A multivariate evaluation of mainstream and academic development courses in first-year microeconomics at the University of Cape Town: A comparative study

by

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Abstract

This study evaluates an academic development course in first-year microeconomics (ECO110H) offered by the School of Economics at the University of Cape Town, relative to a mainstream control group (ECO110S). This comparison is undertaken for the first-year course and subsequent courses in first-year macroeconomics (ECO111S) and second-year microeconomics (ECO203F).

The main aim of ECO110H is to improve students' understanding of economics in first-year and subsequent economics courses through the development of students' skills in the areas of learning, English language, writing and numeracy.

Multivariate analysis is used to test the significance of the relationship between attendance of ECO110H and examination results (multiple-choice and structured/essay questions), which act as a proxy for economics understanding, relative to a control group drawn from the mainstream. Steps to eliminate sample-selection bias are also described.

The results suggest that attendance of ECO110H has a major impact on students' performance in the structured/essay questions, relative to the control group, in first- and second-year microeconomics, and for the multiple-choice questions in first-year macroeconomics. Interaction terms point to a relatively robust relationship between attendance of ECO110H, academic ability and economics performance. Other variables that have a robust and positive relationship with economics performance include the adjusted matriculation points score, mathematics (HG), English first language (HG), physical science (HG) and gender (multiple-choice questions only).

The findings suggest that ECO110H has an important role to play in improving students' understanding of economics. However, it is not possible to say that the emphasis on developing students' skills in the areas of learning, English language, writing and numeracy is responsible for the positive effect of ECO110H on students' performance.

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Chapter 1

Introduction

> "What is the use of teaching the Bantu mathematics when it [*sic*] cannot use it in practice?" (Verwoerd 1953, col. 3585)

> "There is no place for him [the Bantu] in the European community above the level of certain forms of labour. For that reason it is of no avail for him to receive a training, which has as its aim absorption in the European community, where he cannot be absorbed." (Verwoerd 1954, p. 24)

In 1948 the Afrikaner dominated National Party won its first general-election victory. Its primary objective was to secure political and economic power for white people in general, and white Afrikaners in particular. To this end the South African government of the 1950s introduced a raft of legislation designed to remove "people of colour" ("non-whites") from the body politic, to ensure the social separation of the different population groups, and to secure the fruits of economic growth for the white population (Davenport 1978, pp. 259–60).

Among the chief aims of the promoters of apartheid were to ensure that each population group lived in a separate area, attended separate schools and churches, and met only in the workplace. Here job reservation laws protected white workers – certain occupations being reserved for them alone (Davenport 1978, p. 275).

In 1953 the then Minister of Native Affairs, Dr. H.F. Verwoerd, introduced Bantu education. In an infamous speech to parliament he made it quite clear that black children would be taught only those skills necessary for a life of servitude. Unsurprisingly, the white population group received the lion's share of the funds ear-marked for education (Case and Deaton 1998).

The inherent contradictions of such a political and economic system contributed to its collapse. From the early 1960s the revolt against the system gathered pace and by the late 1970s the Nationalist government had begun to adapt the system of apartheid to the economic and political realities of the day.

It was at about this time that universities, which, with few exceptions, had catered for white students only, were allowed to admit increasing numbers of black students. The universities of Cape Town, Natal, Rhodes and the Witwatersrand took the lead. It is not surprising that black students found it difficult to adjust to the academic demands being made of them. Bantu education had done little to prepare them for the rigours of academic study.

It was in response to this situation that the four historically white universities introduced academic support programmes into selected faculties: usually engineering, science and commerce. These programmes took a variety of forms. Extra tutorials, "bridging" courses, and additional courses, usually in English and mathematics, were the norm. The expressed aim of such interventions was to bring black students "up to speed" so that they would be able to cope with university curricula (Volbrecht 1999).

However, it was not long before the academic support model was called into question (Walker and Badsha 1993). This model made the student the problem. It was the student who was under-prepared or who lacked the means to cope with the demands of academic study; the problem was not the curriculum and those who taught it. The academic support programme made it possible for universities to continue their age-old practices. It acted as a buffer protecting academic staff from the need to change both their curricula and their teaching practice (Volbrecht 1999).

Throughout the 1980s the number of black students admitted to the historically white universities remained relatively small. However, by 1990 the writing was on the wall for the apartheid state. In a democratic South Africa the number of black students attending the historically white universities could be expected to increase substantially. Also, the

legacy of both under-funding and the practice of Bantu education would be felt for some time to come.

It also came to be accepted that white students were also "disadvantaged" as a result of their exposure to Christian National Education, which was explicitly designed to encourage the development of obedience and respect for authority (Nzimande 1988). Like their counterparts in the Bantu education system, white, coloured and Indian students were encouraged to regurgitate the stories told them by their teachers. A spirit of independent inquiry was positively discouraged in apartheid South Africa.

These developments called for a positive response from the universities. As a first step, *academic support programmes* were renamed *academic development programmes*. This recognised the obligations of universities to develop the inherent abilities of students. Secondly, the universities were encouraged by the academic development community to change the manner in which they delivered the curriculum. Rather than focussing on remedial programmes running alongside mainstream courses[1] to enable students to cope with the demands of academic life, universities were encouraged to change the content of their degrees and their processes of delivery (Moulder 1991).

Throughout the 1990s universities grappled with the issues surrounding the construction and delivery of academic development programmes and courses (Volbrecht 1999). Yet the efficacy of the courses and programmes, in improving students' academic performance, is largely unknown. There are two main reasons for this unsatisfactory state of affairs. Firstly, relatively little research has been conducted in this area. Secondly, much of the research has been characterised by a variety of methodological deficiencies.

The aim of this thesis is to test the efficacy of a first-year whole-year course in microeconomics (ECO110H) offered by the University of Cape Town's School of

[1] "Mainstream" refers to those courses that make-up the standard three- and four-year degree programmes in the humanities and commerce faculties (Volbrecht 1999).

Economics in conjunction with the university's Department of Academic Development, utilising generally accepted econometric techniques.

This thesis has two main objectives. Firstly, the examination performance of the ECO110H cohort is compared with a control group taken from the mainstream course (ECO110S).[2] Multivariate analysis is used to determine whether students who take ECO110H outperform those in the ECO110S cohort, for both multiple-choice and structured questions, controlling for a number of explanatory variables identified in the literature. To the author's knowledge, this is the first such study that makes an explicit attempt to establish a mainstream control group for an academic development course. This analysis is undertaken for the 2000 and 2001 cohorts.

The second objective is to analyse the success of ECO110H in improving the performance of students in subsequent years. To do this the performance of those successful ECO110H and ECO110S students from the 2001 cohort is compared in subsequent mainstream courses in first-year macroeconomics (ECO111S) and second-year microeconomics (ECO203F). Such a longitudinal study is deemed to be important in order to measure the impact of ECO110H over time, as the effectiveness of an academic development course should be reflected in an improvement in students' academic performance over the course of the whole degree. To the author's knowledge only one other study of this nature has previously been undertaken.[3]

The structure of the thesis is as follows. Chapter 2 includes a discussion of the theories of language and learning; it is these theories that have informed the manner in which the university's academic development course in economics has evolved over time. The history of the academic development course in economics at the university is briefly discussed. The chapter ends with a detailed description of the structure of ECO110H.

[2] In addition to ECO110H, the School of Economics offers two mainstream first-year one-semester microeconomics courses, ECO110F and ECO110S. Unlike the mainstream courses, ECO110H is structured to cater for the academic developmental needs of the students (De Villiers 1990).
[3] The study by De Villiers and Rwigema (1998) is reviewed below.

Chapter 3 describes the empirical methodology used in this thesis. The findings of both international and South African studies are used to identify the most important variables that explain students' performance in economics examinations. To isolate the effect of ECO110H on students' performance, it is necessary to control for the effect of these explanatory variables.

Chapter 4 discusses the econometric methodology and the data used. The results are discussed in Chapter 5, and Chapter 6 presents the conclusions of the thesis.

Chapter 2

Academic development courses in economics

The University of Cape Town's academic development course in economics has evolved over a number of years and is designed to cater for the needs of students from socio-economically and educationally disadvantaged backgrounds.

This chapter begins with a detailed analysis of some of the constraints on learning experienced by academically disadvantaged students. This is followed by a brief review of the development of the University of Cape Town's academic development course in economics, which emerged out of the attempts to deal with these constraints. A detailed description of the current academic development course in economics, ECO110H, which is the primary focus of this thesis, follows.

2.1 Learning and language: Theory and research

It is generally accepted that very few students suffer any cognitive deficit and that academic development programmes based on the premises of cognitive deficit are inappropriate. However, some students find it difficult to mobilise the cognitive skills required to deal with abstract problems (Moll and Slonimsky 1989).[4] Students' difficulties stem from the fact that they have never been taught to use their *cognitive* and *language* skills to analyse complex material in an abstract manner. Insofar as the South African educational system has encouraged learners to rely on rote learning (atomistic or surface processing) it has not encouraged the deep processing of information.[5]

Many South African students who go to university do so having never been exposed to the ground rules that characterise academic discourse. An additional problem faces

[4] McConnell (1980) claims, in respect of first-year students in the United States, that nearly half have not achieved the level of intellectual development necessary for mastering abstract processes.
[5] Meyer and Shanahan (1999) found that students who rely on rote learning are at greater risk of failing their first year.

students who have English as a second language. They are able to think formally in their first language but not in English (Paxton 1998). The highly abstract language of economics presents a particular problem for speakers of English as a second language. In addition, many students lack the necessary quantitative and graphical skills necessary for the successful study of economics.

The topic of meta-learning (deep learning, holistic processing, or learning to learn) has attracted considerable attention. Meta-learning is defined as an activity of a learner who is aware of the learning process, and who can evaluate and monitor this process. It is the deep level restructuring of material in order to understand it, and as such it involves more than the acquisition of study skills (De Villiers 1990). Ramsden (1992) concludes that deep learning occurs when knowledge is "actively constituted" by the learner. Some scholars see it as important that students construct their own meaning by a process of discovery, rather than receiving a meaning constructed by a teacher by means of an explanation (Slabbert 1994); and that new knowledge is related to concepts that the student already knows (Gerrans 1988).

Research into learning and language in South Africa has been relatively limited in scope. One focus has been the importance of independent learning[6] and its contribution to the development of meta-learning. In one study, students who used independent learning were shown to achieve significantly better results in economics than those who relied solely on lectures (Fransman 1995). Another study showed that the use of workshops in a pre-university chemistry course encouraged students to take more responsibility for their own learning (Gerrans, Huddle and Van Zyl 1991), and it has also been found that students' performance is enhanced when they are actively engaged in the learning process in or out of class (Langer and Applebee 1987, Greene 1994 and Benzing and Christ 1997).

Therefore, existing theory and empirical work suggests that learning is best achieved if students develop their meta-learning skills (Moll and Slonimsky 1989, Gerrans 1988, De

[6] Completing tutorials, essays, assignments, and textbook readings and researching journal articles.

Villiers 1990, Ramsden 1992, Slabbert 1994 and Paxton 1998), and their cognitive and language skills (Moll and Slonimsky 1989). This process is facilitated if new concepts are related to concepts that the student already knows. Cooperative learning is considered to be important in achieving this aim (Slabbert 1994, Nyamapfene and Letsaka 1995 and Mather 1997), as are clearly defined tasks (Mather 1997). Gerrans, Huddle and Van Zyl (1991), Greene (1994), Fransman (1995), and Benzing and Christ (1997) show that encouraging students to work independently pays dividends in the form of better results. The role of essay writing is also stressed (Jacobson 1994, Fransman 1995, Nyamapfene and Letsaka 1995, Paxton 1995 and Paxton 1998) as is the contribution group learning can make to written and spoken English (Slabbert 1994).

2.2 The development of ECO110H

It is recognised that students from socio-economically and academically disadvantaged backgrounds have specific problems – they exhibit cognitive and subject-specific inadequacies, and struggle to communicate in English (Walker and Badsha 1993). Academic support programmes were designed to enable students to overcome their disadvantages, and involved the use of extra tutorials, language courses, bridging programmes and foundation years. More recently the emphasis has been on integrating support structures into the mainstream curricula (Hunter 1991 and Walker and Badsha 1993). The development of ECO110H reflects the changing perceptions of the constraints on learning experienced by academically disadvantaged students.

At the University of Cape Town, in the conventional three-year degree, students of economics take one of the two identical first-year semester courses in microeconomics offered by the School of Economics. The first-semester course (ECO110F) is repeated in the second semester (ECO110S). ECO110S fills a dual role. Not only does it give students who have failed ECO110F a second opportunity to pass the course, but it also makes it possible for students to "pick up" the course, having been unable to do it in the first semester.

The structure of these two mainstream courses is essentially the same, and has been largely unchanged over the period of analysis. Once a week students attend a single-period tutorial, in which a few multiple-choice and essay-type questions are discussed. Two tests, consisting only of multiple-choice questions, are written during the semester. The final examination consists of both multiple-choice and essay-type questions.

Prior to 1982 all students of economics were expected to do the mainstream courses; no additional support was given to students from disadvantaged backgrounds. However, in 1982 the Commerce Faculty introduced the Commerce Academic *Support* Programme (CASP). This programme, renamed the Commerce Academic *Development* Programme (CADP) in 1987, is designed for students who do not have enough matriculation points to be accepted into the Commerce Faculty, are considered to come from academically and socio-economically disadvantaged backgrounds, and are reckoned to have the potential, given the right environment, to achieve a Bachelor of Commerce degree. Prior to 1995, CADP students registered for the mainstream courses. They were required to attend additional (supplementary) courses to help them compensate for critical gaps in their education. For example, they were required to attend a whole-year English language course and a double-period economics tutorial running alongside the mainstream course.

However, even with this support, students from academically disadvantaged backgrounds struggled to pass ECO110F and/or ECO110S. Contributing factors were the pace of the one-semester course and the students' poor English language and quantitative skills. The university responded to this situation in 1995 by introducing a four-year Bachelor of Commerce degree for CADP students.[7] This allowed both the Department of Accounting and the School of Economics to introduce first-semester introductory courses in accounting and economics (ECO112) respectively. The latter course was designed to develop students' understanding of key economic concepts, and so facilitate their entry into mainstream first-year courses (Edwards 2000).[8] In addition to being conducted at a slower pace, the course incorporated an introduction to mathematical techniques, and

[7] See Table A1 in Appendix A for a full description of the first-year courses that make-up this programme.
[8] Initially the ECO112 included both microeconomic and macroeconomic topics. However, in the late 1990s the focus of the course shifted to microeconomics.

double-period tutorials in economics and in language and communication. The latter tutorial was used to develop, by means of written assignments, economic literacy and more effective learning and writing skills.

However, ECO112 students continued to struggle with the pace of the first-year mainstream courses as their relative deficiencies with respect to learning, English language, writing and quantitative skills were not adequately addressed in the half-year course. Therefore, in 1999 the School of Economics introduced ECO110H, a whole-year first-year microeconomics course. Instead of repeating the microeconomics course, academic development students could now use their time more effectively by developing their generic skills over the course of the whole year. ECO110H follows an identical syllabus to the one-semester first-year microeconomics courses, ECO110F and ECO110S, and tests and examinations are set to the same standard.[9] Indeed, from 2001 students doing ECO110S and ECO110H wrote the same examination.

ECO110H also forms part of the new four-year Bachelor of Social Science degree.[10] On the completion of their first two years, students taking this degree's courses have the option of transferring to the Commerce Faculty to complete a Bachelor of Commerce degree.[11] In addition to taking the conventional first-year courses, these students are required to take additional courses to help them compensate for critical gaps in their education. For example, students do a course in mathematics (MAM107).

2.3 Structure of ECO110H

In this section the structure of ECO110H is outlined in some detail; in particular attention is given to showing how the various elements of the course are designed to enable students to develop their skills in the areas of learning, English language, writing and numeracy. Also, a comparison is drawn between the ECO110H and ECO110S courses.

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[9] See Table B1 in Appendix B for an outline of the structure, and Table B2 in Appendix B for a summary of the content, of the three first-year microeconomics courses.
[10] See Table A2 in Appendix A for a full description of the first-year courses that make-up this programme.
[11] It is for this reason that the Social Science programme is known as the "Gateway" – it represents a gateway to the Commerce Faculty.

There are three dimensions to ECO110H: lectures and lecturers, tutorial system, and student assessment

2.3.1 Lectures and lecturers

Lectures were used in the traditional manner to deliver the content of the syllabus, and to explain key economic concepts and discourse (Mather 1997). An important subsidiary aim was to encourage independent learning through the development of students' note-taking skills. Modules on quantitative techniques and graphical analysis and in introductory macroeconomics were introduced in the first semester. The aim of the former module was to enable students to develop and hone the skills necessary to make a success of the course. The purpose of the latter module was to give students a context for their study of microeconomics. In every other respect the course content mirrored that of ECO110F and ECO110S.

ECO110H's lecture classes were small relative to the size of mainstream lecture groups.[12] This approach was based on the view that class size is an important determinant of economics understanding; students who are taught in small groups tend to do better in economics examinations than those who are not (Raimondo, Esposito and Gershenberg 1990 and Lopus 1990).

2.3.2 Tutorial system

The tutorial system played a key role in developing students' meta-learning skills. A variety of approaches was used to encourage students to become independent learners. These approaches included clearly defined tasks, the use of co-operative and group learning, relating new concepts to the students' existing knowledge, and developing students' language and cognitive skills through essay writing. Double-period tutorials

[12] Students doing ECO110F/S have four lectures a week delivered by two or three lecturers concurrently and consecutively. Lecture classes range in size from 150 to 400 students.

were offered for economics and for language and communication. Students were required to attend 75% of these tutorials to qualify to write the final examination, as there is evidence to show that tutorial attendance is positively correlated with examination success (Webster 1988 and Hesketh, Mbali and Mkhize 1994).

a. Economics tutorials

Each tutorial group consisted of about 15 students. Each week, students were required to complete and submit written answers to a set tutorial, which included a variety of types of question.[13] Students submitted their answers to their tutor prior to the tutorial. Tutorials were graded; the aggregate mark for the year counted 5% of the final course mark. The questions set in the tutorials were similar to those set in tests and the examination; this encouraged students to use the tutorials to prepare for the tests and the final examination.

Some of the questions were designed to test the students' knowledge of content and theory, but a significant proportion required students to apply economic theory to real-world situations. In the main, the tutorials were made up of clearly defined tasks, and students were encouraged to engage with these in order to find meaning; this activity has been shown to help students develop their meta-learning skills (Mather 1997).

Exercises that required students to read the textbook and articles from other sources were also set; this has been shown to enable students to achieve significantly better results (Fransman 1995). In a similar vein, tasks were set that students would recognise as useful for their better understanding of course material; this has been shown to draw a favourable response from students (Treisman 1985). Other questions encouraged students to "learn through doing" (Greene 1994). Included in each tutorial were a few more

[13] The standard tutorial includes multiple-choice, paragraph, true/false, fill-in, calculation and case-study questions.

difficult and open-ended questions, which were used as a basis for small-group discussions.[14] The relatively small size of the tutorial group facilitated this process.

In general, students were encouraged to take responsibility for their own learning; it has been shown that students who take responsibility for their own learning tend to do better than those who do not (Gerrans, Huddle and Van Zyl 1991 and Venter 1997). This is not to say that these objectives were entirely achieved. There were always some students who did not respond favourably to this arrangement.

Compared to that of ECO110H, the tutorial system offered by ECO110F/S paid little attention to the development of students' meta-learning skills. Students were given few opportunities to engage with the course material along the lines encouraged in the ECO110H tutorials. Each week, students attended a single-period tutorial during which a few multiple-choice and essay-type questions were discussed. Rarely were students required to submit written work, and, if they were, the grades did not count towards their final marks. Students were required to attend a minimum of 7 of the 10 tutorials in order to write the final examination.

b. Language and communication tutorials

The chief aim of these tutorials was to improve students' essay writing skills and their referencing and comprehension techniques. The general impression is that students have poorly developed skills in these areas, irrespective of their educational and socio-economic backgrounds (Paxton 1995). Students attended a double-period tutorial each week for the duration of the course. Tutorial groups consisted of some 25 students each. Students taking ECO110S were not offered language and communication tutorials.

[14] It should be noted that students were encouraged to work in small groups outside the tutorials and lectures. Although no formal record was kept of this activity, it was the convener's impression that many students did work in this manner.

c. Tutors

A strong emphasis was placed on the selection of tutors. It was assumed that the quality of the tutors' input in the tutorial determined the extent to which students benefited from the tutorial experience. Economics tutors were chosen on the basis of their academic performance, experience and ability to act as role models for academic development students. All had previous experience of working with first-year mainstream and/or academic development students; this has been found to be an important variable in affecting student grades (Morgan and Vasche 1978). Specialist and experienced language tutors were chosen to run the language and communication tutorials. Tutors met once a week with their respective conveners to go through the following week's tutorial and to discuss theoretical and practical issues. Pedagogic issues were also considered. That said, tutors did not receive formal training. It is probable that, as a result, some of the aims of the tutorial programme were not achieved.

2.3.3 Student assessment

The purpose of assessment is two-fold. Firstly, the performance of students in developing their understanding of microeconomics is assessed. The second aim is to enable students to develop their skills in the areas of learning, English language, writing and numeracy. Each of the following elements of assessment was designed to achieve these two general objectives.

Students were required to complete three essay assignments during the year, and write four tests in addition to the final examination. The tests and the examination comprised a mixture of multiple-choice, structured and essay questions. In addition the written tutorials also counted towards the students' course-marks.[15]

[15] The final mark was made up as follows:
3 essays at 5% each (15%), 3 tests at 5% each (15%), 1 test at 10% (10%), 20 written economics tutorials (5%) and the final examination (55%).

Students were encouraged to submit at least one draft of their essays for comment. Course tutors and lecturers attended a marking workshop, and students received a comprehensive report on their performance. ECO110S students were not required to write any essays.

The tests included multiple-choice and structured questions in the ratio of about 30 to 70. Tests for the mainstream economics courses consisted of multiple-choice questions only.[16] The emphasis on the structured questions was designed to encourage students to engage with the tutorial material and to enable them to develop their skills in the areas of meta-learning and English language and their understanding of microeconomics. Students' examination performance, particularly in the structured questions, provided some evidence of the success of the tutorials in enabling students to achieve these aims.

A number of other factors informed the decision to give the structured questions a greater weight than the multiple-choice questions. Firstly, the ECO110H course places a strong emphasis on writing, and it was felt that it was important to test students' writing skills. Secondly, there is strong evidence suggesting that multiple-choice examinations discriminate against females.[17] Thirdly, Harris and Kerby (1997) provide evidence to suggest that second-language students do significantly worse in multiple-choice questions than in structured questions. Every effort was made to correct for this bias; multiple-choice questions were carefully worded so that choosing the correct answer did not depend on distinguishing subtle shades of meaning.

2.4 Conclusion

ECO110H is designed to enable students, who come from academically and socio-economically disadvantaged backgrounds, and who have relied on rote learning, to develop their skills in the areas of meta-learning, English language, writing and

[16] The ECO110F/S final mark is made up of the marks gained in two or three multiple-choice tests and the final examination. The tests count 45% of the final mark. The ECO110F examination paper is made up of multiple-choice and essay questions in the ratio of 50 to 50.
[17] This topic is explored in Chapter 3.

numeracy. To the extent that students acquire these skills, their performance in both first-year and future courses in economics and other subjects should be facilitated.

Insofar as the interventions incorporated in ECO110H are successful, it was expected that the ECO110H cohort would out-perform a control group drawn from the ECO110S cohort[18] in both the first-year and in further economics examinations.

In the following chapter the empirical methodology used in this analysis is developed. This methodology is then used to test two propositions. Firstly, the ECO110H course enables students to master first-year microeconomics, as measured by the year-end examination, relative to a control group drawn from a mainstream first-year microeconomics course (ECO110S). Secondly, successful ECO110H students outperform successful ECO110S students from the control group, in subsequent economics courses, again controlling for a number of explanatory variables.

[18] It is assumed that the students who make up the control group have the same deficit in the areas of learning, English language, writing and numeracy as the ECO110H cohort has.

Chapter 3

Literature review: Empirical methodology and academic development courses

In the previous chapter pedagogical issues surrounding learning and language were discussed, and the various interventions designed to develop students' skills in the areas of learning, English language, writing and numeracy were described. These interventions, that are part of ECO110H, are largely absent from the mainstream first-year microeconomics courses (ECO110F/S).

The object of this thesis is to identify the extent to which ECO110H is successful in improving students' performance in economics. To do this it is necessary to identify, and control for, the many determinants of performance in a first-year economics course. In this chapter a production function approach is used to develop a model to isolate and measure the importance of ECO110H in explaining students' performance in microeconomics. Also, the determinants of economics *understanding* and *learning* are analysed with reference to both the international and South African literature on the topic.

3.1 Education production function

A common approach used in empirical work is to view economics education as a production process involving a variety of inputs and outputs.[19] A typical education production function is illustrated in figure 3.1. Key inputs include the student's school subjects, effort or motivation, socio-economic background, university environment, and a variety of affective and cognitive attributes. Outputs of the production process can include cognitive performance, attitudes and values, and generic skills.

[19] However this is not always the case. For example, Shanahan *et al.* (1997), and Meyer and Shanahan (1999), used cluster analysis to assess the determinants of students' performance in university economics.

The production function used in this thesis is designed to identify the importance of the input, ECO110H, in explaining the cognitive output, economics *understanding*, controlling for the effect of a range of inputs identified as important in the literature.

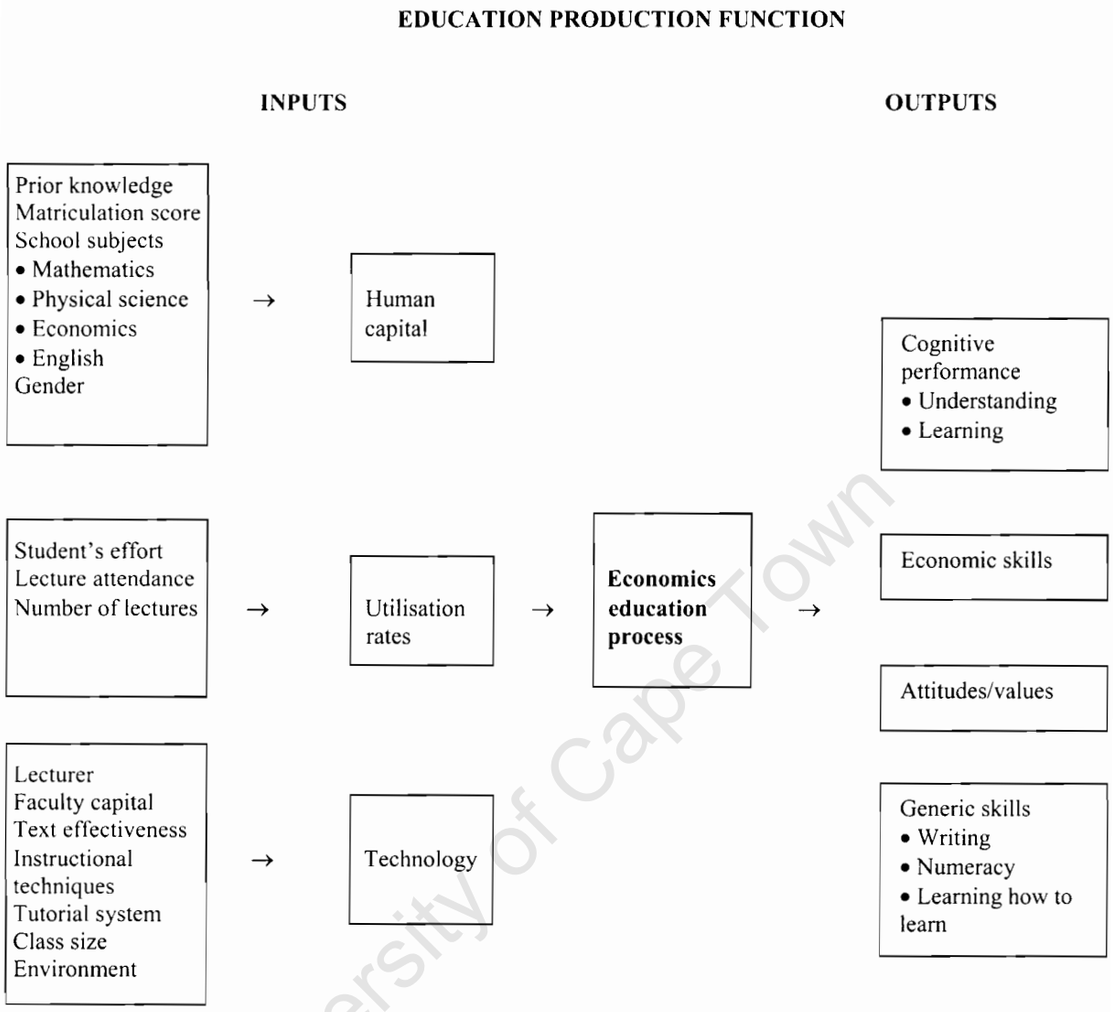

Figure 3.1 The economics education production function[20]

Some of the key components of the production function are discussed in the following section.

[20] Figure 3.1 is from Edwards (2000).

3.2 Cognitive outputs – understanding and learning

The economic education process results in a variety of outputs. These include economics *understanding* and *learning*, economic skills, changes in attitudes and values, social development, and generic skills including writing, numeracy learning how to learn.

The type of output to be measured, and the means of measurement, has been the cause of considerable debate (Hanushek 1979, Polachek, Kriesner and Harwood 1978 and Chizmar and Zak 1983). In their agenda for research on economics education, Becker *et al.* (1991), argue that the multiple outputs from learning economics need to be defined, measured and investigated.

Most of the research to date has focussed on the cognitive outputs of *understanding* and *learning* – the remainder having received little attention as they are difficult to quantify (Becker 1983a 1983b 1983c and Becker *et al.* 1991). It is important to distinguish between models that measure economics *understanding* and those that purport to measure economics *learning*. Following Walstad (1990), a stock model is used to identify the relative importance of a variety of explanatory variables in explaining the student's level of *understanding* (stock of knowledge or absolute level of achievement) usually measured by a set of examination results. In the usual approach, post-test results are regressed on a set of explanatory variables that exclude the pre-test results. However, a flow model is used to identify the relative importance of a variety of explanatory variables in explaining the student's amount of *learning* (absolute improvement), over the duration of a course, usually as measured by a set of examination results. In this instance the set of the students' pre-test scores is included in the set of explanatory variables. Here the amount of learning that has taken place is shown by the change in the post-test scores relative to the pre-test scores. The focus of this study is the cognitive output of economics *understanding*.

Siegfried and Fels (1979) make the important point that many of the problems in the interpretation of ordinary least squares regression coefficients are the result of the failure

to distinguish between stock (level of understanding/knowledge) and flow (amount of learning or attainment) models. Thus it is not made clear what is explained by the multivariate analysis.[21]

There has been much debate on the means of measuring the cognitive output of the education production process. More often than not, researchers have preferred to use multiple-choice, as opposed to structured/essay-type, questions. This is particularly true of research in the United States, where a standardised test (Test of Understanding of College Economics (TUCE)) is available.

The "value of fixed-response (multiple-choice) versus constructed-response (essay or short answer) measures is a hotly debated topic" (Becker *et al.* 1991, p. 244). Research suggests that multiple-choice and structured questions measure different dimensions of economics *understanding* and cognition (Brelland *et al.* 1987, Lumsden and Scott 1987, and Walstad and Robson 1997). Correlation coefficients ranging between 0.60 and 0.75 have been found between the scores on a good multiple-choice test and other measures of economic comprehension (Fels 1970). However, subsequent studies report much lower coefficients (Lumsden and Scott 1983, and Lumsden and Scott 1987).

Structured and essay questions measure important outputs of the education production process, including writing and critical thinking skills. In addition these questions test students in an open-ended manner. However, a particular advantage of the multiple-choice format is that is compatible with complex problem solving processes (Bennett 1993).

That said, there is an argument against the use of multiple-choice questions to measure economics *understanding* and *learning*. Females have been shown to perform relatively

[21] Walstad (1990) observes that many gender studies show significant differences in economics understanding, but fewer show gender differences in learning. In race studies in the United States, stock results are significant but the flow results are insignificant.

poorly on these questions in studies of high-school, and first-year principles, courses in economics (Anderson, Benjamin and Fuss 1994 and Harris and Kerby 1997).[22]

It is clear from the above discussion that multiple-choice questions and structured/essay questions do not measure the same aspects of cognitive performance. This has particular relevance for the investigation of the outcome of an academic development course, as the goals of such a course are broader than those of mainstream courses. These goals include the students' acquisition of skills in the areas of English language and communication, numeracy and learning, which are designed to enable them to cope successfully with subsequent, more demanding courses, in economics and other subjects (Edwards 2000).

Whatever the components of the examination (multiple-choice, structured or essay questions), the examination result can act only as an imperfect proxy for the students' overall level of achievement; they are too narrow a measure of *learning* to be useful (Siegfried and Fels 1979). This is particularly true of an academic development course. The direct implication is that other measures must be used. One such method is to analyse the students' academic performance in subsequent economics courses. Ultimately, the impact of academic development courses and programmes must be measured in terms of their effect on the number of years it takes students to graduate compared to a similar set of students following the conventional three- or four-year mainstream programmes (Edwards 2000). The focus of this thesis is the first step in such an analysis.

3.3 Determinants of economics performance: International studies

In their wide-ranging review of the state of economics education, Siegfried and Fels (1979) identified a variety of *inputs* into the education production process. The first is human capital. This includes general aptitude measures (high-school examination scores and verbal and mathematical abilities), student maturity and age, gender, family income and parents' education, prior knowledge of economics, and level of motivation and effort.

[22] It is noted that the grading of essays is less precise than the grading of multiple-choice questions. This may possibly result in measurement error (Van Walbeek forthcoming).

Other inputs include faculty human capital (years of teaching experience), class size, length of course, and textbook. Morgan and Vasche (1978) identified socio-economic attributes, school environment, economics knowledge, analytical understanding, and instructor characteristics as important inputs into the production process.

An example of a production function is that described by Davisson and Bonello (1976) and Edwards (2000). They identify human capital, utilisation rates (degree to which the student uses the resources available), and technology as the key input variables (see Figure 3.1). The utilisation rate includes a number of key variables: student effort, lecture attendance, number of assignments completed and number of lectures offered. Effort is usually measured by lecture and tutorial participation rates. However, there must be some doubt about whether these two variables capture differences in the quality of individual students' effort and motivation. Technology includes lecturer effectiveness, faculty capital, textbook effectiveness, instructional techniques, tutorial system, class size and general environmental conditions.

It is clear that there are a number of inputs that are used to explain economics *understanding* and *learning*. The purpose of this section is to identify the most important inputs mentioned in the international literature, and so identify the effect of ECO110H on economics *understanding*.

The various inputs, or explanatory variables, are categorised into four sections: student characteristics, school-leaving subjects, course characteristics, and residence arrangements. Each of these is discussed in turn with the aim of identifying the broad trend, given that the evidence is usually ambiguous.[23]

[23] All reported findings are statistically significant at the 5% level at least.

3.3.1 Student characteristics

a. Academic ability

Siegfried and Fels (1979), in their wide-ranging review on the state of economics education, noted that students' general (especially verbal) aptitude is the most important determinant of *understanding* and *learning*. Several studies, using ordinary least squares analysis, have found that academic ability is the key variable in explaining economics *understanding* (Clauretie and Johnson 1975, Morgan and Vasche 1978, Reid 1983, Lumsden and Scott 1987, Walstad and Soper 1989, Raimondo, Esposito and Gershenberg 1990, Park and Kerr 1990, Anderson, Benjamin and Fuss 1994 and Robb and Robb 1999). In these studies the average mark coefficient for the school-leaving examination, which acts as a proxy for academic ability, ranges from 0.50 to 1.2. That is, a one percentage point increase in the average school-leaving mark implies a 0.5 to 1.2 percentage point increase in the economics course mark.[24]

Although a student's effort can compensate for a low level of academic ability, the trade-off appears to be severe. Allison (1977), in a study on the introductory economics course at Harvard, found that the effect of a one percentage point increase in scholastic aptitude verbal and mathematics scores was equivalent to an increase in study time of 10 hours a week.

There have been far fewer studies on the determinants of economics *learning*. Becker, Greene and Rosen (1990), in their survey of research on high-school education, found that the higher the aptitude or intelligence of the student, the greater the learning in economics, again as measured by student performance on a multiple-choice post-test. Van Scyoc and Gleason (1993) found both students' GPA (grade point average) and their pre-TUCE score to be positive and statistically significant in an ordinary least squares flow model designed to identify the determinants of economics learning.

[24] An exception to this general rule is Tay's (1994) finding that grade point average is statistically insignificant in determining student grade symbols in an essay examination at the University of Singapore.

b. Effort, attitude, and motivation

The effort that a student puts into an economics course is governed by attitude and motivation. These two variables represent complex psychological states and it is not surprising that researchers have experienced difficulty in identifying proxies that are both reliable and valid. As a result, the evidence is often ambiguous. For example, Siegfried and Walstad (1990), in a survey of economics education, concluded that study effort has a positive, and attitude an insignificant, effect on students' performance in a first-year economics course. However, Siegfried and Fels (1979), in their review of economics education, noted that study effort does not influence performance very much.

Karstensson and Vedder (1974) used the *Questionnaire on Student Attitude Toward Economics* as a pre- and post-test to measure the change in students' attitude over the duration of the course. They found that a 10 point increase in attitude, out of a maximum possible change of 32, increased grade level performance by approximately one third, from, say, a C+ to a B-. Myatt and Waddell (1990), in a study based in Canada, measured attitude in terms of whether the economics course is compulsory or not. They found the coefficient of the compulsory variable in explaining examination results to be -2.2 and statistically significant.[25] The authors used this finding to suggest that students who choose to study economics tend to do better than those for whom it is compulsory because they have a more positive attitude towards the subject.

Morgan and Vasche (1978) used lecture and tutorial attendance proxies for effort, and found this variable to be positive and statistically significant in affecting students' grades. In similar studies, Schmidt (1983), Lumsden and Scott (1987), and Park and Kerr (1990) confirmed these results. Wetzel (1977) used time devoted to the economics course as a measure of effort. However, this measure is problematic as students learn at different

[25] This implies that students, for whom economics was compulsory, scored 2.2 percentage points less on average in the examination.

rates. He found that A-grade students, and students who expected to get an A grade, put in more effort, and that the level of student attitude had no effect on students' effort.[26]

However, Schmidt (1983) found that the total time allocated to an economics course does not have an impact on student *learning*. This finding was echoed by Gleason and Walstad (1988), reported in Van Scyoc and Gleason (1993), and Park and Kerr (1990), who found that the number of hours spent studying has no on affect student grades.

This brief review highlights the ambiguous nature of the results, which is due in some part to the relative crudeness of the proxies chosen to measure attitude and effort. However, a further problem in interpreting the results is related to the issue of causality. The direction of causality may be from economics performance to a positive student attitude towards economics, rather than the reverse (Becker, Greene and Rosen 1990). Similarly, the relationship between effort and performance is equally difficult to disentangle. These relationships have yet to be unravelled by researchers on economics education.

c. English as a second language

As discussed in Chapter 2, students who have English as a second language experience difficulty in mastering economics when studied through the medium of English. This relationship is generally found in international empirical research.

Lumsden and Scott (1987) found that English as second language has a negative, and statistically significant, effect on students' grades. Similarly, Harris and Kerby (1997), in a study of high-school economics, found that second-language students did significantly worse than students who had English as their first language in multiple-choice questions, but not in essays. The negative impact of English as a second language can also extend into subsequent years. For example, Meyer and Shanahan (1999) showed that English as

[26] Wetzel adopted the same approach as Karstensson and Vedder (1974) to measure attitude.

a second language has a negative impact on students' economics *understanding* into the third year.

d. Ethnicity

Several studies have found that ethnicity is a significant determinant of students' performance in economics. Buckles and Freeman (1984) and Walstad and Soper (1989) found that black students perform relatively poorly, although the latter study found that they had a greater predisposition to learn the subject. Black students have also been shown to perform relatively poorly on multiple-choice questions (Harris and Kerby 1997).

However, the relevance of these results is questionable. Behind this variable lies a spectrum of sociological, economic, educational and political influences. A more productive approach is to focus on these underlying variables, rather than using ethnicity as a proxy, if one wishes to gain a useful insight into the determinants of economics performance.[27]

e. Gender

The effect of gender on *learning* and *understanding* is one that has been explored at great length. The summary finding is that females tend to do better in essay, and males in multiple-choice choice, questions, although numerous studies report results to the contrary (Reid 1983, Park and Kerr 1990, Williams, Waldauer and Duggal 1992 and Tay 1994). There are a number of psychological, cultural and sociological theories to explain why this might be case (Ferber 1984, Childs 1990, Becker, Greene and Rosen 1990, Tay 1994, Anderson, Benjamin and Fuss 1994, Hirschfeld, Moore and Brown 1995 and Walstad and Robson 1997). However, a discussion of these theories lies outside the scope of this thesis.

[27] The effect of ethnicity on economics performance was not tested in this study. That said, all regression equations used in this study were run including ethnic-group dummies. The dummy variable was only statistically significant for one estimation, and then only at the 5% level.

Several studies report that the advantage females enjoy in essay questions, and males in multiple-choice questions, is statistically significant (Lumsden and Scott 1983, Lumsden and Scott 1987, Walstad and Soper 1989, Siegfried and Walstad 1990 and Harris and Kerby 1997). Further, Clauretie and Johnson (1975), Myatt and Waddell (1990), Breland (1991), Anderson, Benjamin and Fuss (1994) and Robb and Robb (1999) reported females scoring between 2.7 and 3.3 percentage points less than males on a multiple-choice examination.

A number of studies have focussed on students' performance in essay questions. For example, Breland (1991) and Greene (1997) showed that females have an advantage in essay questions. However, Lumsden and Scott (1987) found that the female advantage in essay writing decreases, and that the female disadvantage in multiple-choice questions increases, over time.

f. Maturity and age

Maturity refers to the *number of years* a student has been attending university. It is generally assumed that mature students acquire a variety of skills that enable them to make a greater success of any course that they take. Several studies report that more mature students tend to out perform first-year students in first-year economics examinations (Clauretie and Johnson 1975, Bonello, Swartz and Davisson 1984 and Anderson, Benjamin and Fuss 1994).

It is also assumed that there is a positive relationship between students' *age* and economics performance; older students are more likely to have achieved the level of intellectual development necessary for mastering abstract processes (McConnell 1980). However, the evidence regarding students' ages is inconclusive. For example, a number of studies show that students' ages has a positive, and statistically significant, effect on students' performance in economics courses (Siegfried and Walstad 1990, Myatt and Waddell 1990 and Tay 1994). In contrast, several studies found the effect of age to be

statistically insignificant (Morgan and Vasche 1978, Lumsden and Scott 1987 and Park and Kerr 1990).

3.3.2 School-leaving subjects

Most general studies include a number of school-leaving subjects to explain students' performance in first-year economics. These are assumed to capture students' ability, knowledge and important skills that facilitate *understanding* and *learning*. In this section the research findings regarding economics, English, and mathematics are discussed in some detail.

a. Economics (high-school or prior economics courses)

There appears to be a strong argument for a positive relationship between grades obtained in high-school or prior economics courses and performance in the first-year economics examination. A range of findings has emerged regarding the effect of high-school or prior economics courses on economic *understanding* and *learning* at the tertiary level. In summary, it appears that much depends on the content of the course attended by the student (Reid 1983 and Lopus 1997). For example, for the relationship between A-level economics and economics performance in a first-year economics course, Lumsden and Scott (1987) reported an intercept coefficient of 3.5. This result implies that students who have done A-level economics achieve on average 3.5 percentage points more in the first-year economics course than those who have not. Tay (1994) reports a slope coefficient of 0.37 for the same relationship. This means that for every one percentage point increase in their A-level economics mark, students achieve on average a 0.37% increase in their first-year economics course mark. This finding was replicated in Canada by Myatt and Waddell (1990), who showed that students with previous exposure to economics gain 3.5 percentage points[28], and in the United States by Brasfield, Harrison and McCoy (1993).

[28] They reported that the effect of high-school economics decays over time.

However, a number of studies have shown that prior economics courses have little or no effect on economics performance at the tertiary level (Siegfried and Fels 1979, Siegfried and Walstad 1990 and Becker, Greene and Rosen 1990). Indeed, Reid (1983), Robb and Robb (1999), and Anderson, Benjamin and Fuss (1994) found statistically significant negative effects.

Apart from variations in content between high-school economics courses in different countries, and the extent of the match between the content of the high-school economics course and the content of the first-year university course, there is a further difficulty in assessing the impact of high-school economics on *understanding* and *learning*: academically strong students tend not to take economics at school (Peterson 1992 and Anderson, Benjamin and Fuss 1994). This raises an important selection issue. In some countries, academically weaker students may be offered a subject such as economics, as an alternative to mathematics, physics or history, for example. This is certainly the case in South Africa, where many students opt for business economics and economics as alternatives to the sciences and mathematics on the higher grade. In short, a negative relationship may reflect selection bias rather than the negative impact of school economics on economics *understanding* and *learning*.

b. English

In the light of the review in Chapter 2, there are strong grounds for expecting this variable to have a positive impact on economics performance at universities where English is the medium of instruction. Students' ability to understand multiple-choice questions, and to express themselves clearly in answering structured/essay type questions, is thought to be closely allied to their command of English, the language in which they are taught and in which tests and examinations are set.

In general, the studies lend support to this view. For example, Myatt and Waddell (1990) found English grades to be positively and significantly related to examination results, and that good English results have slightly more explanatory power than good mathematics results. However, Anderson, Benjamin and Fuss (1994) found that English grades are not

a significant explanatory variable, although students who have English as one of their six top scoring subjects outperform those who did not by 4.9 percentage points.

c. Mathematics

There is a large body of evidence suggesting that competence in mathematics is strongly associated with economics performance (Reid 1983, Raimondo, Esposito and Gershenberg 1990 and Robb and Robb 1999). It is argued that the ability to understand and interpret graphs, and to use algebra and calculus, facilitates the students' *understanding* of microeconomics in particular and economics in general (Myatt and Waddell 1990).

Lumsden and Scott (1987) and Myatt and Waddell (1990) reported statistically significant slope coefficients of 0.61 and 0.26 respectively.[29] Reid (1983) found the intercept coefficient for mathematics to be 4.23 and statistically significant.[30] Bonello, Swartz and Davisson (1984) found the coefficient of MSAT[31] to be positive and statistically significant. In contrast, Robb and Robb (1999) found courses in calculus and algebra to be statistically insignificant.

However, the positive relationship between school mathematics and economics performance may be due to sample-selection bias. Academically stronger students tend to take more advanced mathematics courses (Myatt and Waddell 1990). Therefore, it may be that their stronger performance in first-year economics is the result of their higher level of general academic ability rather than of their greater proficiency in mathematics.

[29] This means that a 1 percentage point increase in the mathematics mark results in a 0.61% and 0.26% increase in the economics mark, respectively.
[30] This means that students who have taken mathematics achieve on average 4.23 percentage points more in the economics course than those who have not.
[31] Score for the mathematics section of the Student Admissions Test (SAT).

3.3.3 Course characteristics

a. Class size

The evidence regarding the importance of class size in explaining students' *understanding* and *learning* is mixed. According to Siegfried and Fels (1979), class size does not matter very much in explaining *understanding* and *learning* in the principles of economics course. In contrast, Raimondo, Esposito and Gershenberg (1990) and Lopus (1990), found that smaller class sizes, in the United States, improve performance in intermediate microeconomics and school economics, respectively.

b. Teacher/tutor characteristics

It is generally assumed that the teacher/tutor's ability and knowledge of economics is positively related to students' *learning* and *understanding* of economics (Morgan and Vasche 1978, Weaver, Deaton and Reach 1987, Walstad and Soper 1989 and Becker, Greene and Rosen 1990). However, there are a number of dissenting voices. Several studies report that the characteristics of the instructor play an insignificant role in determining students' performance (Morgan and Vasche 1978, Tay 1994 and Siegfried and Walstad 1990).

Other studies have investigated the importance of the relationship between the teacher and the student. Morgan and Vasche (1978) found that the ability of the teacher to communicate and relate to students' problems and questions plays an important role in promoting economics performance. In a similar vein, Becker, Greene and Rosen (1990) reported that the teacher's attitude influences the student's attitude towards subject. In contrast, Lumsden and Scott (1987) found that the students' opinion of their teacher is unimportant in explaining economics performance.

3.3.4 Residence

The environment in which a student lives can impact significantly on the students' performance (Reid 1983). Students who come from poor socioeconomic backgrounds, who live in crowded households, far from their place of study, without access to electricity and running water, cannot be expected to perform as well as their more privileged peers. In a Canadian study, Reid (1983) reported that students living in an adverse environment (selected university residences) have a lower stock of knowledge at the end of an introductory economics course. In contrast, in the United States, Park and Kerr (1990) found that the students' environment has no effect on their economics performance.

3.3.5 Concluding remarks

Numerous studies have been undertaken over the past 35 to 40 years, and these have generated a diverse range of results. There are many factors that contribute to the mixed nature of the results regarding the relationship, and statistical significance, of the inputs (explanatory variables) to economics *learning* and *understanding*.

Firstly, these studies have been conducted in a number of different countries, each with its own cultural and educational system. Within each country there are differences between schools across, and within, regions. For example, the impact of high-school economics on economics performance at the tertiary level has been shown to vary considerably between the United States and the United Kingdom.

Secondly, in the vast majority of studies, each variable is assumed to be independent of the others; multivariate analysis has been undertaken on the basis of this assumption. However, it seems likely that there is some degree of interdependence between several of these variables. For example, the difficulty in determining the nature of the relationship between effort, attitude and motivation has already been considered. Further, the attitude and the ability of the teacher may not be determined independently of the effort and

attitude of the student. It may well be that these variables are simultaneously determined along with the students' examination results.

The precise nature of the relationship between the many variables that may explain students' economics performance is a complicated one. Not only must these interactions be modelled, but it is also necessary that they be built into the procedure of estimation. Steps to elucidate the many complex relationships that determine students' *understanding* and *learning* remain a major challenge for researchers in the years ahead.

3.4 Determinants of economics performance: South African studies

A number of South African studies on the determinants of *understanding* have been conducted in economics and other disciplines. Within economics, the primary studies are those of Edwards (2000) and Van Walbeek (forthcoming). These studies use production function approaches to isolate the explanatory variables that determine economics *understanding*. Some of the key results of these studies are presented in Table 3.1 on page 35.

In most studies, proxies for academic ability are found to be important in explaining students' academic performance at university. In a study of first-year mainstream microeconomics students (ECO110S) at the University of Cape Town, Edwards (2000) reported a slope coefficient of 0.9 for the adjusted matriculation points score.[32] Van Walbeek (forthcoming), in a study of first-year mainstream microeconomics students (ECO110F), at the same university, identifies a positive non-linear and statistically significant relationship between the square of the adjusted matriculation points score and

[32] Edwards (2000) included dummies for English first language and mathematics higher grade as explanatory variables. To limit collinearity between these two variables and matriculation points, an adjustment was made to the matriculation points score. Unfortunately, Edwards did not explain how this adjustment was made. Also, he did not provide a rationale for the inclusion of the points for physical science higher grade in the matriculation points score. It seems probable that there are collinearity issues with respect to this variable too.

the marks for both the multiple-choice and essay questions.[33] This result implies increasing returns to academic ability.

Matriculation points are also shown to be important predictors of students' academic performance in other fields. These include first-year psychology students' at the University of Cape Town (Bokhorst, Foster and Lea 1990), first-year commerce students at the University of Transkei from 1985 to 1988 (Sawyer 1994), and white first- and second-year engineering students of the 1989 intake at the University of Cape Town (Jawitz 1995). The importance of academic ability in explaining students' performance also holds for academic development students. Curtis and De Villiers (1992) and De Villiers and Rwigema (1998) report coefficients of 0.94 and 0.02, respectively, for admission rating. On average, these studies found that a 1 point increase in matriculation points results in a 0.02% to 0.9% increase in the examination mark.[34]

Consistent results for mathematics are found by Hesketh, Mbali and Mkhize (1994) and Van Walbeek (forthcoming), and for physical science by Edwards (2000) and Van Walbeek (forthcoming). However, the findings for English are less robust. Van Walbeek (forthcoming) finds that despite the statistically significant coefficient for English, the English-language grade is less of an important determinant of success, in the multiple-choice examination, than is the performance in any other matriculation subject, barring mathematics. Also, English plays no role in determining the essay mark.

Age is an important determinant of economics performance (Van Walbeek forthcoming), and males are found to outperform females on a mainstream course (Edwards 2000 and Van Walbeek forthcoming) in microeconomics. English (second language) has a negative impact on the economics performance of the academically disadvantaged students (Banach, Fuzile and Rampedi 1992).

[33] Van Walbeek (forthcoming) used the same method as Edwards (2000) to calculate the adjusted matriculation points score.
[34] Matriculation points are calculated on the basis of points awarded for each grade achieved in the matriculation examination on either higher or standard grade for each subject.

Table 3.1 Explanatory variables identified for South African students of economics

	Edwards (2000)	Van Walbeek (forthcoming)	Others
Independent variables	**Economics**	**Economics**	
Students' characteristics			
Academic ability (slope coefficient)	0.9 for adjusted matriculation points	0.10 for (adjusted matriculation points)^2 for the multiple-choice, and 0.07 for the essay questions, respectively	
Age (slope coefficient)		Range of 1.2 for the multiple-choice and essay questions	
English second language	3.0 percentage points for English home language		Banach, Fuzile and Rampedi (1992) Poor grasp of English
Gender – male	3.4 percentage points	7.3 percentage points on multiple-choice	
School-leaving subjects			
Economics	4.16 percentage points		
English language HG	Negative and statistically insignificant	1.88 percentage points for the multiple-choice questions	
Mathematics	Statistically insignificant	0.36 and 0.35 for (matriculation mathematics HG)^2 for both the multiple-choice and essay questions, respectively 3.2 percentage points for additional mathematics on the multiple-choice questions	Hesketh, Mbali and Mkhize (1994) Strong correlation with mathematics
Physical science	8.2 percentage points	2.4 percentage points for the multiple-choice questions	
Education departments			
ex-DET	-3.8 percentage points		
Western Cape		2.1 percentage points for the multiple-choice questions.	
Eastern Cape		3.8 percentage points for the multiple-choice questions and 3.4 percentage points for the structured questions.	
Course characteristics			
Hours allocated to course (number of lectures attended)		1.12 (for multiple-choice) and 1.41 percentage points for essay questions, respectively	

Two studies report on the relative importance of the various education departments in explaining economics performance at the tertiary level. Mainstream students from the Western Cape and Eastern Cape out perform students from the rest of the country and elsewhere (Van Walbeek forthcoming). However, Van Walbeek (forthcoming) offers no explanation as to why this should be the case. Edwards (2000) identified students who attended ex-DET schools and finds a negative (-3.8), and statistically significant, difference in their performance relative to non-DET students.[35]

[35] It was expected that students from schools formerly administered by the DET, and the Houses of Representatives and Delegates, will continue to suffer an educational disadvantage (Case and Deaton 1998). This disadvantage was expected to have a negative impact on their performance at university. Note that the data for this study comes from 1996.

Finally, Van Walbeek (forthcoming) reports that the number of lectures attended has a positive impact on economics performance for mainstream students. However, these findings are open to another interpretation. Lecture attendance might act as a proxy for motivation. Weak students might give up attending lectures at an earlier stage because they are not coping, and successful students might attend because they are more motivated. In short, students might attend lectures because they are doing well, and not that they do well because they attend lectures.

In line with the international findings, discussed in Section 3.3, academic ability is the key variable in explaining economics performance. Other important explanatory variables also referred to in the international literature are age, gender, and the school-leaving subjects, economics, English and mathematics. However, there is no reference to the school-leaving subject physical science (physics and/or chemistry) in the international literature. This variable seems to play an important role in promoting economics *understanding*, particularly as measured by multiple-choice questions, for South African students of the subject (Edwards 2000 and Van Walbeek forthcoming).

3.5 Academic development courses in economics and related subjects: South African studies

Previous research on South African academic development courses in economics and related subjects is highly relevant to this thesis. This section is aimed at highlighting some of the shortcomings of these studies; one of the aims of this thesis is to improve on the research methods employed in this area in the past.

The primary focus of earlier studies was to explain why academically disadvantaged students fail the first-year economics course. These studies were largely analytical, or used simple correlation analysis. For example, Banach, Fuzile and Rampedi (1992) concluded, on the basis of "close scrutiny" of students' papers, that the main explanation for the high failure rate among African students was their poor grasp of English and their lack of analytical skills. Hesketh, Mbali and Mkhize (1994) used correlations and

interviews to identify a low level of mathematical ability as the key reason for a small sample of students failing a first-year economics course.

Only four studies have examined the effectiveness of a development course or programme. These are Ayaya (1996), Curtis and De Villiers (1992), De Villiers and Rwigema (1998) and Edwards (2000). With the exception of Edwards (2000), their empirical methodology precludes an assessment of the robustness of the relationships they describe.

Ayaya (1996) used ordinary least squares to investigate the influence of 29 explanatory variables, including students' first-year weighted mean marks[36], on academic performance of students in a Bachelor of Commerce programme at the National University of Lesotho for the period 1982/83 to 1991/92. Ayaya concluded that the transition programme was successful. However, this conclusion does not seem warranted as there was no control group, and it seems more likely that the transition-year weighted mean mark was primarily a measure of academic ability.

Curtis and De Villiers (1992) and De Villiers and Rwigema (1998) used a mainstream control group to evaluate the success of a bridging year for commerce undergraduates at the University of the Witwatersrand. Students selected for this study had all attended schools falling under the now defunct Department of Education and Training (DET).[37]

Curtis and De Villiers (1992), after controlling for differences in admission rating, used ordinary least squares analysis to establish that students who attended the bridging course achieved an additional 7.7% points.[38]

[36] At the University of Lesotho, first-year courses are transitional courses, which do not count towards the final degree. However, these marks determine whether the student is accepted onto the degree programme.
[37] The Department of Education and Training, formerly known as the Department of Bantu Education, had responsibility for the education of black children from 1954 to 1994.
[38] Admission rating was calculated on the basis of points awarded for each grade achieved in the matriculation examination on either higher or standard grade for each subject.

De Villiers and Rwigema (1998) looked at the effect of the bridging year on the graduation success, compared to those ex-DET students who had followed the mainstream programme. To the author's knowledge, this was the first study that attempted to evaluate the long-term effect of a first-year academic development course or programme. De Villiers and Rwigema (1998) showed, controlling for the admission rating, that bridging-programme attendance had a positive and statistically significant effect for each of the four periods to graduation.

Both the Curtis and De Villiers (1992) and De Villiers and Rwigema (1998) studies suffer from selection bias in that students were chosen for the bridging programme on the basis of a number of criteria, including their admission rating. Ideally, the pool of ex-DET students should have been randomly allocated between the bridging programme and the mainstream. A defect of the study by De Villiers and Rwigema (1998) was the use of ordinary least squares analysis with a binary dependent variable. This can result in heteroskedastic non-normal error terms. In this instance, logit or probit models should be used.

Finally, Edwards (2000) evaluated the success of an introductory first-semester economics course (ECO112), for academically disadvantaged students at the University of Cape Town, in promoting the *understanding* of economics. He also identified the key explanatory variables that helped explain examination success in the first-year microeconomics examination (ECO110S). This paper is reviewed at some length as it poses a number of questions, which this thesis attempts to answer.

ECO112 focussed on graphical and mathematical techniques used in economics, and price theory. The course also included two double-period tutorials in economics and in language and communication. Successful students went on to the second-semester mainstream microeconomics course (ECO110S). They were joined by students taking economics for the first time and those students who had failed the first-semester mainstream microeconomics course (ECO110F). The latter group were used as a "control" group with which to evaluate the relative performance of students who had

taken ECO112. Using multivariate analysis (ordinary least squares and robust regression techniques), for a linear production function, Edwards (2000) identified the significant explanatory variables explaining variations in the final mark, which acted as a continuous dependent variable. He compared the relative effectiveness of ECO110F and ECO112 in explaining success in ECO110S; the "sink or swim" route (failed ECO110F) versus the more resource-intensive ECO112 route.

Further, Edwards (2000) was particularly concerned with the performance of students from ex-DET schools, who made up the bulk of the ECO112 cohort. He ran separate regressions for students from ex-DET schools and the remainder who were not. Again he was able compare the relative effectiveness of ECO112 versus ECO110F, and to identify the other statistically significant explanatory variables.

Edwards' (2000) results are robust with an overall adjusted R^2 of 0.34. Both the ECO112 (coefficient, 7.25) and ECO110F (coefficient, 4.0) cohorts do significantly better than first-time economics students. This means that ECO112 students achieve 7.25 percentage points, and ECO110F students 4.0 percentage points, more on average than first-time economics students. The ECO112 cohort do better than the ECO110F cohort but the difference is not statistically significant. Edwards (2000) concludes that it is not possible to draw any strong conclusions regarding the effectiveness of ECO112 relative to ECO110F, and that this raises important questions concerning the cost-effectiveness of this academic development course.

This study could be improved in two ways. Firstly, a method is required to deal with the sample-selection problem. In an ideal world, a random proportion of academically disadvantaged students would be put through the mainstream; these students would act as a control group. Failing that, a control group should be drawn from the mainstream cohort. Either way, variations in performance, between the control and experimental groups, could be directly related to the different nature of the two courses. In this regard, it would have been useful to have had a table showing the breakdown of both the ECO112 and ECO110F cohorts by each independent variable. It would then have been

possible to judge the degree to which these two groups are matched on each of the explanatory variables.

Secondly, Edwards (2000) did not distinguish between students' performances on the multiple-choice and essay questions. Separate regressions could have been estimated for the multiple-choice and essay marks; this could have given greater insight into the role of each of the explanatory variables. For example, the reported gender bias could have been due to students' performance on the multiple-choice component of the examination.

3.6 Conclusion

The purpose of this chapter was to describe the appropriate empirical methodology, and to identify the key inputs into the education production function that explain economics *understanding*.

The education production function is used to model the relationship between inputs (explanatory variables) and the output, economics *understanding*. Identification of the important explanatory variables (inputs) makes it possible to control for their influence on economics performance, and so isolate the effect of the interventions incorporated in the academic development course in microeconomics (ECO110H).

The most important explanatory variables include the following: the students' characteristics of academic ability, age, gender and English (second language); the students' school-leaving subjects such as economics, English, mathematics and physical science; course characteristics; and residence arrangements.

Many of the South African studies reviewed are descriptive in nature. In contrast, researchers in the international arena have tended to use ordinary least squares multivariate analysis to identify the key inputs that explain economics *understanding* and *learning*. To date, only Edwards (2000) and Van Walbeek (forthcoming) have employed this methodology in the generally accepted manner.

This thesis explicitly analyses the effect of an academic development course in economics using an empirical methodology that investigates the following relationships. Firstly, the performance of academic development students is compared with a control group drawn from the mainstream, in both the first-year microeconomics, and subsequent macro- and microeconomics, courses. Secondly, the statistically significant independent variables explaining student performance in both multiple-choice and essay/structured questions are identified.

The following chapter describes the econometric methodology used to test the effectiveness of ECO110H in both the first-year microeconomics course, and in the subsequent first-year macroeconomics and second-year microeconomics courses, controlling for the variety of explanatory variables.

Chapter 4

Econometric methodology and analysis of data

ECO110H has two main aims. The first is to enable students to achieve success in a first-year microeconomics course, relative to a mainstream control group. Secondly, ECO110H is designed to enable students to achieve success in further economics courses, relative to the same control group.

The objective of this thesis is to estimate empirically both these relationships. The first part of the empirical analysis examines the effect of ECO110H on the performance of students in the first-year microeconomics examination, compared to a control group drawn from a mainstream first-year microeconomics course (ECO110S). To test the robustness of this relationship, the analysis is done for both the 2000 and 2001 cohorts.

In the second part of the empirical analysis the effect of ECO110H on students' performance in subsequent first-year macroeconomics (ECO111S), and second-year microeconomics (ECO203F), courses is compared with that of a control group who took ECO110S. This analysis is only undertaken for the 2001 cohort.

This section develops the specific functions used to estimate these relationships, taking into account some of the shortcomings of the earlier research identified in Chapter 3. In particular, issues relating to sample-selection bias are considered. Given that ECO110H and ECO110S students are not randomly selected for the two courses, it is not possible to generalise the findings to the population of students as a whole. Two methods are designed to deal with the sample-selection problem. The data used in the analysis is also discussed.

A number of other issues, highlighted in Chapter 3, are also addressed in the empirical analysis. Firstly, a greater variety of independent variables has been chosen than is usually the case, with the intention of identifying the precise nature of the relationship

between each explanatory variable and the level of students' economics *understanding*. Secondly, following Van Walbeek (forthcoming), the explanatory variables are identified for both the essay/structured and multiple-choice questions. Finally, in its use of multivariate analysis to estimate the long-term effects of an economics development course, this study breaks new ground.

4.1 Estimation approaches

Following the international and South African literature, this study estimates an education production function, regressing a proxy for economics *understanding* (multiple-choice and structured/essay question marks) on a variety of independent variables. The purpose of this section is to develop an estimation approach to determine whether ECO110H enhances students' economics performance, relative to ECO110S, controlling for a variety of students' characteristics, school-leaving subjects and other relevant characteristics, in both first-year microeconomics and in subsequent macro- and microeconomics courses.

Following the production function approach set out in Chapter 3, separate linear functions are estimated for both multiple-choice (MCQ) and structured (SQ) questions.

MCQ = f(ECO110H, students' characteristics, school-leaving subjects, course characteristics, residence and education departments) (1)

and,

SQ = f(ECO110H, students' characteristics, school-leaving subjects, course characteristics, residence and education departments) (2)

Multiple-choice (MCQ) and structured question (SQ) marks obtained by ECO110S and ECO110H students in their final examination act as proxies for economics

understanding.[39] The two estimations are undertaken for the first-year microeconomics course and the subsequent courses in first-year macroeconomics (ECO111S) and second-year microeconomics (ECO203F).

Another specification of the general functions was estimated to test for the robustness of the relationship between ECO110H and the two dependent variables for the first-year economics course. To test for *non-linearity*, the continuous independent variable, adjusted matriculation points score, was entered in quadratic form. A number of interaction terms were also included to test whether the marginal impact of ECO110H on economics performance is influenced by one or more characteristics of students. For example, the interaction term ECO110H*mathematics (HG) is included in the regression equation to identify whether the impact of ECO110H on students' economics performance depends on the students' mathematical ability, as measured by their matriculation results.

The strong emphasis on developing students' skills in the areas of writing and English language is expected to enhance the students' economics performance, particularly in the structured and essay questions, relative to other students, conditional on all other explanatory variables.

Following Edwards (2000) and Van Walbeek (forthcoming), ordinary least squares multivariate analysis is used, as the dependent variable is continuous. The White heteroskedasticity-consistent standard errors and covariance test is applied in each of the estimations and a top-down strategy (Robb and Robb 1999) is adopted with the level of significance set at 5%. The econometric software package used is EVIEWS.

[39] In 2000, ECO110H and ECO110S students were set different structured questions in the final examination, although the multiple-choice questions were the same. However, the external examiner rated the questions as being of an equal standard. In 2001, both cohorts sat the same final examination.

4.1.1 Control variables

Table 4.1 (page 46) lists the control variables used in this study. In each case, the type and code, the expected sign of the coefficient, and whether it is included in the regression equations for the first-year course and subsequent economics courses is given.

The chief objective of this thesis is to use the ECO110H variable to assess the effectiveness of an academic development course on students' performance in first- and second-year economics courses. ECO110H includes a variety of interventions aimed at enhancing students' skills in the areas of learning, English language, numeracy and writing. Therefore, a dummy for the variable ECO110H is included in all the specifications. This dummy captures all the factors that differentiate ECO110H from ECO110S. In short, this variable captures the educational approach followed in ECO110H that is designed to set this course apart from the two mainstream first-year microeconomics courses, ECO110S and ECO110F. A positive sign for the coefficient of the dummy variable ECO110H suggests that ECO110H exerts a positive influence on students' economics performance relative to ECO110S.

A dummy for ECO110S is also included in the regression equations for subsequent economics courses. If the coefficient of this variable is *negative* and statistically significant, relative to the omitted variable (cohort who passed ECO110F), and the coefficient for ECO110H is statistically insignificant, relative to the omitted variable, ECO110F, it suggests that the ECO110H course has been successful in enhancing students' economics performance in subsequent economics courses relative to the ECO110S course.

The matriculation points score is also included as a measure of academic ability.[40] However, due to construction the matriculation points score is correlated with a number

[40] The University of Cape Town allocates points to matriculation subjects as follows:
Higher Grade: A=8, B=7, C=6, D=5, E=4, F=3.
Standard Grade: Two points less for each grade.
The Commerce Faculty doubles the points for mathematics and English.

of independent variables such as mathematics (HG and SG), English first language (HG), English second language (HG) and physical science (HG). To remove the correlation, following Edwards (2000) and Van Walbeek (forthcoming), the points for English and mathematics are subtracted from the matriculation points score. Also, two points are deducted from the matriculation points score of those students who did physical science (HG).[41] Therefore, the adjusted matriculation points score includes the matriculation points for the four subjects, other than English and mathematics, taken.

Table 4.1 Control variables

Explanatory variables	Code	Continuous/ dichotomous	Regression equations	Expected sign of coefficient	
				MCQ*	SQ**
ECO110H	h	Dichotomous	All	+ve	+ve
ECO110S	s	Dichotomous	Second-year courses	-ve	-ve
First time economics	ftime	Dichotomous	First-year micro	None	None
Control variables					
Student characteristics					
Academic ability Matriculation points adjusted	adjmatpt	Continuous	All	+ve	+ve
Age	age	Continuous	First-year micro	None	None
English home language	enghome	Dichotomous	First-year micro	+ve	+ve
Gender	male	Dichotomous	All	+ve	None
School leaving subjects					
Business economics	busecon	Dichotomous	First-year micro	None	None
Economics	eco	Dichotomous	First-year micro	None	None
English first language (HG) Dummy for each grade	engflhg	Dichotomous	All	+ve	+ve
Mathematics (HG) Dummy for each grade	mathhg	Dichotomous	All	+ve	+ve
Physical science (HG) Dummy for each grade	pshg	Dichotomous	All	+ve	None
Other					
Commerce Faculty	comm	Dichotomous	First-year micro	None	None
Home (2000)	home	Dichotomous	First-year micro	None	None
Residence (2001)	res	Dichotomous	First-year micro	None	None
Education department					
Pre-1994					
Department of Education and Training	det	Dichotomous	First-year micro	-ve	-ve
House of Representatives	cohr	Dichotomous	First-year micro	None	None

* Multiple-choice questions
** Structured/essay type questions

[41] Soper (1976) addressed the problem of independent variable interdependence by specifying separate functions for each of the collinear variables with respect to the same independent variables. He showed that the regression coefficients of the truly independent variables are increased by the use of a multi-equation model. Park and Kerr (1990) used a filtering process to handle multicollinearity in their model. However, these two approaches can be used only if the independent variable is continuous.

The adjusted matriculation points score is taken as a proxy for academic ability. The coefficient of this variable is expected to be positive and statistically significant for both the multiple-choice and structured/essay type questions. The coefficient of the square of this variable was also investigated. There is no *a priori* assumption as to the sign of the coefficient and the statistical significance of this latter variable.

In comparing the performance of students in the first-year microeconomics course, dummies are included for each grade symbol obtained for English first language (HG), mathematics (HG) and physical science (HG). This procedure differs from that followed by Edwards (2000) and Van Walbeek (forthcoming). The former used a dummy for each of the three subjects only, and the latter translated grade symbols into a continuous variable by allocating points for each symbol. It is expected that the coefficient of the dummies representing grades A to C will be positive and statistically significant for both the multiple-choice and structured/essay questions. There is no *a priori* assumption regarding the linearity of the relationship between grades and examination scores.

However, in comparing the performance of students in further economics courses a dummy is included for each of English first language (HG), mathematics (HG) and physical science (HG), and not for grades A to F.

Most of the students who are registered for ECO110S are repeating the first-year microeconomics course, having failed ECO110F. However, a relatively small number are doing economics for the first time. A dummy is included for this control variable; this makes it possible to compare the performance of ECO110S students who are taking microeconomics for the first time with those who are repeating the first-year microeconomics course. It can be argued that insofar as students who take ECO110S have spent more time studying microeconomics, they should outperform those students taking the subject for a single semester only, conditional on all the other explanatory variables. That said, in this study there is no *a priori* assumption regarding the sign of this coefficient.

Insofar as the pernicious effects of the system of Bantu Education persist, students from schools formerly administered by the DET could be expected to perform less well than their peers from schools falling under the remaining education departments. Therefore, the coefficient for this variable is expected to be negative and statistically significant.

As noted previously, the most important explanatory variables excluded from this study are students' effort, attitude and motivation. The omission of these variables is unfortunate. However, as the literature review makes clear, there are very real difficulties in finding suitable proxies for these variables, and in clarifying the nature of the relationship between each of these variables and the dependent variable. Also, complications arise in that the relationship between each of these variables, and the numerous interventions included in the ECO110H course is complex and difficult to unravel.

4.1.2 Estimation issues

The most important issue is that the students were not randomly selected into the experimental and control groups, ECO110H and ECO110S.[42] To the extent that the samples do not represent the population from which they are drawn, there is sample-selection bias, and it is not possible to generalise findings based on the sample to the population as a whole. Others, most notably Edwards (2000), have attempted to use a control group. However, his control group appears to have a very different set of characteristics to his experimental group, although no breakdown of the data is given. In this section the sources of selection bias are identified, and the steps taken in this study to match the two samples described.

To show that ECO110H makes a significant difference to students' performance, it is necessary that the following two conditions are satisfied. Firstly, that the samples of students from ECO110H and ECO110S who do write the final examination do represent

[42] There is an extensive literature on sample-selection problems – this literature includes Park and Kerr (1990), Raimondo, Esposito and Gershenberg (1990), Salemi and Tauchen (1982), and Polachek, Kriesner and Harwood (1978).

the population of students who first registered for these two courses. Secondly, it is necessary to show that students doing ECO110H and ECO110S come from the same population. If they do not, then any difference in the performance on the part of ECO110H students might be due to their differing set of characteristics, rather than the effectiveness of the treatment embodied in the ECO110H course.

It is argued that both ECO110H and ECO110S students are drawn from the same population. One of the chief common characteristics of the two groups is that students doing ECO110H, and most students doing ECO110S, have spent an equal time doing microeconomics. The vast majority of ECO110S students are repeating ECO110F, the first-year first-semester mainstream microeconomics course.

However, there are four sample-selection issues that are relevant to this study.

The first issue is whether to include in the sample those students who do not complete the course. For example, the population of first-year economics students includes students who pass the course, students who fail the course, and students who do not complete the course. If the students who do not complete the course are excluded from the sample, then there is a sample-selection problem. This problem applies to both the ECO110H and ECO110S cohorts.

Douglas and Sulock (1995) used Heckman's (1979) two-step procedure to correct for sample-selection bias caused by omitting those students who do not complete the course and write the final examination (12% of total). They found that selection bias caused the effect of students' effort and ability to be underestimated, and the effect of gender to be overestimated.

The proportion of students who did not complete the course, and therefore did not write the final examination, is given in Table 4.2 on page 50. It is noted that the proportions are very similar for both courses over the two years, and to Douglas and Sulock's (1995) data.

Table 4.2 Proportion of students not writing the final examination for ECO110H and ECO110S

Year	ECO110H	ECO110S
	Percent	Percent
2000	12.8	11.8
2001	10.8	11.2

On the basis that the percentages for the two courses and the two years are very similar, it is assumed that any selection bias is evenly applied across both cohorts over time.

The second sample-selection problem is omitted variable bias. To the extent that all possible independent variables are not included in the multivariate analysis, there is omitted variable bias. It is not unusual to find reported R^2s of less than 0.2, indicating that only a relatively small proportion of the variation in the value of the dependent variable is explained by variations in the independent variables. The implication is that there are several important omitted variables.

To the extent that abilities, motivation and tastes are not fully accounted for, there is omitted variable bias. Unfortunately, too often, potentially significant independent variables are excluded from the analysis of variance of the dependent variable, because of the difficulties of identification and measurement (Anderson, Benjamin and Fuss 1994). This study suffers from omitted variable bias as control variables such as effort and motivation are not included in the specifications for the reasons outlined earlier.

The third sample-selection problem is that some factor influences both selection into the sample and the value of the dependent variable. Peterson (1992) maintains that if some set of unobservable or unmeasured factors influence both the selection and the value of the dependent variable, then the selection process should be incorporated into the specifications of the model. For example, anecdotal evidence supports the view that CADP students tend, as a group, to be more motivated than do the ECO110S and "Gateway" students. The relatively high level of motivation could explain both why these students were selected onto the CADP and their subsequent academic performance at university.

The fourth sample-selection problem arises when a comparison is made between experimental and control groups. In this study, it is important to show that students doing ECO110H and ECO110S are drawn from the same population measured across a broad range of characteristics. To test for the extent of the similarity between the two cohorts, differences of means and proportions tests were done for each of the continuous and discrete variables. It is clear from results given in Table 4.3 on page 52 that the difference between the two cohorts, across a range of variables, is statistically significant.

To reduce the extent of the difference between the two cohorts, two groups of students were excluded from the *full* samples described above. The first group excluded consisted of those students who had relatively high or relatively low levels of academic ability, and the second, those students on the CADP.

The evidence from both international, and South African, research into economics education, reviewed in Chapter 3, suggests that the most important variable explaining economics *understanding* and *learning* is academic ability, as measured by the grades obtained in a school-leaving examination. The average total and adjusted matriculation points scores are greater for ECO110S students, and these students tend to choose matriculation subjects that reflect their greater academic ability (see Table 4.5 on page 55).

However, Edwards (2000), notes that this may not be an insurmountable problem for the following reasons: Firstly, matriculation points scores may be a poor discriminator of students' ability for those students who have a low matriculation points score. Most students in the ECO110H and ECO110S cohorts do have relatively low matriculation points scores. Secondly, it is difficult to make comparisons across the different examination boards as the grading of matriculation scripts is characterised by random error. This implies that the ECO110H cohort might include numerous students who should be in ECO110F/S, and *vice versa*. Hence there is considerable overlap between the two cohorts.

Notwithstanding Edwards' (2000) rider, this study excludes those students who obtained more than 36, or less than 20, matriculation points from the *full* samples for 2000 and 2001, respectively, in order to maximise the overlap of the two cohorts. The vast majority of students achieving more than 36 matriculation points came from the ECO110S cohort.

The second group excluded from the *full* sample included all students who were on the CADP (44 in all). These students were selected for the CADP on the basis of their potential to succeed at university, given their educational and socio-economic disadvantage. Only a proportion of those students who apply are granted a place on the programme. Therefore, to the extent that these students are selected to join the CADP, it is unlikely that they will have the same characteristics as mainstream students. Firstly, and most importantly, their matriculation points scores are likely to underestimate their academic ability. Secondly, as noted above, anecdotal evidence suggests that they have higher levels of motivation and a more positive attitude towards economics.

To test the effect of excluding these two groups on the composition of the ECO110H and ECO110S cohorts, differences of means and proportions tests were conducted on *truncated* samples for 2000 and 2001. The results are presented in Table 4.3 below.

Table 4.3 Differences of means and proportions (2000 and 2001 cohorts)

Sample		2000 Full sample	2000 Truncated sample	2001 Full sample	2001 Truncated sample
Observations		**383**	**258**	**424**	**223**
English home language (enghome)	z=	5.78	4.63	8.65	1.36
Male (male)	z=	5.66	4.57	6.11	2.52
Residence (res)	z=	4.24	5.45	5.85	2.38
Department of Education and Training (det)	z=	3.72	6.73		
Education Department of the House of Representatives (cohr)	z=	8.93	2.33		
English first language (HG) (engflhg)	z=	6.14	7.05	9.39	4.06
Mathematics (HG) (mathhg)	z=	9.32	6.41	10.72	7.99
Physical Science (HG)	z=	11.52	7.11	10.01	7.28
Business Economics (busecon)	z=	8.55	6.43	8.21	4.41
Economics (eco)	z=	9.60	7.11	8.39	5.98
Matriculation points (matpt)	t=	11.35	8.86	11.20	8.58
Adjusted matriculation points (adjmatpt)	t=	5.91	2.88	5.70	1.74

Close inspection of Table 4.3 reveals that the differences between the ECO110H and ECO110S cohorts have been reduced for the *truncated* samples. However, the differences remain statistically significant at the 5% level for all the variables for the 2000 *truncated* sample, and for all the variables, except English home language and adjusted matriculation points score, for the 2001 *truncated* sample.

Excluding students from ECO110H, who had matriculation points scores greater than 36 or less than 20, or who were on the CADP, has failed to eliminate selection bias. The impression that the "Gateway" students have similar characteristics to ECO110S students is not supported by the evidence; the ECO110S and ECO110H cohorts cannot be said to come from the same population.[43]

Nevertheless, the process of estimation outlined was repeated for the *truncated* samples to test the robustness of the relationship between ECO110H and economics performance.

4.2 Data analysis

4.2.1 Performance in first-year microeconomics compared

The examination results for first-year microeconomics, for both the 2000 and 2001 cohorts, are presented in Table 4.4 on page 54. Data for the control variables is presented in Table 4.5 on page 55.

For both the 2000 and 2001 cohorts, the examination results (see Table 4.4) show that the ECO110H students outperformed the ECO110S students in the structured questions. In 2001 the ECO110H cohort outperformed the ECO110S cohort by some 22% in the structured questions, compared to 4.1% in 2000. However, the ECO110S cohort had the greater success in the multiple-choice component of the final examination. It is noted that

[43] That said, ECO110H students have a very different profile to the usual academic development cohort described in the literature. These students speak some 13 first languages, they have attended both private and state schools, they come from a wide variety of socio-economic backgrounds, and they are representative of the population characteristic of Southern Africa.

only the mean scores for the structured questions in 2001 are statistically significant at the 5% level.

Table 4.4 Results for the first-year microeconomics examination

	2000			2001		
	ECO 110H	**ECO 110S**	**Total**	**ECO 110H**	**ECO 110S**	**Total**
Number of observations	**125**	**258**	**383**	**194**	**230**	**424**
Examination results						
Structured questions (SQ) %	47.5	45.5	46.2	46.2	37.8	41.6
Multiple-choice questions (MCQ) %	48.8	49.5	49.3	57.3	59.8	58.7
Examination (exam) %	47.9	46.8	47.2	49.8	45.1	47.3

Careful examination of the data in Table 4.5 reveals the extent to which the two cohorts differ from one another in both 2000 and 2001. For example, the mean matriculation points score for ECO110S is some 15% greater than for ECO110H in 2000, and 12.9% in 2001. In both years the proportion of students taking economics and business economics is greater for the ECO110H cohort, and black students make up a larger proportion of the ECO110H cohort.

More importantly, the ECO110S cohort shows a strong bias towards mathematics (HG), English first language (HG) and physical science (HG), and a greater mean adjusted matriculation points score. Yet, in spite of this apparent advantage, which might have been expected to favour the performance of the ECO110S cohort, the ECO110H cohort enjoyed the greater success in the structured question component of the final examination in both 2000 and 2001.

Table 4.5 Control variables for first-year microeconomics

Cohort	2000					2001				
	Number of observations			Share structure		Number of observations			Share structure	
	ECO 110H	ECO 110S	TOTAL	ECO 110H	ECO 110S	ECO 110H	ECO 110S	TOTAL	ECO 110H	ECO 110S
	125	**258**	**383**			**194**	**230**	**424**		
Faculty										
Commerce (comm)	44	163	207	35.2%	63.2%	101	147	259	52.1%	68.7%
Personal characteristics										
English home language (enghome)	74	176	250	59.2%	68.2%	90	147	237	46.4%	63.9%
Indian (i)	12	27	39	9.6%	10.5%	12	19	31	6.2%	8.3%
White (w)	29	102	131	23.2%	39.5%	33	103	136	17.0%	44.8%
Coloured (col)	30	42	72	24.0%	16.3%	42	38	80	21.6%	16.5%
Black (bl)	54	87	141	43.2%	33.7%	107	70	177	55.2%	30.4%
Male (male)	70	120	190	56.0%	46.5%	114	115	229	58.8%	50.0%
Female (female)	55	138	193	44.0%	53.5%	80	115	195	41.2%	50.0%
Home (home)	73	137	210	58.4%	53.1%	83	117	200	42.8%	50.9%
Residence (res)	52	121	173	41.6%	46.9%	111	113	224	57.2%	49.1%
ECO110S students first registration for ECO110 (ftime)	0	31	31		12.0%	0	56	56		12.0%
Average age (age) in months	222.5	226.8	225.4							
Pre 1994 Education Department										
Department of Education and Training (det)	21	38	59	16.8%	14.7%					
Education Department of the House of Representatives (cohr)	25	24	49	20%	9.3%					
Matriculation subjects										
Matriculation points score (matpt)	30.5	35.0	33.5			31.7	35.8	33.9		
Adjusted matriculation points score (adjmatpt)	20.6	22.5	21.9			21.2	23.0	22.2		
English first language (HG) (engflhg)	97	216	312	76.8%	83.7%	129	189	318	66.5%	82.2%
Mathematics (HG) (mathhg)	39	147	186	31.2%	57.0%	81	158	239	41.8%	68.7%
Physical science (HG) (pshg)	33	136	169	26.4%	52.7%	71	139	210	36.6%	60.4%
Business Economics (busecon)	33	35	68	26.4%	13.6%	55	40	95	28.4%	17.4%
Economics (eco)	32	28	60	25.6%	10.9%	47	32	79	24.2%	13.9%

The difference between the two cohorts is clear for the remaining variables. A close inspection of Table 4.3 reveals that not a single coefficient for the t- and z-tests, for the differences of means and proportions respectively, is significant at even the 10% level for the *full* samples. For the *truncated* samples only English home language and adjusted matriculation points score are significant and then only for the 2001 cohort. These

findings suggest that the ECO110H and ECO110S cohorts are not drawn from the same population. This suggests the presence of sample-selection bias – a topic that has been considered in some detail earlier.

In summary, the analysis of the data suggests that despite the fact that the ECO110H cohort exhibits a lower level of academic ability they do perform marginally better than the ECO110S cohort in the first-year microeconomics examination.

4.2.2 Performance in subsequent economics courses compared

The next step is to consider the performance of the successful ECO110H and ECO110S students, from the 2001 cohort, in subsequent courses in first-year macroeconomics (ECO111S), and second-year microeconomics (ECO203F), compared to those students who successfully passed ECO110F the first-year mainstream course in microeconomics.[44]

The results in Table 4.6 (page 57) show that the successful ECO110H students outperform successful ECO110S students in the multiple-choice and structured/essay questions in both examinations. They also achieved a higher final course mark. Most notably, the average mark achieved by the ECO110H students exceeded those for the ECO110S students by 5.4 percentage points for the structured/essay questions in the ECO203F examination. It is noted that it is only this difference that is statistically significant at the 5% level.

However, in both courses the results achieved by the ECO110H and ECO110S cohorts compare unfavourably with the achievements of their peers from the mainstream microeconomics course, ECO110F. For example, the average mark achieved by ECO110F students for structured/essay questions in the ECO203F examination exceeds that achieved by students from the ECO110H cohort by 6.2 percentage points.

[44] Both courses were taken in 2002. For ECO111S, the ECO110H and ECO110S cohorts are compared to the cohort of students who did ECO110F in 2002. For ECO203F the comparison is with the cohort who did ECO110F in 2001.

Table 4.6 Examination results for ECO111S and ECO203F (2002)

Cohort	ECO111S			ECO203F		
	ECO 110H	ECO 110S	ECO 110F	ECO 110H	ECO 110S	ECO 110F
Observations	**125**	**60**	**920**	**64**	**53**	**925**
Final course mark % (final)*	56.0	52.6	65.2	48.8	45.2	58.2
Multiple-choice mark % (MCQ) (Examination only)	57.7	55.1	68.4	41.6	40.5	53.4
Structured/essay mark % (SQ) (Examination only)	51.8	48.8	57.4	44.6	39.2	50.8

*The final mark for all undergraduate economics courses at the University of Cape Town is made up of a term mark and an examination mark. Usually the examination counts between 50% and 60% of the final mark.

Table 4.7 below contains information regarding the selected control variables for both ECO111S and ECO203F. The chief focus is school-leaving subjects and matriculation points scores.

Table 4.7 Control variables for ECO111S and ECO203F (2001)

Cohort	ECO111S			ECO203F		
	ECO 110H	ECO 110S	ECO 110F	ECO 110H	ECO 110S	ECO 110F
Observations	**125**	**60**	**920**	**64**	**53**	**925**
Male (male)	72	34	539	34	22	531
% of total	57.6%	56.7%	58.6%	53.1%	41.5%	57.4%
Matriculation points (matpt)	32.3	34.7	41.2	33.1	36.6	39.4
Adjusted matriculation points (adjmatpt)	21.8	22.5	26.4	21.8	23.8	25.2
English first language (HG) (engflhg)	86	52	874	58	41	847
% of total	68.8%	86.7%	95.0%	90.6%	77.4%	91.6%
Mathematics (HG) (mathhg)	61	38	826	43	36	775
% of total	48.8%	63.3%	89.8%	67.2%	67.9%	83.8%
Physical Science (HG) (pshg)	52	32	711	36	28	680
% of total	41.6%	53.3%	77.3%	56.3%	52.8%	73.5%

It is again apparent that the ECO110H and ECO110S cohorts represent two distinct populations. For example, the proportion of ECO110S students doing mathematics (HG) is 14.5 percentage points more than for the ECO110H cohort for ECO111S the first-year macroeconomics course. The ECO110S cohort also has a higher average matriculation, and adjusted matriculation, points score. That said, some of the data for ECO203F suggests a lessening over time of the differences between the ECO110H and ECO110S cohorts. For example, the proportions of students who took mathematics (HG) and physical science (HG) for matriculation is very similar for the two cohorts, although a greater proportion of the ECO110H cohort took English first language (HG) for matriculation. That said, the advantage enjoyed by the ECO110S cohort for both the

average matriculation points score, and average adjusted matriculation points score, has increased relative to the advantage enjoyed by the ECO110S cohort in first-year microeconomics.

The academic profile of the ECO110F cohort is very different to that of both the ECO110H and ECO110S cohorts. Compared to the ECO110F cohort, the proportion of students from the ECO110H and ECO110S taking English first language (HG), mathematics (HG), and physical science (HG) is relatively low for both ECO111S and ECO203F. Also, the ECO110F cohort enjoys a substantial premium for the matriculation points and adjusted matriculation points score over the ECO110S and ECO110H cohorts.

In summary, this review suggests that ECO110H students tend to achieve better examination results in both the first-year microeconomics course, and subsequent first-year macroeconomics and second-year microeconomics courses, relative to students who have taken ECO110S. In general the ECO110H students seem to enjoy a greater advantage in the structured, as opposed to the multiple-choice, questions. That said, the ECO110H cohort's academic profile suggests that their peers on the mainstream enjoy a relative advantage in terms of academic ability; the ECO110H and ECO110S cohorts have profiles that are fundamentally different, and these differences continue to exist in further economics courses.

4.3 Conclusion

This chapter describes the econometric methodology and the data used in this thesis, focussing particularly on the approaches to estimation and the issue of selection bias. The production function approach is used determine the importance of ECO110H in furthering economics *understanding* relative to the control course ECO110S. The control variables are identified, and the regression equations specified, for both first-year microeconomics and subsequent courses in first-year macroeconomics and second-year microeconomics.

The issue of selection bias is considered, as are the methods designed to remedy this problem. The findings regarding the efficacy of ECO110H are compromised on two counts. Firstly, key explanatory variables, most notably effort and attitude, are omitted, and secondly, despite the use of the *truncated* samples, the ECO110H and ECO110S cohorts are not matched on a number of key characteristics. In Chapter 5 the results of the multivariate analysis are presented and discussed.

Chapter 5

Discussion of results

This chapter presents the results of the econometric analysis described in Chapter 4. Two sets of results are discussed.

Firstly, the performance of the ECO110H and ECO110S cohorts in first-year microeconomics for the 2000 and 2001 cohorts is compared. Secondly, the performance of successful ECO110H and ECO110S students from the 2001 cohort, in subsequent mainstream first-year macroeconomics (ECO111S) and second-year microeconomics (ECO203F) courses, is compared.[45]

5.1 Performance in first-year microeconomics

In this section the results of the estimations for the first-year microeconomics course are discussed.[46] The chief purpose of the estimations is to test the robustness of the relationship between ECO110H and economics performance, and the channels through which ECO110H most impacts on economics performance.

Firstly, the results of the *linear* estimations for the *full* and *truncated* samples are discussed for both the 2000 and 2001 cohorts.[47] It was shown earlier that the differences between the ECO110H and ECO110S cohorts are reduced as a result of truncating the samples. It is thus possible to test the extent to which the relationship between ECO110H and economics performance holds when the two cohorts are made more alike.

[45] The sample-selection problem, discussed in Chapter 4, remains an important issue. It is noted that ECO110S students who had failed ECO110F are not included in these two samples.
[46] See Appendix D for the complete estimations.
[47] See Appendix E for the full result of each of the estimations.

Secondly, the results of the *non-linear* estimations that include interaction and quadratic terms are considered.[48] The interaction terms make it possible to break-up into sub-effects the broad aggregate effect of ECO110H on economics performance; in short, it makes it possible to identify those within the ECO110H cohort who perform better, or worse, than the average student. Finally, the control variables that have the greatest impact on economics performance are identified.

5.1.1 Multiple-choice question estimations for the first-year microeconomics examination

Table 5.1 (page 62) presents the results of the estimations, with the multiple-choice mark acting as the dependent variable, for 2000 and 2001.

The ECO110H (*h*) variable is statistically insignificant at the 5% level for the *full* and *truncated* samples, conditional on all other variables (Columns 1, 2, 5 and 6). This implies that students from the ECO110H cohort do not outperform those from the ECO110S cohort, conditional on all other variables.

Turning to the non-linear equations (Columns 3, 4, 7 and 8), it is clear that ECO110H (*h*) does have an impact on economics performance through the interaction terms ECO110H*mathematics (HG) (*h*mathhg*) and ECO110H*physical science (HG) (*h*pshg*).

The interaction term ECO110H*mathematics (HG) (*h*mathhg*) is statistically significant for the *truncated* samples (Columns 7 and 8). ECO110H students from the 2000 cohort who have mathematics (HG) as a matriculation subject achieve 9.2 percentage points more, on average, than ECO110S students who have also taken mathematics (HG) (Column 7). The coefficient for the 2001 cohort is 4.5 (Column 8). This finding is relatively robust as it is statistically significant at the 1% level and it applies to the *truncated* samples for both years.

[48] See Appendix E for the full result of each of the estimations.

Table 5.1 Results of the multiple-choice question estimations for the first-year microeconomics examination

	Column 1 Full sample Linear equation 2000	Column 2 Full sample Linear equation 2001	Column 3 Full sample Non-linear equation 2000	Column 4 Full sample Non-linear equation 2001	Column 5 Truncated sample Linear equation 2000	Column 6 Truncated sample Linear equation 2001	Column 7 Truncated sample Non-linear equation 2000	Column 8 Truncated sample Non-linear equation 2001
Obs	**383**	**424**	**383**	**424**	**258**	**223**	**258**	**223**
IVs	**Equation 1**	**Equation 3**	**Equation 5**	**Equation 7**	**Equation 9**	**Equation 11**	**Equation 13**	**Equation 15**
h	3.1*							
h*pshg			9.2***					
h*mathhg							9.2***	4.5***
h*comm				2.9***				
engflhgab		4.0***		4.3***			7.4**	4.7***
engflhgc						-2.9**	3.9**	
mathhgab	8.2***	3.7***	8.4***	4.1***				
mathhgabc					4.8**	6.5***		7.5***
mathhgc	5.2**		5.6***					
mathhgef		3.8***		3.7***		6.5***		4.5***
pshgabc							6.7**	
busecon		-4.2***		-4.2**		-3.4**		
adjmatpt	0.73***	0.38**		0.44***				4.6**
adjmatpt^2			0.02***					-0.1**
male	4.9***	3.1***	4.9***	2.8***	3.8**		4.4**	2.7**
comm		2.2**				3.1**		3.1**
res		-2.9**		-3.0**		-3.1**		-2.7**
enghome		-3.0**						
R^2	0.089	0.138	0.091	0.141	0.031	0.172	0.086	0.214
adj. R^2	0.080	0.120	0.081	0.123	0.024	0.149	0.068	0.181
F-stat.	9.3***	7.4***	10.2***	7.6***	4.1**	7.5***	4.7***	6.4***

*** Statistically significant at 1%
** Statistically significant at 5%
* Statistically significant at 10%
(White heteroskedasticity consistent standard errors and covariance test is used for all estimations)

It appears that ECO110H enhances the mathematical skills of students, enabling them to achieve a higher mark in the multiple-choice component of the examination. It may be that the quantitative elements of ECO110H, which are absent from ECO110S, enable ECO110H students to utilise the skills that they acquired doing mathematics (HG). That said, the corollary is that the numeracy element of the first-year programme in general, and the ECO110H course in particular, does not enable students with mathematics (SG) to improve their relatively poor mathematical skills, relative to students who enter university with a sounder grounding in the subject. This finding suggests that more needs to be done to upgrade the numeracy skills of students with mathematics (SG) if they are

to profit fully from the ECO110H course. Given that only 31.2% of the 2000 cohort, and 41.8% of the 2001 cohort, did mathematics (HG), it is clear that the majority of students would benefit from such support.

ECO110H students who have taken physical science (HG) achieve 9.2 percentage points more, on average, than all other students (including those taking ECO110S) who have also taken physical science (HG) (Column 3). This finding is statistically significant at the 1% level. However, it holds only for the *full* sample of the 2000 cohort and cannot be considered as particularly robust. Similarly to the effect of mathematics (HG), it may be that the quantitative elements of ECO110H, which are absent from ECO110S, enable ECO110H students to utilise the skills that they acquired doing physical science (HG). It is noted that less than 40% the ECO110H cohort took physical science (HG) in 2000 and 2001.[49]

Edwards (2000) reported that students who took physical science for matriculation achieve, on average, 8.2 percentage points more than those who do not. However, he does not report whether he explored the interaction effects between physical science and ECO112. As previously noted, he found the coefficient for physical science to be positive, and statistically significant, in explaining students' *overall* examination results. These findings are noteworthy as attention has not been drawn to the role of physical science in contributing to economics understanding in the international literature.

It may be that students acquire a similar set of skills through studying mathematics (HG) to those they acquire through studying physical science (HG), and that ECO110H enables these students to apply these skills more effectively relative to members of the ECO110S cohort who have done these two subjects. The results also imply that ECO110H students who have mathematics (SG) and/or physical science (SG) do not profit from the ECO110H course. These findings suggest that more needs to be done to upgrade the

[49] ECO110H students with physical science (HG) make up 26.4% of the 2000 cohort and 36.6% of the 2001 cohort.

numeracy skills of students, with mathematics (SG), whether or not they have physical science (SG), if they are to profit fully from the ECO110H course.

There are a number of other findings that merit closer examination. These include the male (*male*), mathematics (HG) (*mathhg*) and English first language (HG) grades A and B (*engflhgab*) variables. For example, male students achieved an average of between 2.7 (Column 8) and 4.9 (Column 1) percentage points more than female students. These findings are robust, for they hold for both the *full* and *truncated* samples for both 2000 and 2001. These results are consistent with Edwards' (2000) and Van Walbeek's (forthcoming) findings, and are in line with the international research findings cited in Chapter 3. Edwards (2000) reported that males achieved an average of 3.4 percentage points more than females did for the *overall* examination, and Van Walbeek (forthcoming) finds the difference to be 7.3 percentage points for the multiple-choice component of the examination.

Mathematics (HG) (*mathhg*) is positively related to multiple-choice question performance. For example, the advantage enjoyed by students who achieved an A, B or C grade for mathematics (HG) ranged between 4.8 and 8.4 percentage points in 2000, and between 3.7 and 7.5 percentage points in 2001. The findings are robust, as they hold for both the *full* and *truncated* samples, and the majority are statistically significant at the 1% level, and are consistent with the research reviewed in Chapter 3. They suggest that students who achieved above average results in matriculation mathematics (HG) have a significant advantage relative to students who achieved relatively poor results at mathematics (HG), or who took mathematics (SG). These results suggest that the analytical skills acquired in mathematics (HG) enable students to achieve greater success in the multiple-choice component of the examination.

English first language (HG) grades A and B (*engflhgab*) are also positively related to performance. The advantage ranges from 4.0 to 7.4 percentage points, with the effect being most apparent for students in the 2001 cohort (Columns 2, 4 and 8), compared to students who achieve less than a B grade, or who have taken English as a second

language. This finding is relatively robust as it holds for the *truncated samples* for both years. These findings suggest that students with relatively poor language skills in general, and with English as a second language in particular, might be at some disadvantage in multiple-choice examinations. As noted previously, there is some support for this finding in the international literature.

To test the importance of the variable English second language, separate estimations were run for each of the ECO110H and ECO110S cohorts in 2000 and 2001. For the ECO110S 2000 cohort, the coefficient for English second language was -4.2 and statistically significant at the 10% level. However, for the ECO110H cohort, the coefficient of this variable was statistically insignificant. This suggests, albeit weakly, that those elements of the language and communication tutorials focusing on economics comprehension had some positive effect on students' performance for the 2000 cohort only.

English home language (*enghome*) has a coefficient of -3.0 (Column 2) for the *full* sample only. Two possible reasons for this counter-intuitive result stand out. Firstly, the variable does not pick up the quality of the English used by students at home, and secondly, there could be false reporting by students of their home language. Further investigation is required to identify the relative importance of these and other variables in explaining this result. However, the result contrasts with that of Edwards' (2000); he reported a positive coefficient of 3.0 for this variable.

Looking at the other variables, the coefficient of the adjusted matriculation points score (*adjmatpt*) is positive and statistically significant for the *full* samples for both the 2000 and 2001 cohorts (Columns 1, 2 and 4). For the 2000 cohort, a 1 point increase in the adjusted matriculation points score results in an average increase in performance of 0.73 percentage points (Column 1). The coefficient for the 2002 cohort is 0.38 (Column 3). Edwards (2000) reports a coefficient of 0.9 for this variable. However, it is noted that the coefficient for $adjmatpt^2$ for the *truncated* sample (Column 8) is negative, indicating diminishing returns to additional adjusted matriculation points.[50] The positive

[50] Van Walbeek (forthcoming) reports increasing returns to this variable.

relationships described suggest that the adjusted matriculation points score remains a useful predictor of academic performance, net of English first language (HG), mathematics (HG) and physical science (HG), although the relationship is not particularly robust across the various estimations.

Business economics (*busecon*) and university residence (*res*) have negative coefficients for the 2001 cohort (Columns 2, 4, 6 and 8). This implies that prior experience in business economics has a negative impact on students' performance in the first-year university microeconomics course. This may be another example of the sample-selection issue referred to in Section 4.1.2. It suggests that academically weaker students in South Africa tend to do business economics rather than mathematics (HG) and physical science (HG).

The coefficient for university residence (*res*) ranges from -2.7 to -3.1. This result shows that students who live at home, or in private accommodation, achieve an average of some 3 percentage points more than those who live in a university residence. This suggests that residence life inhibits students' economics performance as measured by their examination results. Although the disadvantage is relatively small, and holds only for 2001, the finding merits further investigation.[51]

Finally, students registered in the Commerce Faculty (*comm*) achieve an average of 2.2 to 3.1 percentage points more than students registered in other faculties (Columns 2, 6, and 8), for the 2001 cohort. This finding is relatively robust as it holds for the *truncated* sample (Columns 6 and 8), from which the CADP cohort has been excluded, and is supported by Edwards' (2000) reporting of a statistically significant positive coefficient for this variable.

The main impact of ECO110H on students' performance in the multiple-choice component of the examination is that it appears to enhance the performance of students who have taken mathematics (HG) and physical science (HG) for matriculation. Other

[51] See De Villiers (2004) for a detailed discussion and analysis of this topic.

variables that exert a positive and robust effect on economics performance include gender, mathematics (HG) and English first language (HG) grades A and B.

5.1.2 Structured question estimations for the first-year microeconomics examination

One of the arguments of this thesis is that a different set of factors is responsible for students' performance in the multiple-choice and structured questions. In particular, structured questions test students' ability to express themselves clearly in written English. To test this hypothesis, separate regressions were run for the results of each of the two types of question, for both 2000 and 2001.

The statistically significant findings for the structured questions, for the 2000 and 2001 cohorts, are presented in Table 5.2 on page 68.

For the 2000 cohort, the coefficient for the ECO110H is positive and statistically significant for the *full* sample only (Column 1). ECO110H students achieve an average of 3.6 percentage points more than the ECO110S cohort, conditional on all the other variables. The coefficients for the 2001 cohort are 15.2 for the *full* sample (Column 2) and 12.3 for the *truncated* sample (Column 6) respectively, relative to ECO110S.

The relatively low coefficients for adj. R^2 for the 2000 estimation suggest that the structured questions set in each of the ECO110H and ECO110S 2000 examinations might have been significantly different in terms of style and/or content (Columns 1, 3, 5 and 7).[52] The F-statistics for the *complete* estimations, for the *full* and *truncated* samples, are insignificant at the 10% level.[53] This implies that the findings in respect of the structured questions for the 2000 cohort are not significant.

[52] Van Walbeek (forthcoming) notes that regression equations with structured/essay marks as the dependent variable have a much lower explanatory power than do equations with multiple-choice marks as the dependent variable, because the marking process generates a measure of randomness; the inherent variability of the grading system is the cause of measurement error and statistical noise in the data.
[53] Table E2 and Table E6 in Appendix E.

Table 5.2 Results of structured question estimations for the first-year microeconomics examination

	Column 1 Full sample Linear equation 2000	Column 2 Full sample Linear equation 2001	Column 3 Full sample Non-linear equation 2000	Column 4 Full sample Non-linear equation 2001	Column 5 Truncated sample Linear equation 2000	Column 6 Truncated sample Linear equation 2001	Column 7 Truncated sample Non-linear equation 2000	Column 8 Truncated sample Non-linear equation 2001
Obs	**383**	**424**	**383**	**424**	**258**	**223**	**258**	**223**
IVs	**Equation 2**	**Equation 4**	**Equation 6**	**Equation 8**	**Equation 10**	**Equation 12**	**Equation 14**	**Equation 16**
h course	3.6**	15.2***				12.3***		
h*mathhg			7.9***				7.3**	
h*busecon				-8.7***				
h*eco								-11.5**
h*adjmatpt			0.26**	0.99***				0.71***
h*enghome			-7.9***	-11.6***				
engflhgab	5.3***	7.0***	5.8***	6.5***	5.7**		6.2**	
mathhgef		5.5**		5.1**		9.1***		8.8***
busecon		-5.8***						
eco				-4.4**		-6.2**		
adjmatpt		0.77**						
adjmatpt^2				0.02***				
comm	3.1**	6.1***				6.0**		5.9**
ftime		6.4***						
enghome		-4.1**						
R^2	0.043	0.202	0.078	0.209	0.019	0.124	0.043	0.137
adj. R^2	0.035	0.186	0.068	0.195	0.015	0.108	0.035	0.122
F-stat	5.7***	13.1***	8.0***	15.77***	4.8**	7.7***	5.7***	8.7***

*** Statistically significant at 1%
** Statistically significant at 5%
(White heteroskedasticity consistent standard errors and covariance test is used for all estimations)

However, the statistically significant findings in respect of the ECO110H variable for 2001 suggest that the combined effect of the interventions incorporated in the ECO110H course had a positive effect in improving students' economics performance in the structured questions. That said, these same interventions were not as successful in improving performance in the multiple-choice questions. This suggests that the English language and writing skills had the greatest impact on students' performance in the structured/essay questions.

None of the coefficients for the interaction terms appear robust across samples, with the exception of *h*adjmatpt*. The coefficients are positive and statistically significant for both the 2000 and 2001 cohorts, and range in value from 0.26 to 0.99 (Columns 3, 4 and 8). The inclusion of the interaction term *h*adjmatpt* (Column 4) renders the coefficient of

the variable *adjmatpt* (Column 3) statistically insignificant. This implies that the adjusted matriculation points score is a significant predictor of performance for ECO110H students, relative to ECO110S students, conditional on all other variables. This suggests that the interventions incorporated in ECO110H enable students to utilise their skills, to the extent that they are reflected in their matriculation points score, more effectively.

For the 2000 cohort, the coefficient of the interaction variable *h*mathhg* is positive and exceeds 7.0 for both the *full* and *truncated* samples (Columns 3 and 7). It may be that the interventions incorporated in ECO110H enable those students who have taken mathematics (HG) to gain a sounder understanding of the technical aspects of the first-year microeconomics course relative to ECO110S students with mathematics (HG) and those students with mathematics (SG). However, this finding is not repeated for the 2001 cohort.

The coefficients of four other interaction terms are worthy of note. Firstly, the coefficients of *h*enghome*, for both the *full* samples in 2000 and 2001 (Columns 3 and 4), are -7.9 and -11.6 respectively, and statistically significant at the 1% level. Possible explanations for this finding have already been considered above. However, this finding is not robust as it is not statistically significant for the *truncated* samples.

The coefficients for both *h*eco* and *h*busecon* are negative for the 2001 cohort (Columns 4 and 8). Explanations for the relatively poor performance of students who have taken these subjects for matriculation were discussed earlier. However, it is not clear why ECO110H should have such a strong negative impact. Although this relationship is not consistently significant, it merits further investigation.

Of the findings in respect of the control variables, only English first language (HG) grades A and B (*engflhgab*) and Commerce Faculty (*comm*) are statistically significant across samples. The coefficient of English first language (HG) grades A and B (*engflhgab*) is positive, and exceeds an average of 5.3 percentage points, for both the 2000 and 2001 cohorts (Columns 1, 2, 3, 4, 5 and 7). This finding holds for both the *full*

and *truncated* samples. It suggests that students who exhibit an above-average ability in English enjoy an advantage over their peers in answering structured/essay questions. That said, the international evidence is not overwhelming on this count, and both Edwards (2000) and Van Walbeek (forthcoming) find this variable to be statistically insignificant.

As in the case of the multiple-choice questions, the coefficient of the interaction variable *h*engflhg* is never statistically significant. This suggests that ECO110H does not enhance the performance of those students who did English first language (HG) relative to ECO110S students who took the same subject, conditional on all other variables. It might also suggest that ECO110H enables students who have done English as a second language to overcome their disadvantage relative to students who have done English as a first language. To test this hypothesis, separate estimations were run for each of the ECO110H and ECO110S cohorts in 2000 and 2001 to isolate the importance of the variable English second language. The results obtained mirrored those for the multiple-choice questions discussed earlier.

Students registered in the Commerce Faculty achieved an average of between 3.1 and 6.1 percentage points more than students registered in other faculties, conditional on all the other variables (Columns 1, 2, 6 and 8). Given that this variable is statistically significant for the *truncated* samples, as in the case of the multiple-choice questions, it is necessary to look elsewhere for an explanation for this result.

Other control variables exhibiting coefficients that are statistically significant include business economics, economics, and first-time students. The coefficients for business economics (*busecon*) and economics (*eco*) for the 2001 cohort are -5.8 and -6.2 respectively (Columns 2 and 6). Possible explanations were considered in Section 5.1.1. However, these results are not robust across the samples. First-time students (*ftime*) (Column 2) achieve an average of 6.4 percentage points more than ECO110S students, conditional on all other variables. This finding, although not robust across the samples, suggests that there is little benefit to be gained from repeating the first-year microeconomics course.

Finally, it is worth noting that the coefficients for the DET and for the Department of Education falling under the former House of Representatives are never statistically significant. This seems to indicate that by 2000 there had been some amelioration of the negative impact of the apartheid educational system, or that students doing ECO110H and ECO110S had managed to cope successfully with their educational, and possible socio-economic, disadvantages.

ECO110H is the variable that has the largest direct impact in explaining students' performance in the structured questions, conditional on all other variables. This may suggest that the interventions incorporated in the ECO110H course, to improve students' skills in the areas of learning, English language, writing and numeracy, were partly successful in enabling students to overcome some of their educational disadvantages. However, given that the coefficient for ECO110H is not statistically significant in explaining students' performance in the multiple-choice questions suggests that the course had its main impact in giving students the opportunity to practise their writing skills; it might be that this alone enabled them to overcome their prior educational disadvantages relative to the ECO110S cohort.

The role of English first language (HG) grades A and B is not to be underestimated. It should be noted, however, that only 19.8% of the 2000 cohort, and 23.5% of the 2001 cohort, achieved a B grade or better for English first language (HG), and that relatively few are from the ECO110H cohort. This finding suggests that the emphasis on English language, in academic development and mainstream courses, is not misplaced.

In concluding this section it is worth noting that ECO110H and strong performances in English first language (HG) and mathematics (HG) in the matriculation examination are key variables explaining students' multiple-choice and structured/essay performance in both 2000 and 2001. This suggests that students' matriculation results in English first language (HG) and mathematics (HG) offer a fair measure of their academic ability, and of their prospects of success in a first-year microeconomics course.

The coefficient for adj. R^2 is relatively low throughout, for both the multiple-choice and structured question equations. This suggests that the ECO110H and control variables explain a relatively small proportion of the variability in the examination results.[54] Given that the ECO110H and ECO110S students have relatively low levels of academic ability, English language proficiency, numeracy, and poor learning techniques, it might be that learning how to learn, motivation and effort are far more important in explaining success at this level.

5.2 Performance in subsequent courses in economics

In this section the performance of successful ECO110H and ECO110S students is compared in subsequent courses in first-year macroeconomics (ECO111S) and microeconomics (ECO203F), relative to the performance of successful ECO110F students.

The chief purpose of this comparison is to estimate the effect of ECO110H on students' performance in further economics courses. One of the main aims of the first-year academic programmes in general, and courses in particular, is to teach students skills that enable them to succeed in courses taken in subsequent years. Two sets of *linear* equations are estimated (*full* and *truncated* samples), with the marks for the multiple-choice and structured/essay type questions acting as dependent variables. Dummies are included for each of the ECO110H and ECO110S variables. The performance of the two cohorts is then estimated relative to the *omitted* variable, the performance of the ECO110F cohort. The results of the tests for the difference between the coefficients of the ECO110H and ECO110S variables are also described. The statistically significant findings for both ECO111S and ECO203F, for the multiple-choice and structured questions, are presented in Table 5.3 (page 74) and Table 5.4 (page 76).[55]

[54] The relatively small size of the samples and the limited number of continuous, relative to dichotomous, variables contributes to a relatively low R^2.
[55] See Tables E9 to E16 in Appendix E for the complete estimations.

First, the results of the estimations for the multiple-choice questions, for both ECO111S and ECO203F, are discussed. This is followed by a review of the results of the structured question estimations.

5.2.1 Multiple-choice question estimations

The results in respect of the multiple-choice question estimations are presented in Table 5.3.

Table 5.3 (Columns 1 and 2) shows that ECO110S students doing ECO111S achieve an average of 5.2 percentage points *less* than the ECO110F students (omitted variable) for both the *full* and *truncated* samples. The robust nature of these findings is supported by the fact that the difference between the two coefficients, for the ECO110H and ECO110S cohorts, is statistically significant at the 5% level. However, the difference in the performance of ECO110H students, relative to successful ECO110F students, is statistically insignificant. This suggests that the performance of the ECO110H cohort is in line with that of the ECO110F cohort controlling for academic ability.

However, the ECO110H cohort is subject to a number of educational and socioeconomic disadvantages that are generally not experienced by mainstream students, some of which have been explored in Chapters 2 and 3. For example, area of residence, home environment, financial constraints and a general low level of academic preparedness necessary to make a success of academic study at the tertiary level which may not be measured by matriculation results. Therefore, it is suggested that these findings lend some support to the view that ECO110H has been successful in enabling students to overcome some of their educational and socioeconomic disadvantages relative to students from the ECO110F cohort.

The ECO110S cohort underperforms the ECO110F cohort by 7.4 percentage points in ECO203F (Column 3). However, this result is not robust as it is not repeated for the *truncated* sample. Again, the difference in the performance of ECO110H students,

relative to successful ECO110F students, is statistically insignificant for both courses, suggesting that ECO110H has been successful in enabling students to overcome some of their educational and socioeconomic disadvantages relative to students from the ECO110F cohort. However, unlike the finding for the ECO111S, the difference between the two coefficients for the ECO110H and ECO110S cohorts is statistically insignificant. This suggests that the advantaged enjoyed by the ECO110H cohort, relative to the ECO110S cohort, in multiple-choice tests dissipates over time.

Table 5.3 Results of the multiple-choice question estimations for the ECO111S and ECO203F examinations

		ECO111S		ECO203F	
		Column 1	**Column 2**	**Column 3**	**Column 4**
		Full sample	**Truncated sample**	**Full sample**	**Truncated sample**
Observations	**IVs**	**1105** **ECO110S 60** **ECO110H 125**	**1013** **ECO110S 41** **ECO110H 52**	**1042** **ECO110S 53** **ECO110H 64**	**977** **ECO110S 24** **ECO110H 28**
		Equation 17	**Equation 21**	**Equation 19**	**Equation 23**
	110S course	-5.2***	-5.2**	-7.4***	
	adjmatpt	1.69***	1.69***	1.89***	1.92***
	pshg	5.1***	5.2***	6.9***	7.2***
	mathhg			6.0***	6.2***
	male	4.4***	4.5***	2.1**	2.3**
	R^2	0.224	0.222	0.230	0.222
	adj. R^2	0.221	0.219	0.226	0.219
	F-stat.	79.5***	78.6***	61.9***	74.1***

*** Statistically significant at 1%
** Statistically significant at 5%
(White heteroskedasticity consistent standard errors and covariance test is used for all estimations)

The findings in respect of gender (*male*) and academic ability (*adjmatpt*) are in line with much of the evidence cited above. Male students achieve, on average, 4.4 percentage points more (*full* sample), and 4.5 percentage points more (*truncated* sample), than female students in the ECO111S examination. However, the premium is reduced by some 50% in the ECO203F examination. This finding contrasts with that of Lumsden and Scott (1987) who found that the female disadvantage in multiple-choice questions increases over time.

The coefficient for the adjusted matriculation points score (*adjmatpt*) (Columns 1 to 4) implies that a 1 point increase in the adjusted matriculation points score results in an average increase of *at least* 1.69 percentage points in the multiple-choice mark. These findings are robust as they hold for both the *full* and *truncated* samples for both ECO111S and ECO203F, and are statistically significant at the 1% level.

The findings in respect of physical science (HG) for both ECO111S and ECO203F (Columns 1 to 4) are robust and require comment. As noted previously, this variable has not received attention in the international literature. In this study physical science (HG) does not exhibit a robust positive relationship in respect of performance in the first-year microeconomics examination, although both Edwards (2000) and Van Walbeek (forthcoming) found the variable to be statistically significant. It is also noted that there is a positive relationship between mathematics (HG) and economics performance for ECO203F. These findings suggest that the skills acquired doing physical science (HG) and mathematics (HG) are particularly useful in answering multiple-choice questions, and in enabling students to cope with the increasingly technical nature of the subject.[56]

5.2.2 Structured question estimations

The results in respect of the structured question estimations are presented in Table 5.4 on page 76.

The ECO110S cohort achieved an average of 3.6 percentage points *less* than the ECO110F cohort for the *full* sample only in the ECO111S examination (Column 1). This finding is only statistically significant at the 5% level and is not repeated for the *truncated* sample. However, the difference in the performance of ECO110H students, relative to successful ECO110F students, is statistically insignificant[57], suggesting that ECO110H may have been successful in enabling students to overcome some of their

[56] Edwards (2000) suggested that it is the applied nature of physical science (HG) that explains the positive sign and statistical significance of the coefficient.
[57] The difference between the two coefficients for the ECO110H and ECO110S cohorts is only statistically significant at the 5% level for the *full* sample.

educational and socioeconomic disadvantages relative to successful students from the ECO110F cohort.

Table 5.4 Results of the structured question estimations for the ECO111S and ECO203F examinations

		ECO111S		ECO203F	
		Column 1	**Column 2**	**Column 3**	**Column 4**
		Full sample	**Truncated sample**	**Full sample**	**Truncated sample**
Observations	**IVs**	**1105** **ECO110S 60** **ECO110H 125**	**1013** **ECO110S 41** **ECO110H 52**	**1042** **ECO110S 53** **ECO110H 64**	**977** **ECO110S 24** **ECO110H 28**
		Equation 18	**Equation 22**	**Equation 20**	**Equation 24**
	110S course	-3.6**		-11.2***	-12.8***
	adjmatpt	0.93***	0.97***	1.52***	1.49***
	pshg	2.4***	2.5***	4.6***	4.6***
	male			-2.6***	-2.4***
	R^2	0.110	0.105	0.185	0.175
	adj. R^2	0.108	0.104	0.182	0.172
	F-stat.	45.4***	64.8***	58.7***	54.9***

*** Statistically significant at 1%
** Statistically significant at 5%
(White heteroskedasticity consistent standard errors and covariance test is used for all estimations)

The contradictory nature of the findings is surprising, given that the ECO110H cohort achieved an average of at least 12.3 percentage points *more*, for the structured questions, than the ECO110S cohort in the first-year microeconomics examination.

These findings suggest that the advantages enjoyed by ECO110H students dissipate over time as former ECO110S students acquire the necessary writing skills. However, there are two other possibilities: the skills acquired in ECO110H are not applied in ECO111S; and the structured questions set in the ECO111S examination do not act as a particularly good discriminator between the three cohorts. The latter explanation appears to be most likely, given the findings in respect of the multiple-choice questions and the relatively low weighting attached to writing in the ECO111S course and to structured/essay questions in the final examination.

The ECO110S cohort underperformed the ECO110F cohort by more than 11 percentage points in the ECO203F examination. The finding is statistically significant at the 1%

level, and holds for both the *full* and *truncated* samples. The difference in the performance of ECO110H students, relative to that of successful ECO110F students, is statistically insignificant. The difference between the two coefficients, for the ECO110H and ECO110S cohorts, is statistically significant at the 1% level for both the *full* and *truncated* samples. These robust findings suggest that the English language and writing skills acquired in ECO110H persist into the second-year microeconomics course.

The adjusted matriculation points score (*adjmatpt*) and physical science (HG) (*pshg*) also exhibit a robust relationship in explaining students' performance in the structured questions for both ECO111S and ECO203F. These two variables also exhibit a positive and robust relationship in explaining students' performance in the multiple-choice component of the examination. The finding regarding the positive role of physical science (HG) in determining economics performance in both first- and second-year courses warrants further investigation.[58]

For ECO203F the coefficients for *male* are -2.6 and -2.4 for the *full* and *truncated* samples respectively. This finding is not surprising; several studies, for example Lumsden and Scott (1983), Walstad and Soper (1989), Breland (1991) Harris and Kerby (1997), and Greene (1997), show that females enjoy a statistically significant advantage in structured/essay questions.

5.3 Conclusion

ECO110H has its greatest positive impact on students' economics performance in the structured question component of the first- and second-year microeconomics examination.

The main impact of ECO110H on students' performance in the multiple-choice component of the first-year microeconomics examination is its role in enhancing the

[58] 77% of the ECO111S cohort and 74% of the ECO203F cohort, took physical science (HG) for matriculation.

performance of students who have taken mathematics (HG) and physical science (HG). However, for the structured questions, ECO110H has a direct and positive impact on students' economics performance for the 2001 cohort only.

Other variables that exert a positive and robust effect on economics performance in first-year microeconomics include gender (multiple-choice questions only), mathematics (HG), and English first language (HG) grades A and B.

In the subsequent courses in macroeconomics (ECO111S) and microeconomics (ECO203F), the ECO110S cohort under performs the ECO110F cohort in both the multiple-choice and structured question components of the final examinations. However, the same does not hold true for the ECO110H cohort. Most notably, ECO110S students achieve an average of 5.2 percentage points *less* than the ECO110F cohort for the multiple-choice questions in the ECO111S examination, and at least 11.2 percentage points *less* than the ECO110F cohort for the structured questions in the ECO203F examination.

Other variables that have a strong positive relationship in explaining economics performance in subsequent economics courses include the adjusted matriculation points score, mathematics (HG), physical science (HG) and gender.

Chapter 6

Conclusion

In this thesis, performance in the economics course examination is taken as a proxy for the level of economics *understanding*. It is expected that those students who are most successful in overcoming their educational disadvantages will show the highest levels of economics *understanding*, as measured by the course examination.

This proposition was tested by comparing the performance of students doing an academic development course in economics (ECO110H) with that of a mainstream control group in first-year and subsequent economics courses, controlling for a number of explanatory variables. To the extent that the ECO110H cohort out performed the control group, leaving aside the problem of sample-selection bias, it is possible to draw the conclusions discussed below.

The results suggest that ECO110H has a major impact on students' performance in the structured/essay questions, relative to the control group, for the 2001 cohort, in first- and second-year microeconomics, and for the multiple-choice questions in first-year macroeconomics. The findings in respect of first-year microeconomics (2000 cohort), the multiple-choice questions for first-year and second-year microeconomics (2001 cohort), and the structured/essay questions for first-year macroeconomics are mixed.

Interaction terms point to some relatively robust relationships between attendance of ECO110H, academic ability, and economics performance in the first-year microeconomics course. For example, ECO110H students with mathematics (HG) and physical science (HG) outperformed ECO110S students who had taken these subjects, in the multiple-choice questions. Also, ECO110H adds value to the students' adjusted matriculation points score for the structured questions in the same examination.

Other key variables having a robust and positive relationship with economics performance, in both first-year microeconomics and further economics courses, include the adjusted matriculation points score, mathematics (HG), English first language (HG) and male (multiple-choice questions only). Physical science (HG) also exhibits a robust and positive relationship with respect to economics performance, most notably for ECO111S and ECO203F. All these explanatory variables, with the exception of physical science (HG), have been highlighted in the international literature. The relative importance of physical science (HG) for South African students, first identified by Edwards (2000), warrants further investigation.

The nature of the findings suggests that the aims of ECO110H – to improve students' skills in the areas of learning, English language, writing and numeracy – are only partly met. The main impact of ECO110H, in the first-year microeconomics course, is on students' performance in the structured questions. This suggests that ECO110H has facilitated the improvement of students' English language and writing skills relative to the ECO110S cohort. The robust and positive nature of the relationship between ECO110H and students' performance on the structured/essay questions, for the second-year microeconomics course, suggests that this skills advantage persists over time.

That said, the better performance of the ECO110H cohort may be due to the greater effort that they exert, which may or may not have been stimulated by the course, or due to a selection of explanatory variables not included in the econometric estimations. Also, ECO110H is part of the CADP and "Gateway" programme; it may well be that student performance is a result of the effects of ECO110H and the other first-year courses in some combination. This does beg the question as to what the actual determinants of success in first- and second-year economics courses are, and also as to the role in determining this success played by each component of the academic development programme.

Several explanations are offered for the weakness of the relationship between ECO110H and structured question performance for the first-year courses in microeconomics (2000

cohort) and macroeconomics. The fact that these premiums did not extend to the performance of the ECO110H cohort in the first-year macroeconomics course suggests that some proportion might be due to a better understanding of the principles of microeconomics.

The robust and positive relationship between ECO110H and students' multiple-choice question performance in the ECO111S examination begs the question: Why did ECO110H students' not outperform the control group in the first-year microeconomics examination, conditional on the explanatory variables? That ECO110H students did not outperform the control group may be a function of the fact that multiple-choice questions make up a relatively small proportion of ECO110H course assessment relative to that used for ECO110S. That said, by the second-year microeconomics course, the advantage held by the ECO110H cohort ceases to exist.

Finally, the robust nature of the positive relationship between the variables English first language (HG) grades A and B, mathematics (HG) and physical science (HG) and economics performance suggests that every effort should be made to ensure that those students of economics who come from academically and socially disadvantaged backgrounds have the opportunity to improve their skills in the areas of numeracy and English language. Further, schools should be made aware of the fact that they are doing their learners a disservice if they encourage them to opt for economics, accounting and business economics in the mistaken belief that this will be adequate preparation for the rigours of academic study, at tertiary level, in the fields of economics, accounting, finance, and other commerce-related subjects.

The empirical methodology used in this thesis suffers from several shortcomings. The most important is the issue of sample-selection bias. Ideally, two groups of students should be randomly drawn from the same population of first-year economics students; one group to do ECO110H and the other ECO110F/S. Failing that, a selection of students from the ECO110H and ECO110S cohorts should be matched on a variety of independent variables. In this study the samples were *truncated* in an effort to deal with

the problem of sample-selection bias; it is an approach fraught with difficulty, as this study demonstrates.

The estimations undertaken for the structured questions for the first-year microeconomics course in 2000 reveal that ECO110H did not have a statistically significant impact on student performance. One possible reason is that the ECO110H and ECO110S cohorts faced a different set of structured/essay questions in their final examination, and that the two sets of questions are not comparable. To test the robustness of the findings with respect to 2000 cohort, the estimations should be run for the 2002 cohort. It would also seem a worthwhile exercise to run the estimations for ECO111S and ECO203F for both the 2000 and 2002 cohorts, and to identify suitable proxies for the effort/motivation and attitude variables.

In addition to the problems of empirical and econometric estimation referred to above, two further sets of estimations are required. Firstly, the econometric method used in this study can be applied to estimate the effect of ECO110H on third-year economics courses. Secondly, a more sophisticated econometric approach, using the multivariate analysis of panel data, can be adopted. This method makes possible the identification of the key variables that explain success in all economics courses taken through to graduation, including ECO110H and a selection of control variables.

This thesis has thrown up a number of issues that warrant further investigation. That said, further progress is dependent on identifying suitable proxies for the most important affective states, and in modelling the complex interactions between these states, other independent variables, and economics performance.

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Appendices

Appendix A

Structure of the CAD and "Gateway" programmes

The courses taken by CADP, and "Gateway", students in their first year are listed in Tables A1 and A2, respectively. Students take half the mainstream load in their first year.

Table A1 Structure of the CADP

Course Code	Subject	Duration	Format/week	Assessment
ECO110H	Microeconomics	Whole-year	5 lectures 2 double-period tutorials	Essays Assignments Tests Examination
ACC106H	Accounting	Whole-year	5 lectures 1 double-period tutorial	Tests Examination
INF102H	Information Systems	Whole-year	3 lectures 2 single-period tutorials	Assignments Tutorials Tests Examination
STA101H	Statistics	Whole-year	5 lectures 1 single-period tutorial	Tests Examination

Table A2 Structure of the "Gateway" programme

Code	Subject	Duration	Format/week	Assessment
ECO110H	Microeconomics	Whole-year*	5 lectures 2 double-period tutorials	Essays Assignments Tests Examination
MAM107H	Effective numeracy	Whole-year	4 lectures 2 single-period tutorials	Assignments Project Tests Examination
PHY109W	Critical reasoning in the Quantitative Sciences	Whole-year	3 lectures 1 single period tutorial	Assignments Tests Examination
HST105F	The making of the Modern World Economy	1st semester	3 lectures 1 single period tutorial	Essays Assignments Examination
POL104S*	Introduction to Politics	2nd semester	3 lectures 1 single period tutorial	Essays Assignments Tests Examination
SOC105S*	Individual and Society	2nd semester	3 lectures 1 single period tutorial	Essays Assignments Tests Examination
PHI108S*	Moral and Political Values	2nd semester	3 lectures 1 single period tutorial	Essays Assignments Tests Examination

* One of POL104S, SOC105S and PHI108S

Appendix B

Structure and syllabi of the ECO110H/S/F courses

Table B1 Structure of the ECO110H/S/F courses

Course code	Duration	Format/week	Assessment
ECO110H	Whole-year*	5 lectures 2 double-period tutorials	3 Essays 1 Assignment 4 Tests (MCQ and SQ) Examination (MCQ and SQ)
ECO110S	2nd semester	4 lectures 1 single period tutorial	2 Tests (MCQ) Examination (MCQ and SQ)
ECO110F	1st semester	4 lectures 1 single period tutorial	3 Tests (MCQ) Examination (MCQ and SQ)

* One semester course done over two semesters

Table B2 Syllabi for ECO110H/S/F

Course code	Course content
ECO110H	Methods of analysis in economics, economic methodology, basic tools of statistical analysis and quantitative techniques, introduction to macroeconomics Economic systems, production possibilities curves, demand and supply analysis, consumer behaviour, production functions and production costs, market forms and trade
ECO110S	Economic systems, production possibilities curves, demand and supply analysis, consumer behaviour, production functions and production costs, market forms and trade
ECO110F	Same as ECO110S

Appendix C

Truncated sample data

C.1 Examination results

Table C1 First-year microeconomics

	2000			2001		
	ECO 110H	**ECO 110S**	**TOTAL**	**ECO 110H**	**ECO 110S**	**TOTAL**
Observations	78	180	258	91	132	223
Examination results						
Structured questions (SQ) %	45.7	44.5	44.9	41.9	35.5	38.2
Multiple-choice questions (MCQ) %	48.5	46.8	47.3	54.3	58.0	56.5
Examination (exam) %	46.7	45.2	45.7	46.0	43.0	44.3

Table C2 ECO111S and ECO203F

	ECO 111S			**ECO 203F**		
	ECO 110H	**ECO 110S**	**ECO 110F**	**ECO 110H**	**ECO 110S**	**ECO 110F**
Observations	52*	41*	920	28*	24*	925
Final course mark % (final)*	55.8	51.3	65.2	48.8	40.9	58.2
Examination multiple-choice mark % (MCQ)	58.5	53.0	68.4	40.7	37.0	53.4
Examination structured/essay mark % (SQ)	50.8	47.8	57.4	45.5	34.3	50.8

* Full sample

** Truncated sample

C.2 Control variables

Table C3 2000 cohort

	Number of observations			**Share structure**	
	ECO 110H	**ECO 110S**	**TOTAL**	**ECO 110H**	**ECO 110S**
Observations	78	180	258		
Faculty					
Commerce (comm)	0	98	98	0%	54.4%
Personal characteristics					
English home language (enghome)	57	116	173	73.1%	64.4%
Male (male)	46	89	135	59.0%	49.4%
Female (female)	32	91	123	41.0%	50.6%
Home (home)	52	96	148	66.7%	53.3%
Residence (res)	26	84	110	33.3%	46.7%
ECO110S students first registration for ECO110 (ftime)	0	20	20	0%	11.1%
Average age (age) in months	222.5	226.8	225.4		
Pre 1994 Education Department					
Department of Education and Training (det)	6	34	40	7.7%	18.9%
Education Department of the House of	8	17	25	10.3%	9.4%

Representatives (cohr)					
Matriculation subjects					
Matriculation points score (matpt)	29.8	33.0	32.1		
Adjusted matriculation points score (adjmatpt)	20.2	21.2	20.9		
English first language (HG) (engflhg)	72	143	215	92.3%	79.4%
Mathematics (HG) (mathhg)	24	89	113	30.8%	49.4%
Physical science (HG) (pshg)	22	92	114	28.2%	51.1%
Business Economics (busecon)	20	26	46	25.6%	14.4%
Economics (eco)	15	17	32	19.2%	9.4%

Table C4 2001 cohort

	Number of observations			Share structure	
	ECO 110H	**ECO 110S**	**TOTAL**	**ECO 110H**	**ECO 110S**
Observations	91	132	223		
Faculty					
Commerce (comm)	0	89	89	0%	67.4%
Personal characteristics					
English home language (enghome)	58	83	141	63.7%	62.9%
Male (male)	57	79	136	62.6%	59.8%
Female (female)	34	53	87	37.4%	40.2%
Home (home)	52	72	124	57.1%	54.5%
Residence (res)	39	60	99	42.9%	45.5%
ECO110S students first registration for ECO110 (ftime)	0	24	24	0%	18.2%
Matriculation subjects					
Matriculation points score (matpt)	30.2	32.9	31.8		
Adjusted matriculation points score (adjmatpt)	20.4	21.0	20.8		
English first language (HG) (engflhg)	70	108	178	76.9%	81.8%
Mathematics (HG) (mathhg)	25	75	100	27.5%	56.8%
Physical science (HG) (pshg)	30	76	106	33.0%	57.6%
Business Economics (busecon)	22	24	46	24.2%	18.2%
Economics (eco)	22	19	41	24.2%	14.4%

Table C5 ECO111S and ECO203F cohorts

	ECO 111S			ECO 203F		
	ECO 110H	**ECO 110S**	**ECO 110F**	**ECO 110H**	**ECO 110S**	**ECO 110F**
Observations	52	41	920	28	24	925
Male (male)	34	26	539	16	11	531
% of total	65.4	63.4	58.6	57.1	45.8	57.4
Matriculation points (matpt)	30.8	32.6	41.2	30.8	32.9	39.4
Adjusted matriculation points (adjmatpt)	21.1	21.0	26.4	21.4	21.7	25.2
English first language (HG) (engflhg)	43	35	874	23	41	847
% of total	82.7	85.4	95.0	82.1	79.2	91.6
Mathematics (HG) (mathhg)	21	26	826	10	13	775
% of total	40.4	63.4	89.8	35.7	54.2	83.8
Physical Science (HG) (pshg)	22	22	711	10	9	680
% of total	42.3	53.7	77.3	35.7	37.5	73.5

Appendix D

Regression equations

D.1 Performance in first-year microeconomics compared

D.1.1 Full samples

a. Linear equations

2000: 383 observations

Equation 1
ls mcq c adjmatpt age busecon cohr comm det eco engflhgab engflhgc engflhgde enghome ftime h home male mathhgab mathhgc mathhgd mathhge pshgab pshgc pshgd

Equation 2
ls sq c adjmatpt age busecon cohr comm det eco engflhgab engflhgc engflhgde enghome ftime h home male mathhgab mathhgc mathhgd mathhge pshgab pshgc pshgd

2001: 424 observations

Equation 3
ls mcq c adjmatpt busecon comm eco engflhgab engflhgc engflhgd engflhge enghome ftime h male mathhgab mathhgc mathhgd mathhgef pshgab pshgc pshgd res

Equation 4
ls sq c adjmatpt busecon comm eco engflhgab engflhgc engflhgd engflhge enghome ftime h male mathhgab mathhgc mathhgd mathhgef pshgab pshgc pshgd res

b. Quadratic and interaction equations

2000: 383 observations

Equation 5
ls mcq c adjmatpt adjmatpt*adjmatpt h*adjmatpt busecon h* busecon comm comm*h eco eco*h engflhgab engflhgc engflhgd engflhge engflhg*h enghome enghome*h male mathhgab mathhgc mathhgd mathhge mathhg*h pshgab pshgc pshgd pshge pshg*h

Equation 6
ls sq c adjmatpt adjmatpt*adjmatpt h*adjmatpt busecon h* busecon comm comm*h eco eco*h engflhgab engflhgc engflhgd engflhge engflhg*h enghome enghome*h male mathhgab mathhgc mathhgd mathhge mathhg*h pshgab pshgc pshgd pshge pshg*h

2001: 424 observations

Equation 7
ls mcq c adjmatpt adjmatpt*adjmatpt h*adjmatpt busecon h* busecon comm comm*h eco eco*h engflhgab engflhgc engflhgd engflhge engflhg*h enghome enghome*h male mathhgab mathhgc mathhgd mathhgef mathhg*h psab pshgc pshgd pshge pshg*h res res*h

Equation 8
ls mcq c adjmatpt adjmatpt*adjmatpt h*adjmatpt busecon h* busecon comm comm*h eco eco*h engflhgab engflhgc engflhgd engflhge engflhg*h enghome enghome*h male mathhgab mathhgc mathhgd mathhgef mathhg*h pshgab pshgc pshgd pshge pshg*h res res*h

D.1.2 Truncated samples

a. Linear equations

2000: 258 observations

Equation 9
ls mcq c adjmatpt age busecon cohr comm det eco engflhgab engflhgc engflhgde enghome ftime h home male mathhgabc mathhgd mathhge pshgabc pshgd

Equation 10
ls sq c adjmatpt age busecon cohr comm det eco engflhgab engflhgc engflhgde enghome ftime h home male mathhgabc mathhgd mathhge pshgabc pshgd

2001: 223 observations

Equation 11
ls mcq c adjmatpt busecon comm eco engflhgab engflhgc engflhgde enghome ftime h male mathhgabc mathhgd mathhgef pshgabc pshgd pshgef res

Equation 12
ls sq c adjmatpt busecon comm eco engflhgab engflhgc engflhgde enghome ftime h male mathhgabc mathhgd mathhgef pshgabc pshgd pshgef res

b. Quadratic and interaction equations

2000: 258 observations

Equation 13
ls mcq c adjmatpt busecon comm eco engflhgab engflhgc engflhgde enghome male mathhgabc mathhgd mathhge pshgabc pshgd pshge adjmatpt*adjmatpt eco*h busecon*h engflhg*h enghome*h mathhg*h pshg*h adjmatpt*h

Equation 14
ls sq c adjmatpt busecon comm eco engflhgab engflhgc engflhgde enghome male mathhgabc mathhgd mathhge pshgabc pshgd pshge adjmatpt*adjmatpt eco*h busecon*h engflhg*h enghome*h mathhg*h pshg*h adjmatpt*h

2001: 223 observations

Equation 15
ls mcq c adjmatpt adjmatpt*adjmatpt h*adjmatpt busecon h*busecon comm h*eco eco h*engflhg engflhgab engflhgc engflhgde h*enghome enghome male mathhgabc mathhgd mathhgef h*mathhg pshgabc pshgd pshgef h*pshg res h*res

Equation 16
ls sq c adjmatpt adjmatpt*adjmatpt h*adjmatpt busecon h*busecon comm h*eco eco h*engflhg engflhgab engflhgc engflhgde h*enghome enghome male mathhgabc mathhgd mathhgef h*mathhg pshgabc pshgd pshgef h*pshg res h*res

D.2 Performance in subsequent economics courses compared

D.2.1 Full samples

a. ECO111S: 1105 observations

Equation 17
ls mcq c adjmatpt engflhg mathhg pshg hfull male sfull

Equation 18
ls sq c adjmatpt engflhg mathhg pshg hfull male sfull

b. ECO203F: 1042 observations

Equation 19
ls mcq c adjmatpt engflhg mathhg pshg hfull male sfull

Equation 20
ls sq c adjmatpt engflhg mathhg pshg hfull male sfull

D.2.2 Truncated samples

a. ECO111S: 1013 observations

Equation 21
ls mcq c adjmatpt engflhg mathhg pshg htrunc male strunc

Equation 22
ls sq c adjmatpt engflhg mathhg pshg htrunc male strunc

b. ECO203F: 977 observations

Equation 23
ls mcq c adjmatpt engflhg mathhg pshg htrunc male strunc

Equation 24
ls sq c adjmatpt engflhg mathhg pshg htrunc male strunc

Appendix E

Results of selected estimations

Ordinary least squares and White heteroskedasticity-consistent standard errors and covariance test used for all estimations.

E.1 Performance in first-year microeconomics compared

E.1.1 Estimations for linear equations (full samples)

a. 2000

Table E1 Equation 1

Dependent Variable: MCQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	27.54578	10.02628	2.747358	0.0063
ADJMATPT	0.659237	0.283937	2.321773	0.0208
AGE	-0.011615	0.032228	-0.360387	0.7188
BUSECON	0.761608	2.024863	0.376128	0.7070
COHR	-2.798740	2.777596	-1.007612	0.3143
COMM	2.701254	1.750192	1.543404	0.1236
DET	-1.108031	2.977148	-0.372179	0.7100
ECO	-0.416421	2.357274	-0.176654	0.8599
ENGFLHGAB	6.327805	3.606128	1.754737	0.0802
ENGFLHGC	3.700742	3.015483	1.227247	0.2205
ENGFLHGDE	3.573970	3.035803	1.177273	0.2399
ENGHOME	-2.017655	2.277434	-0.885933	0.3762
FTIME	-2.452603	3.553906	-0.690115	0.4906
H	3.697410	2.051162	1.802593	0.0723
HOME	-0.159156	1.811939	-0.087837	0.9301
MALE	5.339377	1.627751	3.280218	0.0011
MATHHGAB	7.310398	2.693699	2.713888	0.0070
MATHHGC	4.480018	2.437426	1.838012	0.0669
MATHHGD	4.291293	2.490509	1.723058	0.0857
MATHHGE	2.233370	2.442342	0.914438	0.3611
PSHGAB	4.902132	4.085584	1.199861	0.2310
PSHGC	3.419428	2.805007	1.219044	0.2236
PSHGD	2.599524	2.112985	1.230261	0.2194
R-squared	0.138878	Mean dependent var		49.12895
Adjusted R-squared	0.085812	S.D. dependent var		14.89282
S.E. of regression	14.23950	Akaike info criterion		8.208533
Sum squared resid	72386.49	Schwarz criterion		8.447017
Log likelihood	-1536.621	F-statistic		2.617067
Durbin-Watson stat	1.854117	Prob(F-statistic)		0.000125

Table E2 Equation 2

Dependent Variable: SQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	30.86672	11.16598	2.764355	0.0060
ADJMATPT	0.255663	0.278912	0.916646	0.3599
AGE	0.017601	0.039571	0.444782	0.6567
BUSECON	2.200829	2.041765	1.077905	0.2818
COHR	-1.392846	2.274151	-0.612468	0.5406
COMM	2.846854	1.600671	1.778537	0.0762
DET	0.380262	2.611453	0.145613	0.8843
ECO	-1.174937	2.104628	-0.558264	0.5770
ENGFLHGAB	7.402132	3.067452	2.413121	0.0163
ENGFLHGC	3.529735	2.580048	1.368089	0.1721
ENGFLHGDE	2.420356	2.659914	0.909938	0.3635
ENGHOME	-2.044554	2.249778	-0.908780	0.3641
FTIME	-0.994171	2.982617	-0.333322	0.7391
H	4.706632	1.838141	2.560540	0.0109
HOME	-0.102901	1.705938	-0.060319	0.9519
MALE	-1.281397	1.530865	-0.837041	0.4031
MATHHGAB	0.467263	2.645776	0.176607	0.8599
MATHHGC	1.657605	2.497797	0.663627	0.5074
MATHHGD	2.829121	2.063361	1.371122	0.1712
MATHHGE	1.661040	1.957806	0.848419	0.3968
PSHGAB	3.270763	3.773415	0.866791	0.3866
PSHGC	0.139429	2.354275	0.059224	0.9528
PSHGD	1.185412	2.097462	0.565165	0.5723
R-squared	0.071369	Mean dependent var		46.07368
Adjusted R-squared	0.014143	S.D. dependent var		13.11024
S.E. of regression	13.01720	Akaike info criterion		8.029038
Sum squared resid	60492.79	Schwarz criterion		8.267522
Log likelihood	-1502.517	F-statistic		1.247139
Durbin-Watson stat	1.864125	Prob(F-statistic)		0.205002

b. 2001

Table E3 Equation 3

Dependent Variable: MCQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	23.20747	3.877528	5.985121	0.0000
ADJMATPT	0.414317	0.172282	2.404883	0.0166
BUSECON	-3.162069	1.386910	-2.279939	0.0231
COMM	2.301823	1.080984	2.129378	0.0338
ECO	-1.045481	1.476755	-0.707958	0.4794
ENGFLHGAB	3.942571	1.673043	2.356527	0.0189
ENGFLHGC	0.084073	1.459797	0.057592	0.9541
ENGFLHGD	1.194198	1.727298	0.691368	0.4897
ENGFLHGE	4.799728	3.130942	1.532998	0.1261
ENGHOME	-2.765346	1.357860	-2.036548	0.0423
FTIME	-0.078346	1.752634	-0.044702	0.9644
H	1.472742	1.037009	1.420182	0.1563
MALE	2.818408	0.984739	2.862086	0.0044
MATHHGAB	4.863765	2.050825	2.371614	0.0182
MATHHGC	3.296579	1.625117	2.028517	0.0432
MATHHGD	1.689137	1.313431	1.286049	0.1992
MATHHGEF	5.043754	1.610574	3.131650	0.0019
PSHGAB	1.572701	2.527668	0.622194	0.5342
PSHGC	-0.491655	1.502220	-0.327286	0.7436
PSHGD	0.776165	1.403860	0.552879	0.5807
RES	-2.821601	1.204802	-2.341963	0.0197
R-squared	0.161022	Mean dependent var		35.17925
Adjusted R-squared	0.119386	S.D. dependent var		9.673925
S.E. of regression	9.078112	Akaike info criterion		7.297869
Sum squared resid	33212.09	Schwarz criterion		7.498446
Log likelihood	-1526.148	F-statistic		3.867326
Durbin-Watson stat	2.009816	Prob(F-statistic)		0.000000

Table E4 Equation 4

Dependent Variable: SQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20.05182	8.284992	2.420258	0.0160
ADJMATPT	0.864006	0.333846	2.588036	0.0100
BUSECON	-3.384312	2.535350	-1.334850	0.1827
COMM	5.817566	1.892182	3.074528	0.0023
ECO	-2.579775	2.627236	-0.981935	0.3267
ENGFLHGAB	7.149859	3.089703	2.314093	0.0212
ENGFLHGC	0.874738	2.770801	0.315698	0.7524
ENGFLHGD	0.368821	3.119631	0.118226	0.9059
ENGFLHGE	10.50639	7.153905	1.468623	0.1427
ENGHOME	-5.706372	2.252776	-2.533040	0.0117
FTIME	5.222815	2.607089	2.003313	0.0458
H	15.84531	1.779747	8.903123	0.0000
MALE	0.932228	1.619577	0.575599	0.5652
MATHHGAB	1.483337	3.016505	0.491740	0.6232
MATHHGC	0.395398	2.300024	0.171910	0.8636
MATHHGD	3.013796	2.472767	1.218795	0.2236
MATHHGEF	6.739670	2.756307	2.445181	0.0149
PSHGAB	4.397635	3.883755	1.132315	0.2582
PSHGC	0.517986	2.322371	0.223042	0.8236
PSHGD	2.168949	2.095881	1.034863	0.3014
RES	-2.118014	1.896029	-1.117079	0.2646
R-squared	0.222795	Mean dependent var		49.92689
Adjusted R-squared	0.184224	S.D. dependent var		17.21627
S.E. of regression	15.54979	Akaike info criterion		8.374231
Sum squared resid	97443.77	Schwarz criterion		8.574807
Log likelihood	-1754.337	F-statistic		5.776247
Durbin-Watson stat	1.934780	Prob(F-statistic)		0.000000

E.1.2 Estimations for linear equations (truncated samples)

a. 2000

Table E5 Equation 9

Dependent Variable: MCQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	23.13008	13.15617	1.758116	0.0800
ADJMATPT	0.031413	0.381002	0.082447	0.9344
AGE	0.047853	0.044431	1.077006	0.2826
BUSECON	2.392990	2.609552	0.917012	0.3601
COHR	-0.039516	3.565599	-0.011083	0.9912
COMM	2.410129	2.326751	1.035835	0.3013
DET	0.344622	4.061627	0.084848	0.9325
ECO	-1.438964	3.238673	-0.444307	0.6572
ENGFLHGAB	13.62287	5.217622	2.610935	0.0096
ENGFLHGC	10.10133	4.243332	2.380519	0.0181
ENGFLHGDE	8.058582	4.215443	1.911681	0.0571
ENGHOME	-1.853790	2.827997	-0.655514	0.5128
FTIME	-4.307277	4.426533	-0.973059	0.3315
H	3.108852	2.750499	1.130286	0.2595
HOME	-2.097093	2.281491	-0.919176	0.3589
MALE	4.418369	2.139786	2.064865	0.0400
MATHHGABC	4.426284	2.774949	1.595086	0.1120
MATHHGD	4.026420	2.982099	1.350197	0.1783
MATHHGE	3.801566	2.912067	1.305453	0.1930
PSHGABC	5.433388	3.333316	1.630025	0.1044
PSHGD	1.731611	2.567254	0.674499	0.5007
R-squared	0.111497	Mean dependent var		47.12549
Adjusted R-squared	0.035557	S.D. dependent var		14.80795
S.E. of regression	14.54231	Akaike info criterion		8.270765
Sum squared resid	49486.04	Schwarz criterion		8.562399
Log likelihood	-1033.523	F-statistic		1.468219
Durbin-Watson stat	1.782104	Prob(F-statistic)		0.093663

Table E6 Equation 10

Dependent Variable: SQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	23.36817	13.97448	1.672203	0.0958
ADJMATPT	-0.052519	0.351129	-0.149571	0.8812
AGE	0.071885	0.053145	1.352637	0.1775
BUSECON	4.240008	2.521537	1.681517	0.0940
COHR	-2.324342	2.568029	-0.905108	0.3663
COMM	1.554858	2.208274	0.704105	0.4821
DET	0.181040	3.051864	0.059321	0.9527
ECO	-1.995652	2.872382	-0.694773	0.4879
ENGFLHGAB	10.54001	4.377946	2.407525	0.0168
ENGFLHGC	6.530588	3.377442	1.933590	0.0544
ENGFLHGDE	4.162901	3.410727	1.220532	0.2235
ENGHOME	0.624823	2.561969	0.243884	0.8075
FTIME	-5.693088	4.011320	-1.419255	0.1572
H	2.314801	2.516242	0.919944	0.3585
HOME	-2.073713	1.973708	-1.050668	0.2945
MALE	-2.665269	1.833746	-1.453455	0.1474
MATHHGABC	3.893878	2.486160	1.566222	0.1186
MATHHGD	3.992908	2.421209	1.649138	0.1005
MATHHGE	3.301613	2.369267	1.393517	0.1648
PSHGABC	1.335536	2.878205	0.464017	0.6431
PSHGD	0.666040	2.476857	0.268905	0.7882
R-squared	0.104721	Mean dependent var		44.71765
Adjusted R-squared	0.028201	S.D. dependent var		13.25576
S.E. of regression	13.06751	Akaike info criterion		8.056899
Sum squared resid	39957.80	Schwarz criterion		8.348532
Log likelihood	-1006.255	F-statistic		1.368551
Durbin-Watson stat	1.824070	Prob(F-statistic)		0.139136

b. 2001

Table E7 Equation 11

Dependent Variable: MCQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.57587	7.310929	2.267273	0.0244
ADJMATPT	0.767341	0.339897	2.257573	0.0250
BUSECON	-2.429697	1.855386	-1.309537	0.1918
COMM	3.249780	1.633214	1.989806	0.0480
ECO	-2.650091	1.978895	-1.339177	0.1820
ENGFLHGAB	2.736835	2.742390	0.997974	0.3195
ENGFLHGC	-2.136960	1.994509	-1.071422	0.2853
ENGFLHGDE	-0.054794	2.199211	-0.024915	0.9801
ENGHOME	-3.573266	2.049660	-1.743345	0.0828
FTIME	-1.756093	2.563230	-0.685109	0.4941
H	2.064840	1.652177	1.249769	0.2128
MALE	3.708326	1.415113	2.620516	0.0094
MATHHGABC	8.222086	2.269178	3.623376	0.0004
MATHHGD	2.139399	2.057662	1.039723	0.2997
MATHHGEF	7.296704	1.695746	4.302947	0.0000
PSHGABC	0.389296	2.170495	0.179358	0.8578
PSHGD	1.030482	2.205456	0.467242	0.6408
PSHGEF	2.538166	2.129594	1.191854	0.2347
RES	-4.718849	1.815994	-2.598494	0.0101
R-squared	0.234822	Mean dependent var		33.89640
Adjusted R-squared	0.166974	S.D. dependent var		9.975676
S.E. of regression	9.104826	Akaike info criterion		7.337186
Sum squared resid	16828.26	Schwarz criterion		7.628406
Log likelihood	-795.4276	F-statistic		3.460989
Durbin-Watson stat	1.702245	Prob(F-statistic)		0.000008

Table E8 Equation 12

Dependent Variable: SQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	22.09227	16.36190	1.350226	0.1784
ADJMATPT	0.855197	0.673360	1.270044	0.2055
BUSECON	-1.158321	3.925511	-0.295075	0.7682
COMM	7.051183	2.582720	2.730138	0.0069
ECO	-7.787022	3.786669	-2.056431	0.0410
ENGFLHGAB	6.697203	5.345278	1.252919	0.2117
ENGFLHGC	0.110730	4.320008	0.025632	0.9796
ENGFLHGDE	1.543588	4.599860	0.335573	0.7375
ENGHOME	-10.32122	3.724512	-2.771161	0.0061
FTIME	4.279524	3.647750	1.173195	0.2421
H	15.62952	3.118421	5.011998	0.0000
MALE	5.020106	2.433811	2.062652	0.0404
MATHHGABC	3.041674	3.896392	0.780639	0.4359
MATHHGD	-0.864515	3.581932	-0.241354	0.8095
MATHHGEF	7.324386	3.239026	2.261293	0.0248
PSHGABC	1.796929	3.400378	0.528450	0.5978
PSHGD	4.870770	3.556239	1.369641	0.1723
PSHGEF	5.790535	3.850609	1.503797	0.1342
RES	-7.942532	2.894489	-2.744019	0.0066
R-squared	0.206582	Mean dependent var		45.63063
Adjusted R-squared	0.136229	S.D. dependent var		16.92928
S.E. of regression	15.73395	Akaike info criterion		8.431218
Sum squared resid	50254.10	Schwarz criterion		8.722438
Log likelihood	-916.8652	F-statistic		2.936383
Durbin-Watson stat	1.876987	Prob(F-statistic)		0.000115

E.2 Performance in subsequent economics courses compared

E.2.1 Estimations for linear equations (full samples)

a. ECO111S

Table E9. Equation 17

Dependent Variable: MCQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	18.18873	4.053318	4.487367	0.0000
ADJMATPT	1.621818	0.140325	11.55755	0.0000
ENGFLHG	1.069802	1.488615	0.718656	0.4725
MATHHG	0.324303	1.261459	0.257085	0.7972
PSHG	4.589438	1.039395	4.415489	0.0000
HFULL*	-1.133548	1.531884	-0.739970	0.4595
MALE	4.380857	0.813638	5.384286	0.0000
SFULL**	-5.561278	1.834311	-3.031808	0.0025
R-squared	0.225331	Mean dependent var		66.49010
Adjusted R-squared	0.220387	S.D. dependent var		14.80496
S.E. of regression	13.07214	Akaike info criterion		7.986057
Sum squared resid	187456.3	Schwarz criterion		8.022311
Log likelihood	-4404.297	F-statistic		45.58401
Durbin-Watson stat	1.869567	Prob(F-statistic)		0.000000

* Students from full sample who passed ECO110H

** Students from full sample who passed ECO110S

Table E10 Equation 18

Dependent Variable: SQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	25.45099	3.332840	7.636428	0.0000
ADJMATPT	0.913924	0.113546	8.048905	0.0000
ENGFLHG	0.001034	1.258463	0.000822	0.9993
MATHHG	0.619373	1.064332	0.581936	0.5607
PSHG	2.247779	0.802341	2.801526	0.0052
HFULL	0.282534	1.307950	0.216013	0.8290
MALE	-0.376656	0.649565	-0.579859	0.5621
SFULL	-3.462129	1.856561	-1.864807	0.0625
R-squared	0.110615	Mean dependent var		50.66606
Adjusted R-squared	0.104940	S.D. dependent var		11.34059
S.E. of regression	10.72906	Akaike info criterion		7.591002
Sum squared resid	126278.6	Schwarz criterion		7.627256
Log likelihood	-4186.029	F-statistic		19.49098
Durbin-Watson stat	1.207649	Prob(F-statistic)		0.000000

b. ECO203F

Table E11 Equation 19

Dependent Variable: MCQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.059357	4.072305	-0.996821	0.3191
ADJMATPT	1.833614	0.153581	11.93906	0.0000
ENGFLHG	0.057024	1.673470	0.034075	0.9728
MATHHG	5.995069	1.440037	4.163134	0.0000
PSHG	6.750122	1.298759	5.197364	0.0000
HFULL	-3.329407	2.143333	-1.553378	0.1206
MALE	2.061576	1.037452	1.987153	0.0472
SFULL	-7.684781	2.186837	-3.514108	0.0005
R-squared	0.231758	Mean dependent var		52.03666
Adjusted R-squared	0.226557	S.D. dependent var		18.36789
S.E. of regression	16.15375	Akaike info criterion		8.409829
Sum squared resid	269815.7	Schwarz criterion		8.447825
Log likelihood	-4373.521	F-statistic		44.56143
Durbin-Watson stat	1.960194	Prob(F-statistic)		0.000000

Table E12 Equation 20

Dependent Variable: SQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20.68695	3.707363	5.579964	0.0000
ADJMATPT	1.447812	0.137615	10.52075	0.0000
ENGFLHG	1.617173	1.459905	1.107725	0.2682
MATHHG	1.058069	1.313797	0.805352	0.4208
PSHG	3.835277	1.167568	3.284841	0.0011
HFULL	-1.637692	1.693390	-0.967108	0.3337
MALE	-2.566390	0.878488	-2.921370	0.0036
SFULL	-11.11073	1.957509	-5.675954	0.0000
R-squared	0.186905	Mean dependent var		59.76488
Adjusted R-squared	0.181401	S.D. dependent var		15.37982
S.E. of regression	13.91512	Akaike info criterion		8.111477
Sum squared resid	200214.0	Schwarz criterion		8.149472
Log likelihood	-4218.079	F-statistic		33.95489
Durbin-Watson stat	1.917985	Prob(F-statistic)		0.000000

E.2.2 Estimations for linear equations (truncated samples)

a. ECO111S

Table E13 Equation 21

Dependent Variable: MCQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.71277	3.705399	4.240506	0.0000
ADJMATPT	1.680300	0.138147	12.16318	0.0000
ENGFLHG	1.202740	1.450608	0.829128	0.4072
MATHHG	0.735786	1.261086	0.583454	0.5597
PSHG	4.814815	1.031308	4.668648	0.0000
HTRUNC*	1.252988	1.944383	0.644414	0.5194
MALE	4.453456	0.815159	5.463294	0.0000
STRUNC**	-4.980103	2.273654	-2.190352	0.0287
R-squared	0.223227	Mean dependent var		66.49010
Adjusted R-squared	0.218270	S.D. dependent var		14.80496
S.E. of regression	13.08988	Akaike info criterion		7.988769
Sum squared resid	187965.3	Schwarz criterion		8.025023
Log likelihood	-4405.795	F-statistic		45.03615
Durbin-Watson stat	1.869232	Prob(F-statistic)		0.000000

* Students from truncated sample who passed ECO110H

** Students from truncated sample who passed ECO110S

Table E14 Equation 22

Dependent Variable: SQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	25.34586	2.944494	8.607883	0.0000
ADJMATPT	0.915394	0.104927	8.724120	0.0000
ENGFLHG	-0.093087	1.251655	-0.074371	0.9407
MATHHG	0.685878	1.059231	0.647525	0.5174
PSHG	2.280907	0.810296	2.814904	0.0050
HTRUNC	0.219567	1.658102	0.132421	0.8947
MALE	-0.347300	0.646821	-0.536934	0.5914
STRUNC	-2.948161	2.123050	-1.388644	0.1652
R-squared	0.108159	Mean dependent var		50.66606
Adjusted R-squared	0.102468	S.D. dependent var		11.34059
S.E. of regression	10.74386	Akaike info criterion		7.593760
Sum squared resid	126627.4	Schwarz criterion		7.630014
Log likelihood	-4187.552	F-statistic		19.00569
Durbin-Watson stat	1.206328	Prob(F-statistic)		0.000000

b. ECO203F

Table E15 Equation 23

Dependent Variable: MCQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.866183	4.066278	-1.688567	0.0916
ADJMATPT	1.896263	0.153119	12.38424	0.0000
ENGFLHG	0.434169	1.708160	0.254174	0.7994
MATHHG	6.093174	1.467743	4.151391	0.0000
PSHG	6.997727	1.303834	5.367037	0.0000
HTRUNC	0.590921	2.915400	0.202689	0.8394
MALE	2.309664	1.039692	2.221488	0.0265
STRUNC	-4.587957	3.567586	-1.286012	0.1987
R-squared	0.223839	Mean dependent var		52.03666
Adjusted R-squared	0.218585	S.D. dependent var		18.36789
S.E. of regression	16.23679	Akaike info criterion		8.420084
Sum squared resid	272596.8	Schwarz criterion		8.458079
Log likelihood	-4378.864	F-statistic		42.59981
Durbin-Watson stat	1.947463	Prob(F-statistic)		0.000000

Table E16 Equation 24

Dependent Variable: SQ				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.22609	3.699548	5.196874	0.0000
ADJMATPT	1.460283	0.137170	10.64579	0.0000
ENGFLHG	2.151098	1.514886	1.419973	0.1559
MATHHG	1.144937	1.322814	0.865531	0.3869
PSHG	3.880995	1.169165	3.319458	0.0009
HTRUNC	1.819338	2.520517	0.721812	0.4706
MALE	-2.323527	0.879878	-2.640736	0.0084
STRUNC	-12.53579	2.731198	-4.589849	0.0000
R-squared	0.177511	Mean dependent var		59.76488
Adjusted R-squared	0.171943	S.D. dependent var		15.37982
S.E. of regression	13.99527	Akaike info criterion		8.122964
Sum squared resid	202527.1	Schwarz criterion		8.160959
Log likelihood	-4224.064	F-statistic		31.87998
Durbin-Watson stat	1.893756	Prob(F-statistic)		0.000000