University of Cape Town

Using Survival Analysis to identify the determinants of Academic Exclusion and Graduation in three faculties at UCT

Author:
Christopher Rooney
chris.rooney1@gmail.com

Supervisor:
Dr. Corné Van Walbeek
Cwalbeek@gmail.com

A thesis submitted in partial fulfillment for the degree of Masters in Applied Economics (Development Stream)

May 2015

Plagiarism Declaration

I, Christopher Rooney, declare that this thesis titled, 'Using Survival Analysis to identify the determinants of Academic Exclusion and Graduation in three faculties at UCT' and the work presented in it are my own. I confirm that:

- This work has not been previously submitted in whole, or in part, for the award of any degree.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given.
- I have acknowledged all main sources of help.

Signed: [signature]

Date: 13/05/2015

Acknowledgements

A number of people deserve recognition for the help and support that I received from them. It gives me great pleasure in conveying my gratitude towards all these people.

Firstly, I would like to express my sincerest gratitude to my supervisor, Corné van Walbeek. His constant guidance, support, insight and unwavering commitment is admirable. He provided a perfect balance between giving me enough freedom during my research but also providing numerous, helpful suggestions. His relaxed and cheerful demeanor was a blessing.

Secondly, I would like to thank Zandile Tennyson and Jane Hendry from UCT's Institutional Planning Department for meeting my numerous requests for data.

Thirdly, my friends who provided encouragement to me throughout these years. All the time we have spent together will always be cherished.

Last, but not least, I would like to express thanks to my parents, Dominic and Teresa Rooney. They have sacrificed so much so that my siblings and I could receive a world class education. I cannot imagine imagine having made it this far without them.

Abstract

University graduation rates have become increasingly important for institutions and policy-makers alike. Academic exclusion, or other forms of withdrawal from university, represents a substantial loss to the individual, the institution and broader society. The purpose of this paper is to investigate the determinants of graduation and academic exclusion in UCT's Commerce, Engineering and Built Environment and Science faculties using survival analysis. The data consisted of 11 959 students who registered for a degree in one of the three faculties between 2006 and 2013.

The results suggest that there are large differences in graduation and academic exclusion rates between different groups of students. Factors which increased the likelihood of graduating were being female, white, ineligible for financial aid, proficient in English, attending a Quintile 5 or independent school and obtained good high school grades. On the other hand, males who are on financial aid, non English-speaking, attend poorly resourced schools and achieved low school grades are more likel to be academically excluded. Further findings indicate that, relative to the Commerce faculty, the Science and EBE faculties exclude a substantially greater proportion of poorly performing students in the first and second years. The Commerce Faculty excludes relatively few poorly performing students in the first two years, but the exclusion rate increases sharply in the third and subsequent years.

The main policy implication of these results is that the secondary schooling system needs to improve greatly in order for a larger proportion of students to graduate at university.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

Student retention, also known as student persistence, is the ability of a university to retain a student from first-year until graduation and has concerned educational policymakers for decades. This topic has received widespread attention because the costs incurred when a student fails to complete his or her studies are substantial for the student, the institution and society at large. The opportunities of students who do not complete their degrees to pursue successful careers are much diminished. In South Africa, the monthly earnings premium between a graduate and an individual with only a matric certificate increased from 182% in 2000 to 241% in 2007 (Branson et al., 2009). Furthermore, a degree is a pre-requisite for entering lucrative professions in South Africa such as actuarial science, accounting and law. In addition, failing to complete a degree represents a substantial opportunity cost because the time spent at university could have been used for more productive purposes.

From the perspective of a university, the most direct effect of a student failing to complete a degree is the loss in tuition fees. In addition, the South African government pays universities a subsidy for every student currently enrolled as well as for every graduate, so a failure to complete a degree is another source of lost revenue. The university also loses a potential future income stream as research has shown that graduates are more likely to donate than those who did not complete their studies (Swail, 2004). The loss of revenue reduces the ability of the university to hire and retain high-quality academics. An exodus of highly-valued faculty members will damage the reputation of the university. Moreover, potential and existing students will look elsewhere to study, further reducing future revenue streams.

The cost to society of students who fail to complete their studies is considerable. Firstly, every student attending a public university in South Africa is subsidised by the government (DHET, 2004). A student who fails to complete a degree programme represents an inefficient use of taxpayers' money because society will derive only a partial benefit from the subsidy it provided. On top of this, these students are more likely to rely on government services (such as welfare benefits) than graduates (Swail, 2004). Finally, graduates contribute more in taxes than non-graduates and have greater civic participation (Baum et al., 2013), increasing the nation's social capital.

Given both the substantial benefits from graduating and the costs of failing to graduate, it is clear that student retention should be a national priority. Laudably, the Department of Higher Education and Training (DHET) has understood the importance of increasing graduation rates at South African universities (Letseka and Maile, 2008). On the surface, the political pressure applied to universities to increase the graduation rate appears to have worked: the graduation rate for the 2000 university cohort (those who entered university in 2000) was 38%. This figure had risen to 52% for the 2006 university cohort (Scott et al., 2007; Ndebele et al., 2013). However, the two studies are not directly comparable[1], and even the improved figure of 52% is troublesome. Part of the problem in improving the graduation rate arises from its complex and intricate nature. There is a large array of observable and unobservable factors that affect the academic success of a university student.

The purpose of this paper is to elucidate the relationships between a set of observable factors with the probability of graduating and academic exclusion. University of Cape Town (UCT) undergraduate students from the Commerce, Engineering and Built Environment (EBE) and Science faculties were selected due to the emphasis placed on the quantitative skills of degrees offered by these faculties.

1.1 Readmission Policies at the University of Cape Town

At UCT, individual faculties decide on the academic requirements necessary to proceed to the next year. Failure to achieve such requirements obliges students to apply to the relevant Readmission Appeals Committee (RAC) if they want to be readmitted and explain their poor performance. If the reason(s) given is plausible, then the RAC will allow the student to re-register.

All undergraduate course codes at UCT end with either a 'F', 'S', 'H' or 'W'. 'F' and 'S' indicate that a course was taken in the first or second semester, respectively. 'H' is equivalent to a semester course (in terms of content covered) but is taken over the whole year. 'W' denotes a full-year course which is identical to two semester courses. In the Commerce faculty, 'F', 'S' and 'H' courses are regarded as one course while 'W' courses are deemed as two (Commerce Faculty Handbook, 2014). In contrast, the Science faculty view 'F', 'S' and 'H' courses as half courses, and 'W' courses as one (Science Faculty Handbook, 2014). The EBE faculty do not use such a weighting system, preferring a system of credits earned to indicate the importance

[1] Different methodologies were used to determine the graduation rate in each study.

of courses (EBE Faculty Handbook, 2014). Credits are also assigned to Commerce and Science courses, as indicated in Table 1.1, although they do not have the same importance as in the EBE faculty, which uses the number of credits passed as a basis for readmission decisions.

Table 1.1: Number of Credits by Type of Course

	Commerce Faculty		**EBE Faculty**		**Science Faculty**	
	F, S, H Courses	W Courses	F, S, H Courses	W Courses	F, S, H Courses	W Courses
First-year	18	36	8 – 18	16 – 44	18	36
Second-year	18	36	8 – 24	4 – 36	24	48
Third-year	18	36	8 – 24	12 – 24	36	72

Sources: Commerce Faculty Handbook (2014); EBE Faculty Handbook (2014); Science Faculty Handbook (2014)

Each credit is equal to about ten hours of studying, which includes lectures, tutorials, self-study, assignments and tests (Commerce Faculty Handbook, 2014; EBE Faculty Handbook, 2014; Science Faculty Handbook, 2014). For example, the total study time of an 18-credit course would be 180 hours. Unlike the Commerce and Science faculties, which apply the number of credits to a course consistently, the number of credits for EBE courses can differ substantially, even if, for example, both courses run for a semester and are from the same department.

1.1.1 Commerce Faculty

The Commerce faculty offers two undergraduate degrees: the Bachelor of Commerce (BCom) and the Bachelor of Business Science (B.Bus.Sci) (Commerce Faculty Handbook, 2014). Although Commerce students can choose from a wide variety of specialisations (e.g. Actuarial Science, Economics, Computer Science, Marketing or Organisational Psychology), the majority major in Accounting.

The faculty also offers an Academic Development (AD) programme for those students who have the potential to succeed at university, but whose secondary education was insufficient to prepare them adequately for the academic rigour of the mainstream courses. The AD programme adds a year to the degree. The first year in the AD programme is used to teach students crucial academic literacy skills (Smith, 2012). Certain courses are taken over a whole year rather than a semester. As a result, undergraduates in the AD programme have a lighter course load, especially in the first two years, and are subject to slightly lower readmission criteria compared to mainstream students, as indicated in Tables 1.2 and 1.3 below. A 'representative student' is one who completes the degree in the minimum time and does not fail or take on any extra courses. Furthermore, although the B.Bus.Sci programme is four years, the final year is treated differently to previous years because it is effectively an Honours year. The implication is that readmission will be solely dependent on the students' performance in that year and individual departments (rather than faculties) prescribe the course load and have authority in who to re-admit. Therefore the Commerce faculty does not set readmission rules for students entering fourth-year Business Science.

Table 1.2: Course Load of a Representative Commerce Student

	Cumulative Number of Prescribed Courses			
	BCom	BCom (AD)	B.Bus.Sci	B.Bus.Sci (AD)
First-year	8 – 10	5 – 6	8 – 10	5 – 6
Second-year	17 – 19	10 – 14	16 – 20	11 – 14
Third-year	25 – 27	17 – 21	26 – 28	19 – 23
Fourth-year	—	23 – 28	Dept-specific	26 – 31
Fifth-year	—	—	—	Dept-specific

Source: Commerce Faculty Handbook (2014)

Table 1.3: Minimum Requirements for Automatic Readmission into the Commerce Faculty

	Cumulative Number of Courses Required to be Passed			
	BCom	BCom (AD)	B.Bus. Sci	B.Bus.Sci (AD)
First-year	4	3	4	3.5
Second-year	8	6	10	7
Third-year	15	10	18	13
Fourth-year	—	15	—	19

Source: Commerce Faculty Handbook (2014)

Table 1.3 describes the minimum number of courses that a student is required to pass by the end of each year in order to proceed automatically into the next year. Excluding the first-year readmission requirements for mainstream BCom and Business Science students, a clear trend emerges of higher readmission requirements of Business Science students, owing to a higher course load (see Table 1.2). Commerce students who major in a Science faculty subject (e.g. Computer Science or Statistics) do not have to complete as many courses as other Commerce students, owing to the different weighting of second and third-year courses between the Commerce and Science faculties (see Table 1.1). This is the main reason for variation in the cumulative number of prescribed courses observed in Table 1.2. In both the mainstream and AD first-year programmes, there are many common courses between the BCom and Business Science programmes, enabling students to switch easily between programmes.

1.1.2 EBE Faculty

The EBE faculty offers five undergraduate degrees, namely Architecture, Construction Studies, Property Studies, Engineering and Geomatics (EBE Faculty Handbook, 2014), of which the latter two are relevant to this analysis. The Bachelor of Science in Engineering (BSc (Eng)) affords students the opportunity to major in a wide variety of engineering disciplines, such as chemical, civil and electrical engineering. The Bachelor of Science in Geomatics (BSc (Geomatics)) allows students to pursue their interest in Surveying, Geoinformatics or Planning.

The EBE faculty also offers an academic development programme - the Academic Support Programme for Engineering in Cape Town (ASPECT). ASPECT students take a literacy course, which *inter alia*, focuses on improving reading and writing skills (Smith, 2012). They are also required to take a specially-designed mathematics course, which is equivalent to the mainstream first-year mathematics course, but involves many more contact hours (Smith, 2012). The readmission requirements and course load are outlined in Tables 1.4 and 1.5 below.

Table 1.4: Course Load of a Representative EBE student

	Cumulative Number of Prescribed Credits		
	BSc (Eng)	ASPECT	BSc (Geomatics)
First-year	144 – 148	104 – 116	142 – 144
Each successive two-year period[1]	264 – 294	232 – 248	296 – 330

Source: EBE Faculty Handbook (2014)
[1] Core courses only

Table 1.5: Minimum Requirements for Automatic Readmission into the EBE Faculty

	Cumulative Number of Credits Required to be Passed		
	BSc (Eng)	ASPECT	BSc (Geomatics)
First-year	80	64	80
Each successive two-year period	192	160	192

Source: EBE Faculty Handbook (2014)

Table 1.4 suggests that Geomatics students have a slightly higher workload than mainstream Engineering students. However, this is more a reflection of the number of core courses that students have to complete. Geomatics students cannot choose any elective courses, while Engineering students can choose a few, which would make up the difference in credit requirements (EBE Faculty Handbook, 2014). Table 1.5 shows that, like the Commerce faculty, readmission requirements are lower for academic development students as a result of a lower course load.

All students in Engineering and Geomatics have to complete at least 576 worth of credits to obtain their degree (EBE Faculty Handbook, 2014), so there is little difference in course loads between the programmes. First-year Engineering and Geomatics programmes are also designed so students can easily transfer to other streams after the first year.

1.1.3 Science Faculty

The Science faculty caters for a wide variety of interests, with majors ranging from mathematics and computer science to archaeology and genetics (Science Faculty Handbook, 2014). Unlike the Commerce and EBE faculties, there are many possible electives, allowing students to select only courses which interest them. The number of courses in Tables 1.6 and 1.7 has been adjusted according to Commerce Faculty rules (i.e. a 'F/S/H' course = 1 course and a 'W' course = 2 courses), in order to allow for easier comparisons between the two faculties.

Table 1.6: Course Load of a Representative Science student

	Cumulative Number of Prescribed Courses	
	Mainstream BSc	EDP BSc
First-year	8	4
Second-year	14	9
Third-year	18	14
Fourth-year	—	18

Source: Science Faculty Handbook (2014)

Table 1.7: Minimum Requirements for Automatic Readmission into the Science Faculty

	Cumulative Number of Courses Required to be Passed		**Cumulative Number of Senior Courses[1] Required to be Passed**	
	Mainstream BSc	EDP BSc	Mainstream BSc	EDP BSc
First-year	2	2	—	—
Second-year	7	6	—	—
Third-year	11	10	3	2
Fourth-year	15	14	6	5

Source: Science Faculty Handbook (2014)

[1] 2nd or 3rd year course.

In contrast to the Commerce and EBE faculties, where the AD programmes have lighter course readmission requirements, the number of courses that mainstream and Extended Degree Programme (EDP) students must pass is the same in first-year. This is despite EDP students going at approximately half the pace of the mainstream cohort because first-semester courses are extended over the entire year (Smith, 2012). The criterion regarding senior courses has been included by the faculty to prevent struggling students from continuously changing majors in order to re-do first year courses, which are easier than senior courses. Both mainstream and EDP students are expected to complete all their required courses by the end of fifth year. Examining Table 1.6, it is apparent that Science students have a lighter course load, especially in third year, compared to the Commerce and EBE students. These differences can be attributed largely to Science students only having to do courses directly related to their majors. In contrast, all Commerce students have to do generic courses such as 'Evidence-Based Management' and 'Business Ethics'. Likewise, compulsory Engineering courses include 'Professional Communication' and 'Project Management'.

In synthesising the material, it is clear that the readmission policies differ quite markedly from faculty to faculty. This is most likely a reflection of the structure and academic demands of the degrees in the different faculties. Although the Commerce and EBE faculties do not distinguish between the type of course passed (core or elective), it is not unreasonable to assume that highly structured degrees (i.e. degrees with many 'core' courses and few electives) will have more stringent readmission standards. Failure to pass a course in a structured degree will prevent students from doing a more senior core course. In contrast, degrees where there are a few core courses and more electives means that failure in an elective will not necessarily impede overall progress in the attainment of a degree, as electives are interchangeable. Readmission committees are more likely to readmit a student who has failed two electives than a student who has failed two core courses, as the implications are far greater for the latter.

Chapter 2

Literature Review

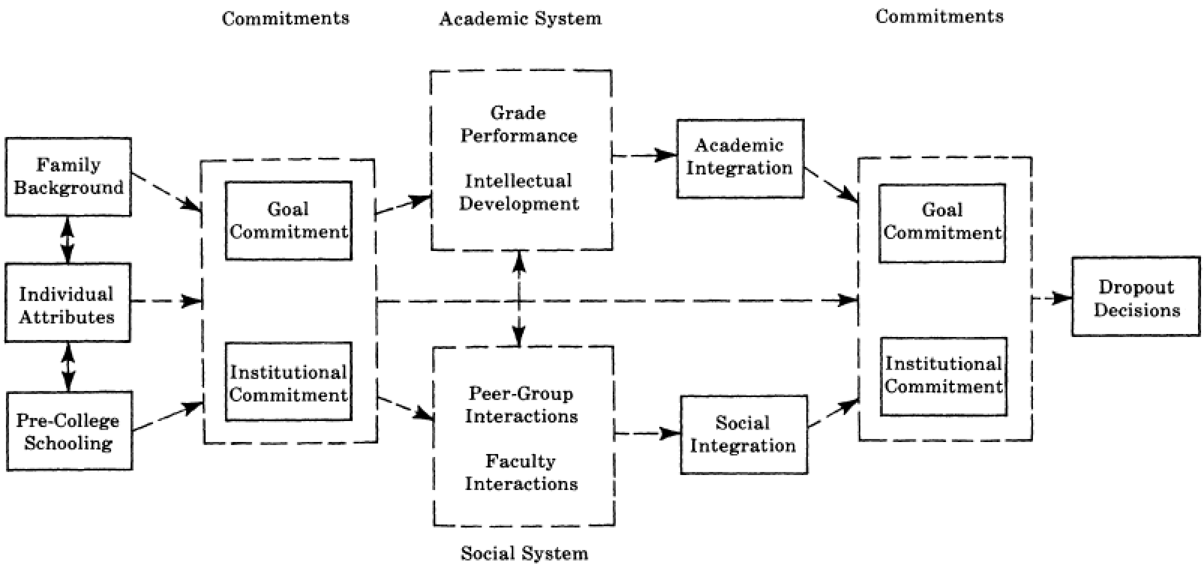
This chapter is divided into two parts. The first part examines the most prominent models of student retention. The second part looks at individual factors which have shown to influence student retention. In South Africa, research in this field has almost exclusively focused on first or second-year economics students in explaining academic performance at university (Horn and Jansen, 2009; Horn et al., 2011; Parker, 2006, 2007, 2010; Potgieter et al., 2010; Smith and Edwards, 2007; Smith and Ranchod, 2010; Van Walbeek, 2004; Van Zyl et al., 2012). As a result, the large majority of the student retention literature consulted is from an international perspective.

2.1 Models of Student Retention

2.1.1 Student Integration Model

Tinto's (1975) conceptual framework is unequivocally the most popular student retention model used in higher education research (Miller, 2006). The model's popularity derives from its simple and intuitive nature regarding the factors which influence student retention. A schematic representation of the Student Integration Model is given below.

FIGURE 2.1: Tinto's Student Integration Model



Source: (Tinto, 1975)

As is evident from the diagram, Tinto posits that both academic and social integration are crucial in determining whether a student is retained. First-time university students have several pre-enrolment characteristics which affect their initial commitment towards their (personal) goals and the institution. Family background variables include the parents' educational background and the expectations they have for their children, wealth and the quality of relationships between family members (Tinto, 1975). Individual characteristics refer to factors such as ability and motivation while previous schooling refers both to academic achievement and resources of the school (Tinto, 1975). According to the model, students who come from an affluent family, attend a good school and achieve excellent grades will initially have greater clarity about their goals and be more devoted to their university studies.

Once students enter university, the motivation to attain their goals is linked to academic integration at the university. Academic integration refers not only to marks achieved, but also to the enjoyment of the subjects and the value students place on their education (Tinto, 1975). Students who have strong career aspirations are more likely to integrate into the academic life of the university than those who are studying without having a clear idea about their ultimate goals. Social integration refers to the level of interaction with faculty members and peers and participation in extracurricular activities (Tinto, 1975). The greater the level of interaction and participation, the greater is the congruence between students and their campus environment. Academic and social integration in turn force students to re-evaluate their commitment to their goals and institution, ultimately determining whether a student remains at university. The higher the academic and social integration, the more likely a student is to graduate. However, it is possible for students who integrate well academically but not socially (and vice-versa) to graduate, although they might take longer to graduate or have a lower overall Grade Point Average (GPA).

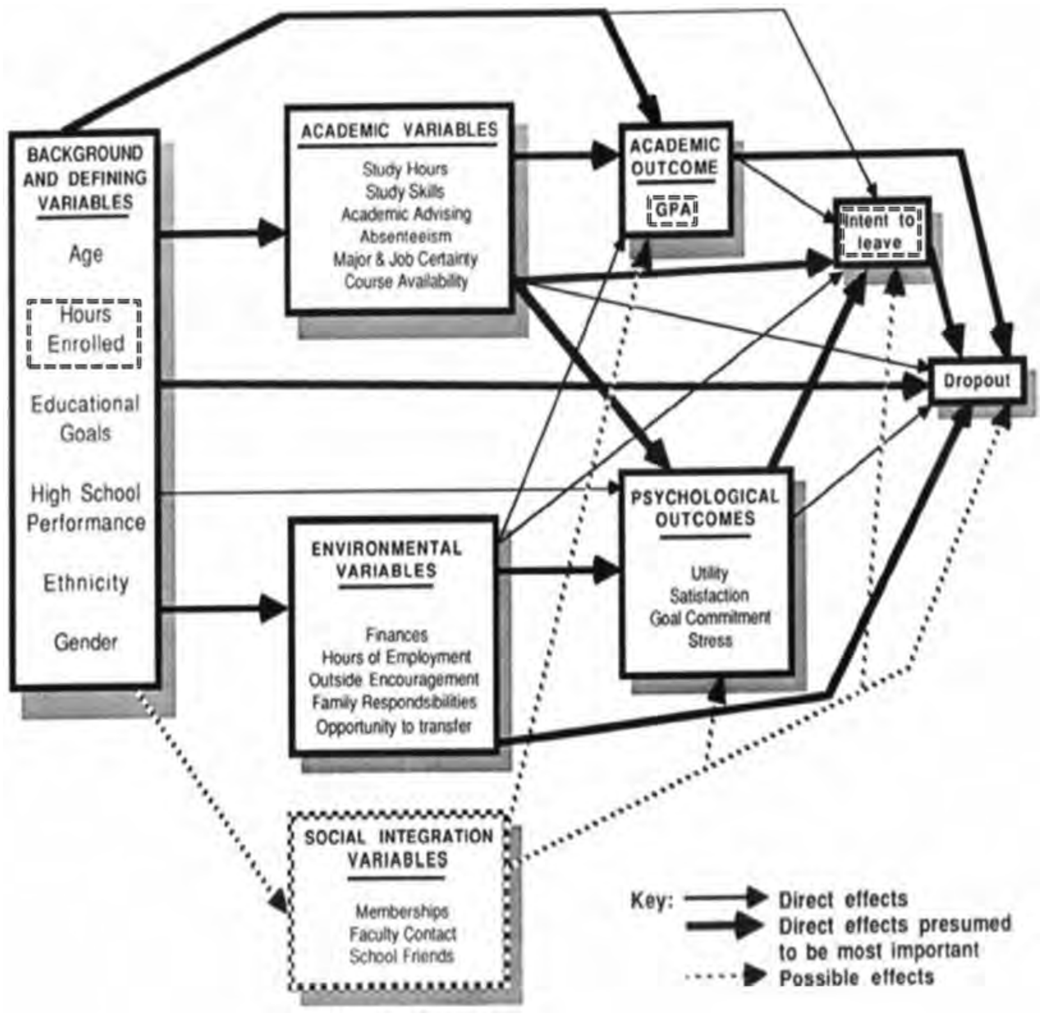
Tinto (1988) extended his model by incorporating the insights from Arnold van Gennep, an anthropologist, who examined rituals in tribal societies which marked the transition from one life stage to another (Van Gennep (1960) cited in Tinto (1988)). Tinto (1988) adapted this framework and identified three stages through which most university students go: separation, transition and incorporation. The separation stage is typified by gradually reducing interaction with individuals (both friends and family) with whom the students associated with before entering university. The transition stage is marked by conflict between the 'old' home environment and the 'new' university environment. Students may become confused because they recognise they are no larger part of their home environments but have yet to adapt to the new campus environment. Finally, the incorporation stage is reached when a student participates fully in both the academic and social lives of the university. A student who navigates through these three stages successfully is more likely to graduate than those who do not. As in the 1975 model, an important conclusion is that the decision on whether to continue at university occurs exclusively within the higher education environment (Grayson and Grayson, 2003). This implies that universities have a large degree of control in increasing the graduation rate (Grayson and Grayson, 2003).

Despite the model's popularity, its empirical support is limited. Braxton et al. (1997) devised thirteen testable propositions from Tinto's model, and after reviewing the literature, only found strong support for five of them. Specifically, Tinto's fundamental premise that greater social integration increased the probability of a student being retained, was confirmed. However, the lack of support for the other core premise of Tinto's theory - academic integration - brings into question the accuracy of the entire model. This lack of empirical evidence stems from the model's over-reliance on the experience of 'traditional' (white, middle-class and in-residence) students to explain student retention (Grayson and Grayson, 2003).

2.1.2 Student Attrition Model

Bean and Metzner's (1985) student attrition model was motivated by the criticism of Tinto's model, and accounted for non-traditional students. They defined a non-traditional student as 'older than 24, or does not live in a campus residence (e.g., is a commuter), or is a part-time student, or some combination of these three factors; is not greatly influenced by the social environment of the institution; and is chiefly concerned with the institution's academic offerings' (Bean and Metzner, 1985, p.489). They maintained that non-traditional students came to university with very specific goals in mind and that social integration was less important because their social support structures were to a large extent drawn from family and friends outside the university. In the South African context, there is another group of students who are neither 'traditional' nor 'non-traditional' but rather 'aspirational'. Owing to historical factors, these individuals are first-generation students, have limited funds (so may have to work to finance their studies) or care for their younger siblings. In addition, there might be pressure to succeed at university from their families, who view a degree as a first step to improving their life circumstances. Accordingly, Bean and Metzner's (1985) model, which can account for a diverse range of student experiences, is more applicable to South Africa's multi-cultural higher education environment than Tinto's model.

FIGURE 2.2: Bean and Metzner's Student Attrition Model



Source: (Bean and Metzner, 1985)

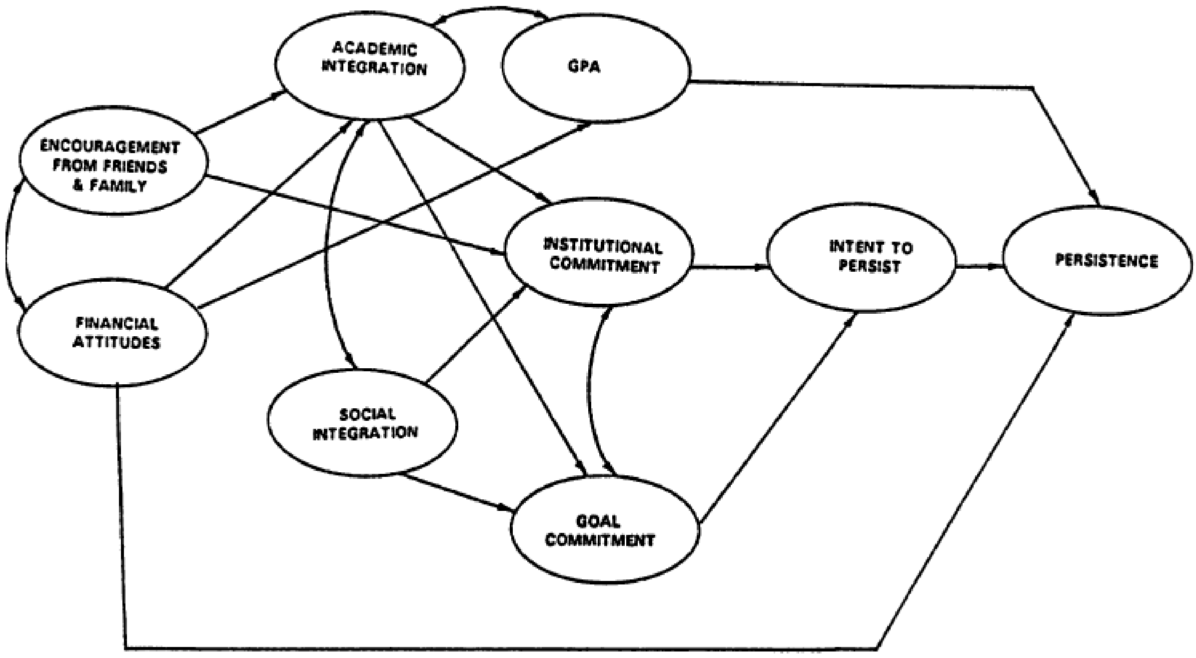
In relation to Tinto's model, there are obvious similarities, especially the sets of academic, background and social Integration variables. In the Psychological Outcomes category, two new variables - utility and stress - were added. Utility refers to the practical value of the degree in terms of the range of future employment opportunities that it unlocks. Stress describes the level of anxiety that students experience both within and outside the university environment. Lack of study time and increased course load are examples of internal factors, while health and family issues are determined exogenously (Bean and Metzner, 1985). However, the most crucial insight from the model was the addition of a set of environmental variables such as finances, hours worked and family responsibilities, which are outside the university's control, in determining student retention. This understanding of student retention behaviour has big policy implications for universities. In contrast to Tinto's model, universities do not have much power in retaining students.

Metzner and Bean (1987) empirically tested their conceptual model on 624 non-traditional students at a large US university. They reported that none of the significant predictors of student retention related to social integration, confirming their hypothesis that it is unimportant for non-traditional students.

2.1.3 The Combined Model

Cabrera et al. (1992) examined the validity of the two aforementioned theoretical models. They found that while more hypotheses from the student integration model were verified (70% vs. 40%), the student attrition model explained more of the variance in student persistence (44% compared to 38%). There were also similarities between the two models, with the constructs of 'Academic Integration' and 'Institutional Commitment' in the student integration model being comparable to the 'Courses' and 'Institutional Fit' constructs of the student attrition model, respectively (Cabrera et al., 1992). Based on these findings, Cabrera et al. (1993) developed a model, shown in Figure 2.3 below, which contained the insights of both models.

Figure 2.3: Cabrera, Nora and Castaneda's Combined Model



Source: (Cabrera et al., 1993)

Cabrera et al. (1993) tested their combined model on 2459 first year students, which was the same sample used in their 1992 study. This allowed them to be more confident in comparing results, because differences in unobservable characteristics between distinct samples could have affected the results in unknown ways. In order of importance, intent to persist, first year GPA, institutional commitment and encouragement from family and friends were found to be the most influential variables in explaining student retention. However, the overall model only explained 45% of the variation in student persistence, which is only a negligible increase over the student attrition model. Despite this result, the model should be recognised as providing a more realistic explanation of student persistence, by recognising the interplay between internal and external factors.

In conclusion, when the different theoretical models are taken in conjunction with each other they present a comprehensive overview of the key determinants that shape the university experiences of students and ultimately, whether they graduate. We will now turn our attention to individual factors which have been shown to influence student retention.

2.2 Individual Factors which Affect Student Retention

As is evident from the previous discussion, there are a large number of factors which influence the decision to remain at university. However, only variables which could be measured with a high degree of accuracy were selected for inclusion in this paper. While the author acknowledges that variables such as motivation, career aspirations and interaction with peers and faculty are important in determining student retention, they are difficult to measure and interpret. Such characteristics are self-reported which, for a variety of reasons, can lead to biased estimates (Fadnes et al., 2008). For instance, self-report questionnaires often use a rating scale to measure the intensity of a particular feeling but people interpret the meaning of the scores differently, making comparisons problematic (Austin et al., 1998). In addition, variables for which data are not readily available but could influence a student's behaviour - such as the death of a close relative or a serious illness - were also excluded from the analysis.

The variables below have been classified into three groups: academic, demographic and environmental.

2.2.1 Academic Variables

High school GPA

High school Grade Point Average (GPA) has consistently been found to be a good predictor of success at university, although much of the research has focused on explaining first-year performance (for an excellent review see Smith (2012)). Many of the studies which have examined determinants of graduation or cumulative GPA are drawn from the international literature, and the evidence is clear: the effect of high school GPA persists throughout the duration of a student's university career. (Adelman, 1999, 2006; De Angelo et al., 2011; Geiser and Santelices, 2007; Krejci, 2011; Mendez et al., 2008; Min et al., 2011; Murtaugh et al., 1999; Smith and Naylor, 2001, 2005; Smith, 2012; Tumen et al., 2008; Zhang et al., 2004; Zwick and Sklar, 2004).

Geiser and Santelices (2007) investigated the performance of 80 000 first years admitted to the University of California between 1996 and 1999, using four-year graduation rates and cumulative GPA as outcome variables. The results suggested that high school GPA was the most important predictor in determining whether a student will graduate, as well as cumulative GPA. This relationship was robust, as it held regardless of the degree obtained or cohort studied. Interestingly, high school GPA accounted for more of the variation in second-year, third-year and fourth-year GPAs than first-year GPA. This result is somewhat counter-intuitive, because one would expect other factors - such as engagement with the academic material or social support - to exert a greater influence on students performance the further they progress through their degree.

Smith and Naylor (2001) used the academic records of approximately 400 000 UK university students who began their three- or four-year degrees in 1989 and who graduated or withdrew between 1990 and 1993. They report that for a one-point increase in the overall A-level score (which is equivalent to obtaining a different symbol in a subject, such as an 'A' instead of a 'B'), the probability of dropping out is reduced by 1.4% for males, and 0.51% for females, *ceteris paribus*. In addition, those who scored above average results in relation to their peer group at school were also less likely to drop out.

With regards to the South African literature on the factors influencing the likelihood of graduation, Smith (2012) is the authority in this area. Smith (2012) looked at UCT students and found that, with the exception of ASPECT students, the adjusted matriculation score[1] was a significant predictor of graduation for both mainstream and academic development students in the Commerce, EBE and Science faculties. The latter finding is important and counter to some received wisdom that matriculation results have limited applicability to educationally-disadvantaged students in determining whether they will be successful at university.

High school Mathematics

Research into the effects of the level of achievement in high-school mathematics on the probability of graduating is limited. Nevertheless, the studies which have been conducted have all reached the same conclusion: high school mathematics scores are good predictors of graduation (De Winter and Dodou, 2011; Parker, 2005; Rose and Betts, 2001; Zhang et al., 2004). Zhang et al. (2004) reviewed the data of 87 000 engineering students across nine US universities between 1987 and 2002. They found that a 10-point increase in the quantitative section of the Scholarly Aptitude Test (out of 800) led to to a 3 to 8% increase in the probability of graduating. De Winter and Dodou (2011) looked at Dutch engineering students and observed a correlation of 0.38 between mathematics exam scores and graduating within 6 years. Parker (2005) analysed data from a university's mathematics placement test, which was taken at the beginning of first year, and sorted students into three groups: those who graduated in four years, those who were still at university but had not graduated, and those who had withdrawn from university. Placement test scores were significantly different across the three groups, with higher scores being associated with students who had graduated in regulation time.

[1]Total matriculation points earned after deducting the points from English and Mathematics.

2.2.2 Demographic Variables

Age

The evidence regarding the effect of age on student retention is mixed (van Stolk et al., 2007; Cantwell et al., 2001; Grayson, 1997; Murtaugh et al., 1999; McNabb et al., 2002; Ott et al., 1984; Pyke and Sheridan, 1993; Roberts, 2011; Smith, 2012; van Stolk et al., 2007; Weng et al., 2008). Older students typically have two opposing influences which affect their performance at university. On the one hand, work and family responsibilities may reduce the amount of time which they can dedicate to their studies. On the other hand, they are likely to be highly self-motivated and have a clear idea of the skills they want to gain from attending university.

Grayson (1997) detailed the factors which resulted in adult students not persisting to second year. He concluded that the reasons for studying for the degree were the most important determinant of persistence. Students who coveted a degree were more likely to persist than those for whom completion of a degree was not a priority. Ott et al. (1984) and Pyke and Sheridan (1993) both found that retention rates for masters and doctoral candidates were independent of age, while Weng et al. (2008) and Blaney and Mulkeen (2008) reported similar results for undergraduate students at Taiwanese and Irish universities, respectively. Smith (2012) recorded that the probability of graduation for mainstream Commerce students was reduced by 1% for every year increase in age. In contrast, Cantwell et al. (2001) concluded that while retention rates were similar between different age groups, mature students outperformed their younger counterparts when comparing cumulative GPAs.

Gender

A substantial body of literature concerning the role of gender suggests women are more likely to graduate than men (Astin and Oseguera, 2005; Council on Higher Education, 2009; McDaniel, 2011; McNabb et al., 2002; Peter and Horn, 2005; Radcliffe et al., 2006; Rask and Tiefenthaler, 2008; Smith, 2012). The reasons for the superior academic performance of women are numerous, and relate to higher job expectations of today's women compared to women of previous generations, increased age of first marriage, the invention of the contraceptive pill, and greater emotional maturity than boys (Goldin et al., 2006).

McNabb et al. (2002) used data from the Universities' Statistical Record office to analyse the differences in educational attainment between men and women graduates from universities in England and Wales. They found that while women, on average, performed better, men were more likely to obtain a first-class degree. The researchers concluded that differences in the class of degree obtained were not due to type of degree studied, variation in academic ability or quality of institution. Rather, gender differences arise when then there is an interplay between these three factors. These findings were supported by McDaniel (2011), who established that women were 50% more likely to have completed a degree, after examining data from 37 European countries.

Peter and Horn (2005) combined several datasets in the US and observed that women had a higher graduation rate than men (50% vs. 45%). Interestingly, this relationship held even when comparing the top 20% of male and female students at intake, suggesting that variation in graduation rates is not as a result of differences in academic ability.

In South Africa, the Council on Higher Education (2009) report that 59% of graduates are women, although they only comprise 55% of the university population. Smith (2012) found that in the Science faculty, males were 4% less likely to graduate in the mainstream programme, and 12% less likely to graduate in the EDP compared to females. Male ASPECT students were 22% less likely to graduate than female ASPECT students. These results are particularly relevant to this thesis and counters the international literature on Science, Technology, Engineering or Mathematics (STEM) graduates, which has consistently shown women have far lower retention rates than men in these disciplines (Griffith, 2010).

Home Language

The issue of home language education has been debated extensively within the South African educational community. According to the 2011 Census, approximately 77% of the population do not speak English or Afrikaans at home (Statistics South Africa, 2011) and yet these languages remain the official media of instruction at universities. Many former 'Afrikaans' universities, such as the Universities of Stellenbosch and Pretoria offer courses in English in addition to Afrikaans (Gerber et al., 2005). Intuitively, students who do not speak English or Afrikaans at home and do not take English or Afrikaans at the Home Language level in high school will be at a disadvantage compared to their peers who are fluent in the medium of instruction at a particular university.

Nash (2006) compared the differences between students who completed their Information Systems (IS) degree in three years with those who took four years at the University of Cape Town. She established that students who had a higher English matriculation score were more likely to finish their degree within three years. However, overall matriculation score (excluding English) was the best predictor in determining time taken to complete an IS degree. Smith (2012) found no significant difference in the likelihood of graduating between students who took English First Language Higher Grade and those who wrote English Second Language Higher Grade. However, he also found that speaking English at home increased the probability of graduation by 8% for mainstream Engineering students.

The international literature on English Second Language (ESL) students shows that, contrary to the South African experience, they do just as well or better than native English speakers where the medium of instruction is English (Coreil and Haber, 2000; Donnelly et al., 2009; Voyles and Asunda, 2014; Washam, 2009). Coreil and Haber (2000) explored the differences between native English and ESL graduates who had completed an English major between 1993 and 1999. They report that ESL students consistently had a higher graduation rate and GPA, and took fewer semesters to graduate. Voyles and Asunda (2014), using data from the Freshman Engineering Student Survey, found that both International (83%) and US citizen (80%) ESL students had higher graduation rates than native English speakers (66%).

Race

In the US, African-American/black students have a graduation rate which is 20% lower than white students (40% vs. 60%) (National Center for Education Statistics, 2012). A similar picture emerges at South African universities, with the white graduation rate being 16% greater than the black graduation rate (62% vs. 46%) (Ndebele et al., 2013). Although graduation data by race are unavailable for the UK, a recent report by the Higher Education Funding Council for England (2010) found that 62% of white students achieved a first or upper second class degree, compared to 37% of black students. However, these statistics conceal the correlation between certain variables with race and educational outcomes. The extent to which these variables can explain the variation in graduation rates remains an open question.

Murtaugh et al. (1999) found that while white students had a higher probability of graduating than black students, black students with similar characteristics to white students (e.g. age, high-school GPA, type of faculty enrolled etc.) had a higher probability of graduating. Fletcher and Tienda (2010) suggested that the type of high-school attended can explain the racial differences in graduation rates at four public Texas universities. Specifically, controlling for the type of school attended, the disparity in graduation rates was reduced by between 40% to 50%. Arcidiacono and Koedel (2013) investigated the influence four factors had in explaining the white-black graduation gap at 13 universities in Missouri: type of university attended, major selected, high-school attended and pre-entry attributes. Pre-entry attributes - composed of the class rank and standardised reading and writing scores - described 86% and 65% of the graduation gap for men and women, respectively. The type of high school attended was the second most important factor, followed by university attended and major chosen. In contrast, McGraw (2006) found that his model - which focused on school and neighbourhood characteristics at an Ivy League[2] university - only accounted for 43% of the black-white graduation gap. He

[2]A group of eight prestigious universities in the USA.

speculated that cultural factors, such as campus climate, exposure to violence and peer influences could be responsible for explaining the remainder of the variation. Smith (2012) showed that white students in the mainstream programmes were 9-10% more likely to graduate in the Commerce, EBE and Science faculties than non-white students at UCT.

Another strand of the literature has focused on affirmative action admission policies. The aim of these policies is to increase the proportion of under-represented groups attending universities. Critics of affirmative action assert that allowing students into universities based on lower admission criteria sets them up for failure. In some US states, affirmative action admission policies were implemented but were subsequently discarded, enabling researchers to study the effect of these policies on graduation outcomes.

Arcidiacono et al. (2013) found that the probability of graduating increased by 4.4% for minority (black, Hispanic and Native American) students at the University of California after affirmative action policies were terminated. Only 18% of the graduation rate increase was by virtue of a better match between the university programme and students' academic abilities. Between 23-64% of the change in graduation rates across the different campuses was as a result of the university investing more resources in minority students. The remainder of the gains in graduation was accounted for by a change in the type of student enrolled. In particular, newly admitted minority students had stronger academic credentials. In contrast, Cortes (2010), using data from nine Texas universities, showed that graduation rates of minority students deteriorated after affirmative action was cancelled. Specifically, graduation rates for minority students ranked in the second decile of their high-school class (according to marks) decreased by 3.3%. For minority students who were ranked in the third decile or lower, this decrease was 4.2%. Hinrichs (2012) analysed data from the Integrated Postsecondary Enrollment Data System, which covers a large number of US universities. He reported that affirmative action bans had a small, positive effect on the graduation rate of Hispanic students, although no significant difference was noted amongst black students. He also observed that affirmative action bans lead to a reduction in enrollments of between 15-30% for Hispanic and black students, which led to a lower number of minority graduates, despite the increased graduation rate.

2.2.3 Environmental Variables

Academic support

As university access has expanded over the decades, an increasing proportion of students are taking academic support or remedial courses. In the US, for example, the proportion of students taking at least one remedial course increased from 29% in 1976 to 45% in 2009 (Levine and Dean, 2012). In 2005, it was estimated that remedial courses cost an extra \$3 billion (R33 billion) in the US (Baird, 2012). The aim of remedial education is to teach students foundational skills - usually in mathematics, reading and writing - which will make them better prepared for university courses and increase the probability of them completing their degree. A further benefit of remedial education is that students can interact with others who are facing the same challenges. However, remedial education often means that the student will take longer to obtain their degree, and that has financial implications, which might have a negative effect on them completing the degree. In addition, mainstream students might attach a negative social stigma to remedial students, who might lose their self-confidence and feel alienated, leading them to drop out of university. Early research into the effectiveness of remedial courses was plagued by selection bias: differences in the type of student who went into mainstream and remedial courses were not taken into account (O'Hear and MacDonald, 1995). However, later studies have used an instrumental variable approach or Regression Discontinuity Design (RDD) to remove this bias.

Bettinger and Long (2009), using data on 28 000 students from public universities in Ohio, found that Maths and English remedial courses increased the probability of graduating within six years by 1.5% and 11%, respectively. The Maths and English courses also reduced the probability of academic exclusion by 14% and 12%, respectively. Bahr (2008) looked at the effects of remedial maths courses on educational attainment. The data consisted of 85 894 students at 107 community colleges across the US. He finds that the educational attainment levels of students who successfully completed a remedial maths course were the same as the students who took maths courses without needing remediation. However, over 75% of remedial students did not complete their course successfully, which raises questions about the suitability of remedial courses.

Attewell et al. (2006) examined the behaviour of 6 879 students at US colleges, using data from the US's Department of Education National Centre of Educational Statistics. Mainstream students had a higher graduation rate at both two-year colleges (43% vs. 28%) and four-year colleges (78% vs 52%) than remediation students. The researchers emphasise, however, that 50% of African-Americans and 34% of Hispanics who received bachelor degrees took remedial courses, and that if these courses were not available, they would have never received degrees. They also found that much of the graduation gap between mainstream and remedial students was due to differences in high school preparation rather than whether students had been on a remedial course.

Calcagno and Long (2008) used a RDD to look at the effect of remedial programmes in Florida, using a sample of 100 000 students in 27 community colleges. An RDD is based on the assumption that students who are just above or below a cut-off score (which is then used to decide whether students should be placed in remedial programmes or not) have similar abilities. Based on this assumption, a causal inference about the effect of remedial programmes on subsequent future educational attainment can be made. Calcagno and Long (2008) found that while marginal remedial students who took a maths remedial course were between 2-3.8% more likely to go into second year than marginal mainstream students, there was no effect of remedial courses on the probability of graduating. Martorell and McFarlin (2011), who also use a RCD on a sample of students at Texas universities, found remedial programmes had no impact on the likelihood of degree completion or on labour market earnings.

Previous South African studies on academic support programmes, as outlined by Smith (2012), are either descriptive in nature or small samples are used. Smith's study found that the AD programmes in the Commerce, EBE and Science faculties at UCT had no significant impact on the probability of graduating.

Financial Aid

The causal impact of financial aid on graduation is ambiguous for two primary reasons. Intuitively, the receipt of financial aid will allow students to spend more time on their studies as they will spend less time working to finance their studies. However, financial aid might have no effect or even a negative effect if it attracts students who are unlikely to graduate, by effectively lowering the cost of education. Secondly, as Alon (2005, 2007) has pointed out that needs-based (as opposed to merit-based) aid recipients and non-recipients often differ in observable characteristics such as type of school attended and family background, which affect the chances of graduation. Researchers often conflate the impact of financial aid with these other factors, which is why some studies have found a negative impact of financial aid on the probability of graduation (Alon, 2005, 2007).

Singell and Stater (2006) studied the effects of need and merit-based aid across three universities. They observed that both forms of aid had indirect effects on graduation. Need-based aid allowed students greater freedom in choosing a university based on non-academic attributes, such as the size or culture of the university. Students are more likely to graduate when the university meets their expectations. Merit-based aid attracts academically able students who are expected to graduate in the regulation time, regardless of whether they received aid. Therefore, universities use financial aid as a tool to increase both the quality of the average student and their graduation rates. Alon (2005), using a sample of 15 000 students, reported that while all forms of financial aid positively affected students' graduation chances; the magnitude - which ranged from 3% to 6% for every additional $1000 offered - was dependent on the type of aid received.

Henry et al. (2004) investigated role of merit aid by matching recipients and non-recipients according to their 'core course' high-school GPA (GPA excluding electives and vocational courses) and type of institution attended. The analysis suggested that for those at university, recipients were 72% more likely to graduate within four years than non-recipients. Dynarski (2008) compared the large-scale merit aid programs in Georgia and Arkansas to states which had not implemented such programs. In order to make her comparison meaningful, she limited her sample to students who received aid in Georgia and Arkansas and those who would have received aid if they resided in either of those two states. Her results suggest that merit aid can increase the university graduation rate by between 3% and 4%. Sjoquist and Winters (2012a) used the same dataset as Dynarski (2008) but employed different statistical techniques and found that merit aid had no significant effects on graduation. Sjoquist and Winters (2012b) extended the analysis of Dynarski (2008) by comparing 25 states which had enacted state-wide merit aid programmes with those which did not. They concluded that most of the coefficients were small, negative and statistically insignificant.

There has been a paucity of research into the effect of needs-based aid on graduation. Much of the current literature has focused on how needs-based aid affects enrolment decisions. Castleman and Long (2013) tracked 55 000 Florida university students and documented that a $1000 in needs-based aid increased the likelihood of students obtaining an undergraduate degree by between 2.5% and 4%. Smith (2012) found no effect of needs-based aid on graduation. The National Student Financial Aid Scheme (NSFAS) - which provided funding for 659 000 South African students between 1999 and 2009 to the tune of R12 billion - stated that of the 67% of NSFAS students no longer studying, 28% had graduated while 72% had not completed their degree (DHET, 2010).

Schools

Spaull (2011, p. 7) has characterised the South African schooling system as a 'tale of two schools.' The first type of school is functional, well-resourced and the students achieve excellent results. The other type is dysfunctional, has few resources and the students receive a poor education. In turn, the sort of education received influences the chances of admission into university and the probability of graduating. Visser and Hanslo (2006) looked at a sample of 22 347 undergraduates who attended UCT between 1995 and 2002. Pupils from disadvantaged schools were significantly more likely to be excluded from UCT than those from advantaged schools. Somewhat surprisingly, Smith (2012) showed that mainstream Engineering students at UCT from former Department of Education and Training schools[3] were 12% more likely to graduate than mainstream Engineering students who had either attended a former Model C or private school at UCT, controlling for other factors.

[3]These types of schools were exclusively for black students, according to apartheid legislation.

While the educational disparities which exist in South Africa are not present to the same extent in other countries, research in the UK has shown that government school students achieve better results at university than their private school counterparts, conditional on achieving the same high school results (McNabb et al., 2002; Smith and Naylor, 2001, 2005). These results are remarkable as private schools are perceived as preparing students for the academic rigour of university. McNabb et al. (2002) found that while government school students perform better at university than private school students, the difference is small. Smith and Naylor (2001) found that government school students were 4% less likely to withdraw from university than independent school students. Smith and Naylor (2005) examined the differences in educational attainment by gender. The results suggested that males derived greater benefit from attending government schools than females, as they had a greater probability of obtaining a 'good' degree (6.5% vs. 5.4%). Betts and Morell (1999) found no relationship between the school attended and academic performance at a university in the US.

Province

Spaull (2011) also noted that primary schools in Gauteng and the Western Cape had better results in standardised tests than those in other provinces. This educational advantage persists until the end of high-school, where Gauteng and the Western Cape are often the two provinces with the best matric pass rates.[4] Smith (2012) found that Western Cape students at UCT were 3% and 6% more likely to graduate in the mainstream Commerce and Science faculties than students from other provinces, respectively. Smith (2012) speculated that superior academic performance of the Western Cape could be due to two reasons. Firstly, students who reside in the Western Cape can adapt more easily to student life since they are more likely to have strong social support structures (e.g. friends and family) nearby. Secondly, there might have been more rigorous marking standards in the Western Cape which implies students' matriculation average were more closely aligned with their actual academic abilities.

Residence

University residences are believed to help students in making the transition from high-school to university and consequently, improve academic performance. Students who are surrounded by peers facing similar challenges realise that they can share their concerns with someone who will understand. In addition, residence students are more involved in university activities and have stronger, positive feelings towards their new environment (Pascarella et al. (1994) in Harvey et al. (2006)). These findings accord with Tinto's theory that social integration is an important contributor to academic success.

[4]The five-year average matric pass rates for Gauteng and the Western Cape between 2009 and 2013 were 80.5% and 80.7% , respectively. In comparison, the average for all other provinces was 68.4%.

Before looking at the research on residences, it is worthwhile to be aware of a few caveats. Firstly, UCT has a slightly different residence policy to universities in other countries. At overseas universities, the norm is to have every first-year student (and sometimes second-year) in residence, regardless of the location of their home. In contrast, due to university housing shortages, UCT gives priority to students from other provinces. This policy effectively results in many Western Cape students staying at home or moving into off-campus student accommodation. Secondly, students rarely remain in a university residence for the entire duration of their degree, which is why the international student housing literature emphasises the effect of residences on academic outcomes in first-year. Nevertheless, after reviewing fifteen studies, Pascarella and Terenzini (2005, p.421) declared that there was 'remarkably consistent evidence that students living on campus are more likely to persist and graduate than students who commute.'

De Angelo et al. (2011) used a nationwide dataset to show that those living off-campus (either in private student accommodation or off-campus residence) or with family were 21% to 38% less likely to graduate within four to six years compared to on-campus residence students. Hosch (2009) reported that the percentage of students living on university grounds explained about 27.8% of the variation in six-year graduation rates. This effect was more evident in universities which had more than 90% of first-years living on campus.

Lowther and Langley (2005) examined 15 466 first-years between 2000 and 2003. 87% of those who lived on campus returned to second-year, while the corresponding figure for off-campus students was 80%. However, when controlling for academic ability, the significant effect of on-campus housing only remained for females.

Coates (2011) demonstrated a correlation between time taken to travel to campus and academic withdrawal rates in Australia. In general, the greater time spent travelling to campus, the more likely a student would leave university. Snyder (2009) observed no relationship between residency and academic performance when looking at elite student athletes. In contrast, both Grayson (1995) (Canada) and Beekhoven et al. (2004) (Netherlands) found a negative relationship between living on campus and first-year academic performance. Grayson (1995) attributed this finding to the greater academic involvement of off-campus students, while Beekhoven et al. (2004) stated that residence students experienced a greater number of personal problems and spent more time participating in recreational activities. A South African, preliminary study conducted by the Department of Higher Education and Training (2011) concluded that although residence students passed more courses in first-year, this superior academic performance did not carry through to graduation, where there was no consistent pattern.

2.2.4 Conclusion

This chapter began with a discussion of the different theoretical frameworks in higher education and then turned to individual factors which have been shown to influence the probability of graduating from university.

Tinto's 1975 student integration model was the first model to attempt to provide a holistic view of student behaviour at university. While the model was imperfect, it provided the foundation and impetus for further research in this area. Later models, such as those by by Bean and Metzner (1985) and Cabrera et al. (1992), provided a more a realistic assessment of the factors influencing student behaviour by incorporating variables such as utility, finances and family responsibilities. However, all of these models are based on behaviors exhibited by students in first-world countries. As noted earlier, none of these models account for the group of 'aspirational' students at South African universities, and therefore caution must be exercised when applying these models to the South African university experience.

The research into individual factors affecting graduation has produced a diverse set of results. Academic variables (First-year GPA, High school GPA and High School Mathematics) consistently show that they are positively related to the probability of graduation, although there are large differences in magnitude. For all other variables, the evidence is mixed. Smith (2012) outlines two reasons which explain the divergence in results.

Firstly, the studies are from different countries - primarily from the US and the UK. The educational system in these two countries countries is markedly different to that of South Africa (Smith, 2012). The content, difficulty and testing methods, especially in high school, all affect the preparedness of high school students in coping with the academic demands of university and consequentially, their chances of graduating.

Secondly, different methodologies are used in these studies (Smith, 2012). The large majority of studies either used a linear or logistic regression framework, which are both unsuitable for modeling the probability of graduating. Multivariate regression analysis makes assumptions that are often unrealistic when dealing with 'real-world' data. For example, in multivariate regression analysis, all variables are assumed to be normally distributed (Wooldridge, 2009). It is highly unlikely, especially with regards to demographic (e.g. Race) or environmental (e.g. School) variables, that this assumption will be met when considering the selective nature of universities. Logistic regression, while not having as many assumptions as multivariate analysis, assumes that students who have not yet graduated or been academically excluded, but are still studying, will never do so. This would underestimate the probability of graduation and academic exclusion occurring, and lead to biased estimates. This is why the survival analysis statistical technique, outlined in the next chapter, was chosen.

Chapter 3

Research Methodology

This chapter outlines the statistical technique used in this study and describes how data were collected. The chapter begins by providing a brief overview of survival analysis and a description of the variables used in this study and concludes with some descriptive statistics.

3.1 Survival Analysis

Survival analysis - which is also known in various fields as reliability, duration or event history analysis - is a term given to a collection of statistical methods which focus on the occurrence and duration of events (Allison, 2010). Although survival analysis was originally developed by bio-statisticians to model the time until the death of a person (hence the name), it is now widely used in sociology, economics, political science, engineering and finance. The key concepts of survival analysis are outlined below.

The first step in survival analysis is to define the events of interest (Allison, 2010). While many applications of survival analysis assume that an individual is at risk of experiencing one event, competing risks models have been developed to account for situations where this is not the case (Allison, 2010). In the context of this paper, a student is at risk of experiencing two events:

1. Graduating within the same faculty.
2. Being academically excluded from the same faculty.

Of course, students can experience other events during their university careers, such as being transferred or leaving university in good academic standing. However, these two groups of students were removed from the sample. If a student initially registers for a Commerce, EBE or Science degree but graduates with a Humanities degree, not much useful information can be inferred about this student. Different skills and competencies are required in each faculty, and therefore for us to have a high degree of confidence in our results, it is logical to only look at students who exhibited similar competencies throughout their degrees. 'Left in good academic standing' means that students could have registered for the next academic year, had they wished to do so. Students in good academic standing leave for a variety of reasons, such as moving to a different university or losing interest in a degree programme. Accordingly, it is uncertain whether resources were 'wasted' or not on such students, so in the interests of fairness, they were also removed. There were 799 (6.0% of total) transfer students and 471 (3.6% of total) students who left in good academic standing.

Secondly, an event is the transition from one state to another (Allison, 2010). At the beginning of the study, all individuals are in the same state - currently studying - since no-one has experienced the events of interest - graduating or academic exclusion from university. Clearly, some individuals cannot be at risk of experiencing an event at every point in time, either because they experienced an event before the end of the study and are therefore not part of the sample in the subsequent time period or withdrew from the study before it ended. The duration that individuals are at risk of experiencing an event is known as the risk period (Willet and Singer, 2003). A related concept is that of the risk set, which is the number of individuals at risk of experiencing an event in a particular time period (Willet and Singer, 2003).

Another important feature of survival analysis data is that of censoring. It is highly probable that some individuals in a study will not experience the events of interest and therefore the data on these individuals is incomplete (Allison, 2010). It might be the case that the individuals will experience the event, but at a later date than the end of the study or they may never experience the event. Some students will not have graduated by the end date of this study, but will graduate at some time in the future. Likewise, some students will never graduate, although they are still at university at the end of the study period.

The above example illustrates the concept of right censoring as the individuals did not experience either events of interest during the study period. It is known as right censoring because the actual event which these individuals will experience is to the right of our study period. This is the most common form of censoring encountered in survival analysis, although left and interval censoring is also present in survival data (Allison, 2010). Left censoring occurs when some individuals have already experienced the event of interest but it is unknown when it occurred (Allison, 2010). As an example, a study might look at the ability of children to learn a task, but some children might already know how to complete the task because they have been exposed to it previously. Interval censoring occurs when we know that an event happened between two points in time, but we are not sure of the exact time (Allison, 2010). For instance, if an individual tests negative for a virus at the end of year 1, but is found to be positive at the end of year 2, then we know the infection occurred between year 1 and year 2, but we cannot be more specific. Since the year in which the student graduates or is academically excluded is known, and no-one could have graduated or been academically excluded from UCT before being admitted, only right hand censoring is present in this study.

A crucial assumption of censoring is that it is non-informative (Willet and Singer, 2003). In other words, censoring must be independent of the outcome of interest. If this is not the case, the event which leads to the individual being censored must be included as an event of interest. Generally speaking, if the censoring is under the control of the researcher, then the censoring is non-informative (Willet and Singer, 2003). Willet and Singer (2003) use an alcohol relapse study to illustrate the difference between informative and non-informative censoring. If, at the end of the study, some individuals are still abstaining from alcohol, then the censoring is non-informative. However, if there is attrition during the study, and the reason for the attrition is due to individuals beginning to drink again, then the censoring is informative. Students who are academically excluded cannot complete their degree, which indicates that academic withdrawal cannot be independent of degree completion.

The final consideration before choosing a survival analysis model is the assumption regarding the distribution of the hazard rate. The hazard rate is the 'conditional probability that individual i will experience the event in time period j, given that he or she did not experience it in any earlier time period' (Willet and Singer, 2003, p. 330). In the context of this study, the hazard rate would be calculated as the probability of a student experiencing either graduation or academic exclusion, conditional that the student had experienced neither of these events in previous time periods. The three classes of models are: parametric, semi-parametric and discrete. These are discussed briefly below.

Parametric models assume that the distribution of the hazard rate is known (Jenkins, 2008). That is, the hazard rate follows a specific functional form over time. Exponential, log-logistic, log-normal and Weibull are some of the more common parametric models. If there is a high degree of confidence that the shape of the hazard rate is known, then a parametric model is suitable as it gives the most precise estimates compared to the other types of models. Often, however, the distributional form is unknown and this is where semi-parametric models are more suitable.

Semi-parametric models offer greater flexibility than parametric models in that hazard rates are allowed to vary across time, although they must be constant within a particular time period (Jenkins, 2008). The most popular semi-parametric model is the Cox Proportional Hazards model (Allison, 2010).

The above two classes of models assume that the data are continuous. If an event can occur at any time, the data are continuous (Allison, 2010). In contrast, if an event can only occur at certain points in time, indicated by many individuals experiencing the event at the same time, then data are discrete (Allison, 2010). As students can only graduate or be academically excluded at the end of semester one or semester two, the data are discrete. Unlike continuous time models, discrete time models can be applied to data regardless of the underlying process which generated the data (Jenkins, 2008). Furthermore, incorporation of time-varying covariates and interpretation of the coefficients are easier in discrete time models (Willet and Singer, 2003). In addition, all survival analysis models are superior to traditional statistical techniques (e.g. OLS regression) (Willet and Singer, 2003). Most importantly, survival analysis models can account for censored observations. Time is explicitly included in such models by including each time period as a dummy variable in a regression.

Scott and Kennedy (2005) developed a discrete time competing risks model. In this model, the risk of experiencing the events of interest are modeled simultaneously and the probability of experiencing an event is conditional on not having experienced another event of interest. This is the model used in this paper.

3.2 Data

All the data for this study were obtained from UCT's Institutional Planning Department, with the exception of the Residence data, which were acquired from UCT's Student Housing and Residence Life Department. The data were anonymised so that no individual could be identified and comprised of students who were initially registered for undergraduate degrees in the Commerce, EBE and Science faculties between 2006 and 2013. The final sample was composed of 11 959 students.

Only full-time students who wrote the final South African school-leaving examination and lived in South Africa were included in the final analysis. This was motivated for two reasons. Firstly, foreign students are not subsidised by the South African government, and therefore withdrawing from university before graduating does not represent a 'cost' to South African society. Secondly, comparing marks across different types of school-leaving examinations is challenging and a common school-leaving examination allows us to be more confident in interpreting our results.

The dependent variable is time to an event, and is coded as 1 for students who graduated within the same faculty and 2 for students who were academically excluded from the same faculty for which they were initially registered. Duration to an event only includes the years in which the student was registered at UCT. Students who met all the conditions of a degree but had an outstanding fee account (and thus could not graduate for financial reasons), were treated as though they graduated. As mentioned previously, students who do not experience the event of interest are censored and are coded as 0, but are nevertheless incorporated into the analysis. A summary of the independent variables used in this analysis is presented in Table 3.1, and some are discussed in more detail below. University cumulative GPA was originally included in the analysis, however, due to high levels of multicollinearity with other variables, it was removed.

TABLE 3.1: Description of Independent Variables

Independent Variable	**Code**	**Units**
Female	Female	Binary Variable: 1 = Female, 0 = Male
Age	Age	Continuous
Race	Coloured, Indian/Asian, White, Black	Categorical
Financial Aid	Financial Aid	Binary Variable: 1 = eligible for financial aid, 0 otherwise
Academic Development	Academic Development	Binary Variable: 1 = AD programme, 0 otherwise
English Home Language	English Home Language	Binary Variable: 1 = if declared Home Language is English (or English and another language) and wrote English on the Home Language level, 0 otherwise
School Quintile	Quintile	Categorical (1 = worst, 5 = best), 6 = independent
Western Cape	Western Cape	Binary Variable: 1 = resides in Western Cape, 0 otherwise
Adjusted Matric GPA (%)	High School GPA	Continuous (out of 400)
High School Mathematics Mark (%)	Mathematics	Continuous (out of 100)
High School English Mark (%)	English	Continuous (out of 100)
High School Physical Science	Science	Binary Variable: 1 = took Physical Science, 0 otherwise
University Residence	Residence	Binary Variable: 1 = in residence, 0 otherwise

The Adjusted Matric GPA is an average of the top four subjects, excluding English, Mathematics[1] and Life Orientation. For students entering UCT under the 'old' matric system (Senior Certificate), only the symbols ('A', 'B' etc.) achieved for various subjects were available. In

[1]Mathematics marks refer only to the marks obtained in the mathematical exam written by all candidates. Consequentially, Additional Mathematics and Mathematics Paper 3 marks were excluded from the analysis in this paper.

addition, they either did a subject on Higher Grade or Standard Grade. Taking these two features into account, percentages were assigned according to Table 3.2. Standard Grade symbols were assigned 75% of the grade of Higher Grade symbols because under the old matric system, Standard Grade subjects were marked out of 300, while it was 400 for Higher Grade subjects.

TABLE 3.2: Conversion of Symbols to Percentages

Symbol	**Higher Grade (%)**	**Standard Grade (%)**
A	85	64
B	75	56
C	65	49
D	55	41
E	45	34
F	35	26

If students re-wrote matric, the higher symbol was included, taking into account whether the subject was written on Higher Grade or Standard Grade. For students who wrote the new matric - known as the National Senior Certificate (NSC), exact percentages were available, and all students wrote the same paper. In the old matric, students had to write a minimum of six subjects, while currently the minimum is seven subjects. However, since we excluded Life Orientation from our entire analysis, we are effectively looking at a minimum of six subjects for both types of students. If students were recorded as writing fewer than five subjects, they were excluded from the analysis as it was felt their average would not be an accurate representation of their academic ability. For students who were recorded as having written five subjects (including Mathematics and English), their top three subjects (excluding Mathematics and English) were taken as an average. A small number of students did Mathematical Literacy, which is set at a lower standard than the former Mathematics Standard Grade. In order to make Mathematical Literacy marks comparable to Mathematics marks, the minimum Mathematics marks required to enter a particular programme were given to those who wrote Mathematical Literacy. For example, a student who obtained 95% for Mathematical Literacy and registered for a BCom programme would have their Mathematics mark set to 60%. Students who took English as a second language (HG) had their marks reduced to 75% of their original mark. No students took English Second Language on Standard Grade.

Age refers to the age (in years) of an individual when they first registered at UCT and was rounded off to two decimal places, in order to account for the exact date they were born. Although age changes over the course of studying, a decision was made not to change age over the years as no cross-sectional variation would be added. The English Home Language variable was created to confirm a student's proficiency in English. If students wrote English at the Home Language level and reported speaking in English at home, they were assigned a value of 1 or 0 otherwise.

Financial aid pertains to students who were eligible for *needs-based* financial aid and is used in this paper as a proxy for socio-economic disadvantage. Students were assumed to be eligible for financial aid for all years of study. This is not an unreasonable assumption to make, as a family is unlikely to greatly increase their income to such an extent that their child or children become ineligible for financial aid over the course of four or five years.

The quintile variable indicates the resources of government schools. Quintile one schools do not have many resources, while quintile five schools are the best resourced. Independent schools are classified as an homogeneous group, despite wide variation in resources between these schools.

Regarding the Residence variable, it is important to emphasise that data were limited to those staying in a university residence only. For the years 2011 to 2013, the duration of stay in a particular residence was available. If students stayed less than 60% of the year (approximately 31 weeks) in residence, then they were regarded as non-residence students, and were assigned a '0'. If they stayed more than 60% of the year in residence, they were assigned a '1'. Since such detailed data was not available for the years 2006 to 2010, all residence students were assumed to be in residence for more than 60% of the year.

3.3 Descriptive Statistics

Table 3.3 presents summary statistics of variables of interest for the entire sample and reveals some interesting patterns. As expected, the number of students registering has gradually increased. There was a large increase between 2008 and 2009, which might be the result of UCT's admission office misjudging the new NSC. In other words, students obtained higher marks than expected by UCT. There is no obvious explanation for the even larger increase between 2011 and 2012.

Gender parity is gradually being achieved, with the male share decreasing by approximately 7%. The racial make-up of UCT has changed, with an increasing proportion of black students and a decreasing proportion of white students. The proportion of coloured and Indian/Asian students has remained roughly constant.

The high proportion of English Home Language students is unsurprising, given that over 80% of UCT students come from Quintile 5 or independent schools. The large majority of these schools have English as a medium of instruction and therefore students can be expected to be proficient in English. The proportion of students at UCT from the Western Cape has been steadily declining, which is perhaps a reflection of UCT's reputation extending to other parts of South Africa. With the exception of 2009, the majority of students considered in this study registered with the Commerce faculty.

Table 3.3: Summary Statistics

	Incoming Cohort							
	2006	2007	2008	2009	2010	2011	2012	2013
Students Registered	1340	1411	1550	1706	1368	1336	1622	1626
Gender (%)								
Male	62.3	65.1	58.0	56.9	56.0	56.1	58.0	55.4
Female	37.7	34.9	42.0	43.1	44.0	43.9	42.0	44.6
Race (%)								
White	44.0	43.5	40.7	35.7	40.1	40.0	38.9	38.0
Black	30.0	32.9	35.4	37.6	35.5	34.1	38.1	34.7
Coloured	15.6	13.2	13.3	13.3	11.3	12.2	12.1	14.0
Indian/Asian	10.5	10.4	10.7	13.4	13.2	13.7	11.0	13.3
Financial Aid (%)	18.6	21.8	25.6	29.2	24.1	21.3	18.4	14.5
AD Programme (%)	23.7	20.6	18.9	21.6	22.2	27.2	24.2	23.4
English Home Language (%)	69.4	67.7	64.7	63.3	66.1	61.3	63.4	65.6
School Quintile (%)								
1	1.9	1.7	1.6	1.4	1.6	1.3	1.2	1.2
2	2.8	2.8	2.9	3.3	3.2	2.4	3.1	2.6
3	8.4	6.8	8.9	8.6	9.1	10.4	8.7	6.6
4	3.9	4.3	6.1	7.2	5.5	6.4	4.3	4.7
5	46.7	47.8	44.4	45.3	43.4	43.9	42.0	44.0
Independent	36.4	36.6	36.1	34.2	37.1	35.6	40.7	40.8
Western Cape (%)	50.0	44.7	42.3	41.2	38.5	39.6	38.4	38.1
Initial Registration (%)								
Commerce	56.1	54.9	53.1	45.5	52.9	57.0	56.4	60.3
EBE	21.1	25.8	22.1	29.5	25.8	25.9	23.8	22.8
Science	22.8	19.4	24.8	25.0	21.3	17.1	19.7	16.9

Table 3.4: Summary Statistics: Academic

	Incoming Cohort							
	2006	2007	2008	2009	2010	2011	2012	2013
Students Registered	1340	1411	1550	1706	1368	1336	1622	1626
Average Adjusted Matric GPA (%)	75.7	75.8	75.4	76.0	77.7	79.7	80.3	81.1
Average Mathematics Mark (%)	74.5	75.1	74.1	83.5	85.4	85.0	81.7	82.1
Average English Mark (%)	73.9	74.1	74.1	73.2	76.2	74.9	75.6	76.2
Proportion Science (%)	85.8	90.8	88.9	87.0	86.5	84.5	84.3	82.7

Table 3.4 looks at the academic characteristics of the different cohorts. Both the Adjusted Matric GPA and English mark have gradually increased over time. In contrast, there was a clear 'break' in Mathematics, with the average Mathematics mark increasing by over 9% in 2009 compared to 2008. This is in line with results obtained by Hunt et al. (2011), who found that the Mathematics marks obtained under the new curriculum were not as good an indicator of mathematical aptitude as under the old curriculum. Clearly, the new Mathematics curriculum is easier than the old one, and this has potentially allowed weaker students to be admitted to programmes with high mathematical requirements. There is a slight downward trend in the proportion of students taking Science at school, although the figure is above 80% throughout the period.

Tables 3.5, 3.6, 3.7, and 3.8 show whether students experienced an event (graduation or academic exclusion) or not (censored) for the whole sample, and for each faculty. For example, the whole sample is comprised of 58.4% of males and 41.6% of females. Of the male students, 44.3% have graduated, 17.3% have been academically excluded and 38.5% are censored. Likewise, 48% of females graduated, while 11.5% were academically excluded and 40.5% were censored. Table 3.5 suggests that women are both more likely to graduate and less likely to withdraw than men. In terms of race, white students are substantially more likely to graduate than any other racial group. Indian/Asian and coloured students have the same probability of graduating, while black students have the lowest probability of graduating. When looking at academic exclusion figures, the story is reversed, with black students being six times more likely to be academically excluded than white students. Students who are ineligible for financial aid and who are on a mainstream academic program are more likely to graduate than financial aid and AD students, respectively. Both financial aid and academic development students are over 2.5 times more likely to be academically excluded from university than their counterparts, who are not on financial aid or in the AD programme, respectively. English Home Language speakers have a clear advantage, with 20% more English speakers graduating than non-English speakers. The latter group are also around three times more likely to be academically excluded from university. The differences in school quintiles is striking, with little difference between the first four quintiles in terms of graduation and academic withdrawal behaviour. On the other hand, Quintile 5 and independent schools are far more successful in producing students who are capable of graduating. Students who reside in the Western Cape perform better than students from other parts of South Africa, and this may be due to the fewer adjustments they have to make when attending UCT. It is noticeable that the 2009 cohort performed badly compared to other cohorts, with nearly a quarter having been academically excluded after five years. This evidence suggests that the admission requirements were too low and consequentially, weaker students were being admitted to programmes which were ultimately too demanding for them.

TABLE 3.5: Descriptive Statistics (%): Whole Sample ($N = 11\,959$)

Variable	**Proportions in Sample**	**Proportions by Subtype**		
		Graduated	**Academically Excluded**	**Censored**
Total	100.0	45.8	14.9	39.3
Gender				
Male	58.4	44.3	17.3	38.5
Female	41.6	48.0	11.5	40.5
Race				
White	39.2	58.7	4.6	36.7
Black	35.6	32.5	26.3	41.2
Coloured	13.1	44.5	16.1	39.5
Indian/Asian	12.0	44.6	13.3	42.1
Financial Aid				
Ineligible for Financial Aid	78.3	48.7	10.6	40.7
Eligible for Financial Aid	21.7	35.2	30.3	34.5
Programme				
Mainstream	77.4	51.3	10.8	37.9

Variable	**Proportions in Sample**	**Proportions by Subtype**		
		Graduated	**Academically Excluded**	**Censored**
Academic Development	22.6	27.1	28.7	44.2
English Home Language				
Yes	65.1	52.8	8.6	38.6
No	34.9	32.8	26.6	40.6
School Quintile				
1	1.5	26.1	42.6	31.3
2	2.9	28.1	35.1	36.8
3	8.4	27.7	35.3	37.0
4	5.3	29.5	32.0	38.5
5	44.6	49.2	12.0	38.9
Independent	37.3	50.4	8.6	41.0
Province				
Western Cape	41.4	51.3	11.6	37.0
Non-Western Cape	58.6	41.9	17.2	41.0
Year of First Registration				
2006	11.2	79.9	18.9	1.2
2007	11.8	79.4	19.2	1.4
2008	13.0	76.7	20.3	3.0
2009	14.3	64.9	24.9	10.2
2010	11.4	57.5	12.7	29.8
2011	11.2	15.3	12.8	71.9
2012	13.6	0.0	7.5	92.5
2013	13.6	0.0	3.0	97.0

Table 3.6 looks at the Commerce Faculty. Compared to the overall sample, there is greater gender parity in terms of graduation and academic withdrawal rates. 1.1% more females have graduated compared to males (overall figure: 3.7%), while 2.5% more males have been academically excluded compared to females (overall figure: 5.8%). The graduation rate in the Commerce Faculty is higher than average for all races, and academic exclusion rates are below average. This pattern of higher graduation rates and lower academic exclusion rates than the average is present throughout the table for the various categories of interest. For example, the mainstream and AD academic exclusion rates are 5.7% and 13.7%, respectively. This compares to the overall sample of 10.8% and 28.7%, respectively. In other words, the academic exclusion rate for mainstream and AD Commerce students is half that of the overall sample. Examining the School Quintile variable, the academic exclusion rate for Commerce students from Quintiles 2, 3, 4 and 5 are 16%, 17.5%, 17.7% and 6.9%, respectively. The corresponding figures for the overall sample are 35.1%, 35.3%, 32% and 12%.

Although Commerce students from Quintile 1 and independent schools also have lower academic exclusions rates than the average, the difference is not as pronounced as for students from Quintile 2-5 schools. Interestingly, while it has already been established that the 2009 cohort performed poorly as a whole, this is not true for the 2009 Commerce Faculty cohort. 81% of the Commerce 2009 cohort have graduated, in contrast to 64.9% of the overall 2009 cohort. Furthermore, the Commerce 2009 cohort academic exclusion rate of 9.7% is far below that of the overall 2009 cohort academic exclusion rate of 24.9%. In addition, while the differences in graduation and academic withdrawal rates between advantaged and disadvantaged students remains large, it is lower than the average of the three faculties.

Table 3.6: Descriptive Statistics (%): Commerce Faculty ($N = 6508$). Whole sample figures in parentheses.

Variable	**Proportions in Sample**	**Proportions by Subtype**					
		Graduated		**Academically Excluded**		**Censored**	
Total	100.0	50.1	(45.8)	7.5	(14.9)	42.4	(39.3)
Gender							
Male	52.4	49.6	(44.3)	8.7	(17.3)	41.7	(38.5)
Female	47.6	50.7	(48.0)	6.2	(11.5)	43.1	(40.5)
Race							
White	40.3	59.8	(58.7)	3.0	(4.6)	37.2	(36.7)

Variable	**Proportions in Sample**	**Proportions by Subtype**					
		Graduated		**Academically Excluded**		**Censored**	
Black	32.4	38.7	(32.5)	13.1	(26.3)	48.2	(41.2)
Coloured	13.0	49.8	(44.5)	7.4	(16.1)	42.8	(39.5)
Indian/Asian	14.3	48.9	(44.6)	7.9	(13.3)	43.3	(42.1)
Financial Aid							
Ineligible for Financial Aid	82.3	52.1	(48.7)	5.5	(10.6)	42.4	(40.7)
Eligible for Financial Aid	17.7	40.7	(35.2)	17.2	(30.3)	42.1	(34.5)
Programme							
Mainstream	76.9	55.4	(51.3)	5.7	(10.8)	38.9	(37.9)
Academic Development	23.1	32.5	(27.1)	13.7	(28.7)	53.8	(44.2)
English Home Language							
Yes	69.3	55.1	(52.8)	4.9	(8.6)	39.9	(38.6)
No	30.7	38.8	(32.8)	13.4	(26.6)	47.8	(40.6)
School Quintile							
1	0.8	34.6	(26.1)	30.8	(42.6)	34.6	(31.3)
2	1.6	30.2	(28.1)	16.0	(35.1)	53.8	(36.8)
3	5.0	32.0	(27.7)	17.5	(35.3)	50.5	(37.0)
4	4.1	37.7	(29.5)	17.7	(32.0)	44.5	(38.5)
5	45.4	52.0	(49.2)	6.9	(12.0)	41.1	(38.9)
Independent	43.1	52.5	(50.4)	5.3	(8.6)	42.2	(41.0)
Province							
Western Cape	40.0	55.1	(51.3)	5.9	(11.6)	39.0	(37.0)

Variable	**Proportions in Sample**	**Proportions by Subtype**					
		Graduated		**Academically Excluded**		**Censored**	
Non-Western Cape	59.9	46.8	(41.9)	8.6	(17.2)	44.6	(41.0)
Year of First Registration							
2006	11.6	87.8	(79.9)	11.3	(18.9)	0.9	(1.2)
2007	11.9	88.2	(79.4)	10.1	(19.2)	1.7	(1.4)
2008	12.6	87.1	(76.7)	10.3	(20.3)	2.6	(3.0)
2009	11.9	80.9	(64.9)	9.7	(24.9)	9.4	(10.2)
2010	11.1	62.6	(57.5)	6.4	(12.7)	31.1	(29.8)
2011	11.7	15.8	(15.3)	7.2	(12.8)	77.0	(71.9)
2012	14.1	0.0	(0.0)	5.4	(7.5)	94.6	(92.5)
2013	15.1	0.0	(0.0)	1.7	(3.0)	98.3	(97.0)

From Table 3.7, it is evident that the EBE is still heavily male-dominated. The EBE qualifications are challenging, as the proportion of students who have graduated (35.8%) in the EBE faculty is lower than the overall sample (45.8%), while the academic exclusion rate (21.6%) is higher than the overall sample (14.9%).

The percentage of females who have graduated in the EBE faculty is only 33.8%, compared to the overall female average of 48%. Likewise, the academic exclusion rate of females in the EBE faculty is 20.6%, nearly double the overall figure of 11.5%. Of particular interest is the 'Program' variable which shows that only 14% of AD students have graduated, and 41.4% have been academically excluded in the EBE faculty. The graduation figure is approximately half that of AD students in the overall sample (27.1%) while the academic exclusion figure is 13 percentage points above the overall sample (41.1% vs. 28.7%). Only 51.2% of the 2009 cohort had graduated (compared to the overall sample of 64.9%), and 32.3% had been academically excluded. The latter figure is the highest of any other cohort, and suggests many students in that cohort were unprepared for the academic intensity of the various EBE programmes.

Table 3.7: Descriptive Statistics (%): EBE Faculty ($N = 2949$). Whole sample figures in parentheses.

Variable	**Proportions in Sample**	**Proportions by Subtype**					
		Graduated		**Academically Excluded**		**Censored**	
Total	100.0	35.8	(45.8)	21.6	(14.9)	42.7	(39.3)
Gender							
Male	75.8	36.4	(44.3)	21.9	(17.3)	41.7	(38.5)
Female	24.2	33.8	(48.0)	20.6	(11.5)	45.7	(40.5)
Race							
White	36.9	50.8	(58.7)	7.8	(4.6)	41.3	(36.7)
Black	38.8	22.2	(32.5)	34.9	(26.3)	43.0	(41.2)
Coloured	12.4	36.4	(44.5)	21.9	(16.1)	41.6	(39.5)
Indian/Asian	11.9	32.7	(44.6)	20.5	(13.3)	46.9	(42.1)
Financial Aid							
Ineligible for Financial Aid	80.5	38.0	(48.7)	17.7	(10.6)	44.3	(40.7)
Eligible for Financial Aid	19.5	26.5	(35.2)	37.5	(30.3)	36.1	(34.5)
Programme							
Mainstream	82.2	40.5	(51.3)	17.3	(10.8)	42.3	(37.9)
Academic Development	17.8	14.1	(27.1)	41.4	(28.7)	44.5	(44.2)
English Home Language							
Yes	61.9	44.1	(52.8)	13.3	(8.6)	42.6	(38.6)
No	38.1	22.3	(32.8)	35.0	(26.6)	42.7	(40.6)
School Quintile							

Variable	**Proportions in Sample**	**Proportions by Subtype**					
		Graduated		**Academically Excluded**		**Censored**	
1	2.4	14.1	(26.1)	49.3	(42.6)	36.6	(31.3)
2	4.1	25.6	(28.1)	36.4	(35.1)	38.0	(36.8)
3	11.9	21.7	(27.7)	41.9	(35.3)	36.5	(37.0)
4	6.5	17.7	(29.5)	38.0	(32.0)	44.3	(38.5)
5	44.2	41.0	(49.2)	16.2	(12.0)	42.9	(38.9)
Independent	30.9	40.7	(50.4)	13.9	(8.6)	45.5	(41.0)
Province							
Western Cape	39.7	42.1	(51.3)	16.2	(11.6)	41.7	(37.0)
Non-Western Cape	60.3	31.6	(41.9)	25.1	(17.2)	43.3	(41.0)
Year of First Registration							
2006	9.6	70.3	(79.9)	29.0	(18.9)	0.7	(1.2)
2007	12.3	68.7	(79.4)	30.0	(19.2)	1.4	(1.4)
2008	11.6	63.6	(76.7)	30.6	(20.3)	5.8	(3.0)
2009	17.1	51.2	(64.9)	32.3	(24.9)	16.5	(10.2)
2010	12.0	36.8	(57.5)	19.0	(12.7)	44.2	(29.8)
2011	11.7	0.0	(15.3)	18.2	(12.8)	81.8	(71.9)
2012	13.1	0.0	(0.0)	7.5	(7.5)	92.5	(92.5)
2013	12.6	0.0	(0.0)	4.9	(3.0)	95.1	(97.5)

As was the case in the Commerce Faculty, women outperform men in the Science Faculty, as Table 3.8 shows. 49.3% of women have graduated, compared to 44% of men. Moreover, only 20.2% of women have been academically excluded, in comparison to 31.2% of men. A notable statistic is the proportion of black students excluded is nine times that of white students - the highest of any faculty. The academic exclusion rate of black (44.5%), coloured (30.6%) and Indian/Asian (29.1%) students in the Science faculty is far higher than the overall academic exclusion rates of these population groups. 52% of students in the AD programme were excluded, which is almost double the overall figure. Like all other faculties, wealthier, English-speaking students who went to a Quintile 5 or independent school and resided in the Western Cape were more likely to graduate and less likely to be academically excluded. As with the EBE faculty, the 2009 year was particularly problematic with only 52% of that cohort having graduated by the end of 2013, and 43.9% having been academically excluded. In contrast, 70% of the 2010 cohort has already graduated, with 21% having been academically excluded.

TABLE 3.8: Descriptive Statistics (%): Science Faculty (N = 2949). Whole sample figures in parentheses.

Variable	**Proportions in Sample**	**Proportions by Subtype**					
		Graduated		**Academically Excluded**		**Censored**	
Total	100.0	46.4	(45.8)	26.1	(14.9)	27.5	(39.3)
Gender							
Male	53.5	44.0	(44.3)	31.2	(17.3)	24.9	(38.5)
Female	46.5	49.3	(48.0)	20.2	(11.5)	30.5	(40.5)
Race							
White	39.3	64.5	(58.7)	5.1	(4.6)	30.4	(36.7)
Black	40.2	31.0	(32.5)	44.5	(26.3)	24.5	(41.2)
Coloured	14.2	40.2	(44.5)	30.6	(16.1)	29.2	(39.5)
Indian/Asian	6.3	46.2	(44.6)	29.1	(13.3)	24.7	(42.1)
Financial Aid							
Ineligible for Financial Aid	65.0	53.2	(48.7)	17.0	(10.6)	29.8	(40.7)
Eligible for Financial Aid	35.0	33.8	(35.2)	42.9	(30.3)	23.3	(34.5)
Programme							
Mainstream	72.7	54.3	(51.3)	16.4	(10.8)	29.3	(37.9)
Academic Development	27.3	25.3	(27.1)	51.8	(28.7)	22.8	(44.2)
English Home Language							

Variable	Proportions in Sample	Proportions by Subtype					
		Graduated		Academically Excluded		Censored	
Yes	58.1	56.3	(52.8)	14.1	(8.6)	29.6	(38.6)
No	41.9	32.7	(32.8)	42.7	(26.6)	24.6	(40.6)
School Quintile							
1	2.1	34.0	(26.1)	45.3	(42.6)	20.8	(31.3)
2	4.7	28.8	(28.1)	50.9	(35.1)	20.3	(36.8)
3	13.2	30.0	(27.7)	45.8	(35.3)	24.2	(37.0)
4	7.2	30.0	(29.5)	46.7	(32.0)	23.3	(38.5)
5	43.4	51.4	(49.2)	20.7	(12.0)	27.9	(38.9)
Independent	29.5	54.3	(50.4)	14.8	(8.6)	31.0	(41.0)
Province							
Western Cape	47.0	52.0	(51.3)	20.0	(11.6)	28.0	(37.0)
Non-Western Cape	53.0	41.5	(41.9)	31.5	(17.2)	27.1	(41.0)
Year of First Registration							
2006	12.1	69.5	(79.9)	28.2	(18.9)	2.3	(1.2)
2007	10.9	68.5	(79.4)	30.8	(19.2)	0.7	(1.4)
2008	15.4	66.2	(76.7)	32.3	(20.3)	1.6	(3.0)
2009	17.0	51.9	(64.9)	43.9	(24.9)	4.2	(10.2)
2010	11.6	69.8	(57.5)	21.0	(12.7)	9.3	(29.8)
2011	9.1	37.3	(15.3)	23.4	(12.8)	39.8	(71.9)
2012	12.8	0.0	(0.0)	13.4	(7.5)	86.6	(92.5)
2013	11.0	0.0	(0.0)	5.1	(3.0)	94.9	(97.0)

Chapter 4

Results and Discussion

As outlined in Chapter 1, the purpose of this paper is to identify factors which explain why some students graduate and others are academically excluded in the Commerce, EBE and Science faculties at UCT. This chapter begins with some survival analysis tables, and concludes with a detailed analysis of the factors which could affect graduation and academic exclusion.

4.1 Survival Data Tables

An important benefit of survival analysis is that it looks at the behaviour of people over time. In the context of this paper, we can examine the flow of students through the system. The tables below describe the graduation and academic withdrawal behaviour of the overall sample and the separate faculties, with the Commerce faculty further divided into BCom and Business Science students. This division was necessary because of the increase in the academic exclusion rate over time in the Commerce faculty.

TABLE 4.1: Presentation of survival data for the whole sample ($N = 11\,959$).

Legend: Y: Academic Year of Study; RS: Risk Set; G: Graduated; AE: Academically Excluded; C: Censored; HRG: Hazard Ratio – Graduates; HRAE: Hazard Ratio – Academically Excluded. 95% confidence intervals given in parentheses below the point estimates.

Y	**RS**	**G**	**AE**	**C**	**HRG** (%)	**HRAE** (%)
1	11 959	0	725	1619	0.0	6.1
					(0.0 ; 0.0)	(5.6 ; 6.5)
2	9 615	0	474	1513	0.0	4.9
					(0.0 ; 0.0)	(4.5 ; 5.4)
3	7 628	1271	335	966	16.7	4.4
					(15.8 ; 17.5)	(3.9 ; 4.9)
4	5 056	2797	145	405	55.3	2.9
					(54.0 ; 56.7)	(2.4 ; 3.3)
5	1 709	1144	77	170	66.9	4.5
					(64.7 ; 69.2)	(3.5 ; 5.5)
6	318	236	15	24	74.2	4.7
					(69.4 ; 79.0)	(2.4 ; 7.0)
7	43	27	7	5	62.8	16.3
					(48.4 ; 77.2)	(5.2 ; 27.3)
8	4	3	0	1	75.0	0.0
					(32.6 ; 117.4)	(0.0 ; 0.0)

Table 4.1 shows the flow the students through the system for the whole sample. The risk set is the number of students at risk of experiencing an event. If a student experiences an event or is censored, then they are removed from the risk set. For instance, the risk set in year 2 (9615) is obtained by subtracting the number of students who were academically excluded (725) and censored (1619) from 11 959 (the risk set in year 1). The number of censored students is comprised of those students who are still studying - mainly 1st years from 2013, 2nd years from 2012 and 3rd years from 2013, although there are still a small number of students who are still studying from 2006 and 2007.

The hazard ratio for graduation and academic exclusion is calculated by dividing the number of students who experienced an event in a particular year by that year's risk set. For example, in Year 1, 11 959 students were at risk, and 725 of them were academically excluded. Dividing 725 by 11959 gives an answer of 6.1%. Excluding years 7 and 8 from the discussion, which have small sample sizes and should be treated with caution, the first-year has the highest academic exclusion rate. This rate gradually decreases until year 4 but increases significantly in year 5 and subsequently becomes unstable due to small sample sizes. In contrast, the probability of graduating steadily increases from years three to six. On the surface, it appears paradoxical that in years five and six students are both more likely to graduate and withdraw. However, this is simply a reflection that the longer a student spends at university, the more likely they are to experience either of the two events of interest.

Table 4.2: Presentation of survival data for the Commerce Faculty ($N = 6508$).

Legend: Y: Academic Year of Study; RS: Risk Set; G: Graduated; AE: Academically Excluded; C: Censored; HRG: Hazard Ratio – Graduates; HRAE: Hazard Ratio – Academically Excluded. 95% confidence intervals given in parentheses below the point estimates.

Y	**RS**	**G**	**AE**	**C**	**HRG** (%)	**HRAE** (%)
1	6 508	0	98	991	0.0	1.5
					(0.0 ; 0.0)	(1.2 ; 1.8)
2	5 419	0	164	877	0.0	3.0
					(0.0 ; 0.0)	(2.6 ; 3.5)
3	4 378	624	125	591	14.3	2.9
					(13.2 ; 15.3)	(2.3 ; 3.4)
4	3 038	1853	53	222	61.0	1.7
					(59.3 ; 62.7)	(1.3 ; 2.2)
5	910	660	40	71	72.5	4.4
					(69.6 ; 75.4)	(3.1 ; 5.7)
6	139	111	7	5	79.9	5.0
					(73.2 ; 86.5)	(1.4 ; 8.7)
7	16	12	3	0	75.0	18.8
					(53.8 ; 96.2)	(−0.4 ; 37.9)
8	1	1	0	0	100.0	0.0
					(100.0 ; 100.0)	(0.0 ; 0.0)

A striking feature regarding Table 4.2, which refers to the Commerce Faculty, is that with the exception of fourth-year, the academic exclusion rate increases after first-year. This means that students are kept in the system, struggle for another year or two and are then excluded. In addition, it suggests that a considerable amount of resources are spent on students who never obtain a degree. This increase in the academic exclusion rate over time prompted a division of the Commerce Faculty into B.Com and Business Science students (Tables 4.3 and 4.4 respectively). While the Business Science academic exclusion rate is fairly constant, the B.Com exclusion rate increases from 2.9% in fourth-year to 10.7% in fifth-year, and remains at 10% in sixth-year. This suggests that readmission committees are being too lenient in letting students back into UCT in the BCom programme in the first few years, only to exclude a sizable proportion of them in subsequent years.

Table 4.3: Presentation of survival data for the BCom Programme ($N = 2560$).

Legend: Y: Academic Year of Study; RS: Risk Set; G: Graduated; AE: Academically Excluded; C: Censored; HRG: Hazard Ratio – Graduates; HRAE: Hazard Ratio – Academically Excluded. 95% confidence intervals given in parentheses below the point estimates.

Y	**RS**	**G**	**AE**	**C**	**HRG** (%)	**HRAE** (%)
1	2 560	0	44	407	0.0	1.7
					(0.0 ; 0.0)	(1.2 ; 2.2)
2	2 109	0	81	380	0.0	3.8
					(0.0 ; 0.0)	(3.0 ; 4.7)
3	1 648	579	71	217	35.1	4.3
					(32.8 ; 37.4)	(3.3 ; 5.3)
4	781	431	23	74	55.2	2.9
					(51.7 ; 58.7)	(1.8 ; 4.1)
5	253	161	27	16	63.6	10.7
					(57.7 ; 69.6)	(6.9 ; 14.5)
6	49	36	5	1	73.5	10.2
					(61.1 ; 85.8)	(1.7 ; 18.7)
7	7	5	1	0	71.4	14.3
					(38.0 ; 104.9)	(−11.6 ; 40.2)
8	1	1	0	0	100.0	0.0
					(100.0 ; 100.0)	(0.0 ; 0.0)

TABLE 4.4: Presentation of survival data for the Business Science Programme ($N = 3948$).

Legend: Y: Academic Year of Study; RS: Risk Set; G: Graduated; AE: Academically Excluded; C: Censored; HRG: Hazard Ratio – Graduates; HRAE: Hazard Ratio – Academically Excluded. 95% confidence intervals given in parentheses below the point estimates.

Y	**RS**	**G**	**AE**	**C**	**HRG** (%)	**HRAE** (%)
1	3 948	0	54	584	0.0	1.4
					(0.0 ; 0.0)	(1.0 ; 1.7)
2	3 310	0	83	497	0.0	2.5
					(0.0 ; 0.0)	(2.0 ; 3.0)
3	2 730	45	54	374	1.6	2.0
					(1.2 ; 2.1)	(1.5 ; 2.5)
4	2 257	1422	30	148	63.0	1.3
					(61.0 ; 65.0)	(0.9 ; 1.8)
5	657	499	13	55	76.0	2.0
					(72.7 ; 79.2)	(0.9 ; 3.0)
6	90	75	2	4	83.3	2.2
					(75.6 ; 91.0)	(−0.8 ; 5.3)
7	9	7	2	0	77.8	22.2
					(50.6 ; 104.9)	(−4.9 ; 49.4)

In contrast to the Commerce faculty, the EBE faculty has a high academic exclusion rate in first-year - 10.3% - and which is gradually reduced over time. This method of reducing student numbers is efficient in the sense that students who cannot cope with the academic workload are removed from the system very quickly and therefore, minimal resources are spent on them. Despite the relatively low academic exclusion rates in fourth, fifth and sixth-year, the probability of graduating is on average, below that of B.Com and Business Science students.

Table 4.5: Presentation of survival data for the EBE Faculty ($N = 2949$).

Legend: Y: Academic Year of Study; RS: Risk Set; G: Graduated; AE: Academically Excluded; C: Censored; HRG: Hazard Ratio – Graduates; HRAE: Hazard Ratio – Academically Excluded. 95% confidence intervals given in parentheses below the point estimates.

Y	**RS**	**G**	**AE**	**C**	**HRG** (%)	**HRAE** (%)
1	2 949	0	305	354	0.0	10.3
					(0.0 ; 0.0)	(9.2 ; 11.4)
2	2 290	0	167	357	0.0	7.3
					(0.0 ; 0.0)	(6.2 ; 8.4)
3	1 766	0	91	282	0.0	5.2
					(0.0 ; 0.0)	(4.1 ; 6.2)
4	1 393	598	45	157	42.9	3.2
					(40.3 ; 45.5)	(2.3 ; 4.2)
5	593	339	20	84	57.2	3.4
					(53.2 ; 61.2)	(1.9 ; 4.8)
6	150	102	5	18	68.0	3.3
					(60.5 ; 75.5)	(0.5 ; 6.2)
7	25	14	3	5	56.0	12.0
					(36.5 ; 75.5)	(-0.7 ; 24.7)
8	3	2	0	1	66.7	0.0
					(13.3 ; 120.0)	(0.0 ; 0.0)

Table 4.6 reveals that the Science faculty has the highest first-year academic exclusion rate of the three faculties considered. However, as opposed to the EBE faculty, the exclusion rate remains high in subsequent years. The probability of graduating is similar to that of the EBE faculty.

TABLE 4.6: Presentation of survival data for the Science Faculty ($N = 2502$).

Legend: Y: Academic Year of Study; RS: Risk Set; G: Graduated; AE: Academically Excluded; C: Censored; HRG: Hazard Ratio – Graduates; HRAE: Hazard Ratio – Academically Excluded. 95% confidence intervals given in parentheses below the point estimates.

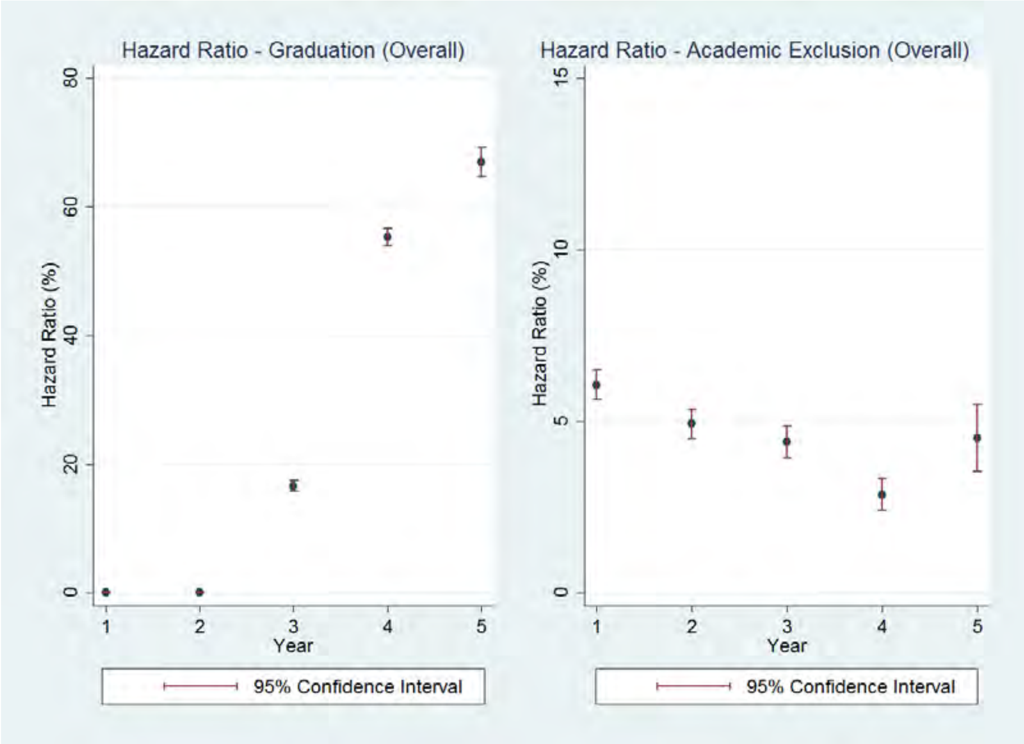
Y	**RS**	**G**	**AE**	**C**	**HRG** (%)	**HRAE** (%)
1	2 502	0	322	274	0.0	12.9
					(0.0 ; 0.0)	(11.6 ; 14.2)
2	1 906	0	143	279	0.0	7.5
					(0.0 ; 0.0)	(6.3 ; 8.7)
3	1 484	646	119	93	43.5	8.0
					(41.0 ; 46.1)	(6.6 ; 9.4)
4	626	347	47	26	55.4	7.5
					(51.5 ; 59.3)	(5.4 ; 9.6)
5	206	145	17	15	70.4	8.3
					(64.2 ; 76.6)	(4.5 ; 12.0)
6	29	23	3	1	79.3	10.3
					(64.6 ; 94.0)	(−0.7 ; 21.4)
7	2	1	1	0	50.0	50.0
					(−19.3 ; 119.3)	(−19.3 ; 119.3)

4.1.1 Graphical Analysis: Point Estimates and Confidence Intervals

In order to illustrate more clearly the differences in the Graduation Hazard Ratios (GHR) and Academic Exclusion Hazard Ratios (AEHR) within and across faculties, Figures 4.1-4.6 were produced. These figures show the sample hazard ratios for graduation and academic exclusion for each faculty/programme, as well as the 95% confidence intervals for these hazard ratios. As the actual numbers have been discussed previously, the focus of this section is on trends.

Figure 4.1 shows the trends in the probability of graduating and academic exclusion for the overall sample. The sharp rise in the GHR between years 3 and 4 is due to the large number of students who become eligible to graduate after four years (e.g. EBE, BBusSci students and some AD students). The GHR continues to increase in years 5 and 6, although the confidence intervals become wider, indicating there are fewer students in the risk pool (since many have graduated or been academically excluded in the previous years). The AEHR is approximately 5%, with the exception of fourth-year where there is a small dip.

Figure 4.1: Hazard Ratio: Graduation and Academic Exclusion (Overall Sample)



Looking at Figures 4.2, 4.3 and 4.4, which represent the Commerce Faculty, BCom, and Business Science programs respectively, it is clear that the Commerce Faculty hazard ratios conceal the large differences between the BCom and Business Science students. For example, while the GHR to complete a BCom within minimum time (3 years) is only 35%, the corresponding figure for Business Science is over 60% (recalling that the minimum time for Business Science students to graduate is 4 years). Furthermore, in year 5, the GHR is near 80% for Business Science students, whereas the BCom GHR is 63% in year 4.

As mentioned previously, the consistency of the AEHRs for Business Science students is remarkable - hovering between 2-2.5%, with small confidence intervals. In contrast, the BCom AEHRs are particularly unstable, rise markedly in the fifth year, although the confidence interval is fairly large.

Figure 4.2: Hazard Ratio: Graduation and Academic Exclusion (Commerce)

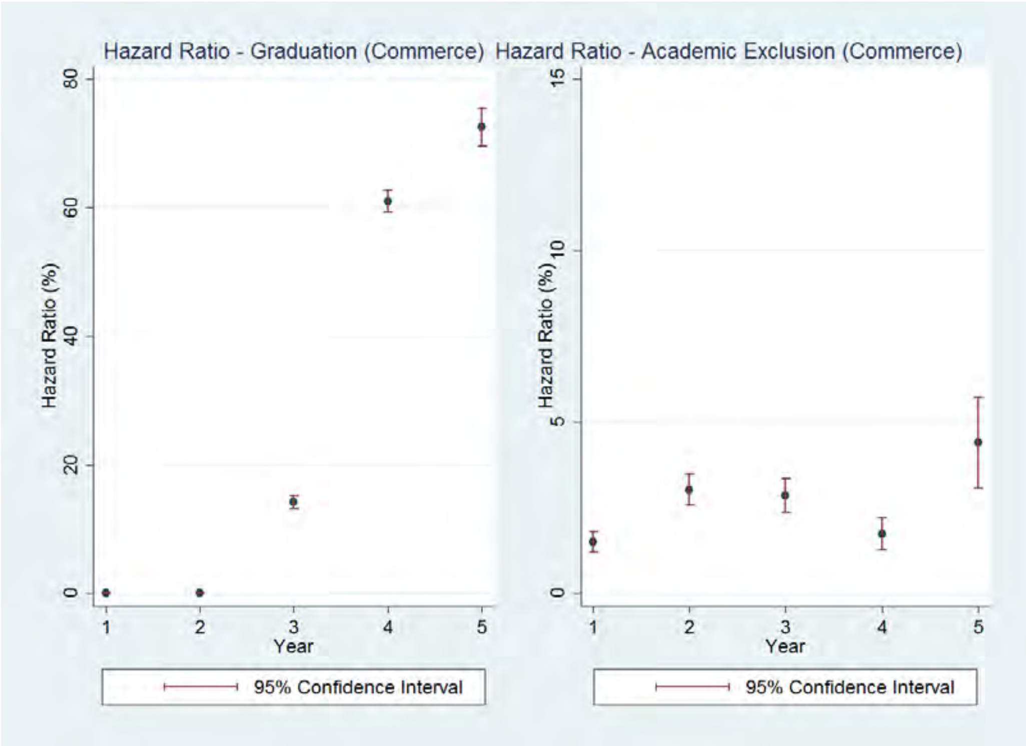


Figure 4.3: Hazard Ratio: Graduation and Academic Exclusion (BCom)

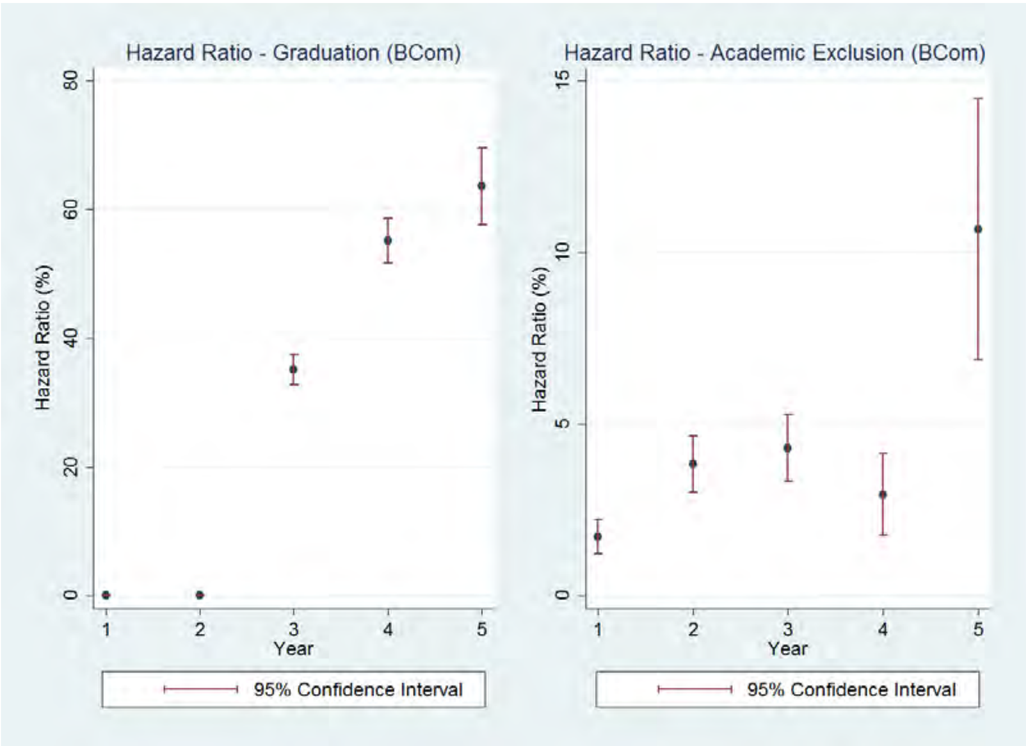
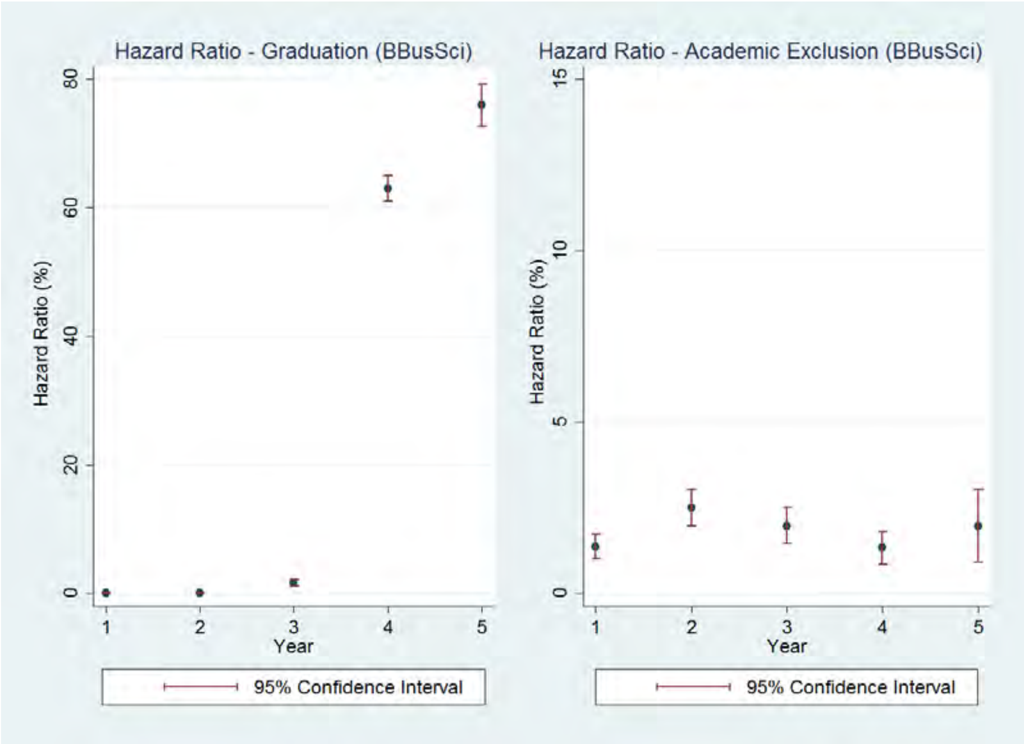


Figure 4.4: Hazard Ratio: Graduation and Academic Exclusion (BBusSci)



The striking characteristic about Figures 4.5 and 4.6, which show the hazard ratios of the EBE and Science faculties, is the similarity between the graduation hazard ratios, when accounting for the difference in the minimum time to complete a degree in those two faculties. Both faculties have an approximate graduation hazard ratio of 45% in the 'minimum time' years (3rd year for the Science Faculty and 4th year for the EBE faculty). This rises to about 55% for the 'minimum + 1 year' time period. However, the confidence intervals for the GHRs are certainly greater for the Science faculty.

While both the EBE and Science faculties have AEHRs of above 10% in first year, the EBE AEHR noticeably declines until fourth year and remains constant at around 3% after that. On the other hand, the Science AEHR remains consistently high at between 7-8%. Furthermore, the graphs allow us to appreciate the scale of the differences between faculties and in the case of the Commerce faculty, within a faculty. The Business Science program has the highest average GHR and the lowest average AEHR. The BCom programme and EBE and Science faculties have similar GHRs, although they diverge when it comes to AEHRs. The fifth year AEHR for the BCom programme is reminiscent of the first-year AEHRs of the EBE and Science faculties, although we are not as confident of the BCom estimates as we are of the EBE and Science estimate, because of the relatively smaller number of students in the risk set. Likewise, the AEHRs in later years in the EBE faculty mimic those of the Business Science programme. The

Science faculty has the highest average AEHR, which is over three times that of the Business Science programme.

FIGURE 4.5: Hazard Ratio: Graduation and Academic Exclusion (EBE)

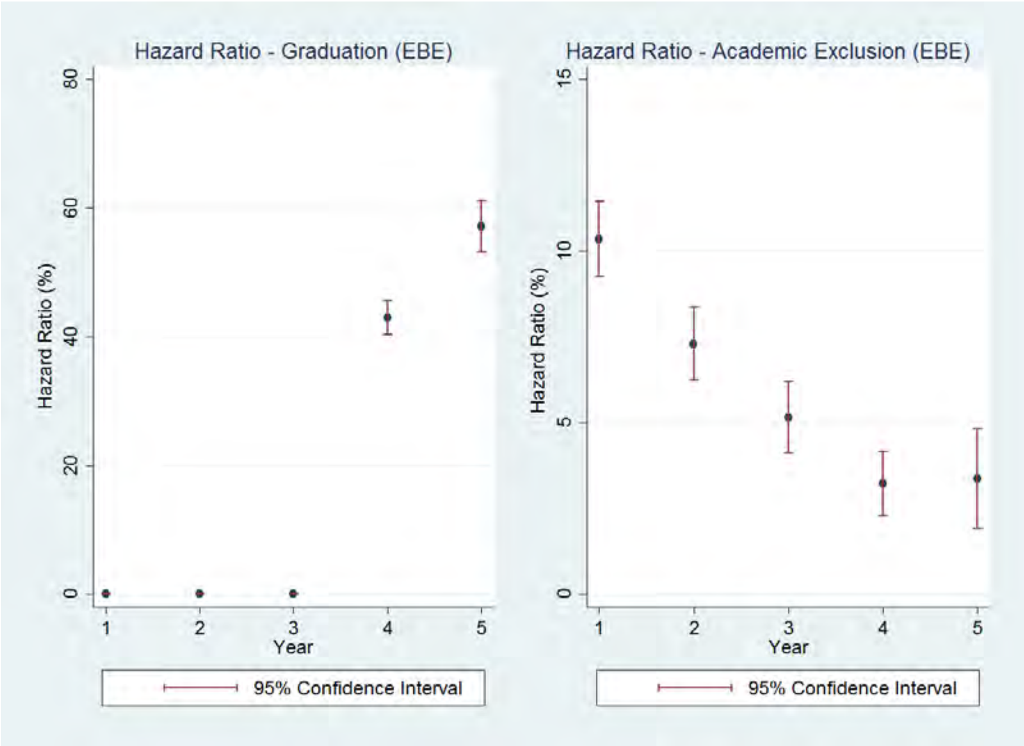
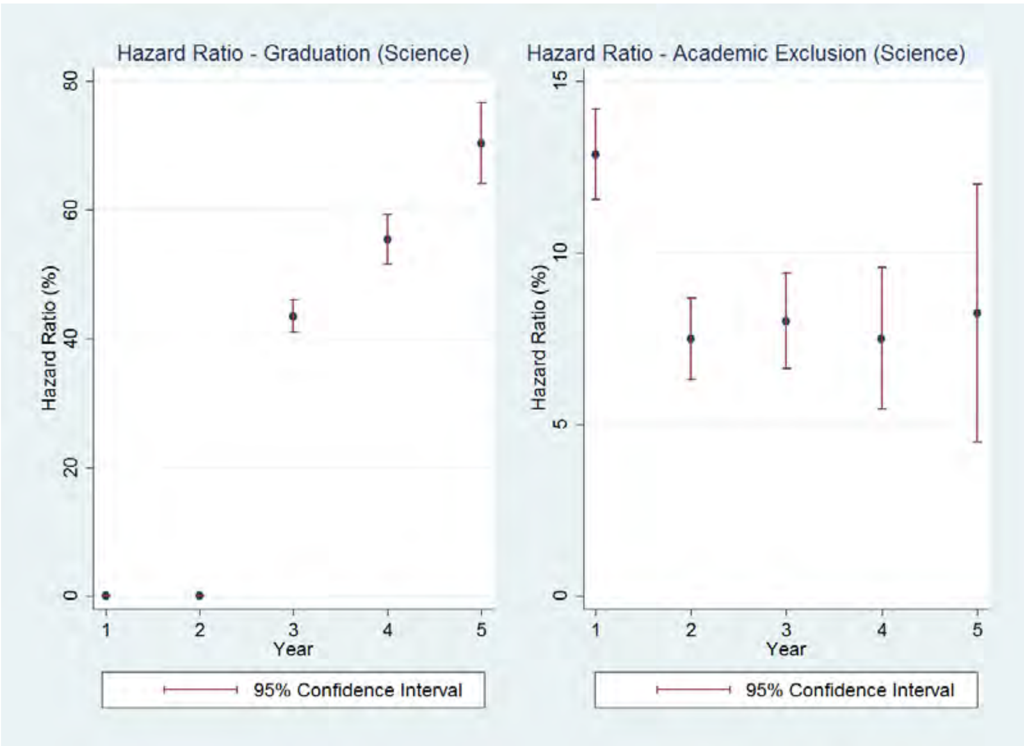


FIGURE 4.6: Hazard Ratio: Graduation and Academic Exclusion (Science)



4.2 Transformation of the dataset

Given the longitudinal nature of survival analysis data, it was necessary for the data to be transformed before carrying out regression analysis. Table 4.7 illustrates the form of a 'person-period' dataset for three individuals. The data are expanded by the number of years that the students are registered at university. The implication of this is there are multiple records per student for those who have registered at UCT for more than one year. The period variable indicates the year. Variables such as Gender and Race are time-invariant, while Residence is time-varying. The 'MEvents' variable denotes whether a student experienced an event (1 or 2) or not (0) for a particular time period. For those students who experienced an event, their last record is either '1' (graduation) or '2' (academic exclusion), with all prior records being '0'. For students who never experienced an event, all their records are coded as '0'.

TABLE 4.7: Person Period Dataset

Random ID	**Period**	**Gender**	**Race**	**Residence**	**MEvents**
1230001	1	Female	Indian/Asian	0	0
1230001	2	Female	Indian/Asian	1	0
1230001	3	Female	Indian/Asian	1	0
1230001	4	Female	Indian/Asian	0	1
1233529	1	Male	Coloured	0	0
1233529	2	Male	Coloured	0	2
1242335	1	Male	White	1	0
1242335	2	Male	White	1	0
1242335	3	Male	White	1	0

Consider the individual with Random ID 1230001. From the beginning of her university career, she was at risk of being academically excluded. In contrast, she was only at risk of graduating in Year 4. A new record is created for each year that she is at risk of experiencing either of the two events. Once she experienced an event (Graduation), she was removed from the sample of students who could experience an event. The same logic applies to the student with the Random ID 1233529, except that he was academically excluded from UCT after 2nd year. In comparison, the third student had neither graduated nor been academically excluded by the end of 2013 and is therefore, right-censored.

4.3 Regression Results

Table 4.8 presents the results of various multinomial logistic regressions. For ease of interpretation, the coefficients are marginal effects on the odds of the even occurring. In each regression, the MEvents variable (0 = censored, 1 = Graduation, 2 = Academic Exclusion) is regressed on independent variables . As the dependent variable has multiple categories, a base category needed to be chosen. It was decided that Academic Exclusion would be the base category, so that the coefficients could be interpreted as the risk of graduating relative to the risk of being academically excluded. A coefficient of 1 indicates that, for the variable to which it applies, the likelihood of graduation relative to the likelihood of academic exclusion is the same as that of the base category. A coefficient less than 1 indicates that, for variable to which it applies, the likelihood of graduation relative to the likelihood of academic exclusion is less than that of the base category. A coefficient of more than 1 indicates that, for the variable to which it applies, the likelihood of graduation relative to the likelihood of academic exclusion is more than than that of the base category.

The coefficients on the female variable suggest that females are between 1.62 and 1.95 more likely to graduate than to be academically excluded compared to males. The coefficient on the female variable is greatest on the overall sample (1.95). Looking at the different sub-samples, the superior performance of females is greatest in the EBE faculty (1.79), while it is smallest in the Business Science (1.63) and BCom (1.62) programmes. The lack of significance on the Female variable in the EBE faculty is almost certainly caused by the small proportion of females in that faculty (see Table 3.7). Smith (2012) found superior academic performance of female students in the EBE and Science faculties and speculated that this might be due to self-selection. Only females who are ambitious and motivated study such degrees, given that those faculties are assumed to be male-dominated and therefore make it harder for women to feel welcome. The age variable is rather interesting - it is insignificant with the exception of the Business Science and BCom regressions, and the significant results suggest differing interpretations with regards to the effects of age. On the one hand, older students who take Business Science degree are less likely to graduate than be academically excluded, but the opposite is true for BCom students. That is, older students are more likely to graduate than be academically excluded in the BCom programmes.

Examining the race variable, it is clear that coloured students do not differ significantly from black students. Contrary to received wisdom, Indian/Asian students seem to perform substantially worse at university than black students, with significant coefficients ranging from 0.34 to 0.67. Specifically, Indian/Asian students are more likely to experience academic exclusion than graduation compared to black students, holding all other factors constant. The white coefficient is the largest in the table and statistically significant for all regressions, and ranges from 2.68

to 12.55. In other words, white students are between 2.7 and 12.5 times more likely to graduate than be academically excluded compared to black students, holding all other factors constant. The smallest relative odds ratio between white and black students is in the Commerce Faculty, while the largest is in the Science faculty. . A possible explanation for the Indian/Asian-black and white-black odds ratios is multicollinearity. Many factors in the regression - such as school quintile, English home language or financial aid - are correlated with race in South Africa.

There is a correlation between students who are eligible for financial aid and and academic exclusion. Specifically, students eligible for financial aid are significantly more likely to be academically excluded than those who do not require financial support. The smallest difference between the two types of students occurs in the EBE faculty (0.75) while the biggest difference occurs in the Business Science (0.42) and BCom programs (0.40). This is not to suggest that being eligible for financial aid reduces the chances of graduation, but rather that such students share common characteristics - for example, the type of school attended and poor school leaving examination results - which negatively affect their chances of graduating.

With the exception of the Science faculty, the finding that the AD programme is insignificant in explaining graduation behaviour confirms the results of Smith (2012). For Science, the result is against prior expectation and is significant. The AD results are particularly relevant in the context of the ongoing debate about undergraduate reform in South Africa. Ndebele et al. (2013) have proposed extending the 3-year and 4-year undergraduate degrees by one year. The rationale behind this proposal is that the one extra year will be used to develop foundational skills so that students have a greater chance of succeeding at university (Ndebele et al., 2013). It is unclear, based on the available evidence, whether extending the time until degree completion will increase the graduation rate. However, Ndebele et al. (2013) have argued that current AD programmes lack financing and resources, and are therefore unrepresentative of the types of foundational courses which would be implemented under the proposal. Even with greater resources devoted to foundational courses, it is unclear that a single year of such courses will be to be able to overcome the effects of many years of poor education.

Students who have English as their home language are between 1.29 to 2.27 times more likely to graduate than be academically excluded compared to those who do not have English as their home language. As UCT's medium of instruction is English, this result was expected. Second language English students face multiple challenges such as: learning material that does not cater for them, misunderstanding of certain technical terms and the ability to express ideas and concepts is limited (Webb, 2002).

Quintile 3 was the base category for schools, as Quintiles 1, 2 and 4 had too few observations. As was the case with descriptive statistics, the impact of having attended Quintile 1-4 schools do not differ significantly from each other. While the coefficients on the entire sample, EBE and Science faculties indicate that Quintile 5 and independent schools do a better job in preparing their students for university than Quintile 1-4 schools, the size of the significant coefficients - which range from 1.53 to 1.85 - are rather small, given the stark inequalities which exist in the South African system.

Students who reside in the Western Cape and study for a BCom degree are 1.6 times more likely to graduate than be academically excluded compared to BCom students who live in another province. In general though, living in the Western Cape does not affect student performance.

High school GPA has a large influence on whether students complete their studies. A 1% increase in high school GPA increases the probability of students graduating (relative to academic exclusion) by between 1.10 to 1.15 times. This result, which has been reported in the South African and international literature, confirms the importance of high school marks in predicting university success. High school mathematics has a modest effect on the performance of students, with a 1% increase in high school mathematics increasing the probability of graduating relative to academic exclusion by between 1.01 and 1.05 times. Surprisingly, the coefficient on BCom students (1.05) is larger than that of Science students (1.02), given that many Science programmes require a greater understanding of mathematical concepts than that of the BCom programmes.

English marks in the school-leaving examination are insignificant, with the exception of BCom students. This insignificance might be as a result of the 'English Home Language' variable, which better captures the advantage that native English speakers have over second language English speakers. Taking Science at school does not appear to have an effect, except in Business Science, where such students are 1.35 times more likely to experience graduation than academic exclusion.

The general lack of significance of the Residence variable is probably explained by many students not remaining in residence for the duration of their degree. It is challenging to isolate the effect of living in residence on student performance when many students stay both off-residence and in-residence during the course of their studies.

Table 4.8: Regression Results

Variable	Base	All	Commerce	B.Bus.Sci	BCom	EBE	Science
Female	*Male*	$1.953^{‡}$	$1.711^{‡}$	$1.626^{‡}$	$1.617^{‡}$	1.005	$1.793^{‡}$
		(0.137)	(0.194)	(0.269)	(0.269)	(0.162)	(0.253)
Age		1.010	0.920	$0.761^{‡}$	$1.288^{†}$	1.066	1.072
		(0.039)	(0.065)	(0.071)	(0.160)	(0.080)	(0.075)
Coloured	*Black*	1.099	1.122	1.482	0.774	1.048	1.276
		(0.186)	(0.327)	(0.600)	(0.340)	(0.354)	(0.461)
Indian/Asian	*Black*	$0.670^{†}$	$0.488^{†}$	1.021	$0.337^{‡}$	0.565^{*}	0.947
		(0.114)	(0.137)	(0.443)	(0.137)	(0.187)	(0.384)
White	*Black*	$5.123^{‡}$	$2.953^{‡}$	$3.510^{‡}$	$2.679^{†}$	$4.748^{‡}$	$12.548^{‡}$
		(0.841)	(0.817)	(1.361)	(1.112)	(1.465)	(4.620)
Financial Aid		$0.678^{‡}$	$0.397^{‡}$	$0.420^{‡}$	$0.400^{‡}$	0.754^{*}	$0.706^{†}$
		(0.056)	(0.054)	(0.077)	(0.081)	(0.129)	(0.118)
Academic Development		0.911	0.930	1.116	0.783	0.897	$0.574^{‡}$
		(0.083)	(0.132)	(0.211)	(0.175)	(0.184)	(0.124)
English Home Language		$1.401^{†}$	$1.716^{‡}$	1.472	$2.265^{‡}$	1.739^{*}	1.293
		(0.208)	(0.433)	(0.512)	(0.864)	(0.493)	(0.418)
Quintile 1	Quintile 3	1.016	1.051	1.250	0.516	0.794	1.469
		(0.244)	(0.456)	(0.610)	(0.783)	(0.375)	(0.627)
Quintile 2	Quintile 3	1.291	1.161	0.966	1.653	1.846^{*}	0.968
		(0.242)	(0.449)	(0.455)	(1.175)	(0.634)	(0.307)
Quintile 4	Quintile 3	0.920	0.771	0.818	0.559	0.827	0.744
		(0.140)	(0.211)	(0.276)	(0.287)	(0.252)	(0.206)
Quintile 5	Quintile 3	$1.760^{‡}$	1.351	1.412	1.616	$1.845^{†}$	1.527^{*}
		(0.218)	(0.301)	(0.390)	(0.687)	(0.465)	(0.362)
Independent	Quintile 3	$1.663^{‡}$	1.203	1.312	1.626	$1.789^{†}$	1.335
		(0.219)	(0.284)	(0.399)	(0.708)	(0.472)	(0.338)
Western Cape		1.145	1.275^{*}	1.144	$1.661^{†}$	1.073	0.950
		(0.099)	(0.183)	(0.235)	(0.358)	(0.192)	(0.167)
High School GPA		$1.119^{‡}$	$1.119^{‡}$	$1.156^{‡}$	$1.111^{‡}$	$1.148^{‡}$	$1.134^{‡}$
		(0.007)	(0.011)	(0.017)	(0.016)	(0.014)	(0.014)
Mathematics		$1.007^{†}$	$1.012^{†}$	1.005	$1.048^{‡}$	$1.054^{‡}$	$1.022^{‡}$
		(0.003)	(0.006)	(0.008)	(0.009)	(0.008)	(0.006)
English		$1.013^{‡}$	1.012	1.006	$1.038^{‡}$	1.007	1.003
		(0.004)	(0.008)	(0.011)	(0.012)	(0.009)	(0.008)
Science		———	1.053	1.352^{*}	1.239	———	1.252
			(0.136)	(0.233)	(0.255)		(0.557)
Residence		1.117	$1.401^{†}$	1.240	1.061	1.019	0.937
		(0.102)	(0.209)	(0.259)	(0.238)	(0.195)	(0.169)
Controls for Time		Yes	Yes	Yes	Yes	Yes	Yes
Observations		36 333	20 409	7 408	13 001	9 169	6 755
Pseudo R^2		0.397	0.451	0.420	0.574	0.419	0.431

Standard errors in parentheses

* $p < 0.05$, † $p < 0.01$, ‡ $p < 0.001$

Chapter 5

Conclusion

The National Development Plan - which is endorsed by the government - sets a target of producing 425 000 graduates per year by 2030, with an emphasis on increasing the number of graduates from the science, technology, engineering and mathematical fields (National Planning Commission, 2011). This target is a considerable increase over the current number of 168 000 graduates produced per year (National Planning Commission, 2011). An important factor in determining whether this goal will be achieved is the graduation rate, which is low at 52% (Ndebele et al., 2013).

The aim of this paper was to examine some of the determinants of graduation and exclusion at UCT using a survival analysis approach. The sample consisted of South African students in the Commerce, EBE and Science faculties who registered at UCT from 2006 until 2013.

Students who experienced either graduation or academic exclusion and students who did not experience either event were included in the analysis. A person-period longitudinal dataset was created to track the progress of students on a yearly basis until they experienced either of the two events or were censored.

There are some general lessons which can be drawn from the results of this study. Firstly, there is a larger gender disparity, with females more likely to graduate than be academically excluded in the Commerce and Science faculties, compared to males. With regards to age, there is not much evidence to suggest that age is a significant factor in shaping university success. There are significant racial differences, with the white/black odds ratios being the largest out of all variables considered.

Financial aid students - who are also likely to be the least prepared for university - are more likely to experience academic exclusion than graduation. Being proficient in English is advantageous, while attending a quintile 5 or independent school has a modest, positive impact on succeeding at university even after controlling for other measures of quality typically associated with wealthy schools (such as GPA). Students who have good high school GPAs are far more likely to graduate.

Although Mathematics and English marks at school have a positive influence, their impact is modest. In general, doing Science at school and living in residence has little effect on the chances of students graduating after controlling for other factors.

Furthermore, there are large differences in academic exclusion rates between the different faculties. Academic exclusion rates in the EBE and Science faculties are high in the first two years, but are either reduced or remain stable in subsequent years. In contrast, the Commerce faculty - and more specifically the BCom programme - has low academic exclusion in first two years, but this rises sharply in the third and subsequent years.

5.1 Limitations

This study has some limitations. Firstly, only variables which could objectively be measured were included in the analysis. Motivation, interest in the degree, self-confidence and sociability also affect the probability of students graduating, although such variables are difficult to measure and may vary over time. Secondly, the duration variable was measured in years, even though a university year is split into two semesters. As a result, we do not know the true length of time that a student was enrolled at university, as some students graduate in June. Lastly, the sample only consisted of UCT students, which is a highly selective university. It would be interesting to extend this analysis to other universities in South Africa.

5.2 Policy Implications

Despite significant flaws in the secondary school system, the high school GPA and mathematics mark achieved in school-leaving examinations are significant determinants in graduation success (or not). As Spaull (2011) noted, school marks are strongly correlated with the type of school attended. It is the challenge to policymakers to emulate the excellent schools (i.e. Quintile 5 and independent schools) in order to give students from poorer backgrounds a greater chance of graduating.

While it is acknowledged that the policies described above ignore the important role of the home environment - which is often more unstable and less conducive to learning in poor households than more affluent households - on educational attainment, it is hoped that such policies would ameliorate some of the difference in academic performance between affluent and poor schools. However, the question remains whether there is political will to do it. A recent report by the ministerial task team suggested that mathematics (as opposed to mathematical literacy) should be offered at all schools and tougher curricula be introduced (Joubert, 2014). This is encouraging, although whether such reforms are implemented remains to be seen.

The lack of significance of the AD programme variable, and the positive correlation between students who are eligible for financial aid and academic exclusion should not be interpreted as evidence to remove the AD programmes or not to finance poor students. Smith (2012) correctly points out that in order for South Africa to grow economically, many more future graduates must come from socially and educationally disadvantaged backgrounds, as they comprise the majority of the population. In this study, 916 students eligible for financial aid and 734 AD students graduated, with 348 of those students being both on the AD programme and eligible for financial aid. These are not insignificant figures, which suggests that academic and financial support programmes can be used to overcome socio-economic disadvantages faced by some students. However, this is not to say AD programmes cannot be improved: Smith (2012) suggests that AD courses could either be extended into second and third year or mainstream courses should be adapted to meet the 'epistemological, educational and psychological needs of the majority of South Africa's students' (Smith, 2012, p. 225). This study supports these sentiments.

5.3 Recommendations for Further Research

Further research in this field could involve conducting qualitative studies of a sample of students and follow them until they graduate, are academically excluded or leave university for some other reason. The questionnaire would involve asking students about their emotional well-being, their friendships, whether they have had health issues recently, their enjoyment of a course etc. The survey would be conducted on a regular basis, and provide additional insight as to why some students succeed at university and others do not.

The research could also be enhanced by the inclusion of more 'background' variables such as parents' and grandparents' educational attainment. Currently, this a voluntary question on UCT's application form, but will become compulsory next year in line with UCT's revised admissions policy, which aims to move away from race as a proxy for socio-economic disadvantage. It will be useful to see how the inclusion of such variables influences the overall results.

A further avenue of research could look at the impact of RAC decisions. In particular, a study could focus on what happens to students who are re-admitted to UCT through the RAC. The key question would be whether re-admitted students eventually graduate, or whether their re-admittance delays the time until they are academically excluded from university. A related question, based on the evidence presented in this paper, is whether RACs, especially in the Commerce Faculty, should adopt a more rigorous position when deciding who to re-admit. A further question relating to RACs is determining whether there are some crucial first-year and second-year courses that are highly predictive of whether a student graduates or not.

The results of the National Benchmarking Tests (NBTs) are increasingly being used by South African universities (in conjunction with high school leaving examination results) to determine whether a student is admitted to university. The need for NBTs arose due to concerns about whether NSC results were a good indicator of a student's ability (Rankin et al., 2012). Initially, the NBTs were voluntary, however, they are now explicitly included in the Commerce, EBE and Science faculties' admission criteria and are compulsory for students who are writing the NSC (Commerce Faculty, 2014; EBE Faculty, 2014; Science Faculty, 2014). It would be interesting to see whether the increasing importance given to NBT results are justified in terms of whether they are better predictors of graduation and academic exclusion than high school marks.

Bibliography

Note: The online-only journals cited in this paper do not have page numbers.

Adelman, C. (1999). *Answers in the toolbox: Academic intensity, attendance patterns, and bachelor's degree attainment*. U.S. Department of Education, Washington, D.C., USA.

Adelman, C. (2006). *The Tool Box revisited: Paths to degree completion from high school through college*. U.S. Department of Education, Washington, D.C., USA.

Allison, P. (2010). Survival analysis. In Hancock, G. and Mueller, R., editors, *The Reviewer's Guide to Quantitative Methods in the Social Sciences*. Routledge, New York.

Alon, S. (2005). Model mis-specification in assessing the impact of financial aid on academic outcomes. *Research in Higher Education*, 46(1):109–125.

Alon, S. (2007). The influence of financial aid in leveling group differences in graduating from elite institutions. *Economics of Education Review*, 26(3):296–311.

Arcidiacono, P., Aucejo, E., Coate, P., and Hotz, J. (2013). *Affirmative action and university fit: Evidence from Proposition 209*. NBER Working Paper No. 18523. Cambridge, MA: National Bureau of Economic Research.

Arcidiacono, P. and Koedel, C. (2013). *Race and college success: Evidence from Missouri*. NBER Working Paper No. 19188. Cambridge, MA: National Bureau of Economic Research.

Astin, A. and Oseguera, L. (2005). *Degree attainment rates at American colleges and universities (Revised Edition)*. Higher Education Research Institute, UCLA, Los Angeles.

Attewell, P., Lavin, D., Domina, T., and Levey, T. (2006). New evidence on college remediation. *Journal of Higher Education*, 77(5):886–924.

Austin, E., Deary, I., Gibson, G., McGregor, M., and Dent, J. (1998). Individual response spread in self-report scales: personality correlations and consequences. *Personality and Individual Differences*, 24(3):421–438.

Bahr, P. R. (2008). Does mathematics remediation work? A comparative analysis of academic attainment among community college students. *Research in Higher Education*, 49(5):420–450.

Baird, K. (2012). *Trapped in mediocrity: Why our schools aren't world-class and what we can do about it.* Rowan & Littlefield Publishers, Maryland.

Baum, S., Ma, J., and Payea, K. (2013). *Education Pays 2013: The Benefits of Higher Education for Individuals and Society.* College Board, New York.

Bean, J. and Metzner, B. (1985). A conceptual model of nontraditional undergraduate students attrition. *Review of Educational Research*, 55(4):485–540.

Beekhoven, S., De Jong, U., and Van Hout, H. (2004). The impact of first-year students' living situation on the integration process and study progress. *Educational Studies*, 30(3):277–290.

Bettinger, E. and Long, B. T. (2009). Addressing the needs of under-prepared students in higher education: Does college remediation work? *Journal of Human Resources*, 44(3):736–771.

Betts, J. and Morell, D. (1999). The determinants of undergraduate grade point average: The relative importance of family background, high school resources, and peer group effects. *The Journal of Human Resources*, 34(2):268–293.

Blaney, C. and Mulkeen, S. (2008). *Student retention in a modular world: A study of student retention UCD Entrants 1997-2007.* Dublin: University College Dublin.

Branson, N., Leibbrandt, M., and Zuze, T. L. (2009). What are the returns for tertiary education and who benefits? In Cloete, N., editor, *Responding to the Educational Needs of Post-School Youth.* Centre for Higher Education Transformation, Wynberg.

Braxton, J., Sullivan, A., and Johnson, R. (1997). Appraising Tinto's theory of college student departure. In Smart, J. C., editor, *Higher Education: Handbook of Theory and Practice Vol. XII.* Agathon Press, New York.

Cabrera, A., Castañeda, M., Nora, A., and Hengstler, D. (1992). The convergence between two theories of college persistence. *Journal of Higher Education*, 63(2):143–164.

Cabrera, A., Nora, A., and Castañeda, M. (1993). College persistence: Structural equations modeling test of an integrated model of student retention. *Journal of Higher Education*, 64(2):123–139.

Calcagno, J. C. and Long, B. T. (2008). *The impact of postsecondary remediation using a regression discontinuity design: Addressing endogenous sorting and compliance.* NBER Working Paper No. 14194. Cambridge, MA: National Bureau of Economic Research.

Cantwell, R., Archer, J., and Bourke, S. (2001). A comparison of the academic experiences and achievement of university students entering traditional and non-traditional means. *Assessment and Evaluation in Higher Education*, 26(3):221–234.

Castleman, B. and Long, B. (2013). *Looking beyond enrollment: The causal effect of need-based grants on college access, persistence and graduation* . NBER Working Paper No. 19306. Cambridge, MA: National Bureau of Economic Research.

Coates, H. (2011). Dropout DNA, and the genetics of effective support. *Australasian Survey of Student Engagement*, 11:1–17.

Commerce Faculty (2014). *Admission Requirements*. Available: http://www.commerce.uct.ac.za/Pages/Admission-Requirements [Accessed: 1 November 2014].

Commerce Faculty Handbook (2014). *Commerce Undergraduate Studies 2014*. Available: http://www.uct.ac.za/downloads/uct.ac.za/apply/handbooks/Handbook6ACommerceUndergraduateStudies2014.pdf [Accessed: 25 February 2014].

Coreil, C. and Haber, S. (2000). *ESL Students and Native Speakers: A Comparative Study of Academic Performance*. Academic Forum, New Jersey City University.

Cortes, K. (2010). *Do bans on affirmative action hurt minority students? Evidence from the Texas top 10% plan*. IZA Discussion Paper No. 5021.

Council on Higher Education (2009). *A case for improving teaching and learning in South African higher education*. Higher Education Monitor 8.

De Angelo, L., Franke, R., Hurtado, S., Pryor, J., and Tran, S. (2011). *Completing college: Assessing graduation rates at four-year institutions*. Los Angeles: Higher Education Research Institute, UCLA.

De Winter, J. and Dodou, D. (2011). Predicting academic performance in engineering using high school exam scores. *International Journal of Engineering Education*, 27(6):1343–1351.

DHET (2004). *A new funding framework: How government grants are allocated to public higher education institutions*. Available: http://www.dhet.gov.za/LinkClick.aspx?fileticket=ZIpvOJ7GheM=&tabid=411&mid=1369 [Accessed: 23 February 2014].

DHET (2010). *Report of the Ministerial Committee on the review of the National Student Financial Aid Scheme*. Available: http://www.dhet.gov.za/LinkClick.aspx?fileticket=b1XjVn4N%2BHc%3D&tabid=92&mid=495. [Accessed 20 March].

Donnelly, T., McKiel, E., and Hwang, J. (2009). Factors influencing the performance of English as an Additional Language nursing students: instructors' perspectives. *Nursing Enquiry*, 16(3):201–211.

Dynarski, S. (2008). Building the stock of college-educated labor. *Journal of Human Resources*, 43(3):576–610.

EBE Faculty (2014). *Faculty of Engineering and the Built Environment: NSC Entrance Requirements for 2015*. Available: http://www.ebe.uct.ac.za/usr/ebe/apply/EBE%202015%20admissions.pdf [Accessed: 1 November 2014].

EBE Faculty Handbook (2014). *EBE Undergraduate Studies 2014*. Available: http://www.uct.ac.za/downloads/uct.ac.za/apply/handbooks/Handbook7AEBEUndergraduateStudies2014.pdf [Accessed: 2 March 2014].

Fadnes, L., Taube, A., and Tylleskär, T. (2008). How to identify information bias due to self-reporting in epidemiological research. *The Internet Journal of Epidemiology*, 7(2).

Fletcher, J. and Tienda, M. (2010). Race and ethnic differences in college achievement: Does high school attended matter? *Annals of the American Academy of Political and Social Science*, 627(1):144–166.

Geiser, S. and Santelices, M. (2007). *Validity of high-school grades in predicting student success beyond the freshmen year: High-school record vs. standardized tests as indicators of four-year outcomes*. Research & Occasional Paper Series: CSHE.6.07. Center for Studies in Higher Education, University of California, Berkeley.

Gerber, A., Engelbrecht, J., and Harding, A. (2005). The influence of second language teaching on undergraduate mathematics performance. *Mathematics Education Research Journal*, 17(3):3–21.

Goldin, C., Katz, L., and Kuziemko, I. (2006). *The homecoming of American women: The reversal of the college gender gap*. NBER Working Paper No. 1239. Cambridge, MA: National Bureau of Economic Research.

Grayson, J. (1995). Place of residence, student involvement and first-year marks. *Canadian Journal of Higher Education*, 27(1):1–17.

Grayson, J. (1997). Institutional failure or student choice? The retention of adult students in Atkinson College. *Canadian Journal for the Study of Adult Education*, 11(2):7–30.

Grayson, J. P. and Grayson, K. (2003). *Research on Retention and Attrition*. Montreal: Canada Millenium Scholarship Foundation.

Griffith, A. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review*, 29(6):911–922.

Harvey, L., Drew, S., and Smith, M. (2006). *The first-year experience: A review of literature for the Higher Education Academy*. Sheffield: Sheffield Hallam University.

Henry, G., Rubenstein, R., and Bugler, D. (2004). Is HOPE enough? Impacts of receiving and losing merit-based financial aid. *Educational Policy*, 18(5):686–709.

Higher Education Funding Council for England (2010). Student ethnicity: Profile and progression of entrants to full-time, first degree study. Technical report, HEFCE.

Hinrichs, P. (2012). *Affirmative action bans and college graduation rates.* Working Paper. Washington, D.C.: Georgetown University.

Horn, P. and Jansen, A. (2009). An investigation into the impact of tutorials on the performance of economic students. *South African Journal of Economics*, 77(1):202–210.

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*, 79(2):202–210.

Hosch, B. (2009). *Effects of parent's education, family income, and first semester grade point average on graduation rates at CCSU.* Institutional Research and Assessment, Central Connecticut State University.

Hunt, K., Ntuli, M., Rankin, N., Schöer, V., and Sebastiao, C. (2011). Comparability of nsc Mathematics Scores and Former SC Mathematics Scores: How Consistent is the Signal Across Time? *Education as Change*, 15(1):3–16.

Jenkins, S. (2008). *Survival Analysis.* Unpublished manuscript, Institute for Social and Economic Research, University of Essex.

Joubert, J. (2014). *Radical matric reform on the cards.* Available: http://www.timeslive.co.za/local/2014/08/03/radical-matric-reform-on-the-cards1 [Accessed: 29 September 2014].

Krejci, A. (2011). *An investigation of the relationship between high school courses taken and graduation from Chadron State College within six years.* PhD thesis, University of Nebraska.

Letseka, L. and Maile, S. (2008). *High University drop-out rates: a threat to South Africa's future.* Human Sciences Research Council Policy Brief.

Levine, A. and Dean, D. (2012). *Generation on a tightrope: A portrait of today's college student.* Jossey-Bass, New Jersey.

Lowther, S. and Langley, J. (2005). *First year retention: Is it housing or affiliation that matters?* Paper presented at the Alabama Association for Institutional Research.

Martorell, P. and McFarlin, I. (2011). Help or hindrance? The effects of college remediation on academic and labour market outcomes. *The Review of Economics and Statistics*, 93(2):436–454.

McDaniel, A. (2011). *Gender differences in university completion across Europe: The influence of family background and national context.* Working Paper, Institute for Social and Economic Research and Policy.

McGraw, M. (2006). *Understanding the racial disparity in graduation rates at a large Ivy League university.* CHERI Working Paper No. 90. Cornell University, New York: Cornell Higher Education Research Institute.

McNabb, R., Pal, S., and Sloane, P. (2002). Gender differences in educational attainment: the case of university students in England and Wales. *Economica*, 69(275):481–503.

Mendez, G., Buskirk, T., Lohr, S., and Haag, S. (2008). Factors associated with persistence in science and engineering majors: An exploratory study using classification trees and random forests. *Journal of Engineering Education*, 97(1):57–71.

Metzner, B. and Bean, J. (1987). The estimation of a conceptual model of nontraditional undergraduate student attrition. *Research in Higher Education*, 27(1):15–38.

Miller, J. E. (2006). *Testing an ADN Predictive Model of Student Retention.* University of Southern California, California.

Min, Y., Zhang, G., Long, R., Anderson, T., and Ohland, M. (2011). Nonparametric survival analysis of the loss rate of undergraduate engineering students. *Journal of Engineering Education*, 100(2):349–373.

Murtaugh, P., Burns, L., and Schuster, J. (1999). Predicting the retention of university students. *Research in Higher Education*, 40(3):355–371.

Nash, J. (2006). Relating is student throughput to English proficiency. *36th Annual Conference of the Southern African Computer Lecturers Association*, University of Cape Town.

National Center for Education Statistics (2012). *The condition of education.* Technical report, United States Department of Education.

National Planning Commission (2011). *National Development Plan: Vision for 2030.*

Ndebele, N., Badsha, N., Figaji, B., Gevers, W., Pityana, B., and Scott, I. (2013). *A proposal for undergraduate curriculum reform in South Africa: The case for a flexible curriculum structure.* Report of the Task Team on Undergraduate Curriculum Structure, Council on Higher Education.

O'Hear, M. and MacDonald, M. (1995). A critical review of research in developmental education, part I. *Journal of Developmental Education*, 19(2):2–6.

Ott, M., Markewich, T., and Ochsner, N. (1984). Logit analysis of graduate student retention. *Research in Higher Education*, 21(4):439–460.

Parker, K. (2007). Correcting for sampling bias in education production functions. *South African Journal of Economics*, 75(1):118–124.

Parker, K. (2010). Does attendance at a historically white university benefit non-white students of introductory economics in South Africa? *South African Journal of Economics*, 78(2):208–218.

Parker, K. M. (2006). The effect of student characteristics on achievement in introductory microeconomics in South Africa. *South African Journal of Economics*, 74(1):137–149.

Parker, M. (2005). Placement, retention, and success: A longitudinal study of mathematics and retention. *Journal of General Education*, 54(1):22–40.

Pascarella, E. and Terenzini, P. (2005). *How college affects students: A third decade of research.* San Francisco, CA: Jossey-Bass.

Pascarella, E., Terenzini, P., and Blimling, G. (1994). The impact of residential life on students. In Schrodeder, C. and Mable, P., editors, *Realizing the Educational Potential of Residence Life on Students*. Jossey-bass, San Francisco.

Peter, K. and Horn, L. (2005). *Gender differences in participation and completion of undergraduate education and how they have changed over time.* U.S. Department of Education, National Center for Education Statistics, Washington, DC: U.S. Goverment Printing Office.

Potgieter, M., Ackermann, M., and Fletcher, L. (2010). Inaccuracy of self-evaluation as additional variable for prediction of students at risk of failing first-year chemistry. *Chemistry Education Research and Practice*, 11:17–24.

Pyke, S. and Sheridan, M. (1993). Logistic regression analysis of graduate student retention. *Canadian Journal of Higher Education*, XXIII(2):44–64.

Radcliffe, P., Huesman, R., and Kellogg, J. (2006). *Modeling the incidence and timing of student attrition: A survival analysis approach to retention analysis.* Paper presented at the Association for Institutional Research in the Upper Midwest(AIRUM).

Rankin, N., Schöer, V., Sebastiao, C., and Van Walbeek, C. (2012). Predictors of academic performance: National Senior Certificate versus National Benchmark Test. *South African Journal of Higher Education*, 26(3):564–585.

Rask, K. and Tiefenthaler, J. (2008). The role of grade sensitivity in explaining the gender imbalance in undergraduate economics. *Economics of Education Review*, 27:676–687.

Roberts, S. (2011). Traditional practice for non-traditional students? Examining the role of pedagogy in higher education retention. *Journal of Further and Higher Education*, 35(2):183–199.

Rose, H. and Betts, J. (2001). *Maths matters: The links between high school curriculum, college graduation and earnings*. Public Policy Institute of California.

Science Faculty (2014). *Faculty of Science: Admission Requirements for 2015*. Available: https://www.uct.ac.za/usr/apply/criteria/ScienceAdmissionsCriteria2015.doc [Accessed: 1 November 2014].

Science Faculty Handbook (2014). *Science Undergraduate Studies 2014*. Available: http://www.uct.ac.za/downloads/uct.ac.za/apply/handbooks/Handbook7AEBEUndergraduateStudies2014.pdf [Accessed: 11 March 2014].

Scott, I., Yeld, N., and Hendry, J. (2007). A case for improving teaching and learning in South African higher education. *Higher Education Monitor 6*.

Scott, M. and Kennedy, B. (2005). Pitfalls in pathways: Some perspective on competing risks event history analysis in educational research. *Journal of Educational and Behavioral Statistics*, 30(4):413–442.

Singell, L. and Stater, M. (2006). Going, going, gone: The effects of aid policies on graduation at three large public institutions. *Policy Sciences*, 39(4):379–403.

Sjoquist, D. and Winters, J. (2012a). Building the stock of college-educated labor revisited. *Journal of Human Resources*, 47(1):270–285.

Sjoquist, D. and Winters, J. (2012b). *State merit-based financial aid programs and college attainment*. IZA Discussion Paper No. 6801.

Smith, J. and Naylor, R. (2001). Dropping out of university: A statistical analysis of the probability of withdrawal for UK university students. *Journal of the Royal Statistical Society*, 164(2):389–405.

Smith, J. and Naylor, R. (2005). Schooling effects on subsequent university performance: Evidence for the UK population. *Economics of Education Review*, 24(5):549–562.

Smith, L. C. (2012). *The effect of selected academic development programmes on the academic performance of academic development students at a South African university: an empirical analysis*. PhD thesis, University of Cape Town.

Smith, L. C. and Edwards, L. (2007). A multivariate evaluation of mainstream and academic development courses in first-year microeconomics. *South African Journal of Economics*, 75(1):99–117.

Smith, L. C. and Ranchod, V. (2010). *Measuring the impact of educational interventions on the academic performance of Academic Development students in second-year microeconomics*. Working Paper 46, SALDRU.

Snyder, E. (2009). The relationship between residency and socio-demographics to academic performance in NCAA Division I athletes. Master's thesis, Utah State University.

Spaull, N. (2011). *A preliminary analysis of SACMEQ III South Africa*. Stellenbosch Economic Working Papers: 11/11, University of Stellenbosch.

Statistics South Africa (2011). *Census in Brief*. Available: https://www.statssa.gov.za/Census2011/Products/Census_2011_Census_in_brief.pdf [Accessed: 12 March 2014].

Swail, W. S. (2004). *The Art of Student Retention: A Handbook for Practitioners and Administrators*. Educational Policy Institute, Austin, Texas.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research*, 45(1):89–125.

Tinto, V. (1988). Stages of student departure: reflection on the longitudinal characteristics of students leaving. *Journal of Higher Education*, 59(4):433–455.

Tumen, S., Shulruf, B., and Hattie, J. (2008). Student pathways at the university: patterns and predictors of completion. *Studies in Higher Education*, 33(3):233–252.

Van Gennep, A. (1960). *The rites of passage*. University of Chicago Press, Chicago.

van Stolk, C., Tiessen, J., Clift, J., and Levitt, R. (2007). *Student retention in higher education courses*. Technical Report, RAND Corporation.

Van Walbeek, C. (2004). Does lecture attendance matter? Some observations from a first-year economics course at the University of Cape Town. *South African Journal of Economics*, 72(4):861–883.

Van Zyl, A., Gravett, S., and de Bruin, G. (2012). To what extent do pre-entry attributes predict first year student academic performance in the South African context? *South African Journal of Higher Education*, 26(5):1095–111.

Visser, A. and Hanslo, M. (2006). *The predictive validity of a university admissions test: A survival analysis approach*. Paper presented at the 32nd Annual Conference of International Association for Educational Assessment, Singapore.

Voyles, E. and Asunda, P. (2014). Retention of linguistically diverse engineering students. *Online Journal for Global Engineering Education*, 7(2).

Washam, E. (2009). College choice and retention of international students in the United States. Master's thesis, University of Tennessee.

Webb, V. (2002). English as a second language in South Africa's tertiary institutions: a case study at the University of Pretoria. *World Englishes*, 21(1):49–61.

Weng, F., Cheong, F., and Cheong, C. (2008). *Determining factors affecting student retention in a higher education institution in Taiwan and building a predication model using logistic regression and support vector machine.* Paper presented at the 7th International Conference on Computational Intelligence in Economics and Finance, Taiwan.

Willet, J. and Singer, J. (2003). *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence.* Oxford University Press, New York.

Wooldridge, J. (2009). *Introductory Econometrics (4th edition).* South-Western Cengage Learning, Canada.

Zhang, G., Anderson, T., and Ohland, M. (2004). Identifying factors influencing engineering student graduation: A longitudinal and cross-institutional study. *Journal of Engineering Education*, 93(4):313–320.

Zwick, R. and Sklar, J. (2004). Predicting college grades and degree completion using high school grades and SAT scores: The role of student ethnicity and first language. *American Educational Research Journal*, 42(3):439–464.