Predicting success in a first-year unit of study

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In this paper, we show that success in a first year unit of study has a substantial and statistically significant gender difference. Using a sample of first year students in an Australian university, we investigate the key characteristics affecting performance in a first year introductory law unit in a non-law degree. The major interests centre on the effectiveness of the University Admission Index (UAI) and a possible differential gender effect. The results indicate that ability factors such as the UAI, English ability and whether a student had a significant amount of mathematics coaching are important factors for differentiating success between males and females. Other indicators such as attendance at tutorials, the amount of study undertaken per week in the course, the type of school attended and whether the student was from a non-English speaking background clearly show differences between the sexes.

Introduction

This paper revisits the research on male/female differences and on the factors predicting success in a unit of study and in an Australian context, investigates whether the University Admission Index (UAI) is the best predictor of success in a first year unit of study. Further, the research can also be used to predict those students at risk of failing. The chosen unit of study is a first year introductory commercial law course which is commonly taken by students enrolled in economics and business degrees. Dancer (2003) shows that the variable, UAI, has a significant impact for two units of study, Economics and Econometrics. However Dancer's study does not specifically differentiate between males and females. Further we consider whether there are other factors that should be taken into account when selecting students for admission to university. The concept of educational significance is introduced as it affects both the university and the student.

Gender differences

There is considerable research into the male/female differences in economics education. Siegfried (1979) surveyed the current literature and noted that male/female differences were "chromosome-linked" in learning, spatial and numerical skills. Anderson, Benjamin and Fuss (1994) investigated the factors that determine a student's success in an introductory economics course. They found that males exceed females by 2.5 to 3.5 percentage points on average. They also found that this gender effect persisted in a sample of students planning to major in Economics. Horvath, Beaudin and Wright (1992) pointed out that most studies found that

significant gender differences existed in economic understanding and learning, with males outperforming females. Using their own data, they examined gender differences in measures of academic aptitude and achievement on predicted persistence in an introductory economics course.

High school qualifications

One factor influencing success in the first year of university in Australia is the entrance criteria. In New South Wales (NSW), there has been some concern both in the wider community and in universities, that too much emphasis is placed on the UAI as a measure of a student's potential to succeed at university. The UAI is a ranking based on the aggregate of scaled marks in the NSW Higher School Certificate (HSC) using the age-cohort. This implies that a student with a rank of 80.00 is regarded as being in the top 20% of students who began secondary school at the same time. In NSW, each university determines its own cut-off score for entrance into each of its degrees. The cut-off score is largely determined by the popularity of the chosen degree. The UAI has a very powerful market signal as approximately half of the students in the top 5% are selected into the elite professional courses.

There has been concern expressed that for students in university courses requiring expertise in English, such as writing essays and communication skills, the UAI is not a good predictor of their abilities in this area. Using a large sample from Monash University, Evans & Farley (1998) found that, in the Faculty of Business and Economics on the Caulfield campus, students' first year performance was related to their discipline specific achievement but not their overall academic achievement at school. They note that the relationship between achievement at school and university can vary by subject area and institution.

Everitt and Robins (1991) studied full-time, first year students in all degrees entering the University of Western Australia and found that the Australian Scholastic Aptitude Test (ASAT) Quantitative Subscale alone was comparable to the TES as a predictor of a student's success in all four first year subjects taken. The authors suggested that a new combination could be used to find a better predictor. It should be noted that the TES includes a possible 10 marks out of 500 which derive from the ASAT -both the verbal and quantitative scores.

There is a great interest in what factors are useful in predicting the success and/or grades of students in individual units of study at university. Most of the studies have used the grade point average (GPA) as a measure of achievement in school or university. Probably the largest research has concentrated on the field of economics. There has been little research into units of study in the field of law, yet students studying economics or business at university often take business law subjects as part of their degrees. It seems reasonable that, in English speaking countries, a student's proficiency in English would be an important predictor of success. Evans and Farley (1998) found prior academic achievement, measured by the TER, had a strong relationship with performance in traditional programs while discipline-specific knowledge appeared more relevant in the applied courses. One exception to this was that advanced mathematics was a strong predictor of performance for all programs.

Student learning

Over the last few years, there has been a considerable amount of interest and research into the factors that affect how students learn. There have been a number of studies investigating the effect of mathematics knowledge on a student's performance in economics (see, for example,

Butler et al., 1998). Two latent variables that researchers have tried to measure are motivation and persistence. There is a belief that a student's attitude with respect to motivation and persistence are important factors in learning. Some of the other factors that have been investigated are the gender difference and/or bias, the Scholastic Aptitude Test (SAT) scores, the effect of living away from home, and whether a student undertakes paid work.

The modelling process should help to explain some of the reasons why a student progresses satisfactorily in a unit of study while others do not. Douglas and Sulock (1995) suggested reasons for explaining students' performance as measured by their grades rather than the students' learning. Good grades are desirable in that they can assist to build the self-esteem of students. A good grade in a unit of study also encourages a student to continue with that unit of study and may stimulate the students' interest. Another feature is that grades are measurable, and that grades may have a positive correlation with learning.

External factors

A study by Bangert-Downs, Kulik and Kulik (1983) used meta-analysis to explore the effectiveness of coaching for achievement tests. The results showed that coaching can significantly influence the scores of students on achievement tests by as much as 0.25 standard deviations. The returns to students were a function of the length and depth of the programs. Dancer (2000, 2003) investigated how coaching in Mathematics and English in the final year of high school affected performance in first year econometrics. In this study, a large amount of mathematics coaching outside of school in Year 12 was found to be detrimental on performance and significant at the 1% level. Thus, students who had had extensive coaching were at a disadvantage at university when compared with other students. One possible reason for this is that students who had had significant amounts of coaching may have reached their academic potential with the aid of coaching and may therefore slip back without the aid of individual coaching at university.

Reid (1983) surveyed students at a liberal arts college in Ontario, Canada, to study the effects of the residential college environment. At this institution, students were randomly assigned to a residence. He found that two out of the six residences had a significant and negative coefficient. As a result of Reid's study, Dancer (2000, 2003) incorporated dummy variables to control for the different places that students live. In Sydney, most students live at home and only about 25% live in student residences (colleges) or rented accommodation. Living in college has a significant and positive effect on the final grade compared with living at home, while living in rented accommodation had a negative effect. A possible reason behind the college effect may be that these students work together and also get extra help from tutors.

Finally, the effect of outside employment has been evaluated by numerous authors (see Paul, 1982, and Dancer, 2000). Generally, moderate amounts of work had no detrimental effect but Paul found that there was an inverse relationship between the hours of work and the academic performance.

There has been little research in this area recently. Most of the research is concentrating on the effect of personality types, whether effort matters and the work drive on the final grades of students. None of the recent research investigates all the possible factors in the same model.

Data

Students enrolled in Commercial Transactions A (CTA) at the University of Sydney in 2000 were invited to participate in this project by completing a questionnaire. This unit of study is a first year introductory commercial law course mainly for students undertaking commerce or economics degrees within the Faculty of Economics and Business. Only students who completed the unit of study and who had a UAI were considered in the analysis. Dancer (2000) showed that sample selection bias was unlikely to be an issue when attriters and non-response were considered. In her study, the non-response sample was approximately 12%. In the current study, the total number of students deemed eligible was 429 of whom 193 responded to the questionnaire. A further 89 students had a UAI but had not completed the survey. There are at least two possible reasons for this. The students may simply have declined to complete the surveyor may have been absent from the tutorial in which the survey was completed. The final group of 147 students did not have a UAI, and did not complete the survey. In this example, there may be some issues of sample selection bias because the non-response rate is approximately 56%. This issue of selection bias is addressed later in the results section. The dataset was spliced together from three sources: the University database, the database held by the Department of Accounting and Business Law, and the survey completed by students. Students who answered the questionnaire gave demographic information on their family background: the type of high school attended; the amount of study done at university; the amount of study in Year 12; whether working part-time.

Table 1. Summary Statistics

Variables	**Female (n=103)**		**Male (n=90)**	
	Mean	**Std. Dev**	**Mean**	**Std. Dev.**
Final Mark (in unit of study)	58.63	8.26	58.04	5.30
UAI	91.69	4.95	92.13	5.26
TutAttend (= number of tutorials attended)	11.11	1.02	10.93	1.11
English (2 unit mark in HSC)	76.86	9.04	76.52	8.39
Legal (2 unit mark in Legal Studies in HSC) (24 females and 14 males)	81.21	3.93	81.14	7.44
Age (years)	18.36	0.78	18.52	1.13
	Percentages		**Percentages**	
NonEnglish (=1 if from a non-English speaking background)	51.4		27.8	
College (=1 if living in a college)	6.8		10.0	
Away (=1 if living away from home)	6.8		6.7	
State (=1 if attended a state school)	30.1		26.7	
MathCoach (=1 if had regular and consistent mathematic coaching outside school)	33.0		32.2	
Study1 (=1 if studied 2-3hrs weekly in unit)	53.4		55.6	
Study2 (=1 if studied 4-5hrs weekly in unit)	26.2		11.1	
Study3 (=1 if studied ≥ 6 hrs weekly in unit)	4.8		1.1	
Paidwork (=1 if ≥11 hrs weekly in paid work)	33.1		49.7	

Table 1 presents a breakdown by gender of the variables. Surprisingly, 51.4% of females and only 27.8% of males come from a non-English speaking background. Most students live at home, 30.1% of females and 26.7% of males went to a state school, and 32.2% of males and 33% of females had significant amounts of mathematics coaching in their final year of school. There is a disturbingly high proportion of students (in particular males) who are doing very little extra study (15.6% of females and 32.2% of males do less than 2 hours per week on average) in this unit of study. Further, only 31% of females and 12.2% of males are studying four or more hours per week. These data statistics show large gender differences.

Model

In broad terms there are four sets of factors that might explain a student's propensity to achieve; ability, commitment, socio-economic and external. The factors that could be considered as indicators of a student's ability are the UAI, the mark in English in the HSC, the mark in Legal Studies in the HSC and the amount of English and Mathematics coaching in Year 12 outside of school. As explained previously, the UAI is a ranking based on the aggregate scaled marks in the HSC. A squared term (UAI^2) has been added to the model as it is expected that a quadratic, rather than a linear, relationship exists between UAI and the final mark. The English and Legal Studies marks are percentages. The amount of mathematics coaching in the final year of high school, represented by MathCoach is a dummy variable which equals 1 if the student had a significant amount of coaching. It is thought that the coaching allows the student to maximise their UAI but has a detrimental effect at university where this intensive coaching does not exist.

For the commitment factor, the number of CTA tutorials attended and the hours of work in the unit were chosen. Gender, age and a non-English speaking background are the socio-economic factors. The external factors used were the level of paid work undertaken by the students in the semester and whether the student lived at home, in college or away from home. It was expected that these factors could impact on a student's success.

The model was further refined to consider males and females separately as it became apparent that different sets of variables were significant for the two groups. The final model for both males and females was:

$$\begin{aligned} Final\ Mark_i = {} & \alpha_0 + \alpha_1 UAI + \alpha_2 UAI^2 + \alpha_3 English + \alpha_4 Legal + \alpha_5 DLegal + \alpha_6 Age \\ & + \alpha_7 NonEnglish + \alpha_8 College + \alpha_9 Away + \alpha_{10} Tutattend + \alpha_{11} State \\ & + \alpha_{12} MathCoach + \alpha_{13} Study1 + \alpha_{14} Study2 + \alpha_{15} Study3 + \alpha_{16} Paidwork + u_i \end{aligned} \quad (1)$$

The disturbance terms, u_i and Vi, are both assumed to be distributed normally with mean 0 and variance 1 and uncorrelated.

Results

Table 2 presents the estimation results. As many of the students were excluded from the data analysis due to incomplete information, descriptive statistics were calculated for this group and compared with those used in the analysis. There was no significant difference between the proportion of females in the two samples. However, the difference in attendance and the final mark were significant at the 1% level of significance for males and at the 5% level of significance for females. This suggests that sample selection bias could exist.

Heckman (1979) demonstrates that sample selection bias is a specification error and he presents a simple consistent estimation method that eliminates the specification error for censored samples. Neither model presented evidence of sample selection bias, the results use ordinary least squares (OLS) for estimating the models. As the data are cross-sectional, it is necessary to correct for heteroscedasticity if it is a problem. White's (1980) robust method is used to calculate standard errors for the coefficients in Table 3. The Ramsey RESET test (Ramsey, 1969) for functional form indicated that the models are not misspecified.
One possible problem with the model is that the number of tutorials a student attends in each semester could be regarded as endogenous. It seems likely that a student who goes to tutorials will receive positive feedback on their progress especially after test results are announced and this may affect their attitude to study and (hopefully) increase their final mark. Likewise, a student, who is performing below standard, may be encouraged to attend lectures and tutorials and to work more consistently. The specification test due to Hausman (1978) is used to test for possible endogeneity. The Hausman test statistic yields a value of 6.23 (for males) and 1.80 (for females) with 17 degrees of freedom and a p-value of 0.995 for males and 0.998 for females. Thus there is very strong evidence that attendance at tutorials is not endogenous provided selection bias does not exist in either the female or the male model.

Both models have reasonable values for R^2 for cross-sectional data. The signs of the coefficients are all as expected, with two exceptions. The sign of the estimated English coefficient is negative but is not significant. Note that the interpretation of the coefficient must be treated with caution. For males having paid work of more than 10 hours per week, the estimated coefficient is positive. This estimated coefficient was expected to be negative which would imply that more hours of paid work impacted negatively on the student's results.

The significant variables for females are English, Legal Studies, age in years, from a non-English speaking background, the number of tutorials attended and the different hours of study in CTA . However, for males, the significant variables are UAI, UAI^2, living in college or away from home, the number of tutorials attended, attending a state school, having mathematics coaching at school and having more than 10 hours of paid work. Note that only one variable is significant for both males and females -the number of tutorials attended.

Most of these variables are also educationally significant because, for students on the border between grades, it can have a large effect. The concept of educational significance does not appear to have been raised in the literature before. Educational significance affects both the student and the university. For students who fail a unit of study, the length of time for completion of the degree can be extended. This extension can also cause financial problems for the student. Further, the university desires all students to complete their degree in minimum time. This is an obviously unrealistic goal but there have been suggestions of financial penalties for the university by the government for students not completing in minimum time.

For example, on average, males living away from home are likely to receive almost 8 marks less than a male student living at home ceteris paribus. Therefore a male living at home will get a pass grade if he receives 53% in his final mark whereas the male living away from home is likely to receive about 46% which will result in a fail grade. This result has a number of possible effects.

Originally, separate variables for English were used - one for 2 Unit English and the other for 2 Unit General English - but testing showed that there was no significant difference between

the coefficients. Thus, a new variable was created: the English mark for each student irrespective of whether the student took 2 Unit General English or 2 Unit English. This is an important result because it is usually assumed that 2 Unit English is a more rigorous subject. This may well be true but, for this case study, the level of English does not differentiate between students. Further work needs to be undertaken to see if, in the Faculty of Economics and Business, this result is more generally true.

Table 2. Results from OLS Regression Model

	Female		**Male**	
Variable	**Coefficient (Std. Error)**	**Std Error**	**Coefficient (Std. Error)**	**Std. Error**
Constant	130.79	149.79	197.69***	67.67
UAI	-3.67	3.16	-3.68**	1.53
UAI^2	0.02	0.02	0.02**	0.01
English	0.17*	0.09	-0.01	0.07
Legal	0.98***	0.33	0.06	0.15
DLegal	-75.74***	26.95	-2.73	11.78
Age	2.06**	0.93	0.33	0.43
NonEnglish	-2.71*	1.53	-1.18	1.00
College	-2.28	2.67	-2.12*	1.08
Away	-2.44	1.84	-7.76***	2.18
TutAttend	1.86**	0.73	1.18**	0.46
State	1.46	1.46	3.40***	0.98
MathCoach	-1.67	1.47	-3.88***	0.99
Study1	5.22**	2.24	1.58	1.07
Study2	5.72**	2.36	-1.21	1.39
Study3	7.86***	2.72	0.40	1.76
Paidwork	2.18	1.45	1.41*	0.83
	$R^2 = 0.439$		$R^2 = 0.434$	

Note: * ** significant at 1% level, ** significant at 5% level, * significant at 10% level.

The key result is that the UAI and UAI^2 are not jointly significant for females, but are for males. Further, for both males and females, the relationship between the final mark and the UAI is a convex relationship. This implies that, as the UAI increases, the predicted final mark will decrease and then at some point will increase. For males, the minimum is 86.45 and for females it is 82.03. These results suggest that possibly the UAI may not be the best predictor of results from high school for females. However, this result conflicts with Dancer (2003) which found that the UAI is a very good predictor for first year units of study in Economics and Econometrics for both males and females. CTA deals with the fundamental elements of business law and thus, unlike first year units of study in Economics and Econometrics, is an intensive user of a student's English communication skills, both oral and written. For females, the estimated coefficient for the English mark is positive and only significant at the 10% level but insignificant for males.

The predicted final mark of a male student who had mathematics coaching at school will be 3.9 marks less on average compared with a male student who had no coaching. Similarly, a male student from a state school will receive 3.4 extra marks on average compared with a male student from a private school. A male student living away from home will receive, on

average, 7.8 marks less than a male student living at home. The dummy variable for a male student undertaking at least eleven hours of work per week is mildly significant and positive. This indicates that paid work does not negatively impact on a student's predicted final mark.

For females, the set of significant variables (that is, significant at less than 10%) are entirely different with one exception -the number of tutorials attended. On average, a female student who devoted between 2 and 5 hours per week in study for this unit of study will receive at least 5 marks more than a student who studies for one or less hours per week, while a student who studies for at least 6 hours per week will receive an additional 7.9 marks. Females receive almost 2 extra marks for each tutorial they attend whereas males only receive just 7 over I mark per extra tutorial. Females from a non-English speaking background receive approximately 2.7 marks less than other females. The results for the hours spent studying CTA outside of lectures and tutorials have a large effect on the female student's final result.

These results for males and females are statistically significant, but are they educationally important? All of these results are very important to males who are on the borderline between grades. These results could certainly mean the difference between passing CTA and failing. Thus, there is a possibility that these results could affect the retention of students and also their progression through their degree.

Whether English or the UAI is the best predictor could have implications for students entering the Faculty of Arts where the English ability of a student is very important and for students in the Faculty of Economics and Business who are largely taking non-quantitative units of study in their degree program. Therefore this result may have different implications for different faculties in the university. There appears to be no current work investigating the predictive properties of the UAI and results in important subjects at school across different units of study and faculties. This poses further interesting questions. Does the UAI have predictive power over a range of units of study in the same and different faculties? Should the UAI be adjusted for individual and relevant subjects at the Higher School Certificate as suggested by Everitt and Robins (1991)?

Our results indicate that there is a bias against male students from state schools. However, preliminary work of Dancer (2003) found that males from state schools in first year Econometric but not in first year Economics did not perform as well as males from private schools. It is suggested that this bias should be further investigated to see if it is unit of study dependent or perhaps Faculty dependent.

How well do these models predict the final marks? Consider a base case for a student with a UAI of 92 and an English mark of 80, not doing Legal Studies at school, English speaking, aged 18 years, living at home, attending 11 tutorials, attended a state school, had mathematics coaching at school, studying 2-3 hours per week in CTA and doing no paid work. The estimated final mark for a female student fitting this profile is 57.30 and for a male student it is 57.98. In this range, the model is reasonably accurate. Note the estimated correlation between the actual and predicted final marks for males and for females is 0.66.

Table 3 indicates the number and percentage of students who are correctly identified as being at risk of failing ($\leq 25\%$) or being very successful ($\geq 75\%$), in this unit of study. Note the models are not very good at predicting final marks for the bottom 10%, or the top 10%, of students. However, we can correctly predict approximately half of the students who will be in the bottom 20% (or even the bottom 25%) or the top 20% (25%) of ranked students. These

predictions would allow the targeting of help towards those students who are potentially at risk of failing.

Table 3. Number and Percentage of Students Correctly Predicted by the Model

Rank of Final Mark	Number of Female Students	Number of Male Students
≤ 10%	5 (5.6%)	2 (1.9%)
≤ 20%	9 (10%)	9 (8.7%)
≤ 25%	12 (13.3%)	14 (13.6%)
≥ 75%	12 (13.3%)	17 (16.5%)
≥ 80%	8 (8.9%)	11 (10.7%)
≥ 90%	3 (3.3%)	3 (2.9%)
Total	90	103

Conclusion

This study has revisited the gender issue with respect to student performance. Here the students were enrolled in CTA which is an introductory commercial law course for students mainly enrolled in a business or economics degree but not enrolled in a law degree. This study has highlighted some of the differences in performance of male and female students. It appears that the UAI is a very important determinant of performance for males, but not for females. This is of considerable concern as universities in Australia all use a measure which is some form of ranking of school students and their performance. Note that, in NSW, the cut-off rank for different degrees is largely a function of demand. These results are also in conflict with results obtained by Dancer (2003).

As the unit of study under discussion here has components requiring oral, written and comprehension skills, it was anticipated that the students' ability in English as demonstrated by their mark in their final year of high school would be an important variable in the models. The English mark, whether in 2 Unit General or 2 Unit English, is significant for females (at 10% level) but not significant for males. For females, the number of hours spent studying in this unit of study is positive and statistically significant. Other variables having a significant and positive effect are age, implying that older females do better than younger females; Legal Studies and the number of tutorials attended. In the final mark, females from a non-English speaking background receive approximately 2.7 marks less than a female from an English speaking background, ceteris paribus.

There are a number of other variables which are important for males but have no significant impact on the predicted average marks for females. These variables which have a negative effect and are statistically and educationally significant include:-having mathematics coaching, living away from home or in college. Attending a state school and having paid work of more than 10 hours per week exert a positive effect on the predicted marks for males.

The concept of educational significance is explored both from the university's perspective and the student's perspective. The statistically significant variables are nearly always educationally significant for students near the cut-off points between grades. In particular, predicting which students are close to the pass mark allows for possible intervention to ensure these students are given every possible chance of passing the unit.

In conclusion, this study has raised a number of questions about the validity of the UAI as the best predictor of academic success for males and females, particularly in relation to units of study which are orientated towards written and oral communication skills. The impact of the UAI for males and females is not definitive as other studies have shown different results. Further research is needed to study whether it is possible to generalise these results to other disciplines in an Economics and Business faculty as well as other university faculties such as Arts and Science.

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