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**UNIVERSITY OF CANTERBURY**

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**PREDICTING STUDENT ACHIEVEMENT IN INTERMEDIATE UNIVERSITY  
ECONOMICS FROM PRINCIPLES ASSESSMENTS.**

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***WORKING PAPER***

**No. 64/2010**

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## PREDICTING STUDENT ACHIEVEMENT IN INTERMEDIATE UNIVERSITY ECONOMICS FROM PRINCIPLES ASSESSMENTS.

by

Stephen Hickson\*

### Abstract

This study investigates how first year Principles of Economics courses assessment items predict achievement in post principles economics courses. Of particular interest is how achievement in different assessment forms (assignments, multiple choice questions, and constructed response questions) predicts future performance. I use assessment data compiled from principles and post principles economics classes at the University of Canterbury from 2002-2008. I also control for performance in first year mathematics, statistics, accountancy and management. I find that constructed response questions particularly in the end of semester final exam generally contain more predictive power than multiple choice questions or the term test constructed response items.

JEL Categories: A22

Keywords: Principles of Economics Assessment, Multiple Choice, Constructed Response, Free Response, Essay.

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## I. INTRODUCTION

Most of the signal given to students on whether or not to continue on in economics is coarse in nature. It usually consists of a letter grade ranging from E to A+<sup>1</sup>. There is no question that students who achieve an A grade in their principles course will stand a better chance of success in subsequent economics courses. As table 1 shows, over 90 percent of students who achieve an A- or better in principles go on to pass 2<sup>nd</sup> year papers. What is also clear from table 1 is that students find 2<sup>nd</sup> year courses more difficult as there is a general trend to achieving a lower grade than they did in principles.

So while students who achieve a C grade or better are allowed to continue on to higher level study it is not the case that all students should. Universities spend time and resources advising students on their best course of study and the quality of that advice to students will improve if the factors that correlate with future success can be better understood. Students will make better choices by being better informed.

Economics principles courses typically employ a mix of multiple-choice (MC) and constructed response (CR) questions. Previous work by this author has addressed the question of whether or not these two types of questions measure the same thing within a principles course. Hickson and Reed (2010) find that CR questions contain independent information related to learning that is not captured by MC. This result is at odds with some of the most cited papers in the literature (e.g. Walstad and Becker, 1994) but seems to accord with what most instructors consider as “common sense”, viz. CR and MC questions are different.

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<sup>1</sup> At the University of Canterbury an E or D grade is a fail. A grade of C or better is a full passing grade that allows a student to continue to upper level courses. A grade of C- is a “restricted pass” where students receive credit for the course but are not allowed to continue on to upper level courses.

If it is true that MC and CR questions capture different levels of learning then it is also likely to be true that performance in the two different assessment types have different predictive power when examining how well students will perform in upper level economics classes. However, other factors will also influence upper level economics performance such as performance in complementary courses and language ability. Gender may also be an influence as it is reasonably well established in the literature that males outperform females in economics (e.g. Anderson, Benjamin and Fuss, 1994).

This study asks how the two different assessment types predict student achievement in upper level courses. Variables for achievement in other commonly taken courses, language and gender will be used as control variables.

I will conduct the analysis at the course level as upper level courses divide into two broad groups: (1) compulsory papers for majors; and (2) electives. The second category is of interest to non economics majors who usually have to take courses at the 2<sup>nd</sup> year in particular that are outside their major.

The contribution of this study to the literature is that the focus is on the transition from principles to upper level study. Most research has focused on how high school subjects, in particular economics, impacts on achievement in university principles courses (e.g. Anderson, Benjamin and Fuss, 1994). Other studies have often focused on how mathematics performance affects achievement in economics, particularly principles of economics (e.g. Ballard and Johnson, 2004). Where research has examined performance in upper level courses it has tended to be at an aggregate level and often examines programme completion (e.g. Nolan and Ahmadi-Esfahani, 2007). This study is unique in

examining how the two standard assessment types (MC and CR) used widely in principles of economics courses predict success in upper level courses in economics.

This paper proceeds as follows. Section 2 outlines the data used, section 3 presents the results and section 4 concludes.

## II. DATA

This study combines assessment data for Principles of Economics courses at the University of Canterbury, New Zealand with achievement in other commonly taken first year papers and some demographic data collected by the university. The assessment data covers the period 2002 to 2008 and contains both microeconomics and macroeconomics principles courses. For each student within each course there are two items of assessment – a term test and a final exam. Both assessment items contain MC and CR questions each of which can be scaled to a percentage to allow the four different assessment items to be compared.

The demographic data is collected by the university at time of enrolment. Language is a self-declared variable. As is typical of most datasets containing self-declared data, the data is somewhat messy. Appendix 2 contains details of how the language data was cleaned to provide usable information. The language variable has three possible categories: English; Chinese; and Other.

I also make use of the fact that a large number of economics students take a common set of courses. First-year accounting, management, mathematics, and statistics are courses frequently taken by economics students (see Appendix 2). This allows me to control for broader student ability and course of study. There are two variables for each of these courses – a dummy variable with a value equal to 1 if the student has taken that course, and the student's GPA<sup>2</sup> in that course if they did take it.

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<sup>2</sup> A GPA is assigned as follows: E=-1, D=0, C=-1, C=2 etc on up to A+=9

This study will look primarily at performance in 2nd year economics papers. The continuing papers in economics are:

ECON 201	Intermediate Macroeconomics
ECON 230	Intermediate Microeconomics (with calculus)
ECON 231	Intermediate Microeconomics
ECON 213	Introduction to Econometrics

To complete a degree in economics students must take ECON 201 and either ECON 230 or 231. ECON 230 is recommended for students wishing to continue to post graduate study and in reality almost no students who continue to post graduate level do so via ECON 231. ECON 213 is not required to complete an undergraduate degree but it is compulsory for students wishing to continue to the post graduate year.

The elective papers in this study are

ECON 209	International Trade
ECON 223	Game theory for Business, Science and Politics

Note that ECON 223 is aimed at students who have successfully completed a year of university study. That year of study does not need to include Principles of Economics so only those students who have taken a principles courses will be included in the sample for ECON 223.

This study will use the GPA obtained in these courses as the dependent variable.

### III. RESULTS

Two specifications of the general model will be examined.

$$(1) \quad 200 \text{ level course GPA} = \alpha_0 + \alpha_1(\text{Principals Assessments}) + \varepsilon, \text{ and}$$

$$(2) \quad 200 \text{ level course GPA} = \alpha_0 + \alpha_1(\text{Principals Assessments}) + \alpha_2(\text{Common Courses}) \\ + \alpha_3(\text{Demographics}) + \varepsilon.$$

Specification 2 introduces controls for wider student ability via performance in courses that students commonly take and that have some potentially useful relationship to economics. Controls are also introduced for demographic variables that may influence performance in economics, viz. language and gender. For the Intermediate Macroeconomics course both specifications are run twice – first with Principles of Microeconomics and second with Principles of Macroeconomics on the right hand side. The reason for this is that both of these principles courses are pre-requisites for Intermediate Macroeconomics. Both specifications will be estimated using OLS.

For the coefficients of the term test and final exam MC and CR items the interpretation of the size of these must account for the fact that scores in these items have different distributions. Dividing each of coefficients by the standard deviation of that variable will allow the coefficients to be compared for size effects.

The full results are reported in table set 6. Tables 2 and 3 contain the coefficients for the principles assessments items to allow easier comparison across courses for the variables of interest. Table 4 contains the term test and final exam MC and CR items divided by their standard deviation for both specifications.

Across specification 1 there is a very common pattern. With the exception of the term test MC in ECON 230 and 213 and the assignment in ECON 230, the coefficients

for all the assessment items are positive and significant as would be expected. To interpret the coefficients, take the final exam CR coefficient for ECON 231 as an example. The value is 0.043. The CR variable is a percentage and the dependent variable is a GPA value. So in this example, an increase of 10 percentage points in the final exam CR section of the Microeconomics Principles course raises the expected ECON 231 GPA by 0.43 (i.e. almost half a grade).

However, within the general pattern there are also some interesting differences. The coefficients for the CR section of the final exam are larger than the coefficients for the other assessment items (table 4). The importance of the final exam CR section is underscored by the t values being generally higher for this item than the others. Interestingly the term test MC result has the second largest effect in 4 out of 5 of the examples.

Why might the result for the term test CR not be as strong as the final exam? Students do find the term test slightly more time constrained than the final exam. This is likely to result in a weaker performance on the CR section of the term test relative to the final exam. In addition to that, students do not have the advantage of a study week at the time of the term test.

The results from specification 1 are what we would expect. If CR questions assess higher levels of learning and deeper learning then they are more likely to be better predictors of future performance where most instructors expect students to display evidence of deeper learning. In addition, CR questions are able to test higher order skills including communication skills which become more highly valued as students progress in their study.

In the absence of controlling for any other factors, it may well be that performance in the MC and CR assessment items is simply picking up broader student ability or English language ability. Specification 2 addresses this by including dummy variables for whether or not a student has taken a particular course from a set of commonly taken courses (first year accounting, mathematics, statistics and management) and their GPA in those courses. Specification 2 also includes a dummy variable for language where the omitted variable is English and for gender where the value equals 1 for male.

There are differences between the results from specifications 1 and 2. Firstly the assignment is no longer significant. This is less surprising than it might first appear. The assignment is designed to be “completed with work” and has a low weight in the overall course grade. Students can work together even though they submit individual pieces of work. There is a strong likelihood that weaker students are able to leverage off more able students. Such leveraging may of course be inside or outside of the rules depending on the level of assistance received. By making the assignment able to be completed with work and a low weight, the impact on the final grade of inappropriate assistance is minimised.

Another difference is that while performance in the final exam CR section is always significant this is not the case for the other assessment items. Performance in the term test CR and final exam MC remain significant in five and the term test MC remains significant in four. In aggregate then CR sections are significant 12 out of 14 times and MC 9 out of 14.

How do the results compare for the continuing courses? In econometrics only the final exam CR assessment remains significant. For Intermediate Microeconomics with Calculus both the term test and final exam CR assessment items are significant but the MC sections are not. However, it should be noted that the invigilated assessment in ECON 230 does not use MC questions whereas the invigilated assessment in both ECON 231 and 201 do include MC questions. We would therefore expect that MC in principles course would help predict some of the GPA in future courses where MC questions are also used. However, this does illustrate a more general point, viz. students will encounter fewer and fewer MC questions in their assessments as they progress which strengthens the role of CR questions in principles courses and the information they contain in terms of likelihood of future success.

From specification 1 to 2 the relative size of the final exam CR coefficient compared to the other items is generally reduced. In specification 1 the coefficients for the final exam CR item are always largest. When control variables are introduced, the final exam CR coefficient is largest in three of the seven runs though it is the second largest in three others (table 4). The explanation for this is the addition of language as a control variable. Performance in the CR sections of principles of economics assessments is dependent on language and performance in subsequent courses is also dependent on language. Having English as a second language is associated with a lower GPA in future courses. Without the control for language, the final exam CR coefficient is picking up much of the language contribution to the variability. The term test CR coefficient, while remaining significant in 5 out of 7 of the examples, is the smallest coefficient in all cases.

Recall that students find the term test more time constrained than the final exam and are more likely to omit marks in the CR section than the MC.

One particularly interesting result is in ECON 230 (Microeconomics with calculus) and ECON 213 (Econometrics) where only CR items have any significance when controls are introduced. Both of these courses are compulsory for progression to post graduate level. If CR questions better capture higher levels of learning than MC then what this result indicates is that students who perform well in the CR sections of their principles assessments are much better placed to continue on to higher level, particularly post graduate study. On the other hand, the results for ECON 231 (Intermediate Microeconomics) suggest that the MC items are the most influential. Students in ECON 231 do not continue on to post graduate level.

In order to gain some appreciation of whether the size of the assessment items coefficients are reasonable, I can compare the results to the impacts of the four common course control variables. The impact of any particular course is found by taking the first derivate of the whole equation with respect to the dummy variable for actually being in that course. The GPA variable for any particular course is actually an interaction variable of the form (dummy for being in the course x GPA in the course). So for STAT 111 in ECON 230 as an example

$$\frac{d(\text{ECON230 GPA})}{d(\text{STAT111})} = \alpha_i + \alpha_j \text{STAT111GPA}$$

where  $\alpha_i$  and  $\alpha_j$  are the coefficients for the STAT 111 dummy variable and the STAT 111 GPA respectively. By calculating this value for the mean student in the course I am able to provide an estimate of how the mean student (contingent on having taken that course)

impacts their future economics paper GPA. Table 5 shows the comparison of the impact of each of the common courses with how a 10 percentage point increase in the principles course assessment item impacts on future GPA.

A positive value for a course impact indicates that the mean student benefits their 200 level course GPA by that amount. A negative value (e.g. mathematics in ECON 230) indicates that a greater than the mean performance in that course (e.g. mathematics) is required to positively impact the 200 level course GPA (e.g. ECON 230).

The range of values in table 5 are reasonable. With one exception the values in absolute terms are all less than 1 so are having less than 1 GPA point effect. Were a 10 percentage point increase in any one particular principles assessment item or a mean score in any common course having a greater than 1 GPA point impact then that result should be examined. The one instance of an absolute value greater than 1 is statistics in ECON 213 (-1.260). This is not a surprise. Statistics is a pre-requisite for econometrics. Hence a purely average grade in introductory statistics results in a less than average grade in econometrics. Students taking econometrics will be better prepared with a B grade or better in introductory statistics.

The comparisons are useful in getting a sense of perspective and being confident that the values are reasonable in size. This paper does not directly address the question of how language, gender or performance in other courses predicts future performance in economics though these are interesting areas for future research. A greater level of analysis is required on the exact meaning of some of these impact variables and how they also interact with each other (e.g. statistics and mathematics).

#### **IV. CONCLUSION**

Students find the jump from first year to second year a difficult one and the only signal they receive from their first year studies on how well they are likely to succeed is a coarse course grade. However simply because a student receives a “C” pass in principles of microeconomics, this does not mean that they are certain to succeed at the next stage. This study finds that in the absence for any controls, performance in CR sections of principles courses tests and exams have a greater influence on future grades than does performance in MC sections or the assignment. However, when controls for performance in commonly taken courses, gender and language are introduced this very clear result is moderated but still holds. In six out of the seven examples examined in this study, after controls are introduced, the final exam CR section remains the most significant in terms of size. However the size is smaller relative to the other significant coefficients.

The cause of this shift is the introduction of the language control variable. Language is more strongly related to performance in CR rather than MC so this direction of change would be expected when language is explicitly controlled for.

The results for ECON 230 (Microeconomics with calculus) and ECON 213 (Econometrics) show that only CR items have any significance when controls are introduced. Both of these courses are compulsory for progression to post graduate level.

The implication of these results is that there is information value in using CR questions in first year principles courses. In general, performance in CR items, particularly in the final exam, is a better indicator of future performance than performance in MC items. The significance of the final exam compared to the term test is that students are generally a little less time constrained and so are more likely to be

able to demonstrate their learning in the CR section and they have the advantage of a study week prior to the exam. This result is strongest in core courses that are on the post graduate track and in fact is the reverse in the core course that non post graduate bound students must take. If it is the case that CR questions capture higher levels of learning better than MC then students who perform well in CR sections of their principles assessments, all else constant, are better prepared for future study in economics.

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**TABLE 1**  
**Percentage of students obtaining a given 2<sup>nd</sup> year economics grade dependent on grade in Principles of Microeconomics.**

		2 <sup>nd</sup> Year Economics Grade										Full Pass	Restricted Pass	Fail	
		A+	A	A-	B+	B	B-	C+	C	C-	D				E
Micro. Principles Grade	A+	25	15	18	21	13	4	4					100		
	A	15	16	15	19	12	7	4	4	4		3	93	4	3
	A-	4	9	18	16	12	11	8	7	3	2	8	87	3	10
	B+	2	2	5	7	9	20	13	10	7	3	22	68	7	25
	B		2	3	9	9	8	9	15	6	5	32	56	6	38
	B-		5	3	7	6	14	17	9	6	6	28	61	6	34
	C+			1	5	5	16	12	11	12	4	32	52	12	36
	C				2	2	7	10	10	17	5	46	32	17	51

Students in the darker grey section improved their grade in their 2<sup>nd</sup> year course compared to their principles course. Students in the while cells achieved the same grade. Students in the lighter grey have a lower grade. The table shows all 2<sup>nd</sup> year courses combined. Percentages are additive across rows.

**TABLE 2**  
**Summary of the Estimates of Coefficients by Course with No Control Variables (Specification 1).**

	ECON 201: Intermediate Macroeconomics (vs. Micro Principles)	ECON 201: Intermediate Macroeconomics (vs. Macro Principles)	ECON 231: Intermediate Microeconomics	ECON 230: Intermediate Microeconomics with calculus	ECON 209: International Trade	ECON 213: Introduction to Econometrics	ECON 223: Introductory Game Theory
Constant	-7.37** (12.72)	-6.095** (13.49)	-7.050** (-11.36)	-9.281** (-6.74)	-6.948** (-10.76)	-5.278** (-6.49)	-5.937** (-7.34)
Assignment	0.013** (2.41)	0.008** (1.98)	0.013** (2.38)	0.011 (0.89)	0.018** (3.20)	0.023** (3.09)	0.012* (1.81)
Term test MC	0.013* (1.89)	0.030** (5.78)	0.031** (4.27)	0.007 (0.39)	0.037** (4.93)	0.013 (1.28)	0.034** (3.41)
Term test CR	0.026** (5.33)	0.026** (5.84)	0.032** (6.17)	0.053** (4.93)	0.015** (2.73)	0.014** (2.00)	0.021** (2.97)
Final exam MC	0.037** (4.82)	0.020** (3.16)	0.027** (3.64)	0.039* (1.85)	0.024** (2.87)	0.025** (2.51)	0.025** (2.30)
Final exam CR	0.049** (8.48)	0.041** (8.37)	0.043** (7.20)	0.064** (4.58)	0.061** (9.82)	0.055** (6.36)	0.048** (6.41)
Observations	655	870	633	180	784	407	485
R <sup>2</sup>	0.4371	0.4155	0.4002	0.5431	0.3528	0.3385	0.3189

(Numbers in brackets are t statistics. A “\*” denotes significance at the 10 percent level and “\*\*” at the five percent level.)

**TABLE 3**  
**Summary of the Estimates of Coefficients by Course with Control Variables (Specification 2).**

	ECON 201: Intermediate Macroeconomics (vs. Micro Principles)	ECON 201: Intermediate Macroeconomics (vs. Macro Principles)	ECON 231: Intermediate Microeconomics	ECON 230: Intermediate Microeconomics with calculus	ECON 209: International Trade	ECON 213: Introduction to Econometrics	ECON 223: Introductory Game Theory
Constant	-3.75** (-4.78)	-3.330** (-5.80)	-3.380** (-4.15)	-2.358 (-1.18)	-3.966** (-4.74)	-0.498 (-0.39)	-3.142** (-2.89)
Assignment	0.006 (1.23)	0.003 (0.88)	0.006 (1.32)	0.003 (0.31)	0.007 (1.31)	0.010 (1.44)	0.005 (0.85)
Term test MC	0.004 (0.64)	0.024** (5.16)	0.018** (2.65)	0.006 (0.34)	0.023** (3.36)	0.005 (0.54)	0.025** (2.57)
Term test CR	0.017** (3.59)	0.010** (2.53)	0.018** (3.68)	0.038** (3.72)	0.011** (2.16)	-0.000 (-0.06)	0.004 (0.53)
Final exam MC	0.022** (3.08)	0.015** (2.64)	0.020** (2.92)	0.007 (0.32)	0.022** (2.85)	0.014 (1.43)	0.021** (2.02)
Final exam CR	0.028** (4.84)	0.020** (4.23)	0.018** (3.10)	0.036** (2.60)	0.036** (5.93)	0.038** (4.56)	0.033** (4.23)
Observations	655	870	633	180	784	407	485
R <sup>2</sup>	0.5323	0.4314	0.5329	0.6639	0.4653	0.4741	0.3967

(Numbers in brackets are t statistics. A “\*” denotes significance at the 10 percent level and “\*\*” at the five percent level.)

**TABLE 4**  
**Coefficients divided by standard deviations**

Values are only shown where the coefficients are significant at the ten percent level.

*No control variables*

	ECON 201: Intermediate Macroeconomics (vs. Micro Principles)	ECON 201: Intermediate Macroeconomics (vs. Macro Principles)	ECON 231: Intermediate Microeconomics	ECON 230: Intermediate Microeconomics with calculus	ECON 209: International Trade	ECON 213: Introduction to Econometrics	ECON 223: Introductory Game Theory
Term test MC	0.00107	0.00217	0.00265		0.00306		0.00283
Term test CR	0.00140	0.00150	0.00186	0.00268	0.00091	0.00076	0.00119
Final exam MC	0.00313	0.00161	0.00229	0.00345	0.00209	0.00195	0.00208
Final exam CR	0.00314	0.00248	0.00289	0.00411	0.00413	0.00352	0.00291

*With control variables*

	ECON 201: Intermediate Macroeconomics (vs. Micro Principles)	ECON 201: Intermediate Macroeconomics (vs. Macro Principles)	ECON 231: Intermediate Microeconomics	ECON 230: Intermediate Microeconomics with calculus	ECON 209: International Trade	ECON 213: Introduction to Econometrics	ECON 223: Introductory Game Theory
Term test MC		0.00174	0.00154		0.00190		0.00208
Term test CR	0.00091	0.00058	0.00104	0.00192	0.00067		
Final exam MC	0.00186	0.00120	0.00170		0.00192		0.00175
Final exam CR	0.00179	0.00121	0.00121	0.00231	0.00244	0.00243	0.00200

**TABLE 5**  
**Impacts of Coefficients.**

Mean GPA		ECON 201: Intermediate Macroeconomics (vs. Micro Principles)	ECON 201: Intermediate Macroeconomics (vs. Macro Principles)	ECON 231: Intermediate Microeconomics	ECON 230: Intermediate Microeconomics with calculus	ECON 209: International Trade	ECON 213: Introduction to Econometrics	ECON 223: Introductory Game Theory	
	Assignment	0.061	0.031	0.065	0.034	0.067	0.100	0.055	Impact on future GPA of a 10 percentage point increase
	Scaled term test MC	0.042	0.242	0.175	0.056	0.229	0.050	0.250	
	Scaled term test CR	0.170	0.105	0.183	0.377	0.114	-0.004	0.039	
	Scaled Final exam MC	0.224	0.154	0.201	0.065	0.218	0.140	0.212	
	Scaled Final exam CR	0.285	0.203	0.182	0.359	0.359	0.376	0.325	
3.95	Accounting GPA	-0.187	-0.200	0.025	-0.518	-0.047	-0.131	-0.391	Impact on future GPA of taking this course for the mean student
3.76	Mathematics GPA	0.570	0.698	0.713	-0.334	0.450	0.351	0.200	
3.63	Statistics GPA	-0.122	-0.055	-0.262	-0.715	0.289	-1.260	0.644	
3.55	Management GPA	0.034	0.034	0.183	0.204	-0.447	-0.235	-0.159	

**TABLE 6**  
**Estimates of Coefficients by Course and Specification.**

	ECON 201: Intermediate Macroeconomics (vs. Micro Principles)		ECON 201: Intermediate Macroeconomics (vs. Macro Principles)	
	Specification 1	Specification 2	Specification 1	Specification 2
Constant	-7.37** (12.72)	-3.75** (-4.78)	-6.095** (13.49)	-3.330** (-5.80)
Assignment	0.013** (2.41)	0.006 (1.23)	0.008** (1.98)	0.003 (0.88)
Term test MC	0.013* (1.89)	0.004 (0.64)	0.030** (5.78)	0.024** (5.16)
Term test CR	0.026** (5.33)	0.017** (3.59)	0.026** (5.84)	0.010** (2.53)
Final exam MC	0.037** (4.82)	0.022** (3.08)	0.020** (3.16)	0.015** (2.64)
Final exam CR	0.049** (8.48)	0.028** (4.84)	0.041** (8.37)	0.020** (4.23)
Accounting		-0.278 (-1.19)		-0.286 (-1.52)
Accounting GPA		0.023 (0.68)		0.022 (0.79)
Mathematics		-0.175 (-0.87)		-0.054 (-0.33)
Mathematics GPA		0.198** (6.08)		0.200** (7.53)
Statistics		-0.779** (-2.63)		-0.726** (-2.93)
Statistics GPA		0.181** (4.96)		0.185** (6.13)
Management		-0.284 (-1.45)		-0.243 (-1.54)
Management GPA		0.090** (2.46)		0.078** (2.61)
Male		0.166 (1.20)		0.108 (0.95)
First language Chinese		-0.175 (-0.92)		-0.370** (-2.48)
First language Other		-0.330 (-1.16)		-0.448* (-1.88)
Observations	655	655	870	870
R <sup>2</sup>	0.4371	0.5323	0.4155	0.5314

(Numbers in brackets are t statistics. A “\*” denotes significance at the 10 percent level and “\*\*” at the five percent level.)

	ECON 231: Intermediate Microeconomics		ECON 230: Intermediate Microeconomics with calculus	
	Specification 1	Specification 2	Specification 1	Specification 2
Constant	-7.050** (-11.36)	-3.380** (-4.15)	-9.281** (-6.74)	-2.358 (-1.18)
Assignment	0.013** (2.38)	0.006 (1.32)	0.011 (0.89)	0.003 (0.31)
Term test MC	0.031** (4.27)	0.018** (2.65)	0.007 (0.39)	0.006 (0.34)
Term test CR	0.032** (6.17)	0.018** (3.68)	0.053** (4.93)	0.038** (3.72)
Final exam MC	0.027** (3.64)	0.020** (2.92)	0.039* (1.85)	0.007 (0.32)
Final exam CR	0.043** (7.20)	0.018** (3.10)	0.064** (4.58)	0.036** (2.60)
Accounting		-0.191 (-0.87)		-0.707 (-1.25)
Accounting GPA		0.055 (1.61)		0.048 (0.60)
Mathematics		0.034 (0.18)		-1.566* (-1.87)
Mathematics GPA		0.181** (5.36)		0.328** (4.14)
Statistics		-1.186** (-3.70)		-1.199 (-1.39)
Statistics GPA		0.255** (6.90)		0.133 (1.34)
Management		-0.227 (-1.20)		-0.036 (-0.07)
Management GPA		0.012** (3.10)		0.068 (0.79)
Male		0.283** (2.07)		0.359 (1.17)
First language Chinese		-0.123 (-0.65)		-1.627** (-3.63)
First language Other		-0.745** (-2.69)		-1.260** (-2.13)
Observations	633	633	180	180
R <sup>2</sup>	0.4002	0.5329	0.5431	0.6639

(Numbers in brackets are t statistics. A “\*” denotes significance at the 10 percent level and “\*\*” at the five percent level.)

	ECON 209: International Trade		ECON 213: Introduction to Econometrics	
	Specification 1	Specification 2	Specification 1	Specification 2
Constant	-6.948** (-10.76)	-3.966** (-4.74)	-5.278** (-6.49)	-0.498 (-0.39)
Assignment	0.018** (3.20)	0.007 (1.31)	0.023** (3.09)	0.010 (1.44)
Term test MC	0.037** (4.93)	0.023** (3.36)	0.013 (1.28)	0.005 (0.54)
Term test CR	0.015** (2.73)	0.011** (2.16)	0.014** (2.00)	-0.000 (-0.06)
Final exam MC	0.024** (2.87)	0.022** (2.85)	0.025** (2.51)	0.014 (1.43)
Final exam CR	0.061** (9.82)	0.036** (5.93)	0.055** (6.36)	0.038** (4.56)
Accounting		-0.576** (-2.42)		-0.528 (-1.56)
Accounting GPA		0.134** (3.67)		0.100** (1.99)
Mathematics		-0.177 (-0.80)		-0.334 (-0.89)
Mathematics GPA		0.167** (4.71)		0.182** (3.93)
Statistics		-0.413 (-1.23)		-2.211** (-3.10)
Statistics GPA		0.194** (4.81)		0.262** (4.21)
Management		-0.632** (-3.15)		-0.769** (-2.98)
Management GPA		0.052 (1.26)		0.150** (2.93)
Male		-0.084 (-0.57)		-0.173 (-0.89)
First language Chinese		0.538** (2.76)		0.457 (1.58)
First language Other		-0.025 -0.09		0.094 (0.22)
Observations	784	784	407	407
R <sup>2</sup>	0.3258	0.4653	0.3385	0.4741

(Numbers in brackets are t statistics. A “\*” denotes significance at the 10 percent level and “\*\*” at the five percent level.)

	ECON 223: Introductory Game Theory	
	Specification 1	Specification 2
Constant	-5.937** (-7.34)	-3.142** (-2.89)
Assignment	0.012* (1.81)	0.005 (0.85)
Term test MC	0.034** (3.41)	0.025** (2.57)
Term test CR	0.021** (2.97)	0.004 (0.53)
Final exam MC	0.025** (2.30)	0.021** (2.02)
Final exam CR	0.048** (6.41)	0.033** (4.23)
Accounting		-0.258 (-0.80)
Accounting GPA		-0.034 (-0.65)
Mathematics		0.034 (0.12)
Mathematics GPA		0.044 (0.79)
Statistics		-0.493 (-1.20)
Statistics GPA		0.313** (5.56)
Management		-0.624** (-2.08)
Management GPA		0.131 (2.32)
Male		0.130 (0.63)
First language Chinese		-0.131 (-0.48)
First language Other		-0.272 (-0.73)
Observations	485	485
R <sup>2</sup>	0.3189	0.3967

(Numbers in brackets are t statistics. A “\*” denotes significance at the 10 percent level and “\*\*” at the five percent level.)

## APPENDIX 1

### Details About the Construction of the Language Variable

The student management system at the University of Canterbury collects data on a range of student characteristics. Students self-report their characteristics for each year they are enrolled. Some characteristics are not compulsory to complete and so may have missing values, language being one of those. Despite this, the database provides a rich source of information with which to classify students.

A complication arises because some students take their introductory economics courses over multiple years. Reasons for this include the fact that students may choose to spread out their study, or because they fail a course. In these cases, the student management system contains multiple records, one for each year the student was enrolled in an introductory economics course. Because of the self-declared nature of the data and the fact that some fields legitimately change over time (e.g., a student may be equally fluent in two languages), the same student may look different from one year to the next. A “best judgment” was used to determine the most appropriate classifications for these students. If this could not be done with reasonable certitude, the student was dropped from the sample.

The “First Language” field in the student information file supplies the following categories: (i) English; (ii) Mandarin, (iii) Other Chinese Dialect, (iv) Other Asian, (v) Maori, (vi) Other, and (vii) Not Specified. As would be expected with self-reported data of this sort, the data is noisy. For example, a student from Hong Kong declared his language as Other Chinese Dialect in one year, but later identified English as his first

language. Similarly, a student from Taiwan originally declared Mandarin as his first language, but reported Not Specified in a later year. In many cases, these ambiguities are legitimate as many students are highly fluent in more than one language, so that there is little basis for choosing one language as “first language” over another. Finally, Maori was included with English because there were only three students in the sample who declared Maori as their first language. All of these would be fluent in English. The table below summarizes the language categorization system used for this study.

<i>Assigned Language Category</i>	<i>“First Language” Reported in Student Records</i>
Chinese	- Mandarin - Other Chinese Dialect - (i) Language reported as “Not Specified”, “Other” or “Other Asian;” and (ii) Citizenship = “Overseas” and Country= “China”
English	- English - Maori - (i) Language reported as “Not Specified”, “Other” or “Other Asian;” and (ii) Citizenship=“New Zealand” and Ethnicity=“European,” OR Citizenship=“New Zealand” and Ethnicity= “Maori,” OR Citizenship=“New Zealand” or “United Kingdom” or “United States” or “Canada”
Other	- (i) Language reported as “Not Specified”, “Other” or “Other Asian;” and (ii) does not meet any of the conditions above

## APPENDIX 2

### Simple counts of commonly taken courses and combinations of those courses.

<b>Course Combinations</b>	<b>Number</b>	<b>Percent</b>
<i>Individual Courses</i>		
Accounting	3226	51
Mathematics	2298	36
Statistics	4184	66
Management	3798	60
 <i>Combinations of two courses</i>		
Accountancy and Mathematics	1364	22
Accountancy and Statistics	2746	43
Accountancy and Management	2366	37
Mathematics and Statistics	1810	29
Mathematics and Management	1187	19
Statistics and Management	3008	48
 <i>Combinations of three courses</i>		
Accountancy, Mathematics and Statistics	1249	20
Accountancy, Mathematics and Management	869	14
Accountancy, Statistics and Management	2108	33
Mathematics, Statistics and Management	1078	17
 <i>All four courses</i>	 823	 13
<i>Taken none of the four courses</i>	792	13
 <i>Total number of individual students</i>	 6313	 100