative summary measures of high school academic achievement should be used if the objectives are to predict successful course completions or letter grades during the first year of study in bachelor's degree programmes. These alternative summary measures of academic achievement would improve the predictive

[1] Tables and figures downloaded from http://data.worldbank.org/indicator/SE.TER.ENRR
[2] The New Zealand tertiary sector covers private training establishments, workplace training, institutes of technology and polytechnics, wananga and universities.

accuracy of our tools for identifying both high-performing and at-risk students entering university.

The remainder of this paper is organized as follows. Section 2 provides a brief literature review and describes the nature of the current assessment system for high school academic achievement in New Zealand. Section 3 describes the data used in our analysis. Section 4 presents the main empirical results in this study. Section 5 provides further empirical results on the likely consequences of using validated summary measures of high school achievement on resulting university outcomes and the representativeness of key demographic groups. Section 6 uses simulation results to test the efficiency and equity implications of using Rank Ranks and empirically-validated alternative measures to select students at this university. Section 7 concludes and suggests possible future extensions to this study.

2. Review of the Relevant Literature and the NCEA System in New Zealand

There is a substantial empirical literature on the determinants of academic outcomes at university. Studies that focus on summary measures of high school academic achievement (e.g., Grade Point Average (GPA) or class rank) as predictors of subsequent university performance are the most relevant for this current project (e.g., see Johnes 1997, Betts and Morell 1999, Cohen et al. 2004 and Angrist et al. 2010). A high school GPA is essentially a cumulative index of letter grades. Because the standards for assigning grades can vary across individual schools, school districts and academic disciplines, one could argue on this basis that GPA captures relevant high school academic achievement in predicting university performance with considerable measurement error. Despite this concern, most empirical studies find that high school GPA positively and significantly influences subsequent university achievement. Our concern is slightly different. Even if individual grades were consistently applied based on clear performance standards, how do we know that the 'weights' attached to this index are correct? At least in terms of their usefulness for predicting subsequent academic outcomes, are individual letter grades really 'worth' the numerical values conventionally assigned to them?

Because Johnes (1997) examines the impact on entry qualifications on university programme completions in the United Kingdom, her analysis is probably more directly relevant to our present study. This is because university entry in the UK is based on Advanced Level subject-based qualifications. This national standards-based system provides more uniform and consistent indicators of academic achievement than a high school grades in the U.S. (even if these could be broken down into subject areas).[3] As expected, Johnes found that summary measures of entry qualifications were negatively and significantly associated with rates of degree programme non-completion.

New Zealand currently has a national standard-based assessment system for high school achievement. The National Certificate of Educational Achievement (NCEA) system has been in place since 2002.[4] It measures student performance against standards of achievement or competence in specific disciplines. Assessments take place over the school year and in nationally administered examinations in the chosen subjects at the end of each calendar year. Grades of ‘Excellence’, ‘Merit’, ‘Achieved’ or ‘Not Achieved’ are awarded in these standard. These qualifications are normally offered over the last three years in high school, and are known as NCEA Levels 1, 2 and 3, respectively. Students must achieve 80 credits in approved standards to gain each qualification.[5] The awarding of University Entrance normally requires an NCEA Level 3 qualification, including a minimum number of credits in three approved subjects, and a minimum number of credits in literacy and numeracy at lower NCEA levels.[6]

A summary measure of these NCEA results known as the ‘Rank Score’ was eventually introduced based on the grades obtained in achieved standards for university entrance. This index is based on the best 80 credits in approved subjects from NCEA Level 3, where each credit is awarded 4 points for Excellence, 3 points for Merit, 2 points for Achieved, and 0 points for Not Achieved. Thus, the maximum Rank Score is 320 (80 Excellence credits at 4 points each). According to this numerical scheme, an Achieved credit is worth exactly one-half of an Excellence credit, while a Merit credit is worth exactly three-quarters of an Excellence credit.

[3] This is why some U.S. studies (e.g., Cohn et al. 2004) also look at the predictive power of national standardized tests (e.g., the Scholastic Aptitude Test or SAT) on subsequent university outcomes.
[4] Alternatives to the NCEA system exist. Some schools use Cambridge International Examination or International Baccalaureate Diploma Programmes. In many cases, students complete both NCEA credits and these alternative qualifications. Approximately 85% of New Zealand high schools offer only the NCEA system.
[5] For more background information on this NCEA system, see http://www.nzqa.govt.nz/qualifications-standards/qualifications/ncea/understanding-ncea/.
[6] There are exceptions to this NCEA Level 3 University Entrance requirement. For example, Special Admissions status allows individuals aged 20 or older to enroll at university without this qualification. For more information on this University Entrance standards see http://www.nzqa.govt.nz/qualifications-standards/awards/university-entrance/.

Over time, this Rank Score has been adopted for use in some capacity in all eight of the universities in New Zealand. At least six of these universities explicitly use Rank Scores in their enrollment procedures.[7] The other two universities, Lincoln University and the University of Waikato, use this measure in awarding scholarships. For example, in 2017 the University of Auckland set minimum Rank Score thresholds that would guarantee applicant placements in Bachelor's degree programmes of 150 in Arts, 180 in Commerce, 230 in Architectural Studies, 250 in Health Sciences, 260 in Engineering, and 280 in Sciences (Biomedical Sciences).

Because Rank Scores are already used in selecting students for admission into university, this may weaken any statistical association between NCEA results and the eventual academic performance of selected students at university. For example, this argument has been made elsewhere that Graduate Record Examination (GRE) results may only weakly predict postgraduate performance in the US (e.g., see Moneta-Koehler et al. 2017), because the GRE has already 'done its job' in selecting the most promising postgraduates. Any further statistical relationship between these entry exams and postgraduate grades or completion rates may be relatively weak or nonexistent. We accept that a similar issue may exist with NCEA results and early undergraduate success at university. However, because of the wider range of student abilities and lesser restrictive standards for students entering Bachelor's degree programmes, we anticipate that this statistical association will prove to be relatively stronger in this case.

A few studies in New Zealand have previously considered the usefulness of Rank Scores for predicting first-year university academic outcomes. Shulruf at al. (2008) used data on 2,877 first-year students at the University of Auckland from 2005 to estimate correlations between Rank Scores and first-year university GPA. Like the present study, they speculated that this conventional summary measure of high school academic achievement may not have the highest possible predictive accuracy. They experimented with a series of alternative summary measures of NCEA results that emphasized variants like 'quantity' (e.g., the total number of credits achieved) and 'difficulty' (e.g., recognizing the percentages of students who achieve subject-specific standards). The authors also showed how the predictive power

[7] These institutions are: Auckland University of Technology, Massey University, University of Auckland, University of Canterbury, University of Otago, and Victoria University of Wellington. These are the six largest universities by full-time equivalent students, including more than 90% of all university enrollments in New Zealand in 2015 (http://www.universitiesnz.ac.nz/nz-university-system).

of these alternative measures for first-year GPA results might vary by ethnicity and high school deciles.[8] They concluded that ‘quality’ measures like the current Rank Score are more predictive of first-year university GPA than alternative summary measures that emphasize total credits achieved or the relative difficulty of discipline areas. Later studies by Scott (2008), Shulruf et al. (2009), and Shulruf et al. (2012) employed similar methodologies.

Our study is different from these previous analyses in that we ‘validate’ the weights attached to the different credit types based on objective assessments of their ability to predict first-year university academic achievement. Simply put, the aforementioned authors did not use available data to test whether the 4-3-2 weighting scheme for NCEA Level 3 credits is optimal from a predictive analytics perspective.

3. Data and Descriptive Statistics

Anonymized, individual-level data were provided by a large urban university in New Zealand for the purposes of this study. Data collected as part of the normal enrolment process were subsequently linked to the first-year outcomes of all students entering bachelor’s degree programmes in three consecutive years (2013 through 2015). Unlike survey data, administrative data provide more complete and accurate results from official high school and university records on academic performance. We use first-year outcomes on individual courses as our unit of observation to avoid concerns about attrition bias in examining later course outcomes for students progressing on to subsequent years of study at this university.

Table 1 provides definitions of the variables used in our analysis, and summary statistics for students with NCEA Level 3 results.

<< Insert Table 1 about here >>

We concentrate on two dependent variables for our predictive risk analysis. We first consider a dummy variable on the successful completion of a first-year course. A value of one

[8] Deciles are used to target funding at disadvantaged schools in New Zealand. Schools are allocated to deciles based on the socio-economic status of the communities from which most of their students are drawn. Decile 1 schools, for example, are the 10% of schools from the poorest and most disadvantaged communities. For more information on the construction of these school deciles https://education.govt.nz/school/running-a-school/resourcing/operational-funding/school-decile-ratings/

indicates that a course was completed with a passing grade; zero otherwise. Course completion rates in New Zealand universities are routinely monitored by the government, and fees subsidies can be forfeited if course completion rates fall below 60%.

Our second dependent variable is a more continuous measure on the course letter grade. We suggest that letter grades offer an important additional dimension to this analysis. Letter grades may be more closely aligned to the acquisition of knowledge, skills and human capital in the classroom, and subsequent returns in the labor market. We convert letter grades to numerical equivalents for our regression analysis on the conventional nine-point scale used in New Zealand.[9] In some cases, we had to exclude course observations from our grade point analysis because no letter grades were assigned. These generally occurred when courses were taken as 'pass/fail'. Valid letter grades are available for nearly 96% of the courses in our samples. We believe that course completions and grade points offer different summary measures of academic achievement at university. Because both may be important in success in subsequent studies at university and eventually in the labour market, we think it is important to consider both outcome measures separately.

The mean course completion rate was 79.1% for the 78,617 first-year course observations for students in our sample with valid NCEA results.[10] The mean course grade point is 3.63, which equates to a letter grade between a C+ and B-.

The independent variables used in our analysis are grouped into nine categories. When the dummy variables are exhaustive and mutually exclusive, the italicized variable in a category is the omitted variable for our regression analysis. For example, for the three annual cohorts of first-year students in bachelor's degree programmes, 2013 is the excluded year. We also know the prioritized ethnicity status as used at this university, country of origin, gender and age of our students.[11] Course observations are almost three-times more likely to come from

[9] These letter grades and their numerical equivalents are A+=9, A=8, A-=7, B+=6, B=5, B-=4, C+=3, C=2, C-=1, and D=0 (or any failing or noncompletion grade). Of course, a GPA from this system can be converted to the four-point US scale by multiplying by four-ninths.

[10] There are several reasons why enrolled students might not have valid NCEA results. They could have graduated from foreign high schools, completed schooling in New Zealand prior to the NCEA system, enrolled without this NCEA level 3 qualification, or previously enrolled at another university.

[11] Students self-report up to three ethnic identities. Anyone who reports being Māori is officially designated as Māori. This prioritized ethnic designation then extends to Pacifica, Asian, European and Other in that order.

students that attended high schools in the top three deciles compared to the bottom three deciles.[12]

There are four possible types of university entry allowed in our dataset. The default entry type is through the NCEA Level 3 qualification. External and internal entrance types exist for students previously admitted to another university or progressing on from lower-level pre-degree programmes at the current university, respectively. The latter entry type represents 'second chance opportunities' for students who had not acquired University Entrance status coming out of high school (even though they may have obtained NCEA Level 3 results). Special Admissions entry includes individuals who had not achieved University Entrance, but are allowed to enroll at university once when they reach their 20th birthdays (i.e., a possible at-risk group for poor university outcomes).

We also have information on the degree programmes in which students initially enrolled at this university. A series of eleven dummy variables capture these individual degree programmes.[13] We also use a dummy variable to indicate the relatively rare event where student initially enrolled in more than one degree programme (i.e., a Double Degree). Since the course outcome is the unit of observation, we also condition on the academic level of each course. Typical first-year courses in a bachelor's degree programmes would be at Level 5. Courses at Level 4 are typically taken in a pre-degree programme, and are relatively rare in this sample. Courses at Levels 6 and 7 would typically occur in the second and third years of study.

Finally, consider the NCEA Level 3 results reported in Table 1. The mean NCEA Rank Score is 173.4, and associated with 11.7 Excellence, 20.4 Merit, and 39.3 Achieved credits. Totaling these means gives us approximately 71.4 credits, which is less than the maximum of 80 credits that can be used in calculating a Rank Score.

[12] This reflects both the distribution of secondary schools across these deciles, as well as the students who attend university from these school deciles. Primary schools are more prevalent in the lower deciles, while high schools are more prevalent in the higher deciles. As a result, university students are more likely to come from medium to high-decile high schools rather than from lower-decile high schools.

[13] These bachelor's degree programmes are Arts (BA), Business (BBus), Computer and Information Systems (BCIS), Communication Studies (BCS), Design (BDes), Education (BEdu), Engineering Technology (BEngTech), Health Sciences (BHS), International Hospitality Management (BIHM), Sports and Recreation (BSR), and a residual category of several smaller degree programmes (Others). Students must enroll in degree programmes in their first year of study at this university.

4. Regression Results on Successful Course Completions

Table 2A displays the maximum likelihood regression results for the dummy dependent variable on successful course completions using both the full set of independent variables, and a restricted specification that includes only the Rank Score. We report estimated coefficients, standard errors and mean marginal effects from this sample.[14] These could be thought of as predictive risk models, where we estimate the probabilities of successful course completions conditional on covariates observable when students first arrive at university. Because the unit of observation for our regression analysis is the outcome of a specific course, and almost all students in our sample have multiple course outcomes in the first year, we allow for the clustering of standard errors using the identity of the student.

<< Insert Table 2A about here >>

Summary measures at the bottom of this table indicate something about the overall predictive accuracy of these two regressions. A Pseudo R^2 Statistic is defined as one minus the ratio of the log-likelihood functions from this regression and a regression with no covariates (McFadden 1974). It roughly corresponds to the overall explanatory power of the model. This Pseudo R^2 Statistic is 0.1082 in this unrestricted specification, and 0.0604 in the restricted regression. Thus, eliminating all other covariates except the Rank Score causes the explanatory power of the model to drop by less than one-half.[15]

We can ask how well these predictions capture this actual outcome of interest. One approach is to borrow a technique sometimes used in predictive risk analysis (e.g., see the application in similar context in Jia and Maloney (2015)). Suppose we use the first regression to predict the probabilities of successful course completions, and sort these predicted probabilities in descending order. We can then ask, for example, what the true course completion rates were for the top and bottom quintiles. The actual completion rates were 58.5% for courses with the lowest 20% of predicted probabilities, and 95.2% for courses with the highest 20% of

[14] Because the estimated coefficients have no direct interpretation in this nonlinear estimation, we report the mean marginal effects or partial derivatives for this sample. For a dummy independent variable like gender, this is the mean marginal effect as this variable goes from zero to one, holding constant all other individual covariates.

[15] Alternatively, we could exclude the NCEA information and estimate this and all subsequent regressions with just the student background factors. Although these results are not reported in this study, they can be easily summarised. Because of the collinearity between NCEA results and these other covariates, the Pseudo R^2 statistics are again more than one-half of these summary statistics on explanatory power in the unrestricted specifications. There is quite a bit of correlation between student backgrounds and NCEA results.

predicted probabilities. A simple way to compare these outcomes is to compute the 'lift' in targeted outcomes in moving from the bottom to the top quintile. This figure is approximately 162.7% (or 0.952 divided by 0.585).

For the second regression reported in Table 2A that includes the Rank Score as the only covariate, the course completion rates were 66.5% and 94.6% for those in the bottom and top quintiles, respectively. The corresponding lift from this restricted regression is 142.3% for course completions.

Consider the estimated marginal effects on the Rank Score from these two regressions. We divided Rank Scores by 10 to move the decimal points on these estimated parameters and ease the interpretation of these results. The estimated marginal effects on this variable are 0.0143 and 0.0151 in the unrestricted and restricted specifications, respectively. The associated *z*-statistics on these results are 49.9 and 76.3, so we can easily reject the null hypotheses that these marginal effects are equal to zero at better than 1% levels. This suggests that, holding other factors constant, every ten-point increase in the Rank Score increases the probability of a successful course completion by 1.43 percentage points. Holding no other factors constant, every ten-point increase in the Rank Score increases this same probability by 1.51 percentage points. [16]

The regressions presented thus far are based on the implicit assumption that the Rank Score is the correct index to use for capturing the relationship between NCEA results and subsequent course completions at university. This hypothesis is easy to test. We can substitute the components that comprise the Rank Score into these regressions in place of this index itself, and see whether or not these arbitrary weights can be empirically verified. Table 2B reports the results on the unrestricted and restricted regressions, where we suppress the results on the other covariates in the initial specification for brevity.

<< Insert Table 2B about here >>

Consider the first set of results on the unrestricted specification. By breaking the Rank Score into the Excellence, Merit and Achieved components for the top 80 credits, the Pseudo R^2

[16] To get a sense of the relative magnitude of these potential impacts, we could divide these figures by their respective sample means. A ten-point increase in the Rank Score is equivalent to a 5.8% increase in this measure of high school academic performance. We estimate that this would increase the probability of a successful course completion by 1.8% (controlling for other covariates) or 1.9% (without any controls).

statistic increases from 0.1082 in Table 2A to 0.1111 in Table 2B (a 2.7% improvement in this summary measure of predictive accuracy). We earlier reported a lift of 162.7% in course completion rates in going from the bottom to the top quintile. This remains the same in this new regression.

In the restricted regression, the Pseudo R^2 Statistic increases from 0.0604 in Table 2A to 0.0714 in Table 2B (an 18.2% improvement in this summary measure of predictive accuracy). We earlier reported a lift of 142.3% in course completions in going from the bottom to the top quintile. This increases to 144.4% in this new regression. These results suggest that an alternative weighting scheme for these top 80 NCEA credits would generally improve the predictive accuracy for course completions.

The estimated partial derivatives on the Excellence, Merit and Achieved credits provide the definitive findings. Recall that a 4-3-2 weighting scheme is used in computing the Rank Score (i.e., Excellence, Merit and Achieved credits are worth 4, 3 and 2 points, respectively). If this weighting scheme is correct, it should be replicated in our regression results. The mean estimated marginal effects are, respectively, 0.0506, 0.0442 and 0.0134 for these three credit types in the unrestricted estimation. All three are significantly different from zero at better than a 1% level. If we inflated the estimated marginal effect for Excellence credits to four points to match its assumed value in the Rank Score. Inflating the other two estimated values by the same figure would give us approximate values of 3.50 and 1.06 points for Merit and Achieved credits, respectively. The last F test at the bottom of Table 3B shows that we can easily reject the null hypothesis at better than a 1% level that a Merit credit is worth three-quarters of an Excellence credit, and an Achieved credit is worth one-half of an Excellence credit.

Similar qualitative results occur with the restricted estimation. The estimated marginal effects are, respectively, 0.0549, 0.0472 and 0.0044 for these three credit types. All three are significantly different from zero at better than a 1% level. However, if we inflate the estimated effect for an Excellence credit to four points, the estimated values for Merit and Achieved credits would be approximately 3.44 and 0.32, respectively. We can easily reject the null hypothesis on the 4-3-2 weighting scheme. Thus, our empirical validation suggests that Rank Scores systematically *undervalue* the relative importance of Merit credits (assigning a value of three rather than the validated quantity of approximately 3.5), and *overvalue* the relative importance of Achieved credits (assigning a value of two rather at most one).

The results generated thus far have been based on the best 80 credits received at NCEA Level 3. Like the arbitrary weighting scheme for the different credit categories, there is no clear reason why any credits beyond the top 80 should be irrelevant in predicting subsequent university outcomes. We include the total numbers of credits earned in the three categories in the regression results reported in Table 2C. The Pseudo R^2 Statistics increase further in magnitude under both specifications. In the unrestricted regression, this summary statistic of 0.1122 is 3.7% higher than in the initial specification using the Rank Score. In the restricted regression, this summary statistic of 0.0722 is 19.5% higher than in the original specification. Using all available NCEA credits improves the lift in predicting course completions (163.6% vs. the initial 162.7%) in the unrestricted specification. Using all NCEA credits improves the lift in predicting course completions (144.8% vs. the initial 142.3%) in the restricted specification. Thus, for the purpose of predicting university outcomes there is no obvious reason to restrict attention to the best 80 NCEA credits.

<< Insert Table 2C about here >>

The estimated partial derivatives on all Excellence, Merit and Achieved credits continue to challenge the 4-3-2 weighting scheme used in computing Rank Scores. In the unrestricted estimation, these estimated mean marginal effects are, respectively, 0.0448, 0.0414 and 0.0152 for these three credit types. If we inflate the estimated effect for Excellence credits to four points, the corresponding values for Merit and Achieved credits would be 3.70 and 1.36, respectively. We can easily reject the null hypothesis at better than a 1% level on the 4-3-2 weighting scheme. We see weak statistical evidence for the first time of any distinction between the effects of Excellence and Merit credits. The null hypothesis that their effects are identical can be rejected at only a 9.4% level.

In the restricted specification using all NCEA credits, the estimated mean marginal effects are 0.0512, 0.0466 and 0.0082 for Excellence, Merit and Achieved credits, respectively. If the estimated effect for Excellence credits is inflated to four points, this implies values of 3.64 and 0.64 for Merit and Achieved credits, respectively. Again, we can reject the null hypothesis that the marginal effects follow a 4-3-2 weighting scheme. Merit credits are closer in value to Excellence credits than they are to Achieved credits in predicting course completion rates.

5. Regression Results on Course Letter Grades

We now duplicate the previous steps for regressions using course grades as an alternative dependent variable. Ordinary least-squares estimation is used on individual course grade points for integers ranging from zero to nine. Table 3A displays the estimated coefficients and standard errors from both unrestricted and restricted specifications.

<< Insert Table 3A about here >>

The R^2 Statistics are 0.2163 and 0.1429 in the two regressions. Eliminating all other covariates except the Rank Score reduces explanatory power by approximately one-third.

We can think of these regression results in a predictive-risk context. Suppose the first regression is used to predict course grade points, and these fitted values are sorted in descending order. We can then compute the actual mean GPAs in the top and bottom quintiles. These figures are 5.509 in the top quintile, and 2.601 in the bottom quintile. This gives us a lift in targeted outcomes in moving from the bottom to the top quintile of 211.8% (5.509 divided by 2.601).

For the second regression reported in Table 3A that includes the Rank Score as the only covariate, the mean GPAs were 5.381 and 2.571 in the top and bottom quintiles, respectively. The corresponding lift from this restricted regression is 209.3% (or 5.381 divided by 2.571).

The estimated coefficients on the Rank Score are 0.1523 and 0.1491 in the unrestricted and restricted regressions, respectively. We can easily reject the null hypotheses that these coefficients are equal to zero at better than a 1% level. This suggests that, for every ten-point increase in the Rank Score, the expected course grade increases by 0.1523 grade points once other covariates are held constant, and 0.1491 points when nothing else is held constant.[17]

[17] We can again divide these estimated effects by the sample means to compute relative impacts on GPA. A ten-point increase in the Rank Score is equivalent to a 5.8% increase in this measure of high school academic performance. We estimate that this would increase grade points by 4.2% (controlling for other covariates) or 4.1% (without other covariates).

As with course completions, we can test whether the Rank Score captures the true relationship between NCEA results and university grades. We can substitute the numbers of Excellence, Merit and Achieved credits for the Rank Score, and see whether or not these arbitrary weights can be empirically verified. The results on the unrestricted and restricted specifications are reported in Table 3B.

<< Insert Table 3B about here >>

Consider the results on the unrestricted regression first. By breaking the Rank Score into its components for the top 80 credits, the R^2 statistic increases from 0.2163 in Table 3A to 0.2307 in Table 3B (a 6.7% improvement in this measure of predictive accuracy). We earlier reported a lift of 211.8% in course grades points in going from the bottom to the top quintile. The lift in grade points in this new regression increased substantially to 268.4% (5.540 in top quintile divided by 2.064 in the bottom quintile).

In the restricted regression, the R^2 statistic increased from 0.1429 to 0.1735 (a 21.4% improvement in this measure of predictive accuracy). We earlier reported a lift of 209.3% in course grades in going from the bottom to the top quintile. This increases to 218.1% in this new regression.

Again, the estimated coefficients on Excellence, Merit and Achieved credits provide the definitive results on the appropriate weighting scheme for predicting course letter grades. The estimated coefficients are, respectively, 0.5311, 0.3488 and 0.0521 for these three credit types in the unrestricted estimation. If we inflated the estimated effect for Excellence credits to four to match its value in the Rank Score calculation. Inflating the other two estimated values by the same figure would give us values of approximately 2.63 and 0.39 for Merit and Achieved credits, respectively. We can easily reject the null hypothesis at better than a 1% level that the coefficients on Merit and Achieved credits are worth three-quarters and one-half of an Excellence credit, respectively.

Similar qualitative results occur with the restricted estimation. The estimated coefficients are, respectively, 0.5341, 0.3495 and -0.0032 for these three credit types. Only the first two results are significantly different from zero at better than a 1% level. The estimated coefficient on Achieved credits is now negative, but statistically insignificant. Once Excellence and Merit credits are held constant, Achieved credits have no measureable impact on university grades. If we inflate the estimated effect for Excellence credits to four, the estimated value of a Merit credit would be approximately 2.62. We can easily reject the null hypothesis that these effects match a 4-3-2 weighting scheme.

The results generated thus far are based on the best 80 credits received through NCEA Level 3. In the regression results reported in Table 3C, we include the total numbers of credits earned in the three categories. The R^2 Statistics remain almost unchanged under both specifications. In the unrestricted specification, this summary statistic of 0.2309 is almost identical to the R^2 Statistic of 0.2307 in Table 3B. In the restricted specification, this summary statistic of 0.1732 is slightly lower than the R^2 Statistic of 0.1735 in Table 3B. At least in terms of predicting grades, adding additional credits beyond the top 80 yields no additional predictive power.

<< Insert Table 3C about here >>

The estimated coefficients on all Excellence, Merit and Achieved credits continue to challenge the 4-3-2 weighting scheme used in computing Rank Scores. In the unrestricted estimation, if we inflate the estimated effect for Excellence credits to four to match its value in Rank Score calculations, the corresponding values would be 2.86 and 0.60 for Merit and Achieved credits, respectively. In the restricted specification, if we inflate the estimated coefficient on Excellence credits to four, the corresponding values would be 2.89 and 0.26 for Merit and Achieved credits, respectively. We can easily reject the null hypotheses at better that Merit credits are worth three-quarters of Excellence credits, and Achieved credits are worth one-half of Excellence credits. In fact, these results suggest that Achieved credits have little predictive power over university grades once we hold constant the number of Excellence and Merit credits obtained by the student. Thus, our empirical validation suggests that Rank Scores slightly *overvalue* the relative importance of Merit credits (assigning a value of three rather than less than three), and substantially *overvalue* the relative importance of Achieved credits (assigning a value of two rather than a value much lower than one).

6. Potential Efficiency and Equity Implications of Using Alternatives to Rank Scores

In this section, we consider what would happen to course completion rates, grade points and the composition of our student body if we were to raise entry standards at this university using either Rank Scores or our alternative empirically-validated measures of NCEA Level 3 results. These simulations are based on our current sample of students. Table 4 shows these results on course completions. The first row provides the starting point for our analysis. Using all students in our sample, the mean course completion rate is 77.42%. This original sample has 11.47% Māori, 14.87% Pacifica, and 15.78% of students from the lowest three school deciles.

<< Insert Table 4 about here >>

Suppose we now restrict student intake using increasingly higher Rank Score cutoffs. These results are shown in the first panel of Table 4. For example, if we restrict entry to those students with Rank Scores in excess of 110, only 84.49% of this original sample would remain. Course completion rates would increase to 80.03%. There would be nearly the same percentage of Māori students (11.46%), but fewer Pacifica students (13.59%) and those from the bottom three school deciles (14.94%). If we continue to raise this Rank Score threshold, we can see these effects on course completion rates and student characteristics in the remaining samples. For example, at a Rank Score cutoff of 190, only 46.24% of the original sample of students would remain. Their course completion rate would rise to 88.15%. There would be slightly fewer Māori students (11.02%), but far fewer students Pacifica students (9.36%) and those from the bottom three school deciles (10.90%).

The second panel of Table 4 displays the results of using an alternative, empirically-validated measure of NCEA results based on the regressions results in Table 2C to reach the exact same numbers of students entering this university. In other words, we set these thresholds for this validated score to match the student intake in the previous simulations using the Rank Score. For example, a validated score in excess of 182.57 gives us the same proportion of students remaining from the original sample as we get with a Rank Score cutoff of 190. Thus, the order of the rows in the two simulations can be directly compared to one another because they retain exactly the same numbers of students.

Consider the ultimate outcomes from the two sets of simulations by reducing the proportion of students retained at this university to 46.24% of the original sample. The course completion rate using the Rank Score cutoff (88.15%) is only slightly lower than the completion rate using the empirically-validated measure (88.22%). Using this validated measure slightly improves the percentage of Māori students remaining at this university (11.40% vs. 11.02%), but results in fewer Pacifica students (9.09% vs. 9.36%) and those from the bottom three school deciles (10.68% vs. 10.90%).

Using simple algebra, we can compare the course completion rates for students who would be retained from this original sample relative to the completion rates actually observed for students who would be excluded under these higher entry criteria. We know that 46.24% of the highest-performing students by these NCEA measures would have course completion rates of 88.15% and 88.22%, respectively. The course completion rates would be 68.19% and 68.13%, respectively, for the students who would be excluded from this university by these entry standards. With either measure, the absolute difference in course completion rates between retained and excluded students would be approximately 20 percentage points.

We can next ask whether these selection standards would have similar effects among Māori and Pacifica students. In other words, as these entry standards based on NCEA results increase, do they similarly discriminate between students in these ethnic groups who will succeed and fail at university? These results are not reported in Table 4, but can be quickly summarized. For the same thresholds associated with a Rank Score cutoff of 190, there are slightly fewer Māori students (44.51%) and substantially fewer Pacifica students (29.10%) retained compared to the full sample (46.24%). However, these higher entry standards have similar abilities to discriminate between successful and unsuccessful students in these ethnic groups relative to the full sample. Māori retained with the equivalent of a Rank Score of 190 or better have course completion rates of 84.81% and 84.00%, respectively. These are only slightly lower than the course completion rates for the full sample. Māori students excluded by these entry standards have course completion rates of 62.98% and 63.63%. Again, these are lower than the comparable figures for the full sample. These measures produce absolute differences in course completion rates between retained and excluded Māori students of between 20 and 22 percentage points.

Pacifica students retained with the equivalent of a Rank Score of 190 or better have course completion rates of 84.81% and 82.47%, respectively. Pacifica students who would be excluded from this university with these entry standards have completion rates of 51.87% and 53.16%. These course completion rates for excluded Pacifica students are substantially lower than similar figures for the full sample. These measures produce absolute differences in course completion rates between retained and excluded Pacifica students of between 29 and 33 percentage points. These findings suggest that these screening tools are just as effective among Māori and Pacifica student populations in distinguishing between those who will succeed academically in the first year at university from those who will struggle and either require additional assistance or might be advised not attend university.

Table 5 repeats this same exercise using the GPAs of these students. As a starting point, using all students with NCEA results and valid course letter grades in our sample, the mean GPA is 3.621. This original sample has 11.42% Māori, 14.86% Pacifica, and 15.80% of students from the lowest three school deciles.[18] We can again compare outcomes as we increasingly restrict the sample by raising the Rank Score and alternative empirically-validated thresholds to achieve the same intake of students. The mean outcomes from these simulations show a higher GPA (4.194) from using this validated measure compared to the Rank Score (4.173). These two approaches again result in mixed effects on the composition of the student body. Using this validated measure slightly improves the percentage of Māori students remaining in this university (11.55% vs. 11.30%), but would also result in fewer Pacifica students (11.28% vs. 11.53) and those coming from the bottom three school deciles (13.12% vs. 12.94%).

<< Insert Table 5 about here >>

It is important to note that although these validated measures result in better academic achievement for students remaining in this sample relative to a selection system based on Rank Scores, these effects are relatively small in magnitude. In percentage terms, these improvements are approximately 0.1% for course completion rates and 0.5% for GPAs. The relatively larger estimated GPA effect is consistent with the validation of NCEA credits that shows minimal values for Achieved credits in predicting letter grades.

As we did with course completions, we can ask whether these selection standards would have similar effects among Māori and Pacifica students on their GPAs. These results are not reported in Table 5, but can be quickly summarized. For the full sample, we know that 46.48% of the highest-performing students by these NCEA measures would have GPAs of 4.578 and 4.601, respectively. These results imply that the GPAs would be 2.790 and 2.770 for the students who would be excluded from this university by these entry standards. With these measures, the absolute differences in GPAs between retained and excluded students are 1.787 and 1.830 grade points, respectively.

[18] These mean student characteristics are slightly different from the starting points in Table 4 because this current sample is restricted to students with GPAs based on valid letter grades.

For the same entry standards, there are slightly fewer Māori students (44.70%) and substantially fewer Pacifica students (28.87%) retained compared to the full sample. However, these higher entry standards have similar abilities to discriminate between successful and unsuccessful students in these ethnic groups relative to the full sample. Māori students retained would have a GPA of 4.268 and 4.232, respectively. Those excluded by these entry standards would have GPAs of 2.693 and 2.722. The resulting absolute differences in GPAs between retained and excluded Māori students are 1.574 and 1.511 grade points. These are slightly smaller than the absolute differences in these GPAs between these two groups of Māori students relative to the full sample. Pacifica students retained would have a GPA of 3.340 and 3.326, respectively. Those excluded from these entry standards would have GPAs of 2.078 and 2.084. Both sets of figures are substantially below similar GPAs for the full sample and among Māori. The resulting absolute differences in GPAs between retained and excluded Pacifica students are 1.262 and 1.242 grade points. These findings suggest that these screening tools are slightly less effective for Māori and Pacifica student populations in distinguishing between who will succeed academically in terms of GPAs in the first year at university. Pacifica students, in particular, have relatively lower GPAs among both those students who would be selected and not selected for university by these higher entry standards.

7. Conclusions

This study has shown that the weighting scheme used in summarizing academic achievement at the end of high school in New Zealand through the Rank Score is potentially problematic. If the purpose of this summary measure is to predict either course completion rates or letter grades during the first year of university study, then alternative empirically-validated measures would improve this predictive accuracy. The current index uses a 4-3-2 weighting scheme for Excellent, Merit and Achieved NCEA credits, respectively. In predicting both course completions and grades, Achieved credits are worth far less than the two points implied by the Rank Score. Merit credits are worth more than their three points if the goal is to predict successful course completions, but less than three points if we want to forecast course grades.

We also show the comparative effects of raising entry standards to restrict student numbers by using Rank Score and empirically-validated alternative thresholds. These simulations gradually reduce the original sample by raising entry standards using these alternative measures, while retaining the same number of students. For example, if a higher Rank Score was used to retain less than half of the original students, we estimate that the mean course completion rate would increase from the present 77.42% to 88.15%, and the current GPA from 3.621 to 4.577. The use of this alternative, empirically-validated measure would have minimal effects on these outcomes for the students selected. This alternative measure of NCEA performance would only slightly increase the course completion rate to 88.22%, and GPA to 4.601. Higher entry standards of either form would lead to slight decreases in the proportions of Pacifica students and students from schools in the bottom three deciles. However, these higher entry standards would have little impact on the proportion of Māori students enrolled at this university.

The primary purpose of this paper is to point out the importance of validating weights assigned to indices of prior academic achievement. For example, if Rank Scores are used by New Zealand universities in making enrollment and scholarship decisions, then the weights attached to these credits should most likely reflect their contributions in predicting subsequent academic success. Much more could be done on this topic. Only the appropriate weights of broad categories of NCEA credits have been considered in this paper. These weights could vary by the subject matter of these exams, the degree programmes or majors in which students first enroll, or interactions between the two sets of variables. The key is that even conventional university administrative data can be used to objectively construct more efficient summary measures of past academic achievement based on statistical associations between finer details on this prior achievement and eventual outcomes at university.

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Table 1: Variable Definitions and Descriptive Statistics

Variables		Sample Means
Course Completions	1 if course successfully completed; 0 otherwise	0.7909
Grade Points*	Integers ranging from 0 (D or failing grade) to 9 (A+)	3.6286
NCEA Results		
Rank Score	Rank Score for NCEA Level 3 (i.e., best 80 credits using point values of 4, 3 and 2 for Excellence, Merit and Achieved credits, respectively).	173.447
Excellence Credits	Excellence NCEA Level 3 credits obtained	11.725
Merit Credits	Merit NCEA Level 3 credits obtained	20.358
Achieved Credits	Achieved NCEA Level 3 credits obtained	39.275
Enrolment Years		
2015	1 if student enrolled in calendar year 2015; 0 otherwise	0.3781
2014	1 if student enrolled in calendar year 2014; 0 otherwise	0.3552
2013	*Omitted category for students enrolled in the year 2013*	0.2667
Prioritized Ethnicities		
Māori	1 if student is Māori; 0 otherwise	0.1114
Pacifica	1 if student is Pacifica; 0 otherwise	0.1550
Asian	1 if student is Asian; 0 otherwise	0.2410
Other Ethnicities	1 if student is any other ethnicity; 0 otherwise	0.0620
Undeclared	1 if student did not declare ethnicity; 0 otherwise	0.0211
European	*Omitted category for European ethnicity*	0.4095
Countries of Origin		
Asia	1 if student country of origin Asia; 0 otherwise	0.0635
Pacific Islands	1 if student country of origin Pacific Islands; 0 otherwise	0.0224
Other Countries	1 if student country of origin not listed; 0 otherwise	0.1039
New Zealand	*Omitted category for New Zealand country of origin*	0.8102
Demographic Factors		
Female	1 if female student; 0 male	0.6282
Part-time	1 if student studying part-time; 0 full-time	0.0541
Age	Student age in years	18.9765
High School Deciles		
Decile 1	1 if student from school decile 1; 0 otherwise	0.0387
Decile 2	1 if student from school decile 2; 0 otherwise	0.0464
Decile 3	1 if student from school decile 3; 0 otherwise	0.0776
Decile 4	1 if student from school decile 4; 0 otherwise	0.1726
Decile 5	1 if student from school decile 5; 0 otherwise	0.0648
Decile 7	1 if student from school decile 7; 0 otherwise	0.0953
Decile 8	1 if student from school decile 8; 0 otherwise	0.0954
Decile 9	1 if student from school decile 9; 0 otherwise	0.1504
Decile 10	1 if student from school decile 10; 0 otherwise	0.2253
No Decile	1 if school decile unknown; 0 otherwise	0.0250
Decile 6	*Omitted category school decile 6*	0.0732

Table 1 Continued

Entrance Types		
External	1 if student previously enrolled at another university; 0 otherwise	0.0352
Internal	1 if students obtained pre-degree qualification from this university; 0 otherwise	0.0984
Special	1 if student entered with special admission (aged 20 or over without University Entrance); 0 otherwise	0.0253
NCEA Level 3	*Omitted category for NCEA Level 3 entrance*	0.8411
Bachelor's Degree Programmes		
BBus	1 if Business; 0 otherwise	0.2234
BCIS	1 if Computer Information Science; 0 otherwise	0.0610
BCS	1 if Communication Studies; 0 otherwise	0.0880
BDes	1 if Design; 0 otherwise	0.0692
BEdu	1 if Education; 0 otherwise	0.0306
BEngTech	1 if Engineering Technology; 0 otherwise	0.0484
BHS	1 if Health Science; 0 otherwise	0.1801
BIHM	1 if International Hospitality Management; 0 otherwise	0.0355
BSR	1 if Sports and Recreation; 0 otherwise	0.0682
BSc	1 if Science; 0 otherwise	0.0298
Other Degrees	1 if other small degree programmes; 0 otherwise	0.0673
BA	*Omitted category for students enrolled in Bachelor of Arts*	0.1166
Double Degree	1 if enrolled in a double degree programme; 0 otherwise	0.0181
Course Levels		
Level 4	1 if course level 4; 0 otherwise	0.0036
Level 6	1 if course level 6; 0 otherwise	0.2054
Level 7	1 if course level 7; 0 otherwise	0.0149
Level 5	*Omitted category level 5 course*	0.7762
n		78,617

* There are fewer course observations on students with valid letter grades (n = 75,451). The reported grade point mean is conditional on courses with valid letter grades. An unknown school decile is most often associated with a student who completed high school outside New Zealand. There are very few of such students in our sample, because they must report valid NCEA results to be included in our analysis. In a few cases, students completing high school within New Zealand do not have a recorded school decile. Most, but not all, private schools in New Zealand have a school decile.

Table 2A: Maximum Likelihood Probit Regressions on Course Completions
Full Set of Results Using NCEA Rank Scores

Independent Variables	Unrestricted Estimation Coefficient	Unrestricted Estimation Standard Error	Unrestricted Estimation Marginal Effect	Restricted Estimation Coefficient	Restricted Estimation Standard Error	Restricted Estimation Marginal Effect
Constant	0.0613*	0.0355	---	-0.1066***	0.0136	---
NCEA Results						
Rank Score/10	0.0557***	0.0011	0.0143***	0.0560***	0.0008	0.0151***
Enrolment Years						
2015	-0.0597***	0.0142	-0.0153***	---	---	---
2014	-0.0529***	0.0139	-0.0135***	---	---	---
Prioritized Ethnicities						
Māori	-0.2502***	0.0184	-0.0640***	---	---	---
Pacifica	-0.4050***	0.0176	-0.1036***	---	---	---
Asian	-0.0202	0.0168	-0.0052	---	---	---
Other Ethnicities	-0.2029***	0.0225	-0.0519***	---	---	---
Undeclared	0.0233	0.0421	0.0060	---	---	---
Countries of Origin						
Asia	-0.0665***	0.0211	-0.0170***	---	---	---
Pacific Islands	-0.0325	0.0286	-0.0083	---	---	---
Other Countries	-0.0475	0.1020	-0.0122	---	---	---
Demographic Factors						
Female	0.1360***	0.0123	0.0348***	---	---	---
Part-time	-0.1680***	0.0224	-0.0430***	---	---	---
Under Age 18	0.1266	0.0929	0.0324	---	---	---
Age 19	-0.0176	0.0132	-0.0045	---	---	---
Age 20	-0.0373**	0.0168	-0.0095**	---	---	---
Age 21	-0.0368	0.0238	-0.0094	---	---	---
Above Age 21	0.1217***	0.0455	0.0311***	---	---	---
High School Deciles						
Decile 1	-0.5701***	0.0330	-0.1458***	---	---	---
Decile 2	-0.1511***	0.0319	-0.0386***	---	---	---
Decile 3	-0.1953***	0.0284	-0.0499***	---	---	---
Decile 4	-0.1717***	0.0266	-0.0439***	---	---	---
Decile 5	0.0113	0.0261	0.0029	---	---	---
Decile 7	-0.0743***	0.0280	-0.0190***	---	---	---
Decile 8	-0.2411***	0.0274	-0.0617***	---	---	---
Decile 9	-0.1368***	0.0258	-0.0350***	---	---	---
Decile 10	-0.1801***	0.0245	-0.0461***	---	---	---
No Decile	0.1071***	0.0411	0.0274***	---	---	---

Table 2A Continued

Entrance Types						
External Entry	0.2513***	0.0303	0.0643***	---	---	---
Internal Entry	0.2938***	0.0196	0.0751***	---	---	---
Special Admission	0.1945***	0.0342	0.0497***	---	---	---
Degree Programmes						
BBus	-0.1207***	0.0190	-0.0309***	---	---	---
CIS	-0.0291	0.0264	-0.0074	---	---	---
BCS	0.3400***	0.0291	0.0870***	---	---	---
BDes	0.2921***	0.0300	0.0747***	---	---	---
BEdu	0.6132***	0.0406	0.1568***	---	---	---
BEngTech	-0.1224***	0.0290	-0.0313***	---	---	---
BHS	0.1336***	0.0204	0.0342***	---	---	---
BIHM	0.3283***	0.0340	0.0840***	---	---	---
BSR	-0.1503***	0.0250	-0.0384***	---	---	---
BSc	-0.2020***	0.0326	-0.0516***	---	---	---
Other Degrees	0.0794***	0.0253	0.0203***	---	---	---
Double Degree	0.6842***	0.0705	0.1750***	---	---	---
Course Levels						
Level 4	0.1520*	0.0857	0.0389*	---	---	---
Level 6	0.1334***	0.0142	0.0341***	---	---	---
Level 7	0.3612***	0.0490	0.0924***	---	---	---
n		78,617			78,617	
Pseudo R^2 Statistic		0.1082			0.0604	
Pseudo Log-Likelihood		-35,950.7			-37,877.0	

*** Statistically different from zero at a 1% level using a two-tailed *t* test
** Statistically different from zero at a 5% level using a two-tailed *t* test
* Statistically different from zero at a 10% level using a two-tailed *t* test

Notes: Estimated standard errors are adjusted for clustering with multiple course observations for individual students. The NCEA Rank Score is divided by ten to make it easier to report and interpret these estimated effects.

Table 2B: Maximum Likelihood Probit Regression Results on Course Completions
Partial Results Using the Best 80 NCEA Credits Instead of Rank Scores

	Unrestricted Estimation			Restricted Estimation		
Independent Variables	**Coefficient**	**Standard Error**	**Marginal Effect**	**Coefficient**	**Standard Error**	**Marginal Effect**
NCEA Results						
Excellence Credits/10	0.1981***	0.0060	0.0506***	0.2058***	0.0050	0.0549***
Merit Credits/10	0.1732***	0.0052	0.0442***	0.1772***	0.0042	0.0472***
Achieved Credits/10	0.0525***	0.0045	0.0134***	0.0166***	0.0036	0.0044***
n		78,617			78,617	
Pseudo R^2 Statistic		0.1111			0.0714	
Pseudo Log-Likelihood		-35,832.9			-37,432.5	
H_0: $\beta_E = \beta_M = \beta_A$		1,346.35 (0.0000)			2,907.51 (0.0000)	
H_0: $\beta_E = \beta_M$		10.82 (0.0010)			16.15 (0.0001)	
H_0: $\beta_E = \frac{4}{3}\beta_M = 2\beta_A$		241.29 (0.0000)			907.50 (0.0000)	

*** Statistically different from zero at a 1% level using a two-tailed *t* test
** Statistically different from zero at a 5% level using a two-tailed *t* test
* Statistically different from zero at a 10% level using a two-tailed *t* test

Notes: Estimated standard errors are adjusted for clustering with multiple course observations for individual students. The three credit categories are divided by ten to make it easier to report and interpret these estimated effects. The same additional 45 covariates included in the unrestricted estimation in Table 2A were included in the unrestricted estimation in this table. Chi-squared statistics and *p* values on Wald tests involving these credit coefficients are reported at the bottom of this table.

Table 2C: Maximum Likelihood Probit Regression Results on Course Completions
Partial Results Using All Available NCEA Credits Instead of Rank Scores

Independent Variables	Unrestricted Estimation Coefficient	Unrestricted Estimation Standard Error	Unrestricted Estimation Marginal Effect	Restricted Estimation Coefficient	Restricted Estimation Standard Error	Restricted Estimation Marginal Effect
NCEA Results						
Excellence Credits/10	0.1756***	0.0057	0.0448***	0.1923***	0.0050	0.0512***
Merit Credits/10	0.1622***	0.0049	0.0414***	0.1747***	0.0042	0.0466***
Achieved Credits/10	0.0597***	0.0037	0.0152***	0.0306***	0.0032	0.0082***
n		78,617			78,617	
Pseudo R^2 Statistic		0.1122			0.0722	
Pseudo Log-Likelihood		-35,787.4			-37,403.4	
H_0: $\beta_E = \beta_M = \beta_A$		718.12 (0.0000)			1,722.53 (0.0000)	
H_0: $\beta_E = \beta_M$		2.81 (0.0936)			5.29 (0.0214)	
H_0: $\beta_E = \frac{4}{3}\beta_M = 2\beta_A$		121.51 (0.0000)			539.77 (0.0000)	

*** Statistically different from zero at a 1% level using a two-tailed t test
** Statistically different from zero at a 5% level using a two-tailed t test
* Statistically different from zero at a 10% level using a two-tailed t test

Notes: Estimated standard errors are adjusted for clustering with multiple course observations for individual students. The three credit categories are divided by ten to make it easier to report and interpret these estimated effects. The same additional 45 covariates included in the unrestricted estimation in Table 2A were included in the unrestricted estimation in this table. Chi-squared statistics and p values on Wald tests involving these credit coefficients are reported at the bottom of this table.

Table 3A: Ordinary Least-Squares Regressions on Course Grade Points
Full Set of Results Using NCEA Rank Score

Independent Variables	Unrestricted Estimation		Restricted Estimation	
	Coefficient	Standard Error	Coefficient	Standard Error
Constant	1.5849***	0.0580	1.0331***	0.0257
NCEA Results				
Rank Score/10	0.1523***	0.0019	0.1491***	0.0013
Enrolment Years				
2015	0.0010	0.0221	---	---
2014	-0.0622***	0.0215	---	---
Prioritized Ethnicities				
Maori	-0.4221***	0.0302	---	---
Pacifica	-0.9554***	0.0301	---	---
Asian	-0.2706***	0.0260	---	---
Other Ethnicities	-0.5704***	0.0376	---	---
Undeclared	-0.3302***	0.0678	---	---
Countries of Origin				
Asia	-0.1752***	0.0351	---	---
Pacific Islands	-0.1172**	0.0480	---	---
Other Countries	-0.1408	0.1646	---	---
Demographic Factors				
Female	0.2616***	0.0200	---	---
Part-time	-0.1421***	0.0411	---	---
Under Age 18	0.2990*	0.1670	---	---
Age 19	-0.0269	0.0203	---	---
Age 20	0.0116	0.0276	---	---
Age 21	0.1069***	0.0413	---	---
Above Age 21	0.4776***	0.0828	---	---
High School Deciles				
Decile 1	-1.1681***	0.0550	---	---
Decile 2	-0.2794***	0.0510	---	---
Decile 3	-0.3473***	0.0450	---	---
Decile 4	-0.2591***	0.0410	---	---
Decile 5	-0.0141	0.0426	---	---
Decile 7	-0.1306***	0.0409	---	---
Decile 8	-0.3542***	0.0418	---	---
Decile 9	-0.2925***	0.0376	---	---
Decile 10	-0.3841***	0.0354	---	---
No Decile	0.2078***	0.0641	---	---

Table 3A Continued

Entrance Types				
External Entry	0.8068***	0.0552	---	---
Internal Entry	0.5608***	0.0329	---	---
Special Admission	0.7796***	0.0645	---	---
Degree Programmes				
BBus	-0.7633***	0.0346	---	---
CIS	-0.3522***	0.0474	---	---
BCS	-0.7634***	0.0376	---	---
BDes	0.1146***	0.0432	---	---
BEdu	1.2013***	0.0567	---	---
BEngTech	-0.5667***	0.0532	---	---
BHS	-0.0222	0.0351	---	---
BIHM	0.3760***	0.0514	---	---
BSR	-0.6450***	0.0434	---	---
BSc	-0.3991***	0.0607	---	---
Other Degrees	-0.0428	0.0444	---	---
Double Degree	2.0524***	0.0735	---	---
Course Levels				
Level 4	0.4353***	0.1672	---	---
Level 6	0.1249***	0.0224	---	---
Level 7	0.5543***	0.0713	---	---
n	75,451		75.451	
R^2 Statistic	0.2163		0.1429	

*** Statistically different from zero at a 1% level using a two-tailed *t* test
** Statistically different from zero at a 5% level using a two-tailed *t* test
* Statistically different from zero at a 10% level using a two-tailed *t* test

Notes: Estimated standard errors are adjusted for clustering with multiple course observations for individual students. The NCEA Rank Score is divided by ten to make it easier to report and interpret these estimated effects.

Table 3B: Ordinary Least-Squares Regressions on Course Grade Points
Partial Results Using the Best 80 NCEA Credits Instead of Rank Scores

	Unrestricted Estimation		Restricted Estimation	
Independent Variables	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
NCEA Results				
Excellence Credits/10	0.5311***	0.0083	0.5341***	0.0066
Merit Credits/10	0.3488***	0.0082	0.3495***	0.0065
Achieved Credits/10	0.0521***	0.0082	-0.0032	0.0068
n	75,451		75.451	
R^2 Statistic	0.2307		0.1735	
H_0: $\beta_E = \beta_M = \beta_A$	3,537.95 (0.0000)		5,749.34 (0.0000)	
H_0: $\beta_E = \beta_M$	453.57 (0.0000)		451.99 (0.0000)	
H_0: $\beta_E = \frac{4}{3}\beta_M = 2\beta_A$	678.03 (0.0000)		1,383.12 (0.0000)	

*** Statistically different from zero at a 1% level using a two-tailed *t* test
** Statistically different from zero at a 5% level using a two-tailed *t* test
* Statistically different from zero at a 10% level using a two-tailed *t* test

Notes: Estimated standard errors are adjusted for clustering with multiple course observations for individual students. The three credit categories are divided by ten to make it easier to report and interpret these estimated effects. The same additional 45 covariates included in the unrestricted estimation in Table 3A were included in the unrestricted estimation in this table. Chi-squared statistics and *p* values on Wald tests involving these credit coefficients are reported at the bottom of this table.

Table 3C: Ordinary Least-Squares Regressions on Course Grade Points
Partial Results Using All Available NCEA Credits Instead of Rank Scores

Independent Variables	Unrestricted Estimation		Restricted Estimation	
	Coefficient	Standard Error	Coefficient	Standard Error
NCEA Results				
Excellence Credits/10	0.4729***	0.0062	0.4939***	0.0056
Merit Credits/10	0.3381***	0.0069	0.3568***	0.0061
Achieved Credits/10	0.0707***	0.0063	0.0319***	0.0057
n	75,451		75.451	
R^2 Statistic	0.2309		0.1732	
H_0: $\beta_E = \beta_M = \beta_A$	2,158.53 (0.0000)		3,397.22 (0.0000)	
H_0: $\beta_E = \beta_M$	214.54 (0.0000)		214.67 (0.0000)	
H_0: $\beta_E = \frac{4}{3}\beta_M = 2\beta_A$	461.09 (0.0000)		894.14 (0.0000)	

*** Statistically different from zero at a 1% level using a two-tailed *t* test
** Statistically different from zero at a 5% level using a two-tailed *t* test
* Statistically different from zero at a 10% level using a two-tailed *t* test

Notes: Estimated standard errors are adjusted for clustering with multiple course observations for individual students. The three credit categories are divided by ten to make it easier to report and interpret these estimated effects. The same additional 45 covariates included in the unrestricted estimation in Table 3A were included in the unrestricted estimation in this table. Chi-squared statistics and *p* values on Wald tests involving these credit coefficients are reported at the bottom of this table

Table 4: Estimated Effects of Using Rank Scores and Validated Measures to Select Students
Paper Completion Rates and Composition of Student Body

	Proportion				
	Sample Remaining	Course Completions	Māori Students	Pacifica Students	Bottom Three School Deciles
Original Sample of Students	**1.000**	**0.7742**	**0.1147**	**0.1487**	**0.1578**
Rank Score > 110	0.8449	0.8003	0.1146	0.1359	0.1494
Rank Score > 130	0.7631	0.8159	0.1152	0.1275	0.1422
Rank Score > 150	0.6588	0.8396	0.1135	0.1186	0.1325
Rank Score > 170	0.5600	0.8606	0.1125	0.1056	0.1212
Rank Score > 190	0.4624	0.8815	0.1102	0.0936	0.1090
Mean Outcomes from Above Simulations	**0.6578**	**0.8396**	**0.1132**	**0.1162**	**0.1309**
Validated Score > 105.71	0.8449	0.8013	0.1161	0.1333	0.1416
Validated Score > 122.51	0.7631	0.8190	0.1156	0.1239	0.1409
Validated Score > 142.33	0.6588	0.8397	0.1142	0.1164	0.1312
Validated Score > 161.28	0.5600	0.8596	0.1150	0.1054	0.1180
Validated Score > 182.57	0.4624	0.8822	0.1140	0.0909	0.1068
Mean Outcomes from Above Simulations	**0.6578**	**0.8404**	**0.1150**	**0.1140**	**0.1277**

Notes: The original sample of students for this analysis is 9,520. The thresholds for the validated measures in the second panel were chosen to match the exact number of students selected using the Rank Scores in the first panel. This validated measure is the probability of a course completion based only on the total number of Excellent, Merit and Achieved credits. This measure comes from the regression results on the restricted estimation listed in Table 2C (i.e., this probability is $\Phi(0.1923\times\text{Excellence Credits} + 0.1747\times\text{Merit Credits} + 0.0306\times\text{Achieved Credits})$ where $\Phi(\cdot)$ is the Cumulative Density Function of Standard Normal).

Table 5: Estimated Effects of Using Rank Scores and Validated Measures to Select Students Grade Point Averages and Composition of Student Body

	Proportion				
	Sample Remaining	Grade Point Averages	Māori Students	Pacifica Students	Bottom Three School Deciles
Original Sample of Students	**1.000**	**3.6209**	**0.1142**	**0.1486**	**0.1580**
Rank Score > 110	0.8453	3.8241	0.1146	0.1354	0.1499
Rank Score > 130	0.7636	3.9576	0.1149	0.1269	0.1425
Rank Score > 150	0.6610	4.1491	0.1135	0.1175	0.1331
Rank Score > 170	0.5622	4.3566	0.1121	0.1043	0.1212
Rank Score > 190	0.4648	4.5774	0.1098	0.0923	0.1091
Mean Outcomes from Above Simulations	**0.6594**	**4.1730**	**0.1130**	**0.1153**	**0.1312**
Validated Score > 105.71	0.8453	3.8482	0.1165	0.1319	0.1484
Validated Score > 122.51	0.7636	3.9837	0.1166	0.1219	0.1398
Validated Score > 142.33	0.6610	4.1676	0.1146	0.1152	0.1318
Validated Score > 161.28	0.5622	4.3673	0.1157	0.1066	0.1203
Validated Score > 182.57	0.4648	4.6005	0.1142	0.0882	0.1066
Mean Outcomes from Above Simulations	**0.6594**	**4.1935**	**0.1155**	**0.1128**	**0.1294**

Notes: The original sample of students for this analysis is 9,346. The thresholds for the validated measures in the second panel were chosen to match the exact number of students selected using the Rank Scores in the first panel. This validated measure is the probability of a course completion based only on the total number of Excellent, Merit and Achieved credits. This measure comes from the regression results on the restricted estimation listed in Table 3C (i.e., this expected grade point is 0.4939×Excellence Credits + 0.3568×Merit Credits + 0.0319×Achieved Credits).