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THE ASSIGNMENT-EXAMINATION RELATIONSHIP AND THE PROBABILISTIC PERFORMANCE OF INTERMEDIATE MACROECONOMICS STUDENTS: 2000-2011

Te Kunenga ki Pūrehuroa

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The Assignment-Examination Relationship and the Probabilistic Performance of Intermediate Macroeconomics Students: 2000-2011

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ABSTRACT

The paper reports the results of a statistical analysis of the assignment and examination marks and final grades obtained by students in intermediate macroeconomics at Massey University over the 2000-2011 period. Basic probability concepts and multiple regressions are employed. Unconditional and conditional probabilities of obtaining the various letter grades are estimated. The information is expected to help students plan their studies more effectively and increase their motivation to learn. Multiple regressions of examination marks run on assignment marks, selected control variables and year dummies reveal interesting associations but the models have characteristically low explanatory power. The evidence supports some popular notions about relative student performances and challenges others. A more objective basis is suggested for calculating proxy final examination marks for students who either miss or write the final examination under extenuating circumstances and later apply for aegrotat and grade change.

Key words: assignments, examinations, aegrotat, [un]conditional probabilities.

JEL Classification: A22, C20.

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1. Introduction

The course that is the subject of this study, 178.200, Intermediate Macroeconomics, at Massey University is taken by students who have palpably diverse levels of motivation and intellectual ability and come from twenty different academic programmes. It is a compulsory course in many of the College of Business programmes and an elective in other programmes; it is also a prerequisite for the senior undergraduate advanced macroeconomics course. Two out of five of those on its roll are foreign students and about a third of all the students take the course off-campus – they are called 'distance learners' by Massey University. The overall assessment in 178.200 weights the final examination seventy percent and the assignments or coursework component thirty percent. A student's grade is based on the weighted final mark. Students come to the course with only a sketchy idea of how past students had fared in it and of their own chances of getting a particular grade. Most of them probably reckon that they would either maintain or improve on the grades they obtained in the introductory principles of macroeconomics course which is a prerequisite for 178.200.

At the end of each semester between five and ten percent of students apply for aegrotat and grade change on account of no-show or 'impaired performance' at the final examination. University-wide, decisions on those requests invariably involve the course coordinators having to guess, in an *ad hoc* manner, at how the students would have performed in the final examinations based on their marks in assignments and/or pre-examination tests. Much as that procedure is decried, no one has established a more objective alternative. Nearly all lecturers would attest that because assignments are not answered under examination conditions, and students have the opportunity to consult or copy from one another, assignment marks are not necessarily the result of independent work by the students. Hence, assignment marks are generally regarded as poor indicators of examination performance. However, because class tests mimic examination conditions, test marks are perceived to be better indicators of examination performance than assignment marks. One would therefore expect that if the coursework component (the non-examination part) of the final assessment is a mixture of assignments and tests, greater attention should be given to test results in gauging how well a student might perform in a final examination. In situations where the coursework component is made up of only assignments, forecasting examination marks from assignment marks is fraught with uncertainties. However, this paper argues that a judicious analysis of the historical marks of all students of the course can yield a data-driven guideline that can reduce the subjectivity and uncertainties and give robust forecasts.

Motivated by the foregoing concerns, this paper sought to answer two main questions:

- (i) What is the probability of a student obtaining any of the letter grades awarded in the course?
- (ii) How good a predictor of students' examination performance are their assignment marks?

Whereas the grade distribution of all past students may be a good guide to estimating the probabilities current students have of obtaining the various grades, the estimation of proxy final examination marks is less straightforward. The literature on determinants of student performance is voluminous and varied. The studies may be distinguished along a number of dimensions. One dimension is level of institution – primary, secondary, tertiary or a mixture. Country and date of study can also be a distinguishing feature (e.g., Hanushek, 1997, from the US; Smith and Naylor, 2001, from the UK; Sidiropoulos *et al*., 2008, from Greece; Harb and El-Shaarawi, 2006, from the United Arab Emirates; Dolado and Morales, 2009, from Spain; Cheesman *et al*., 2006, from Jamaica; Alfan and Othman, 2005, and Ibrahim and Rusli, 2007, from Malaysia, to name a few). Studies may further be classified according to whether they considered performance in individual subjects/courses or whole curricula (e.g., Alldredge and Brown, 2006, on statistics; Rochelle and Dotterweich, 2007, on business statistics; Friday *et al*., 2006, on management; Kantartzi *et al*., 2010, on science classes; Yunker *et al*., 2009, on accounting; Ballard and Johnson, 2004, on economics; and Pritchard *et al*., 2000, on finance). The increased integration of the internet in the delivery of university courses has generated a genre of studies looking at the comparative performance of online versus traditional classroom students (e.g., McDonald *et al*., 2004; Ury *et al*., 2005; Friday *et al*., 2006, and references therein). A preponderance of the relevant empirical literature on student performance in economics seeks to identify predictors of performance in introductory courses (e.g., Anderson *et al*., 1994; McCarty *et al*., 2006 and references therein), although a few have studied intermediate level students (e.g., Williams *et al*., 1992 and Horn *et al*., 2011). The most popular indicators identified and used include: personal and situational variables (gender, age, class, course, semester, time of day, personality characteristics, effort measures); general academic ability variables (grade point average [GPA], scores on university-qualifying standardised tests); intervention variables (supplementary instruction, scores in pre-tests or performance in a relevant introductory level course); and variables reflecting ability in mathematics. Findings are not uniform and seem to depend on the contexts of the studies.

Given the main focus of this study (the estimation of final examination marks of intermediate macroeconomics students from their assignment marks) the main benefit of this literature review is in the selection of control variables. Given that the class rolls already contain information on programme of study, on-campus/distance learner status and domestic/foreign status, which can be used as control variables, the major new variable to be introduced is gender. Most of the studies found males performed better than females in economics (e.g., Anderson *et al*., 1994; McCarty *et al*., 2006;); others found that females perform better than males (e.g., Alfan and Othman, 2005; Harb and El-Shaarawi, 2007; Dolado and Morales, 2008); and still others found that gender did not make any difference (e.g., Williams *et al*., 1992; Sidiropoulos *et al*., 2008). Apparently, the effect of gender is contextual.

Analysing twelve years of records of students' marks and grades, the study estimated the probabilities of scoring each of the ten letter grades awarded in the course and determined that students have 91 percent chance of passing the course. These estimates are a new set of information that is expected to help students plan their studies better. Although the explanatory power of the regressions of examination marks on assignment marks and other factors were low, the signs and magnitudes of the slope coefficients made sense and were extremely useful for forecasting examination marks. The forecast error of the prediction mechanism constructed from the regression coefficients averaged less than one percent above the actual values. Consequently, this paper advocates the adoption of the formula obtained in this study for forecasting examination marks for students in cases of aegrotat and impaired performance requests. The methodology used in arriving at the forecasting model may be duplicated for other courses. In the rest of the paper, Section 2 describes the data used and briefly outlines the analytical methods employed. After a discussion of the analytical results presented in Section 3, the paper ends with the summary and conclusions in Section 4.

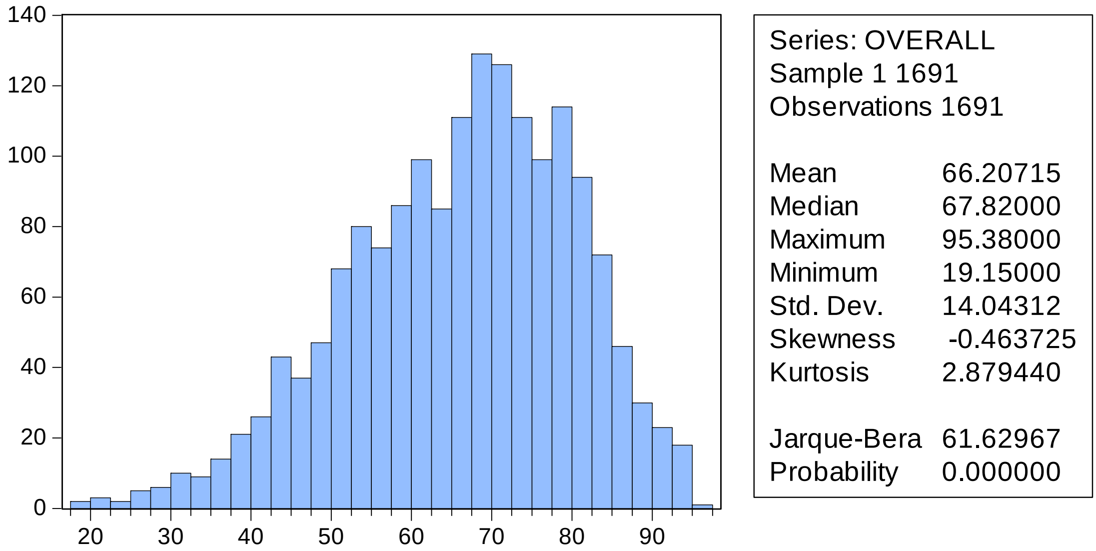
2. Data, Variable Construction and Analytical Methods

The data used are the recorded marks in assignments, tests and examinations and the final marks and grades of students who enrolled in 178.200 Intermediate Macroeconomics (hereafter, 178.200) from the year 2000 to 2011. One lecturer taught the course the whole twelve years using one textbook. The study period traversed four editions (the fourth through the seventh editions) of the textbook used for instruction: *Macroeconomics* by N. Gregory Mankiw; the current edition is Mankiw (2010). The course has three coursework components (weighted 30%) and an examination (weighted 70%) comprising the assessment. The assignment, test and examination questions were chosen from the textbook's accompanying test bank with occasional moderation. The assignment questions covered the topics progressively treated in the thirteen-week teaching semester making similarly numbered assignments in different years comparable. Each year, detailed course study guides and administration guides are prepared and given to students. Among the students, those who take the paper on-campus are referred to as 'internals' and each week they may attend the three one-hour lectures and one of two one-hour tutorials; lecture attendance is not recorded. Those who take the paper off-campus are referred to as 'externals' or distance learners; they cannot attend lectures but may avail themselves of one-day or two-day 'campus courses' organised for them during mid-semester breaks. The course has gradually increased its web usage over the years (transitioning from WebCT to Moodle/Stream) but the printed study materials are still self-sufficient in the provision of information required to follow the coverage of topics and assignment deadlines. The course coordinator is available by telephone and email to both internal and external students. Whereas for externals the coursework component has always comprised three assignments, the internals had to write a test in addition to the three assignments in each year of the first half of the study period. The practice was perceived to have disadvantaged the internal students because it brought down their coursework scores. It was therefore discontinued after 2006.

The final weighted marks of students (captured by the variable **OVERALL**) are transformed into letter grades using the following schedule: A-*plus* (89.5-100), A (84.5-89.4), A-*minus* (79.5-84.4), B-*plus* (74.5-79.4), B (69.5-74.4), B-*minus* (64.5-69.4), C-*plus* (59.5-64.4), C (49.5-59.4), R (46.5-49.4), D (39.5-46.4) and E (less than 39.5). Grades D and E are fail grades and R is a 'restricted pass', meaning the student cannot use it to satisfy a prerequisite for another course. To be awarded any of these grades a student needs to have done 'satisfactory work' on the coursework component and also have sat the final examination. Students who do not do all three assignments are barred from sitting the final examination which is three hours long and comprises forty compulsory multiple-choice questions and six short-answer questions with the option to answer any four. The grade DNC (did not complete) is awarded to those who did not sit the final examination and WD (withdrawn) to those who officially withdrew from the paper. On average, about 21% of external students withdrew from the course before completion whilst only 4% of internal students withdrew, translating into completion rates of 79% and 96%, respectively, for the two groups. Overall, however, the completion rate in the course was 89%. For obvious reasons the study sample excluded DNC- and WD-students.

The total number of students who qualified to be graded (i.e., those who took the final examinations and did some or all of the assignments) came to 1,691. For these, the final marks ranged from 19 to 95, averaging 66 out of a maximum of 100 (or grade B-*minus*). The histogram of the final marks is presented in Figure 1 which is slightly skewed to the left suggesting that a few relatively low marks dragged the mean below the median. The median mark of 67.8 is also a B-*minus* grade. The value of the Jarque-Bera statistic (of 61.63 instead of zero expected for a normal distribution) leads to the rejection of the null hypothesis of normal distribution of the final marks. Hence, the widely popular assumption of normal distribution of marks in a course is not strictly supported by the evidence from 178.200.

Figure 1: Histogram of the Final Marks Obtained in 178200: 2000-2011



To estimate the probabilities of getting the different grades, the numbers of students getting each grade in each year were tabulated. These numbers were expressed as proportions of the gross total or the relative frequencies and interpreted as the probabilities. From these the unconditional probabilities and probabilities conditional on the internal/external status were calculated. A good reference for this methodology is Keller (2009). The results are reported in the next section.

For the assignment-examination nexus, multiple regressions of the examination marks were run on the assignment marks, some selected control variables and year dummies. The control variables considered included gender, internal/external status, domestic/foreign status, and programme of study. These were the variables for which data could readily be accessed from the class rolls. It is conceded that other factors (some measurable others not directly measurable) do influence student performance at examinations. It is for brevity that the nominated determinants were selected. The names given to the various variables are explained as follows. Marks in the three different coursework components were given the names **ASS1**, **ASS2** and **ASS3,** respectively, to suggest they are assignment marks. The marks obtained in final examinations were given the name **EXAM** and the grades obtained were given the name **GRADE**. To reduce omitted variable bias in the regression results, a number of control variables were introduced; these mostly took the form of dummy variables. The class rolls show students' internal/external and domestic/foreign status and the programmes they are in. The dummy variable **DOMESTIC** took the value 1 in the cases of domestic students and 0 in the cases of foreign students; **EXTERNAL** took the value 1 in the cases of distance learners and 0 in the cases of internal students. The information on gender came from the university registry's student management system. The dummy variable **MALE** took the value of 1 in the cases of male students and 0 in the cases of female students. The male students constituted 52% of the sample.

The programmes the students came from included Bachelor of Accounting (BAcc), Bachelor of Agricultural Commerce (BAgCom), Bachelor of Applied Economics (BApEc), Bachelor of Applied Science (BApSc), Bachelor of Arts (BA), Bachelor of Arts-Bachelor of Business Studies Joint Programme (BA-BBS), Bachelor of Aviation Management (BAvM), Bachelor of Business Studies (BBS), Bachelor of Business Studies-Bachelor of Science Joint Programme (BBS-BSc), Bachelor of Information Sciences (BIS), Bachelor of Resource and Environmental Planning (BREP), Certificate in Accounting (CAcc), Certificate in Arts Human and Social Science (CAHSS), Certificate in Business Studies (CBS), Certificate of Proficiency in Business Studies (CoPBS), Certificate of Proficiency – Study Abroad (CoPSA), Graduate Certificate in Arts (GCA), Graduate Diploma in Business Studies (GDBS), Graduate Diploma in Religious Studies (GDRS) and Master of Management (MM). As a lecturer in economics, the author's main concern was with the students for whom the course was principally designed – the BBS and BApEc students. Unofficially, the economics lecturers view BApEc as their flagship programme and think the BApEc students (comprising about 9% of the roll) are smarter than all the others. The largest single group is the BBS cohort (72% of the roll). To capture how well these two groups did *vis a vis* the others, two dummy variables were employed: **BAPEC** took 1 in the cases of BApEc students and 0 otherwise, and **BBS** took 1 in the cases of BBS students and 0 otherwise; all the other students were grouped as 'other'. In the years when internal students took tests in addition to the assignments, their test marks were integrated appropriately in the mark for ASS2. To capture the effect of the incident of mid-semester tests, the dummy variable **MSTEST** took the value 1 in those years mid-semester tests were taken by internal students and 0 otherwise. However, to control for year effects, and using the year 2000 as the base year, dummy variables **DV2001**, **DV2002**, up to **DV2011** were utilised. A popular econometrics textbook that outlines the multiple regression methods used is Wooldridge (2009). The EViews 6 software was used for all the computations.

3. Analytical Results

3.1 Probabilistic Achievements

The focus in this section is on the unconditional and conditional probabilities of students attaining any of the ten grade classifications. The estimates are based on the grade frequency distribution reported in Table 1 where the Massey University Registry practice of grouping the internal students and the external students separately is followed. The resulting joint probability distribution is reported in Table 2. In that table the last row gives the unconditional [marginal] probabilities of a student attaining the different grades. From the highest to the lowest the probabilities are: C (17.7%), B (14.5%), B-*minus* (13.9%), B-*plus* (12.4%), C-*plus* (10.8%), A-*minus* (10.6%), F (9.3%), A (4.9%), R (3.1%) and A-*plus* (2.8%). It is noteworthy that the probability of failing the paper is estimated to be about 9% and, conversely, the probability of passing is 91%. For an idea about how the different groups ranked in their performance, a weighted score was calculated for each group. Grade A-*plus* was valued at 10 points and each grade below it sequentially got one point less so that grade F (= D and E) was worth 1 point. The weights were formulated from the proportion in the group that got the particular grade. The theoretical maximum score is 10 (that is, if everyone in the group got A-*plus*). The various groups have been ranked according to their weighted scores in the last two columns in Table 1. The top group is the internal group of the year 2004, and the bottom group is the internal group of the year 2001. Year-wise, it is difficult to discern a pattern in the results.

Table 1: The Frequency Distribution of the Final Grades

CLASS	GRADE										Class Total	Score	Ranking
	A+	A	A-	B+	B	B-	C+	C	R	F			
2000 INTLS	1	0	10	6	10	13	10	25	10	24	**109**	3.817	22
2000 EXTLS	1	3	7	2	14	9	10	11	2	7	**66**	4.848	18
2001 INTLS	0	2	5	6	6	7	9	22	8	31	**96**	3.333	24
2001 EXTLS	0	2	1	4	6	7	7	10	2	5	**44**	4.364	21
2002 INTLS	2	4	10	12	13	16	8	13	2	3	**83**	5.494	8
2002 EXTLS	0	3	8	7	3	10	6	5	1	8	**51**	5.039	15
2003 INTLS	6	11	13	23	15	9	13	22	1	7	**120**	5.717	5
2003 EXTLS	4	2	8	4	10	7	3	7	2	6	**53**	5.434	9
2004 INTLS	2	16	33	32	35	22	13	11	1	4	**169**	6.290	1
2004 EXTLS	4	3	6	6	8	4	8	9	2	5	**55**	5.327	11
2005 INTLS	1	5	11	19	23	25	19	31	2	4	**140**	5.114	12
2005 EXTLS	4	4	6	10	8	10	3	9	2	5	**61**	5.574	7
2006 INTLS	3	3	10	6	17	21	16	19	2	4	**101**	5.099	13
2006 EXTLS	2	4	7	11	9	6	8	8	2	3	**60**	5.600	6
2007 INTLS	2	1	3	7	10	5	5	9	1	1	**44**	5.386	10
2007 EXTLS	1	3	7	7	9	5	3	12	0	0	**47**	5.723	4
2008 INTLS	2	1	1	6	6	3	3	7	1	4	**34**	4.971	17
2008 EXTLS	5	2	8	7	8	3	3	4	0	4	**44**	6.182	2
2009 INTLS	1	0	3	3	4	16	10	24	3	13	**77**	3.766	23
2009 EXTLS	1	2	4	3	3	6	6	9	3	7	**44**	4.386	20
2010 INTLS	1	3	4	8	7	11	10	13	1	3	**61**	5.016	16
2010 EXTLS	0	0	1	5	5	7	3	8	0	2	**31**	4.710	19
2011 INTLS	4	5	10	10	6	9	3	6	2	5	**60**	5.917	3
2011 EXTLS	0	3	3	5	10	4	4	6	3	3	**41**	5.098	14
Col Total	**47**	**82**	**179**	**209**	**245**	**235**	**183**	**300**	**53**	**158**	**1691**	**---**	**---**

Table 2: The Joint Probability Distribution of Class and Final Grades

CLASS	GRADE										Row Total
	A+	A	A-	B+	B	B-	C+	C	R	F	
2000 INTLS	0.0006	0.0000	0.0059	0.0035	0.0059	0.0077	0.0059	0.0148	0.0059	0.0142	**0.0645**
2000 EXTLS	0.0006	0.0018	0.0041	0.0012	0.0083	0.0053	0.0059	0.0065	0.0012	0.0041	**0.0390**
2001 INTLS	0.0000	0.0012	0.0030	0.0035	0.0035	0.0041	0.0053	0.0130	0.0047	0.0183	**0.0568**
2001 EXTLS	0.0000	0.0012	0.0006	0.0024	0.0035	0.0041	0.0041	0.0059	0.0012	0.0030	**0.0260**
2002 INTLS	0.0012	0.0024	0.0059	0.0071	0.0077	0.0095	0.0047	0.0077	0.0012	0.0018	**0.0491**
2002 EXTLS	0.0000	0.0018	0.0047	0.0041	0.0018	0.0059	0.0035	0.0030	0.0006	0.0047	**0.0302**
2003 INTLS	0.0035	0.0065	0.0077	0.0136	0.0089	0.0053	0.0077	0.0130	0.0006	0.0041	**0.0710**
2003 EXTLS	0.0024	0.0012	0.0047	0.0024	0.0059	0.0041	0.0018	0.0041	0.0012	0.0035	**0.0313**
2004 INTLS	0.0012	0.0095	0.0195	0.0189	0.0207	0.0130	0.0077	0.0065	0.0006	0.0024	**0.0999**
2004 EXTLS	0.0024	0.0018	0.0035	0.0035	0.0047	0.0024	0.0047	0.0053	0.0012	0.0030	**0.0325**
2005 INTLS	0.0006	0.0030	0.0065	0.0112	0.0136	0.0148	0.0112	0.0183	0.0012	0.0024	**0.0828**
2005 EXTLS	0.0024	0.0024	0.0035	0.0059	0.0047	0.0059	0.0018	0.0053	0.0012	0.0030	**0.0361**
2006 INTLS	0.0018	0.0018	0.0059	0.0035	0.0101	0.0124	0.0095	0.0112	0.0012	0.0024	**0.0597**
2006 EXTLS	0.0012	0.0024	0.0041	0.0065	0.0053	0.0035	0.0047	0.0047	0.0012	0.0018	**0.0355**
2007 INTLS	0.0012	0.0006	0.0018	0.0041	0.0059	0.0030	0.0030	0.0053	0.0006	0.0006	**0.0260**
2007 EXTLS	0.0006	0.0018	0.0041	0.0041	0.0053	0.0030	0.0018	0.0071	0.0000	0.0000	**0.0278**
2008 INTLS	0.0012	0.0006	0.0006	0.0035	0.0035	0.0018	0.0018	0.0041	0.0006	0.0024	**0.0201**
2008 EXTLS	0.0030	0.0012	0.0047	0.0041	0.0047	0.0018	0.0018	0.0024	0.0000	0.0024	**0.0260**
2009 INTLS	0.0006	0.0000	0.0018	0.0018	0.0024	0.0095	0.0059	0.0142	0.0018	0.0077	**0.0455**
2009 EXTLS	0.0006	0.0012	0.0024	0.0018	0.0018	0.0035	0.0035	0.0053	0.0018	0.0041	**0.0260**
2010 INTLS	0.0006	0.0018	0.0024	0.0047	0.0041	0.0065	0.0059	0.0077	0.0006	0.0018	**0.0361**
2010 EXTLS	0.0000	0.0000	0.0006	0.0030	0.0030	0.0041	0.0018	0.0047	0.0000	0.0012	**0.0183**
2011 INTLS	0.0024	0.0030	0.0059	0.0059	0.0035	0.0053	0.0018	0.0035	0.0012	0.0030	**0.0355**
2011 EXTLS	0.0000	0.0018	0.0018	0.0030	0.0059	0.0024	0.0024	0.0035	0.0018	0.0018	**0.0242**
Col Total	**0.0278**	**0.0485**	**0.1059**	**0.1236**	**0.1449**	**0.1390**	**0.1082**	**0.1774**	**0.0313**	**0.0934**	**1.0000**

From the joint probabilities of mode of uptake and grade classifications in Table 3 the conditional probabilities of a grade given the mode are reported in Table 4. This is perhaps the most important probability table. Regardless of the mode, students have the highest probability of getting a C grade but internals stand a slightly better chance. Grades in which external students have comparatively higher chances are A-*plus*, A, A-*minus*, B and R; in all the others internals have comparatively higher chances.

Table 3: The Joint Probabilities of Mode of Uptake and Grade Classification

MODE	GRADE										Row Total
	A+	A	A-	B+	B	B-	C+	C	R	F	
Internal	0.0148	0.0302	0.0668	0.0816	0.0899	0.0928	0.0704	0.1195	0.0201	0.0609	**0.6470**
External	0.0130	0.0183	0.0390	0.0420	0.0550	0.0461	0.0378	0.0580	0.0112	0.0325	**0.3530**
Col Total	**0.0278**	**0.0485**	**0.1059**	**0.1236**	**0.1449**	**0.1390**	**0.1082**	**0.1774**	**0.0313**	**0.0934**	**1.0000**

Table 4: The Conditional Probabilities of Grade Attained Given the Mode of Uptake

MODE	GRADE										Row Total
	A+	A	A-	B+	B	B-	C+	C	R	F	
Internal	0.0229	0.0466	0.1033	0.1261	0.1389	0.1435	0.1088	0.1846	0.0311	0.0941	**1.0000**
External	0.0369	0.0519	0.1106	0.1189	0.1558	0.1307	0.1072	0.1642	0.0318	0.0921	**1.0000**

3.2 Regression Results

Whereas the total sample numbered 1691, not everyone did all three assignments. The subsample that did all three assignments numbered 1605. The subsample allowed the estimation of the pair-wise correlations among ASS1, ASS2, ASS3 and EXAM. The correlation coefficients are reported in Table 5 where it would be seen that there is positive but weak correlation between each pair of variables.

Table 5: The Correlations between the Marks

Variable	ASS1	ASS2	ASS3
ASS2	0.2019		
ASS3	0.4090	0.2537	
EXAM	0.4030	0.3220	0.3633

Two pairs of regression models were run. The first pair used the data for all the twelve years; the second pair used the data for the second half of the study period (i.e., the years 2007-2011) when the internal students did not write mid-semester tests and for the coursework component were assessed on three assignments just as for the externals. The first variant of each pair considered the subgroup that did all the assignments and the second variant considered the whole group. These separations were done to see if the regression results would depend critically on the period studied and on compliance with the assignments. The first variant of the first pair used the subsample of 1,605 observations and the second variant used the full sample of 1,691 observations. They are dubbed Models 1.1 and 1.2 and they regressed the final examination mark (EXAM) on the marks in the three coursework components (ASS1, ASS2 and ASS3), the control variables and the year dummies for the subsample and the full sample, respectively. For the second half of the study period, the number of students that did all three assignments came to 450 although the total numbered 482. Models 2.1 and 2.2 are the corresponding regressions based on the data for the second half of the study period. The results of all the estimated models are reported in Table 6.

In Table 6 it would be realised that the explanatory power (by way of the R^2) of each of the regression models is generally low (around 40%). This is characteristic of regression models in the student performance literature. That result notwithstanding, the regression models have provided estimates of the marginal contributions of the marks from the three assignments towards the examination mark after controlling for some factors and year effects. The assignment variables (ASS1, ASS2 and ASS3) take consistent signage and are statistically significant in all the models; also, their standard errors generally decrease with increases in the sample sizes from the first variant to the second variant of each pair of models. This underscores the utility of assignment marks for forecasting examination marks. Interpreting a predicted examination mark from any one model as the total of the model's intercept plus the weighted sum of assignment marks with the slope coefficients as the weights, one can rank these models. Models 2.2 and 1.2 'give away' 19 and 10 marks, respectively, and correspondingly ascribe relatively lower weights to the assignments. On that basis the 100%-assignment-compliance variants do better than their opposite variants. Model 1.1 does better than Model 2.1 because it is more parsimonious in giving away only about 1 mark compared to Model 2.1's 8 marks. Hence, Model 1.1 is the model of choice. Its superiority is also buttressed by the fact it covers the whole sample period and utilises all the nominated explanatory variables and none of the variables has gaps in the data. In that model, an increase of 10 percentage marks in ASS1 leads on the average to an increase of 2.7 percentage points in the examination mark; the corresponding contributions by ASS2 and ASS3 are 2.9 and 2.0, respectively. A possible explanation for these relative impacts is that students do well in the first assignment, improve on the second assignment but trip on the third assignment because it is due quite late in the semester when students would generally be struggling to meet the deadlines of last assignments in other courses would.

Table 6: The Regression Results

Variable	Model 1.1	Model 1.2	Model 2.1	Model 2.2
Intercept	0.664 (3.035)	10.209*** (2.598)	8.303 (5.493)	19.400*** (4.428)
ASS1	0.269*** (0.033)	0.224*** (0.025)	0.200*** (0.057)	0.148*** (0.039)
ASS2	0.289*** (0.022)	0.249*** (0.019)	0.159*** (0.042)	0.155*** (0.032)
ASS3	0.198*** (0.024)	0.164*** (0.018)	0.324*** (0.043)	0.254*** (0.029)
MALE	0.819 (0.623)	0.969 (0.623)	2.544** (1.187)	2.667** (1.169)
MSTEST	9.157*** (1.485)	8.620*** (1.424)		
BAPEC	-0.426 (1.292)	-0.231 (1.284)	-0.958 (2.209)	-0.499 (2.131)
BBS	-2.407*** (0.868)	-2.817*** (0.858)	-3.604** (1.498)	-3.942*** (1.467)
DOMESTIC	-0.375 (0.813)	-0.692 (0.811)	0.335 (1.559)	0.205 (1.534)
EXTERNAL	3.830*** (0.990)	4.201*** (0.978)	3.620** (1.442)	3.667*** (1.407)
DV2001	-4.426*** (1.462)	-3.655** (1.444)		
DV2002	1.247 (1.696)	2.494 (1.678)		
DV2003	-0.304 (1.658)	0.874 (1.638)		
DV2004	1.550 (1.630)	2.280 (1.610)		
DV2005	3.881** (1.627)	3.569** (1.614)		
DV2006	2.559 (1.652)	3.158* (1.634)		
DV2007	1.126 (1.702)	2.329 (1.679)		
DV2008	7.822*** (1.795)	8.174*** (1.745)	4.978** (2.109)	4.191** (2.011)
DV2009	-6.729*** (1.609)	-6.269*** (1.560)	-10.076*** (2.037)	-10.354*** (1.855)
DV2010	-7.404*** (1.699)	-5.600*** (1.678)	-9.884*** (2.008)	-8.877*** (1.924)
DV2011	9.399***	9.472***	7.596***	6.316***

	(1.621)	(1.624)	(1.910)	(1.861)
Statistics				
R^2	0.3961	0.3964	0.4244	0.4129
Adjusted R^2	0.3884	0.3892	0.4086	0.3979
F-Stat	51.941	54.839	26.851	27.484
Obsvns	1605	1691	450	482

Note: Standard errors are in parentheses. Single, double and triple asterisks indicate statistical significance at the 10%, 5% and 1% levels, respectively.

As MALE takes an insignificant positive coefficient, it means gender is not an important factor in examination performance in 178.200. MSTEST takes a highly significant coefficient (and also in Model 1.2), meaning students are likely to perform better in examinations when they have taken a mid-semester test. The Model 1.1 result suggests students are likely to get an average of 9 percentage marks more in the examination for having taken the test. Students in the BBS programme perform significantly worse than those in other programmes (getting an average of 2 less marks than the others) and external students consistently perform significantly better than internal students (getting an average of 4 more marks than internals). Owing to the non-significance of the BAPEC coefficients, BApEc students may be deemed to be not different from 'other' students. Domestic students are not significantly different from foreign students. Compared to the base year (2000), examination performance was significantly better in a quarter of the sampled years (e.g., 2005, 2008 and 2011) and significantly worse in another quarter of the sampled years (e.g., 2001, 2009 and 2010); the remaining years (one-half of the sampled years) were similar to 2000. This configuration is sufficiently random to dispel any notion of a drift in the marks and therefore the performance of the students.

Finally, the greatest utility of the regression results actually lies in using them to forecast a student's examination mark given the assignment marks. Utilising the coefficients of Model 1.1, the suggested formula for the expected examination mark is the following:

E(EXAM) = 1 + 0.27(ASS1) + 0.29(ASS2) + 0.20(ASS3) and subtract 2 if BBS and add 4 if distance learner.

A naive illustration of this is: If a student got 100 marks in all three assignments the application of the formula leads to these outcomes.

E(EXAM) = 1 + 0.27(100) + 0.29(100) + 0.20(100) = 77 $\Rightarrow$ Overall = 83.9 (= grade A-);
If a BBS student subtract 2: 77 – 2 = 75 $\Rightarrow$ Overall = 82.5 (= grade A-);
If an external student add 4: 77 + 4 = 81 $\Rightarrow$ Overall 86.7 (= grade A)

The outcomes are robust for other combinations of assignment marks. A student missing a mark for ASS1 loses a maximum of 27 marks towards the expected examination mark; for ASS2 and ASS3 the corresponding marks are 29 and 20, respectively. A check with all the 1,605 in-sample observations showed that the prediction errors, as proportions of the actual examination marks, ranged from -0.527 to 4.022 with a mean of 0.008 and a median of -0.069. The graph of the prediction errors is presented in Figure 2. It can clearly be seen that the maximum value of 4.022 is an outlier. When the identity of the student was traced, it turned out that they got 97.5 marks for ASS1, 100 marks for ASS2, 85 marks for ASS3 but only 15 marks at the final examination instead of a mark anywhere near the 75.3 predicted by the model. No 'impaired performance' request was received from that student. Identification is required for admission to the final examinations. A case like this raises the possibility of students having other people do the assignments for them which, of course, cannot be proven. The histograms of the prediction errors with and without the outlier are shown in Figures 3 and 4, respectively. The two distributions are clearly skewed to the right but the kurtosis and the skewness are understandably reduced after the outlier is dropped. For all intents and purposes, the prediction error is skewed and therefore the median is a better measure of central tendency than the mean. The median of -0.069 (from both distributions) suggests that the forecasting mechanism under-predicts the final examination mark by about 7%. This bias may or may not be corrected for in actual applications of the forecasting model.

Figure 2: In-Sample Prediction Errors of the Examination Mark Forecasting Model

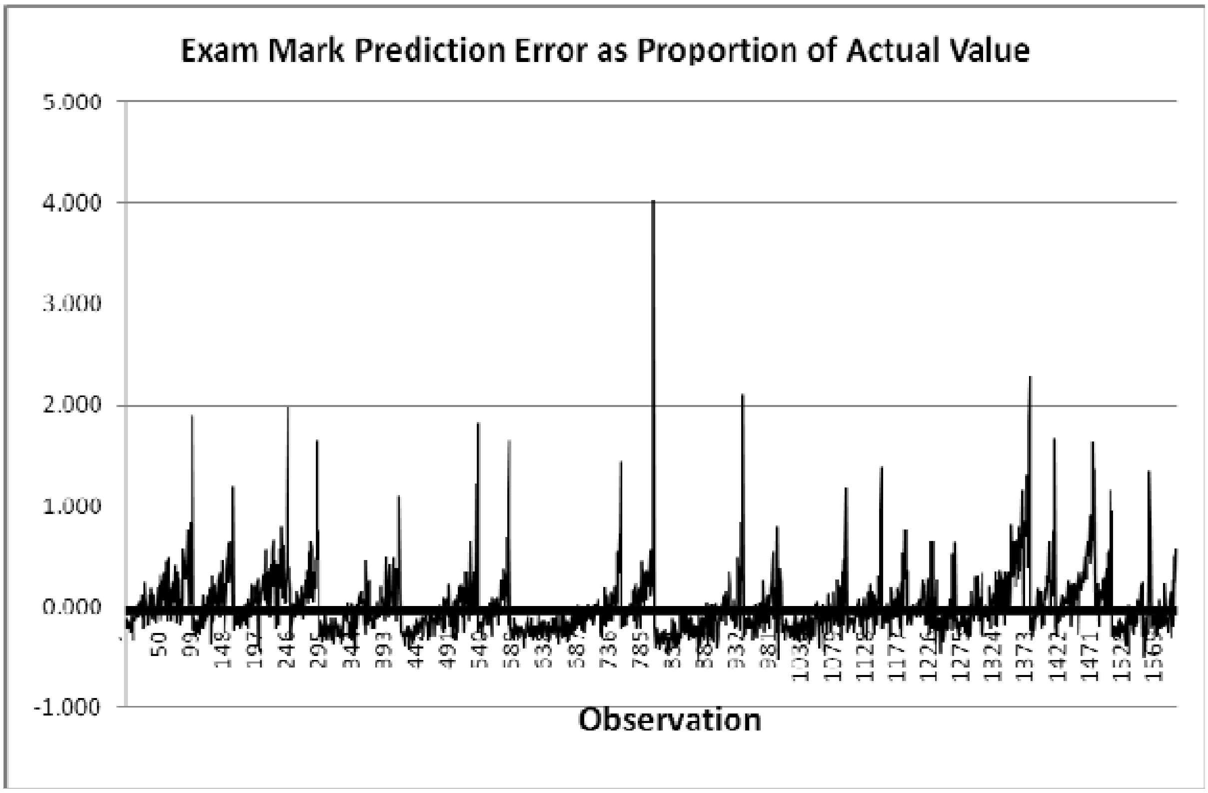


Figure 3: Histogram of the Prediction Error with the Outlier

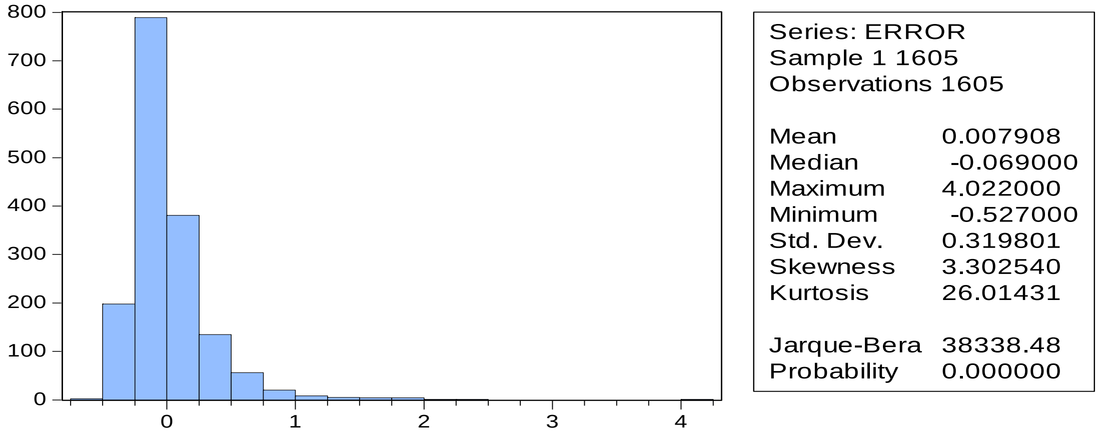
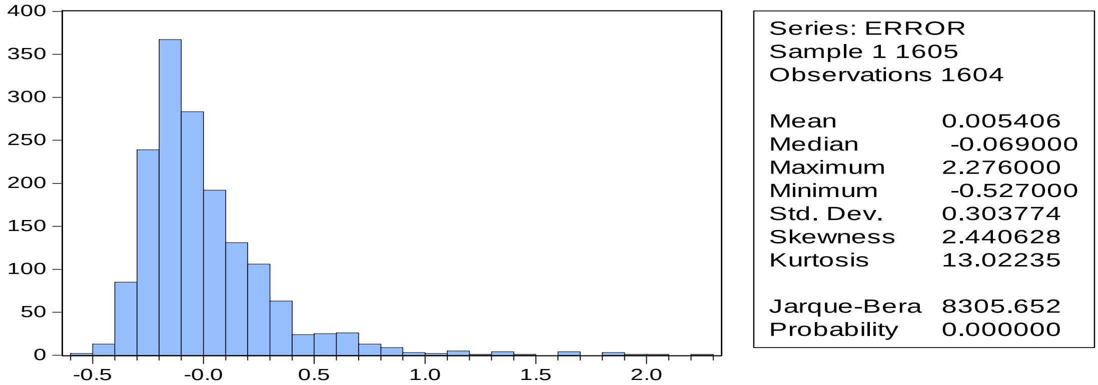


Figure 4: Histogram of the Prediction Error without the Outlier



4. Summary and Conclusions

To publicise the chances students have of obtaining the various grades awarded in 178.200, Intermediate Macroeconomics, taught at Massey University and also to estimate a formula for calculating proxy marks for students who are unable to write the final examination, this paper undertook a statistical analysis of the recorded assignment and examination marks obtained by students over the 2000-2011 period. The course is taken by both on-campus (internal) and off-campus (external) students from twenty different academic programmes. About 89% of those who enrolled completed the course, with the drop-out rate among the external students five times higher than that for the internal students. The grades awarded are: A+, A, A-, B+, B, B-, C+, C, R, D and E; the last two are fail grades and together may be renamed ‘F’. Unconditional and conditional probabilities of obtaining the various grades were estimated. Students have the best chance (of about 18%) of obtaining a C grade; they also have a 9% chance of failing the course.

After controlling for students' gender, programmes of study, domestic/foreign status, mid-semester test, internal/external mode of uptake and year effects, the regressions of examination marks on assignment marks show assignment marks are significant predictors of examination marks but the explanatory power of the models is low. However, from the regression results, it was gleaned that mid-semester tests seemed to prepare students better for the final examinations than assignments; external students who complete generally perform better than internals (perhaps because of self selection), Bachelor of Business Studies students perform worse than students from other programmes; gender and domestic/foreign status are not significant factors; and Bachelor of Applied Economics students do not perform better than other students. The examination-mark prediction formula constructed from the regression coefficients performed reasonably well in predicting the in-sample observations and so it is being recommended for use in deciding on requests for aegrotat and grade change submitted on account of impaired performance.

REFERENCES

Alfan, E. and Othman, M. N. (2005) Undergraduate Students' Performance: The Case of University of Malaya, *Quality Assurance in Education*, Vol 13, No. 4, pp. 329-343.

Alldredge, J. R. and Brown, G. R. (2006) Association of course performance with student beliefs: An analysis by gender and instructional software environment, *Statistics Education Research Journal*, Vol 5, No. 1, pp. 64-77.

Anderson, G., Benjamin, D. and Fuss, M. A. (1994) The Determinants of Success in University Introductory Economics Courses, *The Journal of Economic Education*, Vol 25, No. 2, pp. 99-119.

Dolado, J. J. and Morales, E. (2009) Which Factors Determine Academic Performance of Freshers in Economics? Some Spanish Evidence, *Investigaciones Economicas*, Vol XXXIII, No. 2, pp. 179-210.

Friday, E., Friday-Stroud, S. S., Green, A. L. and Hill, A. Y. (2006) A Multi-Semester Comparison of Student Performance between Multiple Traditional and Online Sections of Two Management Courses, *Journal of Behavioral and Applied Management*, Vol 8, No. 1, pp. 66-81.

Hanushek, Eric A. (1997) Assessing the Effects of School Resources on Student Performance: An Update, *Educational Evaluation and Policy Analysis*, Vol 19, No. 2, pp. 141-164.

Harb, N. and El-Shaarawi, A (2007) Factors Affecting Students' Performance, *Journal of Business Education*, Vol 5, No. 82, pp. 282-290.

Horn, P., Jansen, A. and Yu, D. (2011) Factors Explaining the Academic Success of Second-Year Economics students: An Exploratory analysis, *South African Journal of Economics*, Vol 79, No. 2, pp. 202-210.

Ibrahim, Z. and Rusli, D. (2007) Predicting Students' Academic Performance: Comparing Artificial Neural Network, Decision Tree and Linear Regression, Paper presented at the 21st Annual SAS Malaysia Forum, Shangri-La Hotel, Kuala Lumpur, retrieved from http://www.sas.com/offices.../academic/2007.../ZaidahDaliela.pdf on 01/09/11.

Kantartzi, S. K., Allen, S., Lodhi, K., Grier IV, R. L. and Kassem, M. A. (2010) Study of Factors Affecting Students' Performance in Science Classes: General Biology, Biology and Microbiology at Fayetteville State University, *KBM Journal of Science Education*, Vol 1, No., 1, pp. 13-18.

Keller, Gerald (2009) Statistics for Management and Economics, 8th edition, South-Western Cengage Learning, Mason, OH.

Mankiw, N. Gregory (2010) Macroeconomics, 7th edition, Worth Publishers, New York, NY.

McCarty, C., Padgham, G. and Bennett, D. (2006) Determinants of Student Achievement in Principles of Economics, *Journal for Economics Educators*, Vol 6, No. 2, pp. 1-9.

McDonald, M., Dorn, B. and McDonald, G. (2004) A Statistical Analysis of Student Performance in Online Computer Science Courses, *ACM SIGCSE Bulletin*, Vol 36, Issue 1, pp. 71-74.

Rochelle, C. F. and Dotterweich, D. (2007) Student Success in Business Statistics, *Journal of Economics and Finance Education*, Vol 6, No. 1, pp. 19-24.

Sidiropoulos, D., Makridou-Bousiou, D. and Stavros, T. (2008) Student Performance in Economics, Unpublished paper, University of Macedonia, Greece, retrieved from http://www.mooi.nl/aeee/Lectures/.../AEEE_SID-TSOP-MBOUS-Revised.doc on 01/09/11.

Smith, J. and Naylor, R. (2001) Determinants of Degree Performance in UK Universities: A Statistical Analysis of the 1993 Student Cohort, *Oxford Bulletin of Economics and Statistics*, Vol 63, No. 1, pp.29-60.

Williams, M. L., Waldauer, C. and Duggal, V. G. (1992) Gender Differences in Economic Knowledge: An Extension of the analysis, *Journal of Economic Education*, Vol 23, No. 3, pp. 219-231.

Wooldridge, Jeffrey M. (2009) Introductory Econometrics: A Modern Approach, 4th edition, South-Western Cengage Learning, Mason, OH.

Yunker, P. J., Yunker, J. A. and Krull, G. W. (2009) The Influence of Mathematics Ability on Performance in Principles of Accounting, *The Accounting Educator's Journal*, Vol XIX, pp. 1-20.

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