

THE LABOUR MARKET DROP-OUT RATE:
A NEW APPROACH TO ESTIMATING THE RETURNS TO
GOVERNMENT INVESTMENT IN HIGHER EDUCATION:
THE CASE FOR MARINE SCIENCE
IN SOUTH AFRICA

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Abstract

The private and social returns to education literature share the same conclusion: that education is beneficial for both the individual and society. However, the theoretical underpinnings are flawed as the literature does not account for the main feature that leads to the acquisition of education: the private demand for education. An understanding of the factors that motivate the individual to invest in education would lead to a deeper insight as to why both private and social returns to education exist, and would provide a clearer framework on which to base the government funding of education.

This thesis provides a first attempt at filling this gap by introducing a method of estimating the returns to government investment in education, which is labelled the 'labour market drop-out rate approach'. The approach focuses on the social return to education, not in terms of graduate earnings, but in terms of the interaction of the graduate with the economy. The approach introduces a measure of expertise utilisation, based on the premise that there is no social return to an individual acquiring education if he or she does not utilise the acquired knowledge base on entering the labour market.

The approach is tested using the labour market for marine scientists in South Africa as a case study. In this case the private demand for education is found to be heavily influenced by the provision of student bursaries from the National Research Foundation, with a resulting estimate of the social return to a degree in marine science being a mere 20% to 25%. Owing to this, a new approach to government investment in marine science is introduced, that of graduate contribution schemes.

Of broader significance is the ease of application of this approach, it may be adopted to analyse *any* funding programme in which a government may decide to invest. As such, the labour market drop-out rate provides an extension to the returns to education literature through its theoretical dealings of the private demand for education, as well as a practical tool which government agencies can use to evaluate the efficacy of any government funding of education.

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List of abbreviations

Fort Hare	University of Fort Hare
Free State	University of the Free State
IV	Instrumental Variable
MCM	Marine and Coastal Management
NRF	National Research Foundation
OLS	Ordinary Least Squares
ORI	Oceanographic Research Institute
PE Museum	Port Elizabeth Museum
Rhodes	Rhodes University
SAIAB	South African Institute of Aquatic Biodiversity
SANCOR	South African Network of Coastal and Oceanic Research
Stellenbosch	University of Stellenbosch
UCT	University of Cape Town
UDW	University of Durban Westville
Un. Pretoria	University of Pretoria
UPE	University of Port Elizabeth
UWC	University of the Western Cape
UZULU	University of Zululand
WITS	University of the Witwatersrand

1) Introduction

Public funding of education and research is a contentious issue. Does society benefit from allocating taxpayers' money to research and student support and, if so, what are these benefits likely to entail? Government funding agencies are continually bombarded with all manner of questions as to the efficacy of their actions, naturally with all those involved in research and tertiary education having their own opinions. Many of the questions regarding the funding of research and student support revolve around the possibility of over-education (Dolton & Vignoles, 2000; Riddell, 2002) and the recent debate in the British parliament indicates just how controversial an issue student support at the tertiary level has become (Economist, 2004a; b). Similarly in South Africa, the Department of Education finds itself continually under scrutiny for the policies and decisions being implemented (Financial Mail, 2003).

Much research of varying levels of rigour and quality has been conducted, both locally and internationally, on the effects of government funding of the tertiary education sector. Traditionally the focus has been on the effect of higher levels of education on earnings. This study introduces the concept of valuing the output of tertiary education in terms of utilisation of skills and not simply on earnings.

Jewkes (1960) provided one of the first concise arguments for state provision of funding for research and student support, based implicitly on the assumption of positive externalities to education. His work was primarily in proposing that funding should be made available in order to increase the number of graduate scientists as a means of stimulating economic growth. Jewkes' (1960: 4) implicit assumption is that "more science is a necessity for improving economic standards". Since then numerous attempts have been made to evaluate the effects of state funding of the tertiary education sector. The most extensive of such attempts is the Dearing Report of the National Committee of Inquiry into Higher Education in the United Kingdom, published in 1997.

Recently, those involved in research of the labour market in South Africa have been calling for a more extensive research programme into the conditions of the labour market in South Africa to assess whether successful transition from education to

employment actually occurs (Strydom & Fourie, 1999; Bhorat & Lundall, 2002). With the labour market increasingly expecting graduates to be directly employable, especially with regard to experiential knowledge (Kruss, 2002), this information would be even more valuable. However, given the current structure of the university training environment and the given role of the ‘traditional’ university being a seat of learning and research rather than of vocation, satisfying these expectations is most likely to be extremely costly or even impossible (Strydom & Fourie, 1999).

The literature on the returns to education is well established. The private returns to education literature received renewed focus with the development of human capital theory (Becker, 1962) and the signalling hypothesis (Spence, 1973), while the argument for the social return to education has existed for centuries (Weiss, 1995). The work on evaluating the effects of government funding of education may be separated into two streams. The first stream focuses more on the level of funding for research purposes (e.g. Brown, 2001; Mitcham & Frodeman, 2002), while the second focuses on the effects of student support on the supply of graduates to the labour market (e.g. Freeman, 1975; Romer, 2000; Freeman et al., 2001). However, while both streams look at the relative social returns to government funding, with the exception of Romer (2000) and Freeman et al. (2001), no comprehensive work has been done to evaluate the determinants of supply of expertise to the labour market of a country. Even the above-mentioned studies look at overall measures, such as job advertisements in departments, without actually engaging with the future supply itself: the student body. This has implications for the accuracy of the social and private returns to individuals obtaining graduate degrees. Questions such as why they enrolled for a degree, and the source of funding, should be answered *before* making an estimate of the social return to education.

This research focuses on the funding actions of the National Research Foundation (NRF), the government agency responsible for funding research endeavours and the provision of student support at the higher degrees level (masters and doctorate degrees) in South Africa. The aim of the NRF is that of “capacity building and investing in the development of South Africa” (NRF, 2002a). This can and has been interpreted in a number of ways. Many academics believe that funding should be allocated to active researchers, others believe that students should be the primary

beneficiaries, and yet others are calling for a careful balance between the two. As such, there are many opinions as to the efficacy of the funding provided by the NRF, but no research has ever been conducted as to the effects of such funding on the labour market for expertise in South Africa.

The main call from the academic community, especially the scientists, is obviously for more money, but how it should be allocated becomes a critical issue. Many believe that more students need to be educated at the higher degrees level in order to enhance South Africa's level and quality of research output (Woods, 2003), but the question is how this should be accomplished and whether there is a greater need for research output. Others believe that funding structures should not focus on students as an output but rather on the expected scientific outputs of research projects submitted for funding (Herbert, 2001). This point is especially valid for those areas of research where employment opportunities for new graduates are limited. Some academics ridicule this idea that the allocation of funding should be based on proposed project outputs. As Dennison (2000: 2) firmly states, "Muses of science are shy creatures; they flourish best when least controlled and vanish at the hint of a political agenda, leaving behind the hack 'prostitutes of science', who will do anything for a buck and who judge themselves and others by their income rather than their output." Dennison's (2000: 2) conclusion is that project-based research funding can only be labelled as funding of "science fiction" and that the current system is open to abuse as there is no possible objective manner in which to "peer review" project proposals.

However, this is as far as analysis and opinions go. Thus far no thought has gone into the utilisation of the expertise and research output developed through the provision of funding. Only recently in the USA has anyone conducted research into the possible effects of research funding on the future of the individual who receives it, where it is indeed political agendas and the ego of the research scientist that affect the choices of students to enrol for a higher degree, and hence the social and private returns to such education (Freeman et al., 2001). No such study has been conducted in South Africa. One attempt (Akkers et al., 1999) has been made to evaluate the supply of graduates to the marine science, engineering and technology community in South Africa, but the focus was on the demographic composition of the student body, not on whether these

students are likely to find employment on completion of their studies. While this study made a valiant attempt, its mandate was confused and the lack of responses from participating institutions not only hampered the validity of any conclusions drawn (Akkers, 1999: 5), but also points to a particular attitude towards such research within academic institutions in South Africa.

Therefore, there is a desperate need for research into the effects of the provision of student support at the research level on the labour market for expertise in South Africa. In addition, an easily manageable approach to evaluate the outputs of funding needs to be developed to aid those in policy-making positions. This is vital if South Africa is to develop its research ethos and capacity and allow the NRF to successfully fulfil its mandate.

The aim of this research is to develop and test a new approach for estimating the social returns to education that would satisfy the above conditions of being manageable and easily applicable to the current funding structure in South Africa. This involves a review of the literature of the returns to education and whether currently used approaches to evaluate the social and private returns are accurate. Chapter 2 provides a review of the literature with the conclusions that the current private (human capital and signalling hypothesis) and social returns (macroeconomic growth models) methodologies fail to explain the endogenous choice of education and hence misrepresent the social returns to individuals graduating with a higher degree.

Owing to this weakness, a new approach to evaluate the social returns to higher degree graduates is introduced, labelled the labour market drop-out rate approach. This approach focuses on whether graduates actually utilise the expertise gained through their studies in their current employment position, rather than on graduate earnings. In doing so, the approach takes into account the demand for and supply of expertise to the labour market, emphasizing the importance of the determinants of supply. This approach is presented in Chapter 3.

Chapter 4 presents the methodology developed in applying the labour market drop-out rate approach to estimate the social return to expertise developed through a higher degree, using the labour market for marine scientists in South Africa as a focus group.

The methodology is survey-based involving surveys with those employed as and those studying to become marine scientists.

Chapter 5 presents an analysis of the results of the two surveys. The results are startling in that the supply of marine scientists to the labour market is principally driven by government intervention on the supply side, not to alleviate a credit constraint, but rather owing to possible private interest groups and a failure of the NRF to fully grasp the effects of its actions.

Chapter 6 concludes by discussing the effectiveness of this new approach to evaluate the social returns to education and provides new insights into the role of government funding of research and student support at the higher degrees level. Further to this, a discussion of potential policy changes is presented to ensure that society benefits from the government provision of research funding and student support.

2) Theories of the returns to education

2.1) Introduction

The acquisition of education has long been seen as a panacea to the troubles of individuals and nations alike. The universally held view is that obtaining an education will improve an individual's life, but the question is, how?

The concept and measurement of a return to education have received attention for centuries. As Bowen states in 1964, "of late economists have been spending considerable time attempting to assess the economic contributions of education" (Haveman & Wolfe, 1984: 377).

Today there are journals and research institutes solely dedicated to conceptualising and measuring the possible returns to education, e.g. the *Economics of Education Review* and the Centre for the Economics of Education at the London School of Economics. However, this does not mean there is consensus in the study of the effects of education. The theories and estimates available have made the returns to education a contentious issue, as the research results may well influence the policy decisions taken by those governments that subsidise education.

A picture of the returns to education may be formed by first focusing on the individual. It is likely that the individual is to receive some form of return to education, but to what extent? Does education enrich the individual's life, does it affect his or her future earnings and, if so, how is this effect to be measured? The microeconomic theories of Human Capital (Mincer, 1958; 1974; Schultz, 1960; Becker, 1962) and the sorting models of the Signalling Hypothesis and Credentialism theories (Spence, 1973; Ferrer & Riddell, 2002) attempt to explain and measure the individual's returns to education.

To expand this picture, it is also probable that society will benefit from a more highly educated population. In other words, there is likely to be a social or macroeconomic return to education, which is dependent on the individual benefiting first (Temple, 1999; Krueger & Lindahl, 2001). The debate of the social or macroeconomic returns to education may be separated into three groups according to the conceptualisation of

and the methodologies applied to estimating the social return. The first group is the social returns to education, second is the city-wide effects of increasing levels of education and the third is the relevant macroeconomic theories. This last group may be further separated into theorists who follow the extended neoclassical Solow Growth Model and those who follow the ‘New Growth’ theories.

This chapter is separated into debates on the microeconomic and macroeconomic theories and their respective empirical estimations of the returns to education.¹ Section 2.2 discusses the microeconomic returns and Section 2.3 the macroeconomic returns to education literature. Section 2.4 concludes with an analysis of the weaknesses in both the micro and macro approaches to measuring the returns to education.

2.2) Microeconomic returns to education

An analysis of the theories of the microeconomic returns to education surrounds the debate as to whether human capital theory or the signalling hypothesis and related sorting models is best suited for revealing the benefits an individual receives from acquiring education. The two theories attempt to measure the effect of acquired or future education on an individual’s current or future earnings. The methodologies are essentially the same, while the distinction between the two theories lies in the manner in which the individual’s decision to acquire education is to be included.

The basic methodology of the two is to use a measure of education as well as other explanatory variables in regression analysis using either Ordinary Least Squares (OLS) or Instrumental Variable (IV) techniques. These methods attempt to estimate the returns to education, as measured by the impact education may have on the wage received by the individual. While the methodologies are similar, there is substantial debate over the accuracy of the different estimation techniques. This is due partly to the theoretical gaps of both theories to account for the full private return to education and partly to bias inherent within the various estimation techniques.

¹ Appendix II presents a discussion of the empirical results of private returns to education, while Appendix III for the social returns to education.

This section is organised in the following manner: firstly a discussion of the returns to education for which both human capital and the signalling hypothesis cannot account; secondly a review of the human capital literature; thirdly a review of the signalling hypothesis and a debate as to whether there is any real difference between the two viewpoints, especially considering the similarity in their methodology. Finally, the strengths and weaknesses of the various methodologies are presented.

2.2.1) Non-monetary returns to education

The return to education may be defined as the benefits an individual acquires from education compared to an individual without education. If this is the case, a distinction needs be made between those returns that are related to the wage and those returns not related to the wage. Human capital and the signalling hypothesis measure the private monetary return to education which is represented by the wage rate or earnings received by an individual for successive increments of education. Because data on the wage rates and earnings of individuals is readily available, much of the economic theory related to the returns to education has emphasised and analysed the effects education has on the wage received.

The non-monetary and hence less quantifiable returns to education make economic analysis of such returns more difficult – how does one quantify enjoyment experienced from reading a book? The reality is that the returns to education involve far more than simply having an impact on the earnings of an individual.

Individual non-monetary returns to education may include the following:

1. The additional things an individual can produce for himself (e.g. repairs at home) owing to increased skill or more leisure time.
2. Psychic returns from the sort of job he is able to hold (job preference).
3. Non-market production that his education prevents or that is incompatible with the time needed to realise a monetary return.
4. Added enjoyment in any given leisure time attributable to his education (e.g. reading, music appreciation).
5. Enjoyment from which his education disqualifies him (Bowman, 1962: 650).

One would expect the third and fifth item to have a negative effect and the other items to have a positive effect on the private non-monetary, hence non-market, returns to education.

Haveman and Wolfe (1984) provide an extensive list of private returns to education, distinguishing between returns which are market (thus quantifiable) and non-market, and often ignored, private returns to education.²

2.2.2) *Human capital theory*

The explicit statement of ‘capital’ embodied in the individual (hence *human capital*) and the theories to explain the relevance and returns to this ‘capital’ can be attributed to three individuals, Jacob Mincer (1958), Theodore Schultz (1960) and Gary Becker (1962). While they are responsible for the development of research into returns to education as a form of a return to an investment it should be noted that the concept of wealth as unspecified wealth embodied in the individual, has been in the literature for some time, e.g. Fisher’s ‘Senses of Capital’ (1897) and the work of Von Thunen (1863: in Renshaw, 1960).

The first clear definition of human capital was put forward by Schultz (1960: 571) in an attempt to explain the effect education may have on current and/or future earnings, by proposing to:

treat education as an investment in man and to treat its consequences as a form of capital. Since education becomes a part of the person receiving it, ... I shall refer to it as human capital.

This definition labels the process of acquiring education as the investment period, and the period of time post acquisition as the period of time in which the return to such investment is received.

² Market returns being those for which a monetary value already exists such as an hourly wage; non-market returns to education being those for which a value needs to be imputed. See Appendix I for a list of possible private and macroeconomic or social returns to education.

Becker puts forward a more elegant definition of human capital, broadening it to encompass not only education but also skills acquisition during employment. Thus Becker (1962: 9) is:

concerned with activities that influence future real income through the imbedding of resources in people. This is called investing in human capital.

The definition of human capital shows that “human capital is different from physical capital because it is an accumulated factor that is embodied in people” (Saint-Paul, 1997: 230). This distinction is vital: physical capital can be renewed while human capital has to be acquired and thus involves a potentially substantially longer period of time before it can be of any use. Moreover, theory may be used to explain both the decision of a firm to invest in training of its workforce and the decision of an individual to acquire education or training before entering the labour market. Becker (1962) first explains the process of investment in human capital related to the behaviour of the firm.

In a competitive market the skills required of an individual across firms are expected to be the same, as firms are following the same production processes. In this case, the individual is mobile between employers as he has the skills required of any employer in the market. It is not worthwhile for a firm to invest in enhancing the skills of its workforce as the individual may move to another firm on completion of the training programme. If this occurs, the firm responsible for the investment in the skills training would not receive a return on its investment, with the benefit going to the competing firm for which the employee now works.

The firm that provided skills training receives no return on its investment because “labour [hence human capital] is embodied in the individual” (Kaufman, 1986: 4). The individual leaving the firm takes the ‘capital’ or investment with him. Remaining with the firm in the competitive market, the effects of labour being embodied in the individual are to some extent only linked to what Becker and others refer to as ‘general skills’. General skills are those skills that are useful to many firms; in the case of the perfectly competitive market all skills would be equally useful to any firm.

There are three potential beneficiaries to investment in general skills training. The individual will always benefit, the firm responsible for the training may benefit, and

the firm which hires the individual on completion of the training provided by another firm may also benefit. The particular significance of human capital is that the investment is embodied in a *moveable* feature, the individual, so there will always be more than one beneficiary as human capital is *used* by many but owned by one.³

As a result of the ownership characteristic of human capital, firms in competitive markets are unlikely to invest in general skills development because of the possibility of not receiving the return to the investment in a training programme. The result is an expected under-investment by firms in general skills training.

The picture changes when one analyses actual production processes of individual firms. Each firm within a competitive market is producing the same or similar product, but production methods will vary according to the capital/labour ratios available to the firm. This creates an environment in which the production process of each firm is specific and thus requires specific knowledge and skills. In this case it is beneficial for the firm to invest in the training of individuals.

Becker recognises the role played by training in the development of human capital theory. According to Becker's (1962: 17) framework, specific training is defined as training that "has no effect on the productivity of trainees that would be useful in other firms". However, it is unlikely that training would be only specific or general. It is likely that training would combine both general and specific skills, with the 'mixture' being defined by the production process and capital/labour ratio available to each firm. The factor most likely to influence the mix of general and specific trainings is the degree of competitiveness of the market in which the firm operates (Becker, 1962: 18). The situation of a non-competitive market resulting from labour market institutions, such as unions and minimum wage legislation that could compress the wage structure within an industry, may well increase the incentive for firms to invest in general training (Acemoglu & Pische, 1999a: F139; 1999b).

³ This is the main reason for the existence of a social or macroeconomic return. As mentioned earlier, the individual must first benefit before there is to be a social return. Thus education or training essentially has some externality characteristics.

Human capital thus provides a framework for analysing the effects of training on the productivity of an individual, who is to benefit from the resulting increase in skills and who is willing to pay to develop such an increase. The framework can be used to determine the level of investment which firms allocate to general and specific skills training.

The other side of the coin in the issue of training regards investment made by the individual in acquiring training or education *before* entering the labour market. In this sense, schooling may be defined as “a [process] specialising in the production of training, as distinct from a firm that offers training in conjunction with the production of goods” (Becker, 1962: 25). Schooling or education has distinct benefits over on-the-job training because the individual develops a level of productivity that may be of use to the firm immediately on employment, thus removing the need for investment in training programmes.

Returning to Becker’s view of human capital involving those “activities that influence future real income through the imbedding of resources in people” (1962: 9), an incentive therefore exists for all parties, both employer and (future) employee, to invest in such resources. The returns to such an investment accrue partly to the firm in higher productivity, partly to the individual in both the non-monetary effects of education and the possible effects on future earnings and partly to industry (and hence society) in the form of a more productive workforce.

It is interesting to note that the developing stages of human capital theory reveal an incentive for the individual to invest or acquire education, and that only those who are capable will succeed through successively higher levels. This would surely represent a signal of ability. Why is it, then, that the signalling hypothesis and other related sorting models are presented only in 1973 (Spence, 1973)? A possible answer, which fuels the debate of the efficacy of human capital versus the signalling hypothesis, is that a clear methodology for testing the effects of human capital had yet to be developed.

Despite this, from its inception human capital theory presented economics with a concise deductive explanation for many facets of the labour market, including:

- The returns to education.
- The incentives for individuals to enrol in education.
- The incentives for the market to invest in education.
- The reason for the development of skills shortages and mismatches.
- Explanations for the wage structure across and within industries as well as countries.

2.2.3) *The signalling hypothesis*

In an attempt to explain why individuals invest in education on the one hand and why employers look for education in employees on the other, Spence (1973) presented the signalling hypothesis in his article 'Job Market Signalling'. Rather like Becker and human capital theory, while the development of the idea may have begun in the 1960s (Riley, 2001: 432) and in Akerlof's 'Market for Lemons' (1970), Spence was the first to put forward a clear proposal of any sorting of individuals occurring in the labour market. The signalling hypothesis is rooted in the theory of asymmetric information and the potential for moral hazard in the selection of an employee by an employer, or the acceptance of a job offer by an employee. The hypothesis is that in a competitive labour market, where there are both high and low productivity workers, employers value the former more than the latter, and illustrate this by paying the former higher wages.

On the basis of this premise, how does an employer isolate the high from the low productivity workers and, the corollary, how do high productivity workers make their capacity known to the employer? This situation calls for a tangible and observable separation of the high from the low: that is, the need for a signal. According to Spence's (1973) hypothesis, the employer evaluates job applicants according to a set of criteria drawn from the employer's experience, perceptions and beliefs. This set of criteria comprises characteristics of the individual that are unalterable, such as race, gender and age, and alterable characteristics, such as the level of education that the individual has obtained. The former characteristics are labelled *indices*, while the

latter are “observable characteristics attached to the individual that are subject to manipulation by the individual” (Spence, 1973: 357) and are referred to as *signals*.

Other than the employer’s predetermined qualitative beliefs and perceptions based on an individual’s indices, the signals of the individual are used as a measure of his or her potential productivity. The employer must rely on such signals owing to the failure of the flow of free and full information through the labour market (Stigler, 1961; 1962). In this manner signals influence the hiring decision by acting as a screening mechanism which the employer uses to overcome the problem of incomplete information.

Simultaneously, individuals respond to signals as an indication of ‘worth’ or actual productivity and thus invest in a signal, say education, to the level which he or she believes to be optimal. In other words individuals are expected to invest in signals in order to “maximise the difference between offered wages and signalling costs” (Spence, 1973: 358).

2.2.4) Human capital versus the signalling hypothesis

Whether human capital theory is to be replaced or complemented by the signalling hypothesis and other sorting models, or whether signalling should be considered a logical extension of human capital, can best be answered by comparing the respective methodologies.

Becker (1962) developed the theoretical framework of human capital with which to evaluate the effects of education on earnings. However, the first widely adopted method for measuring the returns to education was provided by Jacob Mincer (1958; 1974), to the extent that Mincer has been described as Becker’s “empirical mind and conscience” (Bowman, 1966: 115. In: Burton et al., 1971: 158). Mincer’s (1974) work (and that of others) is based on the observation that people with higher levels of education command higher annual earnings. Therefore, it seems obvious that education contributes to the earning power of the individual.⁴ If this is the case, then it should be possible to measure the effect of higher levels of education on earnings.

⁴ Education directly leading to higher earnings has been questioned, e.g. Blundell et al. (1999).

The relationship was first tested in a simple schooling model of returns to education, where an individual's income is compared to successive years of schooling, thus determining the effect of additional years of schooling on the income received by an individual, interpreted as the rate of return to schooling.

The schooling model is as follows:

$$\text{Log}(Y_s) = \log(Y_o) + rs \quad (1)$$

Where: Y_s = income earned after schooling

Y_o = income earned with no schooling

s = number of years at school

This equation was the first simple empirical test of human capital theory and represents the possibility that “percentage increments in earnings are strictly proportional to the absolute differences in the time spent at school” (Mincer, 1974: 11). The model represents a homogeneous return to each successive year of schooling common to all individuals and is more formally known as a one-factor human capital model. Heterogeneous factor models were then developed to account for all manner of factors, be they individual characteristics such as gender or race, or quantifiable factors such as years of education or experience in the job market. These models are designed to suit various conditions, with the results being specific to a particular period and location (Blundell et al., 2001: 7). The familiar heterogeneous Mincerian or human capital wage equation is presented below (Chevalier et al., 2002: 5):

$$\text{Log}(\omega_i) = \beta X_i + rS_i + \delta x_i + \gamma x_i^2 + u_i \quad (2)$$

Where ω_i represents an earnings measure for an individual (e.g. earnings per hour or annual income), S_i represents a measure of the individual's years of schooling, x_i is an experience measure represented by age less the age on completion of full-time study and X_i is a set of other observable variables, such as race or gender, expected to affect earnings. In this case the coefficient r is considered to be the private financial return to schooling as well as the proportionate effect on wages of an increment to S (Harmon et al., 2000: 9). The error term (u_i) represents unobservable factors that are either not explicitly or cannot be measured. Note that experience is included as a quadratic term to capture the concavity of the earnings profile.

The signalling approach to measuring the returns to education varies little. The hypothesis states that it is both indices and signals that may affect the earning power of the individual, as do the heterogeneous human capital models. The only difference in the methodology to that of human capital is the manner of controlling for the effect of education. As Spence (1973) suggests, employers observe concrete signals such as a qualification completed, they do not observe the number of years an individual spent in education. Therefore, the question is whether it is the years of education or the completion of certain levels of education that determine the earnings of an individual. The approach taken by the sorting models is that it is the possession of the degree/diploma/professional qualification that is rewarded (the observable signal), not the time spent acquiring the qualification (Chevalier et al., 2002; Ferrer & Ridell, 2002). The support for such an argument is that the effect successive years of education have on productivity is surely cumulative and that the existence of a homogenous rate of return to each year, as suggested by Mincer, is unlikely. If the effect of successive years is cumulative, the measurement of the change in wages for an individual who goes to school for 12 instead of 11 years would measure the “combined effect of one additional year of learning and the [individual would be] identified as the type of person who has attended 12 rather than 11 years of schooling” (Weiss, 1995: 134). The effect of the possession of such on earnings is frequently labelled a ‘sheepskin’ effect.

The methodology of the signalling approach thus manipulates the human capital equation to account for the completion of certain levels of education rather than the number of years completed. This is done by accounting for discrete groupings rather than for years of education. The signalling, or extended human capital wage equation as it is commonly referred to, is presented as follows:

$$\text{Log}(\omega_i) = \beta X_i + r\text{QUAL}_i + \delta x_i + \gamma x_i^2 + u_i \quad (3)$$

Here QUAL_i indicates the acquisition of a qualification by an individual, where r represents the average return to acquiring the qualification (Chevalier et al., 2002: 5). It must be made clear that by using discrete groupings of education (such as primary, secondary and tertiary education) or qualifications, the coefficient r measures the *return* to acquiring such a signal and not a *rate* of return. The return represents an

earnings premium over a base category, i.e the use of dummy variables, determined at the outset of the model.

Therefore, the empirical methodology of the signalling hypothesis makes no real change to the original human capital approach. The only adjustment is to account for the cumulative rather than proportional effect education may have on productivity. However, are the results following the signalling approach any different from the human capital approach? Those with higher levels of education have learned more and this is reflected in wages as per human capital. Employers screen applicants by qualification as a measure of unobservable characteristics using the level of education as a proxy for productivity, and this is reflected in the wage (Ferrer & Ridell, 2002: 879). These two points are essentially the same.

The difference between the two approaches may be shown in the empirical challenges of the human capital approach. The theoretical considerations of human capital are well founded, yet the empirical results of the approach have been under continuous scrutiny since the idea was introduced. Much of this stems from the inconsistency of the results using the human capital methodology. Blaug (1976) presents a thorough critique of human capital, attacking the many ‘researchers’ for playing the ‘number-crunching’ game of producing hundreds of results using a myriad of data sources and having to rely increasingly on highly technical methods of analysis⁵ to develop the proxies for the return to human capital. Blaug (1976: 831) accuses these ‘researchers’ of ignoring the core issue of why investment in education occurs, such as the private demand for education.

But, is the signalling hypothesis literature any better? The methodology is hardly different to the human capital approach to measuring the returns to education. The only difference is in dealing with the acquisition of education in terms of discrete groups or qualifications instead of years. The strength of this approach, though, may be in that it is more easily applied to any situation than establishing the number of years an individual has spent acquiring education. The weakness, however, is that it

⁵ See, for example, Hogan and Rigobon (2002).

does not distinguish between those who take longer than the requisite period to complete a discrete measurement of education.

One critique of human capital is its apparent incapacity to account for the ‘lumpiness’ of education (which signalling accomplishes through the use of discrete levels of education), yet there is nothing in human capital theory to prevent ‘lumping’ together certain levels of education if they are to have an end rather than a continuous effect. It is simply that the first empirical human capital model, the schooling model, dealt with years of schooling in a continuous manner.

Therefore, in comparing the methodologies of human capital and signalling, it appears that the difference is that the signalling approach extends human capital to account for the cumulative effect of education. Theoretically, however, there is no difference. To satisfy this, observe the behaviour of an individual in choosing the optimum level of education to be acquired according to the signalling and human capital approaches. In the signalling hypothesis, individuals are expected to invest in signals (levels of education) so as to “maximise the difference between offered wages and signalling costs” (Spence, 1973: 358). Regarding human capital, the level of investment chosen by the individual (or the firm) is the point where the marginal private benefit of investment is equal to the marginal private cost of investment. Therefore, “sorting (signalling) models of education can best be viewed as extensions of human capital models” (Weiss, 1995: 134), which only adds to the strength of the human capital research paradigm, rather than challenging it.

2.2.5) Weaknesses in the methodologies and results of human capital and signalling models

As the methodologies of both human capital and signalling indicate, there is a range of possible factors which may have an impact on an individual’s earnings. Owing to this, the estimates of (rates of) returns to education may be upwardly or downwardly biased owing to a failure to account for characteristics that influence the earnings an individual receives (Weale, 1993). Yet, even though there is a potential plethora of factors that may affect the earnings of an individual, the human capital and extended human capital approach is still widely used. This is most likely owing to its ease of use and the relatively simple data variables required. However, while in the past the

literature discussed the possibility of various factors other than education affecting the earnings of an individual (see Renshaw, 1960: 321), the recent literature attempts to establish the effects of such factors (see Heckman & Li, 2003). These factors include race, gender, cognitive ability, social class, networks developed during training, family size, level of parents' education, geographic location within a city, school quality and school type, vocational versus academic training and even personality type.

There are various techniques used to determine the returns to education, such as quantile regression, matching, Instrumental Variable (IV) analysis and even the use of heteroscedasticity. However, the most widely used technique is Ordinary Least Squares (OLS) regression, the approach first introduced by Mincer (1958; 1974). While each technique has its inherent strengths and weaknesses, they all suffer from the same problem of whether the measurements of the variables used are of any consequence. This discussion focuses on the errors expected when using OLS, as it is the foremost technique applied when measuring the returns to education.

There are three main errors that OLS regression is susceptible to:

1. Ability bias.
2. Returns bias.
3. Measurement error.

The primary difficulties faced by any theory attempting to measure the benefits received from education are the very components of human capital. An individual not only acquires knowledge and skills, but also has inherent characteristics that will affect the *manner* in which he or she both acquires and *applies* this knowledge and skills. This requires an understanding of the components of human capital (as these components would determine whether an individual would acquire a particular signal, it would affect the signalling approach equally). Blundell et al. (1999: 2) suggest that there are three components of human capital:

1. Early ability, both innate and acquired (such as social conditioning of thought processes).
2. Qualifications and knowledge acquired through formal education.
3. Skills, competencies and expertise acquired through on-the-job training.

It is the first component, innate ability, or more recently termed “cognitive functioning” (Bowles et al., 2001: 24) that hinders the accuracy of any estimate generated via the above methodologies. Innate ability would affect the level of effort required for an individual to acquire years of schooling or qualifications (Chevalier et al., 2002: 7), and, if not accounted for, would lead to a bias in the reported returns to education. As there is an evident correlation of ability and years/level of education (Blundell, 1999), this would be reflected in the error term of both the OLS and IV techniques, thereby causing an upward bias in the reported returns to education.

Therefore, a useful extension to both human capital and signalling methodologies is to consider the effect the individual’s ability may have in determining his or earnings. Including ability introduces two complications. Firstly, more able individuals may be able to ‘convert’ schooling into human capital more efficiently than the less able, raising the return received by the more able as it requires less effort. Innate ability thus complements the acquisition of higher levels of education, so that, for a given increment to schooling, a larger endowment of ability generates a higher level of human capital (Psacharopoulos, 1985; 1994). On the other hand, the more able may have higher opportunity costs since they may have been able to earn more in the labour market, if ability to progress in school is positively correlated with the ability to earn, and this reduces the private rate of return (Harmon et al., 2000: 11).

A number of techniques have been employed to account for the effect of ability on earnings, including the use of IQ scores (introduced by Griliches, 1977), sibling and twin tests (Harmon & Walker, 1995; Bowles et al., 2001; Chevalier et al., 2002) and other natural setting experiments, including changes in legislation regarding school entry and exit ages (Psacharopoulos, 1994: 1331). It is widely accepted that, owing to measurement error, ability bias is cancelled out (Griliches, 1977; Chevalier et al., 2002), though certain studies have illustrated an upward bias in the return to schooling of as much as 40% when controls for ability are omitted (Blackburn & Neumark, 1995:222). It is worth noting here that studies testing for a signalling (i.e. education level signifies innate ability) compared to a human capital (the ‘embedding’ of resources in an individual) return to investment in education yield the same results

(Harmon et al., 2000: 20), substantiating the earlier conclusion (Section 2.2.4) that signalling is an extension of the human capital research paradigm.

The second bias, returns bias, is a result of the assumptions of the human capital and signalling methodologies. Both methodologies assume that the level of education is chosen exogenously. However, as suggested by the signalling hypothesis, an individual will invest in a signal (education) if he or she believes there will be a return for doing so. In this case, the choice of the level of education is endogenous, a factor which neither the human capital nor the extended human capital models can account for. Many factors may affect the 'schooling' choice, such as social status (Fields, 1974). Whether the bias is upward or downward depends on the returns of those already employed with the particular education level in question.

Measurement error affects all research where values need to be imputed. Regarding human capital and signalling, measurement error may occur in the schooling or qualification variable. The source of error in the education is based on the various forms of education. Firstly, there are distinct differences between vocational and academic education, yet in the strict human capital models, relying on years of education, this would be invisible unless variables were introduced to distinguish between the two types of education, in other words, a need to apply the extended human capital model of signalling. As an indication of this problem, many studies show a higher return to academic than vocational education (Psacharopoulos, 1994: 1329; McIntosh, 2002: 1). Secondly there is also a difference in returns between different academic faculties (Psacharopoulos, 1985: 590; 1994: 1330; Steel & Sausman, 1997) which introduces the need to separate academic education into separate categories as well.

But, do these problems render the OLS technique null and void? A variety of studies comparing the different techniques for the measurement of the returns to education, such as IV analysis and heteroscedasticity measures, all seem to indicate that the sources of bias using OLS estimators effectively cancel each other out. IV estimates generally appear to be slightly higher than OLS estimators but are less robust and not significantly different (Krueger & Lindahl, 2001; Hogan & Rigobon, 2002; McIntosh, 2002; Psacharopoulos, 2002).

The weaknesses in interpretation of the results of the human capital and signalling models generally occur through a misunderstanding of the measurement used. One of the foremost misinterpretations of the returns to education is that the coefficient given to the dummy-form qualification method (extended human capital models) of the determination is reported as the returns to education. To a certain extent it does reflect a return to education but it also reflects a wage premium (sheepskin effect) associated with a particular qualification. As discussed earlier, while conceptually the coefficient of years of education versus qualification essentially measure the same effect (Weiss, 1995), it is more correct to interpret the coefficient associated with qualifications as a wage premium (Psacharopoulos, 2002) to the particular qualification – a wage effect of obtaining the qualification which can reflect either a screening equilibrium (signalling) or a discrete package of ‘resources’ (human capital).

Rate of return analysis is also problematic in that it measures the wage rate that an individual receives only once he or she has actually entered the labour market. Some occupations require particular qualifications, but what if the individual obtains the qualification and whether the individual finds employment? Therefore the reported coefficient does not take into account the risk involved in the education choice (Harmon et al., 2001: 1; Kivinen & Ahola, 1999). Therefore, the coefficient will over-report the private return to the investment in obtaining the qualification. This risk is explored in a number of studies, frequently via the incidence of unemployment across individuals with degrees from various faculties (Weale, 1993; Siegfried & Stock, 1999). The differential probability of employment for different qualifications will have a significant effect on the private and social returns to education, but is beyond the scope of this research.

Appendix II presents empirical results of private returns to education from around the world, focusing on the differences in the returns across levels of education in the developed and developing world.

2.3) Macroeconomic or social returns to education

It is commonly held that education benefits not only the individual but also society. This is recognised in the very origins of human capital theory where labour being ‘embodied in the individual’ leads to problems with regards to firms not investing in training of the workforce. What are the social returns to education, how are they to be defined and how are they to be quantified? This section is devoted to answering these questions. Similarly to Section 2.2, the discussion begins with a presentation of the non-monetary social benefits of education. The focus then moves to the various approaches to and methodologies for quantifying the social return, namely the social returns to education approach, the city-wide wage effects approach and the macro-economic approaches of the augmented neoclassical Solow growth model and the ‘new growth’ theories.

2.3.1) Non-monetary social returns to education

Economic literature abounds with possible positive externalities of education. But, while the private and social returns to education represented by wage or productivity increases have been exhaustively estimated, little attention has been paid to the socially beneficial effects of education of a non-monetary nature.

Haveman and Wolfe (1984⁶) made the first bold attempt to catalogue the impact of increasing levels of education on the well-being of society. Since then research into these non-monetary returns to education has increased, primarily in developed nations owing to the availability of data. A major criticism of these studies is of causality: is it an increase in education levels that leads to a change in social behaviour or is it a change in social behaviour that leads to an increase in education levels?

A host of social effects of education have been identified, of which six are briefly discussed:

1. Social cohesion, civil engagement and meritocracy.
2. Crime reduction.
3. Fertility.
4. Health.

⁶ See Appendix I.

5. Income distribution.
6. Intergenerational education transfers.

Firstly, it has been qualitatively debated and accepted in the literature (Weiss, 1995; Bynner & Egerton, 2001; Sianesi & Van Reenen, 2002) that higher levels of education are likely to have an effect on social cohesion, civil engagement and meritocracy. It is expected that the level of tolerance of different opinions and ways of life will increase the more educated a population becomes, as will greater participation in democratic governance. A question arises here as to whether the higher income earned by those with higher levels of education makes the individuals more interested in protecting their gained benefits and thus participate more in an economy in order to do so (private interest groups), or whether philanthropic activities increase with increased income.

Nevertheless, studies have shown that there is a strong correlation between civic engagement and the level of education acquired by the individual. Bynner and Egerton (2001) carried out research into many of the above-mentioned issues. Their results regarding social cohesion and civil engagement for both men and women clearly indicate a strong correlation between the levels of education and civic engagement. However, a weakness in their analysis is that there is no control for the income of higher income groups. Again the causality debate arises.

The second social effect of higher levels of education, a reduction in crime, is supported by a large body of qualitative evidence along the lines of 'those with higher levels of education have a higher standard of living therefore they need not commit crime' (Weiss, 1995; Harmon et al., 2000). Others however suggest that it is simply the *nature* of crime that changes with higher levels of education: petty crime develops into more devious crime such as fraud (e.g. WorldCom, Parmalat), which requires a higher level of skill gained from a higher level of education.

Thirdly, higher levels of education may affect fertility. It is now widely accepted that an increase in the level of education is associated with significantly lower net fertility, and thus population growth. While the growth literature of the 1960s and 70s placed an emphasis on the positive effect population growth may have had on economic

growth (Cleland & Hobcraft, 1985), it is now held that population growth may do more harm than good, as evidenced by the high incidence of formal unemployment in developing countries. However one cannot ignore the problems associated with negative population growth currently being experienced in Europe, especially in Germany and Italy (Economist, 2003a; b; 2004c).

Higher levels of education are also associated with better levels of health and longer life expectancy – the fourth social non-monetary return to education. Such levels of education have been shown to have significant effects on mortality rates, diseases and nutrition. These effects are particularly related to the level of education of the mother, to the extent that education has been seen to have a “higher impact on health than the number of doctors per capita” (Weale, 1993: 735).

Fifthly, it is possible that the income distribution in an economy may become more equal as levels of education increase. This would be dependent on the quality of and access to education. An increase of educated individuals would also put downward pressure on wage rates as the skills and productivity of these individuals is less scarce than previously, i.e. the signalling feature of education becomes eroded. This conclusion is supported by Chevalier and Walker (1999).

The sixth possible non-monetary effect is that of parents’ levels of education on the level of education acquired by children, referred to as the intergenerational spillover of human capital. It is repeatedly shown that children whose parents have a high level of education are also likely to acquire a high level of education. While this may seem a return to the household unit, the social picture is much the same. The second generation will be expected to acquire at least the same level of education as achieved by the first generation (see Fields, 1974). This will generate and increase all the above-mentioned non-monetary social returns to education and lead to a continuous upliftment process of a society both economically and socially.

As pointed out, the problem most often faced with conceptualising the non-monetary returns to education is that of causality. Increasing levels of education will lead to increasing levels of income, which in turn allow a higher standard of living, in essence all the non-monetary social returns to education. Therefore it is essential that

studies conducted to measure the existence and effect of such returns account for different levels of incomes (Chevalier et al., 2002). In light of the issue of causality, using the example of civic engagement, it can be argued that education is indeed the source of these returns, and not other factors such as income.

Initially it appears as if education leads to a higher level of civic engagement. But what about the income levels of those who show high levels of civic engagement, is it not the level of income that determines this? It is also a likely assumption, considering the wealth of evidence of private returns to education, that higher income is a result of higher levels of education, therefore the level of civic engagement is a result of higher levels of education. This line of thought pervades the non-monetary social returns to education literature.⁷

2.3.2) Estimating the social returns to education

The first approach to estimating the social returns to education focuses on tracking the monetary flow of investment in education. The rates of return are calculated using an accounting framework comparing the direct costs of education, as well as public subsidies, in comparison to pre-tax earnings. The calculations provide estimates that include net transfers, the cost side represented by subsidies and the earnings side represented by income taxes, thus fully accounting for the private benefits and costs of education.

There is a growing consensus (Chevalier et al., 2002: 68; Sianesi & Van Reenen, 2002: 10) that these returns must be seen as a lower bound because while the full costs of education are included the full benefits are not. Benefits excluded from the accounting framework include features such as job satisfaction in a particular occupation that requires a specific level of education. An example of this is the role of an academic, not many other professions pay an individual for pursuing their hobby (Economist, 2004b; Steel & Sausman, 1997). Other excluded benefits are the lower likelihood of unemployment among those with higher levels of education (Chevalier et al., 2002; Weale, 1993) and the possible human capital externalities in the form of

⁷ For a detailed debate on the non-monetary social returns to education see: Chevalier et al. (2002), Sianesi & Van Reenen (2002; 2000), Bynner & Egerton (2000), Weiss (1995) and Haveman & Wolf (1984).

macro-economic gains. These externalities form the basis of the macro-economic returns to education literature.

As mentioned earlier, the private returns to education are always likely to be higher than the social returns. This is explained by the social returns to education technique. The private returns to education literature particularly when using the standard human capital wage equation report the gross return without accounting for the costs of education for the individual. The social returns framework accounts for the full social cost of education and compares it to the returns to education the individual receives in the form of pre-tax earnings, thus the social returns will always be lower than the private returns.

Attempts to overcome the problems existing in measuring the flow of benefits have been made by the introduction of an ‘alpha’ factor after Denison (1964, in Chevalier et al., 2002: 67). The social return is calculated by comparing the flow of benefits over a graduate’s life with the cost of study where the measurement is based on the wage difference between different levels of education reflecting differences in productivity.⁸ However, because productivity is affected by other characteristics such as ability and motivation the estimate of the social return is scaled down by the use of this alpha factor. Due to ongoing debate regarding the size of the ‘alpha’ factor, results are typically reported using a range of values between 0.65 and 0.8.

Even though the estimates provided using this approach are lower bounds of the social returns to education, many suggest that a correctly calculated social return following the accounting framework should be guiding governments’ decisions in the funding of education (Psacharopoulos, 1984, 1994; Weale, 1993; Sianesi & Van Reenen, 2000, 2002; Chevalier et al., 2002;). The reason for this is that any social returns received over the expected results according to the analysis are therefore ‘free.’

The accounting framework has three advantages over other methodologies for estimating the social return to education. Firstly, because it deals with the monetary

⁸ This requires an acceptance of the microeconomic human capital proposal where investment in education leads to an increase in productivity.

flows of costs (of provision) and benefits (in earnings) it does not require any theoretical underpinning to explain the effects of human capital on the economy. Secondly, it does not require statistical estimation techniques, such as OLS, IV and probit models, which each suffer from bias inherent to the technique. The accounting framework makes one attempt to deal with the issue of the components of human capital, such as motivation, by inserting the 'alpha' factor, but it does not deal with an individual interacting with the economy as the methodologies below include. Thirdly, the framework is not data-intensive and is thus easy to implement.

However, it may be the very simplicity of the framework that is its flaw. The estimates of this approach should always be interpreted as the lower bound because of the exclusion of non-monetary benefits. This is attractive in the first but not the second view. The first view is that if a social return exists, policy makers may always assume a higher social return. The second view questions the validity of the method. Because the method is simple it fails to measure any interaction between the state of the economy and increasing levels of education. Even with the inclusion of the 'alpha' factor for individual human capital, the method cannot capture any human capital externalities which may have a significant impact on productivity and economic growth, thereby limiting the explanatory power of the accounting approach to measuring the social returns to education

The literature following the accounting framework for estimating social returns lacks estimates for developing countries and shows no real consensus on how to group various education levels, particularly at the tertiary level. This prevents cross-country comparisons of social returns to education of different studies. Nevertheless, while the theoretical underpinnings or lack thereof may be a weakness in this method, the ease with which it may be implemented ensures its survival as a tool for estimating the social returns to education.

Turning now to regional or city-wide wage effects, the social return to education may be explained as the external return from an individual's education from which society benefits. Human capital theory states that education leads to an increase in productivity, a notion that is supported by a number of studies (Chevalier & Walker, 1999; Jones, 2001; Chevalier et al., 2002). If levels of education are to increase, the

externality in the form of increased overall productivity is expected to increase, this representing a social return. This reasoning was put forward by Moretti (1999) and used to test whether an increase in the number of higher educated individuals affects the wages of those with lower education in a city. The interaction of the more educated with the less educated in the employment relationship could lead to a “sharing of knowledge and skills through formal and informal interaction” (Moretti, 2002: 1), which generates positive externalities across workers in the form of higher overall productivity. The idea is that the individual does not capture all the benefits to his or her education and that some level of knowledge spillover occurs through formal and informal interaction in the workplace. The lesser educated individuals gain knowledge ‘for free’ by interacting with those with a higher level of education, thereby increasing their level of productivity. However, if their productivity has increased, according to neoclassical theory these lower educated individuals should now receive a higher wage.

This effect fits within the human capital and signalling analysis of private returns where experience is also an explanatory variable of the wage. Experience is to be understood as productivity-enhancing effects of time gained through working on the job. The increase in productivity occurs not only through experience from repetition of the task at hand but also through the potential to learn and implement new techniques via the interaction with others, namely the more educated individuals.

The social return exists in that experience leading to the increase in productivity of the individual would not have occurred without the interaction between the higher and lower educated individuals. Such a spillover effect may be the reason for individuals with an observed lower level of education earning a higher income living in one city in comparison to those living in another. In other words, individuals in the same labour market may benefit monetarily from spillovers⁹ associated with higher overall levels of education.

⁹ The increase in overall productivity could also be due to complementarities of production and not necessarily a spillover effect. Nevertheless, the complementarity exists through interactions of different levels of education and thus still represents a social return.

The empirical testing of the external returns to education, the spillover effects, may be aided by defining the external return to education as “the effect of an increase in the share of educated workers in a city on total wages minus the effect due to private returns to education” (Moretti, 2002: 4). By controlling for city-specific shocks on earnings and other observable characteristics it is possible to determine the effect of an increasing supply of individuals with higher levels of education on the wages earned by those already employed but with lower levels of education.

Using average education levels of cities, Moretti (1999, 2002) suggests that increasing numbers of the highly educated affects the earnings of all within a geographical region. His results are as follows: a one percentage increase in the supply of tertiary level graduates raises high school drop-outs’ wages by 1.9%, high school graduates’ wages by 1.6% and the tertiary graduate component of the labour force by 0.4% (Moretti, 2002: 38).

Acemoglu and Angrist (1999) find that by analysing state-wide wage levels and education there is no social return to an increase in earnings across the levels of education within the labour market, but that private returns do exist. However, this study focused on schooling and did not include tertiary education. The possibility that graduates raise the productivity of non-graduates, such that aggregate productivity is higher is also discussed by Greenaway and Haynes (2000, in Harmon et al., 2000: 33), Gemmell (1997) and Blundell et al. (1999: 15).

Comparing average levels of education across wages in cities is a new method for determining the empirical effects of human capital spillovers and complementarities between different levels of education and is subject to much criticism, not least because of the need to accurately define human capital externalities in terms of productivity effects that would be measurable.

The focus now shifts to the macroeconomic approach to estimating the social returns to education. Owing to the existence of human capital externalities and the (non-monetary) effect that education may have on the social structure of an economy, one can almost assume that successive levels of aggregate education and the stock of such human capital will affect both the level and rate of growth of an economy. Simply

put, “human capital is ... an engine for growth due to the potential positive external effect on final good production” (Barañano, 2001: 460).

One of the conclusions of a vast body of literature is that, at the aggregate level, education increases productivity, therefore human capital *must* have some impact on economic growth. This indicates that education is productivity enhancing rather than being a simple signalling device for indicating innate ability (Sianesi & Van Reenen, 2002: 4).

Other broad conclusions are as follows:

- Schooling returns are generally higher in developing compared to developed nations.
- The impact of increases in various levels of education appears to depend greatly on the level of a country’s development, with tertiary education being the most relevant for OECD countries.
- Education yields additional indirect benefits to growth, in particular by stimulating physical capital investments and technological development and adoption.
- Schooling quality, as well as the efficiency with which resources are allocated to the various levels of education matter considerably, since they not only directly impact on economic growth, but also affect the impact of the quantity of education on growth.(Sianesi & Van Reenen, 2002: 4–5).

A topical question is how to clearly model the effects of increasing levels of human capital on economic growth. In reply, two approaches have come to the fore. The first is the augmented neoclassical Solow growth approach and the second is the ‘new growth’ theories, with their empirical counterparts of growth accounting and macroeconomic growth regressions.

The neoclassical approach first put forward by Solow (1957) and the empirical techniques of growth accounting assess the relative contribution of inputs to outputs within a system. Because output growth could not be attributed to growth in either capital or labour, the framework of the traditional Cobb-Douglas production function

has been extended to include features of the quality of the inputs. It is relatively easy to assume a standard quality for features such as physical capital, but it is the quality of labour embodied in the individual that may vary considerably, hence the inclusion of a measurement of human capital in the neoclassical growth models to explain overall growth. These models, however, suffer from failing to explain the causal relationship between levels of human capital and economic growth (Sianesi & Van Reenen, 2000; 2002).

The new growth theories emphasise the endogeneity of both levels and rates of growth, and the importance of both the stock and the flow (or rate of growth) of human capital. New growth theorists explicitly incorporate human capital as a factor input in the production function by, in contrast to the extended neoclassical model, attempting to model individual educational investment choices and often allowing human capital to have external effects, thus departing from the constant returns to scale assumption of the neoclassical approach (Sianesi & Van Reenen, 2002: 8).

The factors leading to endogenous growth (in particular technological change) are explicitly related to the stock of human capital. This may be either because human capital is assumed to directly produce new knowledge and technology or because it is an essential input into a research sector which generates such knowledge and technology (Sianesi & Van Reenen, 2002: 8; see also Blundell et al., 1999: 16; Chevalier et al., 2002: 74–77). There is ongoing debate within the literature as to whether the stock of human capital or the rate at which it is developed is more important in determining its effect on growth. The debate may be related to empirical results where different statistical techniques attribute greater significance to either one or the other variable (Gemmell, 1996).

Both of the above-mentioned approaches struggle with the problem of how to measure human capital accurately as well as how to account for experience of the labour force (Gemmell, 1996). Moreover, both approaches tend to be observationally equivalent despite differing theoretical assumptions of how human capital affects the level and rate of growth (Sianesi & Van Reenen, 2002: 8–9). Sianesi and Van Reenen

(2002: 41–42)¹⁰ suggest that the neoclassical approach is more accurate as its results are more consistent with microeconomic results and are less susceptible to measurement bias. However, results from both techniques emphasise the significant rôle played by tertiary level education in the adoption and/or development of more productive technologies, leading to increases in the output of an economy.

In conclusion, the argument for the existence of a social return to education is well established and accepted. Numerous studies show how society may benefit from an increase in the aggregate level of education. The debate lies in which method to apply. The accounting framework is a non-technical approach that may be implemented fairly easily, yet it appears to disagree with the high returns found by the macroeconomic approaches for tertiary subjects which may have a significant impact on technological growth. This is owing to the comparison of costs and earnings rather than the outputs of such subjects. It may also result from incorrect groupings of subjects in estimating the social return.

The effect of an increase in the number of educated individuals in the labour market of a region on the wage of the lesser educated (the city-wide wage effects theory) constitutes a new route to estimating the social return to education, yet no one would argue against the benefits of real income growth.

The macroeconomic approaches have received much attention recently, possibly because they offer a strong theoretical basis for the empirical studies, a feature lacking in the accounting framework. Furthermore, the macroeconomic approach does not rely on individual wage data as do the other two approaches, making data collection less arduous, but it encounters problems in accurately measuring the inputs into the analysis, such as of the quality of education.

Appendix III presents a discussion of empirical results of social returns to education studies, comparing the developed to the developing world.

¹⁰ For a detailed discussion of the methodological issues faced by the macro-growth theorists and a detailed review the reader is referred to: Sianesi & Van Reenen (2002; 2000), Chevalier et al. (2002); Blundell (1999) and Gemmel (1997; 1996).

2.4) Weaknesses in the literature of the returns to education

The private and social returns to education methodologies display theoretical and empirical weaknesses. The theoretical argument between human capital and signalling forms the crux of the microeconomic literature, while whether the stock or the rate of increase of human capital is of greatest importance for growth embodies the theoretical debate in the macroeconomic literature. This section discusses the weak points encountered in both the micro- and macroeconomic returns to education literature, and reveals a neglect of a level of education which is crucial to both: the higher degree in the form of the masters and doctorate qualification.

The microeconomic literature frequently argues for or against human capital or signalling as an explanation of wages. However, the methodologies converge to the extent that there is no genuine difference between the two. Earlier it was shown that human capital and signalling essentially measure the same factor, as they are both based on the opportunity cost of acquiring education. The difference between the two is the extension of the original human capital wage equation to account for the cumulative effect of education on productivity. This is most likely the source of much of the confusion. In order to establish whether 'signalling' is a factor of greater influence on income than years of education, studies have been conducted comparing the returns to education for individuals who are employed with those who are self-employed. The results suggest comparable rates of return and imply that the signalling component of an individual's earnings is small (Harmon et al., 2000: 20).

However, while the level of reported income affects the estimate of the returns to education, human capital and signalling models fail to account for the possibility of a high ability, highly educated individual selecting a low-paying occupation. There may be characteristics of an occupation that appeal to the highly educated individual other than the wage offer, such as a high level of job satisfaction, generous non-pecuniary benefits, e.g. annual leave, etc. This is illustrated by certain professions requiring a high level of education and ability yet offering low remuneration, as in the case of scientists (Stern, 1999). The effect of the endogenous occupational choice would be a downward bias in the returns to education, yet this has been neglected in the literature.

Another factor that the microeconomic literature fails to address is the endogeneity of the choice of education. The literature broadly states that labour market conditions *may* affect the education choice, but no research focuses on the demand for education as the signalling hypothesis suggests. The private demand for education may not necessarily expect a return to education in terms of wages, as is shown by the non-monetary private benefits of education. Therefore, determining the private demand for education in conjunction with the wage effects of different levels of education would provide a more precise actual return to education. The provided estimates of the private returns to education also differ for various estimation techniques. OLS estimates are typically lower than IV estimates, yet IV estimates suffer from less statistical rigour and are more prone to selection bias.

The macroeconomic literature differs theoretically on the impact of stocks versus flows of human capital on growth. Both the neoclassical and new growth theories, however, suffer from weaknesses in the variables used. Similarly to the microeconomic estimates, the macroeconomic estimates can be criticised regarding the measurement of the quality of education, which has been performed in different ways in different studies, rendering cross-country comparisons inaccurate. The endogenous choice of education also affects the viability of cross-country comparisons as individuals in different countries face different labour market conditions. For this reason, many are calling for within- rather than cross-country comparisons to evaluate the effect of human capital externalities on growth (Harmon, 2000: 38).

There is a vast amount of literature on the effects of schooling and an increasingly growing amount evaluating the returns to tertiary education. Nevertheless, the literature neglects the different levels within tertiary education. Existing studies compare the post-schooling vocational with academic education returns to education, but there are few which focus on the return to the next level of tertiary education, the higher degree. The substantial microeconomic evidence of high returns to education at the tertiary level in developing and developed countries does not incorporate the different levels of tertiary education. The macroeconomic literature is based on human capital externalities and the importance of such to the rate of innovation and technological change. The majority of direct human capital spin-offs at the tertiary

level are generated through the endeavours of established researchers and the higher degree students under them, yet this level of education is not considered as a factor in growth and development in the current models of returns to education.

In the light of substantial government subsidising of both the research and the student costs in most countries at this level, it is a concern to find that there have been few empirical studies focusing exclusively on the higher degrees level. If, as the literature increasingly suggests, tertiary education is so important, to the individual for the high returns, and to society for the human capital externalities, surely there is a need to evaluate the costs and benefits of obtaining a higher degree for the individual and society? The benefits to society would include society 'using' the output of research programmes at the higher degrees level, yet few studies have looked at specific knowledge and skills utilisation of graduates with a higher degree.¹¹

Analysing the return to education at the higher degree level is thus a new area of research on which the returns to education literature should focus. What follows is an approach for measuring the social return to education from individuals acquiring a higher degree.

¹¹ Most of these studies are conducted on what happens to PhD economists! See: Siegfried (1971), Hosking (1997) and Siegfried & Stock (1999).

3) A model to measure the social returns to higher degrees

3.1) Introduction

It seems obvious that, because a large amount of funding is provided for research at the Masters and Doctorate level, both in the form of student funding and research costs, a methodology to measure the return to such an investment should be developed. Who is to benefit from such investment? Could the result be a social loss rather than a social gain?

The proposed model is based on a combination of the macro and micro approaches to estimating the returns to education in an attempt to specifically estimate the social or government returns to investment in students for higher degrees, as well as being a step towards resolving the weaknesses in the current literature. This approach rests on the accounting framework for calculating the social returns to education in that it accounts for each investment, but it does not under-report the true returns because the focus of the return is not on the individual's earnings post graduation, but rather on the individual's interaction with the economy.

To take this step, a premise is put forward of the social returns to government investment in a student for a higher degree. This is conveyed in Section 3.2. A major feature that will affect the returns to the investment is the manner in which students choose to enter a higher degree programme, in other words the endogeneity of education that affects both the micro and macro literature. The effect of the endogenous choice of education on the social returns is the topic of Section 3.3. Section 3.4 provides a new approach, the labour market drop-out rate approach, for measuring the social returns to government funding of students for higher degrees. Section 3.5 discusses the data requirements for testing it. Section 3.6 concludes by discussing the strengths and weaknesses of this new approach.

3.2) The social returns to investment in students for higher degrees

The micro- and macroeconomic evidence clearly illustrates that higher levels of education are beneficial for both the individual and society. What level of education should an individual strive for, and are there positive social returns for individuals

obtaining higher and higher levels of education? Is there a level of education that may not be fully utilised in an economy and, if so, is this a social loss?

In the case of tertiary education, these issues may be addressed by introducing a fourth category in the levels of education used by the returns to education literature: the first level being primary, the second secondary, the third a Bachelor's degree and the fourth, the Masters and Doctorate degrees (referred to as a higher degree)¹². Separating tertiary education into either the bachelor's or higher degree may be done following Becker's (1962) example of general and specific skills. This is accomplished by comparing the knowledge and skills set an individual represents on completion of a bachelor's degree to that he or she possesses on completion of a higher degree.

For example, an individual who graduates with a bachelor's degree in Engineering has a basic knowledge and skills set of the field followed. On employment the individual may utilise this set to perform the tasks required and may augment this set through on-the-job training and/or experience. The individual who completes a bachelor's degree in engineering may, however, continue to study for a higher degree in engineering. In this case, the individual's basic knowledge and skills set is enhanced through the addition of the specific set gained from studying a more specific aspect of the subject. Therefore, the bachelor's degree graduate represents general skills and the higher degree graduate specific knowledge and skills, or expertise¹³, in the labour market for engineers.

There is a difference in the private and social returns to education between the two categories. There are expected social and private returns to possessing the basic knowledge set and different social and private returns to possessing the expertise. The private return as measured by wages would indicate both the demand for and the value of the two knowledge sets within the labour market for engineers. The social return, according to the accounting framework, would be calculated in relation to the

¹² It is debatable whether the difference between a Masters and Doctorate degree is significant to the extent that they should *not* be classified together. However, in terms of comparison to the Bachelors degree they are significantly different in both the level of focus and type of work, being research and knowledge development rather than knowledge acquisition.

¹³ The specific knowledge and skills set developed through a higher degree is henceforth referred to as 'expertise.'

costs involved in acquiring the different knowledge sets and the earnings received. As explained earlier, though, this approach would yield the lower bound social return for the two knowledge and skills sets.

However, there is an alternative approach to valuing the social return within an accounting type framework. Instead of focusing on the costs of provision and earnings, the social return can be calculated by focusing on the interaction the graduate has in the economy and questioning whether the different levels of expertise are fully utilised. The private returns to education literature on over-education looks at this in terms of whether graduates are now employed in formerly non-graduate positions (Tsang & Levin, 1985; Chevalier, 2000). To the individual this may be perceived as a negative return, but the social return could be positive *or* negative. If the graduate enhances the productivity of such a position the social return is positive; if the graduate suffers from job dissatisfaction, and this negatively affects productivity, the social return is negative.

This may be applied to the utilisation of the expertise acquired through a bachelor's and higher degrees. If the knowledge set of the bachelor's degree is fully utilised by the employer and hence society, the full social return to the knowledge set is received. Similarly, if the expertise of the higher degree is fully utilised the social return is also fully realised. However, if the expertise is only partially utilised, or not utilised at all, the social return to such expertise obviously decreases.

Thus, the situation of social returns to the development of expertise revolves around the demand for individuals with such expertise by society. If a higher degree is required for the tasks of employment, the full social return is realised. However, full utilisation may not occur due to the very nature of expertise, it being specific. In this case, there may be either a partial or zero social return, depending on the employment found. If there is zero utilisation of the expertise there is no social return to the acquisition of such expertise and, as such, a social loss.

An aspect of the higher degree that may complicate the measurement of the social return is the requirements for a student to graduate. Typically, the individual is expected to conduct research in order to graduate with a higher degree. Therefore,

regardless of expertise utilisation, the research output constitutes an immediate social return of a contribution to the body of knowledge (Verry & Layard, 1975). The quality of, and thus, the real social return to the research will not be debated and is assumed to be constant.

Therefore, the specific social return of a higher degree within an accounting framework should include the immediate positive return on completion of the degree and the possible social return of the expertise, if fully utilised. If the social return to the research output is held constant then measuring the social return of a higher degree involves establishing whether the expertise is fully utilised. In other words, the social return may be estimated by analysing the demand for and supply of expertise to the labour market.

3.3) Endogeneity of supply of higher degree graduates: student choices

The previous section discussed a measure of the social return of a higher degree by introducing the accounting measure of skills utilisation, rather than earnings. This led to the conclusion that the demand for and the supply of expertise may be used as a measure of the social return to the acquisition of a higher degree. This section suggests an approach to analyse the supply of individuals with a higher degree to the labour market. Such a supply is directly related to the demand individuals have for higher education and the qualification of a higher degree. In other words, the model must now address the difficulty faced by the micro and macro models of returns to education of how to explain the choice of education.

The discussion is separated into two sections, firstly explaining the factors that influence the private demand for education and, thus, the supply of individuals with a higher degree to the labour market. Secondly, it describes the effects of any interventions in this process particularly that of government intervention in the form of student support.

3.3.1) *The private demand for education*

Individuals demand education for a number of reasons, which may be separated into three groups according to the types of private return that they may receive. In other words, the determinants of demand for education may be represented by:

1. **Income expectations:** those who intend, or expect, to receive a return greater than the costs involved in obtaining the education. These are the monetary returns to education represented by the human capital and signalling theories.
2. **Private consumption:** those who choose to enter the level of education to satisfy consumptive demands for further knowledge, without intending to directly utilise the knowledge gained to improve their employment opportunities for the future. This represents the non-monetary returns to education.
3. **Social choice:** those individuals whose choice of education may be influenced by pressures from the wider community.

Each of the above is likely to affect the choice and level of education an individual makes and acquires, and thus also the private and social returns to that education.

Income expectations represent the individual's choice of entering a level of education with the expectation of a higher long-term return, represented by earnings. This is the human capital and signalling explanation of the demand for education. Income expectations are based on the knowledge the individual has of future opportunities and labour market conditions for a person with a certain level of education. Because this information is likely to be incomplete (Stigler, 1962; Altonji, 1993), the choice to study further is likely to be biased towards optimism regarding the future income and employment opportunities (Harmon et al., 2001: 1). Frequently, the earnings to be received are not known, and whether the qualification will indeed be acquired is also a risk factor not taken into account (Harmon et al., 2001: 1).

This is exacerbated by the nature of education, especially when comparing the bachelor's to the higher degree. As the level of education increases, so does the specificity of expertise. There is much debate on the effect of the specificity of education on the individual's earning power (private return) (Acemoglu and Pischke,

1999), but, using the definition of the social returns to a bachelor's and higher degrees being the utilisation of the expertise acquired, the specificity of education has a direct impact on the social return of education.

Private consumption represents the individual's choice of entering a level of education prompted by an interest in the subject matter, with no specific aim or expectation of a return in the future. If the choice is consumptive, the returns are immediate, as there is an immediate satisfaction of the consumption with the commencement of studies. However, regardless of the possible consumptive reasons for the choice, the individual is expected, according to human capital and signalling theory, to benefit from a return to the education acquired, in the same manner as those who made the selection based on income expectations.

The choice of an individual entering a particular level or education category owing to 'external' pressure may be seen as social choice. Social choice may be defined as:

‘the choice made by an individual to pursue a specific education level/category owing to expectations of, or status within, the community, be it the household, peer group or of a wider community influence.’

The individual's demand for education, according to human capital and signalling theory, is based on income expectations, but as Field (1974: 907) points out, “the primary factor motivating citizens to demand education [is] the enhancement of their own personal economic *and* social status”, hence the impact of the wider community on his or her choice of education. The social pressure stems from expectations of the family, or community, for an individual to follow a certain education or career path.

The choice to enter a study programme such as a higher degree may be affected by each of the above-mentioned factors. A choice based on income expectations and private consumption greatly hinders the measurement of the private return, as part of the return is immediate and thus is not measurable using an income variable. The fact that the return cannot be accurately assessed leads to difficulties in policy decision making with regard to effective allocation of funds. This is discussed further in Section 3.3.2.

The interaction of social choice and income expectations is also expected to have an impact on the returns to education at a private and social level. If the individual's choice is based on income expectations only, and is based on insufficient information, the private and social returns received are likely to be lower than he or she expected. If the individual follows social choice only, and is subjected to community pressure based on imperfect information, the outcome is also not an optimum. However, society may be better informed than the individual, thus reducing the effect of imperfect information.

Therefore the components of choice are either possible complements (when income expectations, private consumption and social choice are in agreement) or imperfect substitutes (when they are not). In the latter situation, even if an individual's choice is based on the expectations of the community, he or she will still receive a private (monetary) return for having acted on that choice, assuming that the human capital and signalling theories hold. The downside of this is the effect this has on the non-monetary returns to education. Although the individual may benefit monetarily from a specific career choice, he or she may gain higher levels of satisfaction from having followed a different career path.

The interaction of the three components of choice results in the demand for different levels and types of education, and thus has a significant impact on both the private return to the individual and the return to society. The social return is affected by whether there is a demand for the type of education that individuals choose to acquire. If individuals choose their levels and types of education contrary to the demands of the market, the expertise generated is unlikely to be fully utilised and thus yields a low or negative social return.

3.3.2) Intervention in the mechanisms of student choice

The determinants of the demand for education related to the expected return do not include the cost of acquiring education. If an individual has a private demand for education that he or she cannot afford to satisfy, the education will not be acquired. Thus, the cost of education becomes a determinant of the supply of graduates to the labour market. This introduces the problem of a credit constraint to acquiring

expertise, which, in turn, could lead to society facing a shortage of individuals with the needed expertise.

However, the empirical evidence of the macroeconomic literature, especially in developing countries, shows significant social returns to tertiary education and knowledge production, especially at the higher degree level, therefore presenting society (government) with an incentive to intervene and lower, or remove, the credit constraint to prevent such a shortage of expertise from occurring.

If governments act to lower the credit constraint by providing student bursaries in those fields of expertise in which a shortage exists, the full return to such investment is only received *if* the expertise is fully utilised in the labour market. There are three factors that may contribute to government not receiving the full return to such investment:

1. **Selection:** a student is funded to acquire a higher degree so that the shortage of expertise in an economy can be addressed. However, the student may accept the funding without any intention of directly utilising the expertise on graduation. In this case, the provision of funding lowers the cost of education and allows the student to satisfy his or her private consumptive demand for it. If, on graduation, the student does not find employment using the expertise acquired through government funding, the return to the investment is the research output alone. This situation is exacerbated in cases where bursaries cover living expenses and are thus sought by students as a form of employment, which is an embodiment of the ‘short-term employment mechanism’ discussed in Sections 4.3 and 5.3.3.
2. **Labour market conditions:** the demand for the specific knowledge and skills set of the higher degree changes with time. Labour market conditions may change in the time required to complete a higher degree¹⁴, to the extent that the shortage may have been circumvented by a change in the demand for expertise. If this occurs, again the only return to the investment is the research output.

¹⁴ Normally two years for a Masters degree and four years for a PhD, if the student studies full-time.

3. **Volume and type of funding:** the volume and type of funding affects the supply of expertise by reducing the credit constraint. The nature of the bursary awarded to students will determine who acquires a higher degree. If the bursary is small, only those with other sources of funding will be able to afford the higher degree. This has implications for corrective action due to former discrimination, as well as attempts to equalise the opportunities for education across the socio-economic divide.

The discussion now focuses on the volume and type of funding, the factor over which government has most control. There are three possible outcomes if a government provides student support, in the form of bursaries, to alleviate a perceived shortage of expertise in the labour market (holding demand constant):

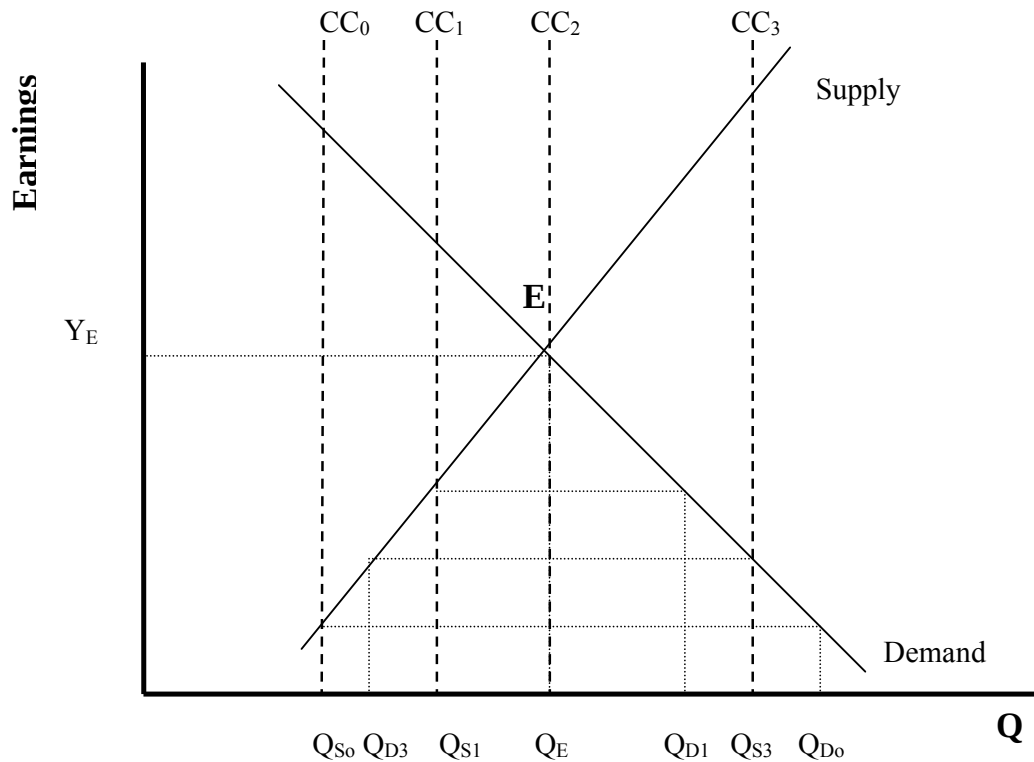
1. The gap between demand and supply might not be closed – there is still a shortage of expertise. The social return to investing in individuals to acquire the higher degree is fully received as the individual is expected to find employment that fully utilises the expertise developed.
2. The shortage could be met and a state of equilibrium could be reached in the market for expertise. In this case, the full social return to investing in expertise is received.
3. The provision could generate an oversupply of expertise to the market. If the number of bursaries available leads to too many students graduating with the higher degree, the labour market may not be able to absorb the supply. If the graduate is forced to search for employment not requiring the expertise developed, the return to the government's investment in such expertise does not materialise. Nevertheless, a student may choose to enrol for a particular degree fully aware of the scarcity of job opportunities. This would occur if the private consumptive or social motive is sufficiently compelling, or if the value of the bursary makes the choice financially viable.

These three scenarios are represented in Figure 3.1.

Firstly, allow point E to represent equilibrium in the market for expertise. Q_E represents the number of individuals with the required expertise at equilibrium and point Y_E the equilibrium earnings for a graduate on entry to the labour market. If

human capital and signalling theories are to be believed, point E represents the point at which the costs of acquiring education are equal to the benefits to be received, as represented by earnings.

Figure 3.1: Effects of government intervention on labour market equilibrium



Following this, assume there is a shortage of expertise owing to a credit constraint. This is shown by the line CC_0 . The credit constraint prevents the equilibrium number of individuals from obtaining the required expertise with the shortage represented by the difference between Q_{D0} and Q_{S0} . The government now recognises the social benefits for overcoming this shortage and intervenes on the supply side of the market, reducing the credit constraint through the provision of bursaries.

The first scenario occurs when the government intervenes to lower the credit constraint, but not to the point of equilibrium. A shortage of expertise still exists. This is represented by the movement of the credit constraint from CC_0 to CC_1 . The shortage is now the difference between Q_{D1} and Q_{S1} , the monetary return for

acquiring the expertise still being higher than equilibrium earnings. The excess demand guarantees that there are employment opportunities for the expertise and thus the social return to the government investment is fully received.

The second scenario occurs when the government provides the exact number of bursaries so that the market clears. The credit constraint moves to CC_2 . This is the exact point of market clearance and the full social return to the investment will still be received. The individual now earns at the market clearing level.

The third scenario occurs when the government provides too many bursaries, reducing the credit constraint to the extent that an oversupply of expertise develops. This is represented by the difference between Q_{S3} and Q_{D3} . Unless the market can adapt to absorb the excess supply, many graduates will have to search for employment outside their area of expertise, representing a low social return to expertise utilisation.

Other factors that would have an impact on the social return are the nature of earnings of the labour market and the elasticity of demand. Equilibrium may never occur if wages are sticky downward. If wages *are* sticky downward, the social return to the government investment would be substantially lower as the labour market would have a lower absorptive capacity. Similarly, the same situation may occur if the demand for expertise is inelastic.¹⁵ However, these two factors should form part of the policy formulation in providing student bursaries to lower the credit constraint. If these features are not included, the social return to investment is likely to be substantially lower than expected.

The discussion presented thus far discusses the use of bursaries to lower the credit constraint in the supply of expertise. An alternative method that may be applied to lower the credit constraint is the introduction of government loan or graduate contribution schemes (London Economics, 1997). The aim of these methods is to ensure that the student who receives funding, while he or she cannot afford the costs of education now, pays in the future through a myriad of options, such as required

¹⁵ This is an important point that is further explored in Chapters 5 and 6.

employment in the public sector (as practised in Gabon) or financial contributions over the long term.

The weakness in the bursary approach is that the government affects the quantity of supply to the market without any corresponding value attributed to the intervention. The student may well accept a bursary purely to satisfy the private consumptive demand for education. If it were to be a contribution scheme the student faces a lowered credit constraint in the present in return for some manner of 'interest' payments in the future. This method would, especially at the higher degrees level, put a constraint on supply which the corresponding levels of bursaries would not. Hence, partially manipulating the supply of expertise by quota means, by the use of bursaries, is more likely to suffer from a lower overall social return.

The strength in the use of bursaries, however, is the ease with which they may be used to attract students to study for higher degrees and to equalise opportunities across the socio-economic divide. Applying loan schemes to such a problem would require complex rules and classifications of applicants, whilst the allocation of bursaries may follow a relatively simple process. The discussion of the social returns to government investment in expertise will from now on be confined to the allocation of bursaries to lower the credit constraint.

3.4) The labour market drop-out rate approach to estimating the social return to government investment

If the social return is to be defined as the full utilisation of expertise, then the analysis of the investment in a particular expertise in the form of bursaries should focus on the productive employment of the individuals who receive funding. This is affected by the absorptive capacity of the labour market for expertise, but how is such a capacity to be measured empirically?

The only manner in which the social return to the government investment may be received is in the case of the higher degree graduate finding employment using the expertise developed. Therefore, a measure of the return is formed by accounting for the labour market drop-out rate. Do many of these graduates find employment utilising their expertise, or are they forced to seek employment elsewhere? If a large

number of graduates is forced to find employment elsewhere, i.e. a high drop-out rate, the social return is low, receiving only the return of the research output of the higher degree. Conversely, if the drop-out rate is low, the return to the government investment is high.

This approach thus measures the return to government investment in expertise by comparing the labour market demand for expertise to the supply of expertise. The approach is called the labour market drop-out rate approach to estimating the social returns to government investment in expertise. Measuring the social return to investment using this approach has three requirements:

1. The demand for expertise.
2. The supply and determinants of expertise.
3. Labour market drop-out rate of recent graduates.

This section discusses the components required to estimate the return to government investment in expertise using the labour market drop-out approach. The methodology illustrates the derivation of the demand for expertise, the supply of expertise, the drop-out rate and the difficulties encountered in establishing these.

3.4.1) The demand for expertise

Firstly, the labour market drop-out rate approach requires a clear definition of the expertise concerned. The definition allows a qualitative assessment to be made as to whether the education and training acquired during the higher degree process satisfies the requirements of the labour market.

The second requirement is to establish the labour market conditions for such expertise. This involves finding out where individuals with the expertise in question are employed, the demand for new graduates, the degree of competition for new employment opportunities and the level of remuneration.

The level of remuneration is important for determining the wage structure of the market, which can then be used to identify the factors that most affect earnings of those employed. This, then, may be used to evaluate the private returns to acquiring

the expertise, which is expected to have an impact on the endogenous choice of education.

It should be possible to gain this information through surveys of those already employed in the labour market for the expertise in question, and of those who are involved in the education and training of new entrants to the labour market.

3.4.2) The supply of expertise

The supply of expertise is determined by the interaction of the private demand for education and the possible existence of a credit constraint. The private demand is expected to have a significant effect on the social return, thus the motivation behind students' choices needs to be exposed. This may be accomplished by finding the answers to questions such as why students enrol for a higher degree, and what their expectations of future job opportunities and levels of future remuneration are. The supply of expertise in recent years must also be determined.

This information may then be compared to the demand for such expertise to establish whether there is a shortage, providing the incentive for the government to invest in student support. It may be gathered through surveys of currently registered higher degree candidates at universities.

While the results of such a survey provide merely a snapshot in time, the determinants are assumed to be the same for previous graduates. Therefore, if the costs of acquiring a higher degree have remained comparable over previous years, the conclusions drawn from the survey may be applied to previous graduates. This is of particular significance when analysing the effect of government investment in individuals at the higher degree level. The questions, here, are whether the provision of student support influences the choices made by students and if this affects the social return.

3.4.3) The social return: the labour market drop-out rate

The final component of estimating the social return to government investment in higher degrees is establishing the whereabouts of previous graduates of the higher degree under focus. Whether these graduates are employed in their specific field or

not allows the application of the labour market drop-out approach to measuring the social return. By applying the definition of the social return as the full utilisation of expertise, the drop-out rate will clearly illustrate the effect the provision of student funding has on the supply of expertise to the labour market. The result may then be used to evaluate the effectiveness of such government investment and whether any changes need to be made.

3.5) Strengths and weaknesses of the labour market drop-out rate approach

Economists have made many attempts to estimate the returns to education at both a private and social level, but, as pointed out in Chapter 2, very few focus on the source of funding for the education, on what affects the choices made by individuals to acquire education, or on whether this education is ever fully utilised.

The labour market drop-out rate approach attempts to address these three issues by following an accounting type framework to measure the social return to expertise, but focusing on the utilisation of the specific knowledge rather than on graduate earnings. The approach requires three sets of information: the demand for graduates with expertise (including the wage structure of the market), the determinants of and the supply of graduates, and whether the expertise is utilised, using a measure of the labour market drop-out rate.

This change of focus provides a simple method for evaluating the effects of government funding on the supply of expertise to the labour market. The approach attempts to uncover the factors that determine the labour market drop-out rate. Is it a low demand for expertise or is there an over/under -supply? If so, what led to the over/under-supply? The answers to these questions lead to a measurement of the social return to expertise as a measure of the interaction of graduates with the economy in a direct fashion.

The data requirements of such an approach may be seen as arduous owing to the necessary reliance on a survey approach for information regarding the demand and the determinants of supply, an approach which in itself is problematic owing to inherent bias. The weakness in the approach most likely lies in the necessity of tracking down recent graduates to establish the drop-out rate.

The strength in this approach is in the formulation of government investment policy in the development of expertise. The macro literature continually puts forward solid support for government investment in knowledge production, typically occurring at the higher degree level at universities in the form of research, yet it neglects to consider the utilisation of the expertise of the individual upon graduation. The suggested approach of tracking labour market drop-out rates does exactly this. By comparing the drop-out rate to the determinants of the private demand for education, this approach provides a powerful tool for analysing the effects of government investment on the knowledge production process.

Assuming a high level of student support, if the drop-out rate is high the social return to the investment is low. If this high rate is caused by the government intervention in the form of funding, through establishing the determinants of the private demand for education, the government investment policy may be accurately re-evaluated with the reduction of the volume of bursaries acting as the initial tool to control for the low social return to investment. In this manner, the accounting measure does not suffer from the lower bound estimates reported if focusing on graduate earnings.

4) Applying the drop-out rate approach to the labour market for marine scientists in South Africa

4.1) Introduction

The aim of this chapter is to develop a methodology to apply the labour market drop-out rate approach to the labour market for marine scientists in South Africa. Section 4.2 presents the methodology developed to determine the demand for graduate marine scientists and the difficulties in doing so. Section 4.3 describes the methodology used to determine the determinants and the supply of new entrants to the labour market. Section 4.4 discusses the application of this approach to the labour market for marine scientists and presents any expected flaws in the methodology

4.2) The demand for marine scientists in South Africa

Before any discussion of the demand for marine scientists takes place, a definition of what exactly a marine scientist is must be established. Section 4.2.1 presents a debate within the marine science community concerning the definition of a marine scientist, after which a definition applied to this research is suggested. Section 4.2.2 presents the methodology developed to establish the demand for marine scientists as well as the wage structure¹⁶ of the labour market.

4.2.1) A definition of a marine scientist

In order to arrive at a definition of a marine scientist suitable for the purposes of this study, discussions were held with three highly regarded leaders in marine science, two from South Africa and one from the USA. Professor Love of the Marine Science Institute, University of California, provides a broad definition. Love (2003) states that a marine scientist is “anyone conducting research on organisms or processes in oceans or seas ... as long as they are ferreting out information about marine organisms or marine systems”. Love emphasises ‘research’, implying that a marine scientist *must* be involved in the activities of scientific discovery.

Professor George Branch of the University of Cape Town (UCT) has a different opinion. While marine scientists are still trained in the traditional sense at

¹⁶ According to human capital and signalling, future earnings are a significant factor of the endogenous choice of education. The wage structure is thus intimately linked to supply and, therefore, needs to be established to fully evaluate the supply of marine scientists to the labour market

universities, Branch (2002) believes that “training in one discipline does not narrowly confine one to that particular discipline”. Branch’s (2002) opinion is that a graduate marine scientist should be able to use the expertise developed during his or her training period to “step over the boundaries of other disciplines and make a useful contribution”. Branch states that success in this is more likely related to the individual’s attitude than a reliance on training. He believes that this is the case for many marine scientists operating in South Africa today, especially those working for Marine and Coastal Management (MCM).¹⁷

However, if a marine scientist ‘crosses boundaries’ the scientist is no longer involved in the core competencies of the expertise developed. The suggestion that graduate marine scientists are capable of fitting into different environments implies that there is only a partial social return to the investment in specific expertise. The partial return represents the return of the research output on graduation, but if the expertise remains un- or underutilised the return to its development is not received.

The third definition is derived from the expected outcomes of marine science studies at the higher degrees level, by looking at course curricula. The typical undergraduate student would complete a four-year degree in the natural sciences before enrolling for a higher degree. The student then conducts research under the broad umbrella of marine science, analysing living organisms in coastal and oceanic environments. On completion of this research the individual graduates as a marine scientist.

Individuals who have obtained a higher degree in the natural sciences, whose research analysed terrestrial systems and who are subsequently employed as marine scientists, are seen as marine scientists through adaptation rather than training. Although much of the knowledge and skills gained through the acquisition of a higher degree in the natural sciences is universal, the specific knowledge base and skills pertaining to each area will prevent a smooth transition (McQuaid, 2003). This point also applies to the transition made by graduate marine scientists to other disciplines, indicating that,

¹⁷ Marine and Coastal Management is a directorate of the Department of Environmental Affairs and Tourism. MCM is responsible for the management, conservation and protection of South Africa’s marine and coastal resources.

while such transition may occur it cannot be fully successful, unless the knowledge base for that particular situation is acquired.

Individuals who have completed a Masters degree in marine science by coursework are also not considered to be marine scientists. This distinction intends to differentiate between the expertise gained through research work and the knowledge base and skills developed through coursework degrees. The former is likely to be highly specialised within a research area, whereas the latter is likely to be of a broader nature.

Individuals who complete a PhD after a coursework Masters are to be considered marine scientists. This definition is supported by Professor McQuaid of Rhodes University. In addition, McQuaid (2003) expressly believes, in contrast to Branch, that marine scientists should remain in marine science and not cross the ‘boundaries’ to contribute to other disciplines. McQuaid comments that,

training in marine biology does not qualify one to deal effectively with policy, socio-economic issues, resource management, etc. The ability to deal with these issues is clearly the product of completely different types of training. Otherwise why would we bother with training people in management, economics, sociology etc., if marine scientists can do it all? It is only by default that marine scientists are doing these things in this country.

McQuaid’s (2003) viewpoint is supported internationally. The consensus among marine scientists in the USA is that they should not be involved in management and policy-making activities, but rather that experts from fields such as economics, law and sociology be included in research programmes (NRC, 2000: 1–3). A major shortcoming identified in marine science research in the USA is the lack of inclusion of such experts, leading to marine scientists making decisions on issues for which they have not acquired education or training (NRC, 2000: 1–3 and 8–11). Further support for this perception comes from New Zealand and Australia. New Zealand and Australian marine scientists also believe that marine scientists should *not* be involved in policy decisions, concluding that “traditionally trained fishery managers [i.e. a higher degree in marine science] may not have the requisite skills to advance private and public welfare” (Sylvia et al., 2002: 1).

In light of the above opinions, a concise definition of a marine scientist is an individual who has a minimum qualification of a Masters degree through research with a focus on coastal or oceanic systems, and is actively employed in such research.

4.2.2) A methodology for determining the demand for marine scientists

An exploratory study was conducted to ascertain the conditions of the labour market for marine scientists. The study took the form of face-to-face and telephonic interviews conducted between March and May 2002. The aim was to develop a picture of the labour market; the questions were thus open-ended to allow the interviewee full scope to express his or her opinion. Examples of the questions asked are:

- What is the state of marine science in South Africa?
- Where are marine scientists employed?
- Where may graduate marine scientists expect to find employment?
- Is there an over-or under-supply of marine scientists in South Africa?
- Is there a skills gap between the expertise required by the labour market compared to the expertise developed during the Masters or PhD degree in marine science?

Twenty marine scientists were interviewed: nine employed at universities (three from Rhodes University, two from the University of the Western Cape (UWC) and four from UCT), two employed in research positions at research institutes, one employed by a private company, two employed by MCM in the public sector and six working in their own consulting initiatives. The results indicated areas that required further exploration, such as the effects of the funding allocations for research and a possible gap between the expertise demanded by the labour market and the expertise acquired through a traditional higher degree.

A detailed questionnaire was developed to address these points. The aim was twofold: firstly, to corroborate the opinions of those interviewed in the exploratory study and, secondly, to generate a wage structure for the labour market for marine scientists to investigate which observable characteristics of a marine scientist affect the level of remuneration received. This information is required to test the

endogeneity of education with regard to the supply of marine scientists to the labour market. The analysis of the wage structure must of necessity be microeconomic as it is the microeconomic factors that potential students will observe, and not the social returns to acquiring a higher degree in marine science.

The microeconomic returns to education literature (Section 2.2) expects a number of factors to influence earnings, namely unalterable characteristics of the individual such as age, race and gender, and alterable characteristics such as the job category, experience, previous employment, tenure in current position and productivity. The questionnaire is provided as Appendix IV, and has been numbered here for convenience of discussion.

Section 1 of the questionnaire gathers information of the observable characteristics consistent with the empirical studies of human capital and signalling theory. Questions 1 to 3 establish the unalterable characteristics of the individual, while question 4 ascertains the respondent's qualifications. Questions 6 to 10 requests information on the individual's movements within the market. This information is crucial as it affects the endogeneity of education.

Questions 11 to 13 establish the source and level of earnings of marine scientists in South Africa. The salary scale in question 13 is based on a composite of the academic salary scales of Rhodes University and UCT for 2002, as provided by the relevant Human Resource divisions.

Section 2, question 14, comprises a measure of productivity. The construction and the reliability of this measure is discussed below.

Section 3 aims to identify the most important aspects in the occupation of a marine scientist. Question 15 provides a number of aspects which may significantly affect the level of effort required of a marine scientist to adequately complete the required tasks. An example of this is having to learn how to interpret the legal framework pertaining to marine issues. The list of tasks is drawn from the requirements of job advertisements within the marine science community, the results of the exploratory

questionnaire and the conclusions of marine scientists in the USA (NRC, 2000: 1–3; 8–11; Wilson, 2002), New Zealand and Australia (Sylvia et al., 2002: 1).

Questions 16 and 17 compare the value of the individual's qualification in relation to their current position of employment.

Section 4 poses open-ended questions for the individual to express his or her opinion on the demand for marine scientists. This is to corroborate the opinions expressed in the exploratory questionnaire. Question 20 tests the results of questions 16 and 17: the relevance of the individual's qualification to current employment.

The results of the questionnaire are fitted into a typical extended human capital wage equation to establish which features of the individual most affect earnings. The model used is presented below:

$$\text{Log}(W) = c + b_1A + b_2R + b_3G + b_4\text{Qual} + b_5E + b_6E^2 + b_7J + b_8P \quad (4)$$

where: W = annual income

A = age

R = race

G = gender

Qual = qualification separated into MSc or PhD in marine science

E = experience

J = job category

P = productivity

The model does not include the primary source of bias in the measurement of private returns to education, i.e. ability bias. This bias is usually overcome by the inclusion of a measure of aptitude, such as IQ scores (Griliches, 1977), but this is not possible here. However, owing to the highly academic nature and standard of a higher degree, it is plausible to assume that one is testing a group with a similar aptitude.¹⁸ The factors that would differ within this highly select group are the levels of motivation and job satisfaction, characteristics that are inherent weaknesses in the measurement

¹⁸ This assumption is made when comparing the aptitude of a student who completes a Bachelor's degree to a student who enrolls for a higher degree.

of human capital (Blundell et al., 1999). However, due to the inclusion of the productivity variable, these differences may be noticeable and, according to human capital and signalling theory, should have an impact on the individual's earnings.

The entry-level requirement for the labour market for marine scientists is at least a Masters degree. Therefore, the level of qualification is separated into two, the MSc and the PhD, to determine whether acquiring a further level of education/qualification is of any benefit to the individual. A PhD qualification is expected to provide a positive premium on income in comparison to a Masters degree.

The expected results are that age and experience negatively affect income, hence the inclusion of the square of experience. Race and gender are included to test for any possible discrimination. The job category is included to evaluate whether there is a significant benefit to any type of employment within the labour market.

An individual's productivity is often measured by his or her output and is expected to have an effect on the earnings of an individual. The reliability of a measurement, however, is often questioned due to the difficulties encountered in defining output. For example, the output of one category of employment within marine science may not be comparable to the output of another. Nevertheless, an attempt to develop a measure of a marine scientist's productivity was made in discussion with Professor Hecht of Rhodes University. According to Hecht (2002), the standing of a marine scientist in the marine science community of South Africa is based on scientific outputs, the number of students supervised and the subsequent impact these students have in the labour market. Thus, the measure of productivity is based on *academic* output.

The outputs are scientific (first author) publications in recognised journals separated into total outputs over career and years 1995 to 2001,¹⁹ conferences attended separated into total and 1995 to 2001, number of PhD and Masters students supervised in total and 1995 to 2001, and involvement with consulting projects.

¹⁹ The year 1995 saw the introduction of the Sea and the Coast funding programmes. The cut-off of 2001 represents the year prior to the beginning of this research.

Outputs are separated into total and 1995 to 2001 to establish whether marine science output in South Africa has increased or decreased in recent years.

This measurement of productivity is expected to suffer from five weaknesses:

1. The measure of output would obviously be correlated with the age of the individual.
2. It is heavily biased towards those employed to conduct research and student supervision, namely academics at universities.
3. It requires output to be published in scientific journals, while many consulting reports are either not of such nature, or are under confidentiality agreements.
4. The job category of the individual is likely to affect the types of research output and comparability of such output is suspect. For example, those not employed as academics may compile a number of in-house reports which are not applicable to scientific journals.
5. Those interviewed may not have kept accurate records of their outputs over their careers.

The distribution of the questionnaire was to be with the assistance of the South African Network for Coastal and Oceanic Research (SANCOR),²⁰ which is the principal representative for marine scientists in South Africa. Initially, the selection of respondents to the questionnaire was those marine scientists who were private members of SANCOR, but this proved to be of little use as the SANCOR database was frequently incorrect. This problem was overcome using two techniques. The first obtained contact details through an internet search for firms and individuals who conduct marine science research in South Africa. The second involved the use of ‘snowballing’: asking respondents for contact details of other marine scientists who may be interested in participating in the research.

²⁰ SANCOR is a “non-statutory body that generates and communicates knowledge and advice. It promotes the wise and informed use and management of marine and coastal resources and environments” (SANCOR, 2004). The steering committee of SANCOR consists of a loose grouping of academics from tertiary institutions involved in the marine sciences, employees of museums and research institutes, and representatives from MCM and private sector associations as well as private firms. The committee is dominated by academics from tertiary institutions. See: <http://www.botany.uwc.ac.za/sancor>

Understandably, a problem of selection bias develops. Those who participated in the study are likely to put forward the contact details of only the individuals they expect to be willing to participate in this study, which ignores those with a vested interest in not revealing their opinions of the conditions of the labour market. However, it may be in the interests of others to participate and provide misinformation, such as under-reporting of earnings. Nevertheless, the snowballing technique proved highly successful, with approximately 35% of those interviewed being contacted in this manner.

The first choice of distribution was email, but due to the incorrect details in the SANCOR database and a poor response rate, the questionnaire was then conducted telephonically, or, where possible, face-to-face to ensure a high response rate. The questionnaire was conducted between September and December of 2002.

In general, marine scientists proved enthusiastic about participating in the study, especially in giving their opinion of the state of employment opportunities for new graduates. The response from institutions for direct information or contact details of marine scientists in their employ was mixed. For most institutions, particularly universities, contact details came from departmental websites, but certain institutions refused to release such information or to allow employees to participate in the study. Numerous attempts to contact marine scientists employed by MCM proved fruitless.

4.3) The supply of marine scientists in South Africa

The supply of marine scientists is determined by the interaction of the private demand for education and the costs involved in acquiring a higher degree, as discussed in Chapter 3. Owing to the components of the private demand for education (income expectations, private consumption and social choice), there are two mechanisms that drive the supply of marine scientists. The first mechanism is when there is no intervention by government in lowering the credit constraint. The student chooses to enrol for a higher degree because of a demand to become a marine scientist, via income expectations or social choice. This mechanism may be called the occupation choice mechanism. The supply of marine scientists would, in this case, be hampered by a credit constraint and an expertise shortage may develop. The second mechanism comes into play when available funding affects the student's choice. If an individual

participates in a research project because funding is provided, the individual is essentially 'paid' to conduct the research. This is the short-term employment or private consumption mechanism of the supply of graduates to the labour market.

Both mechanisms lead to the supply of marine scientists to the labour market, but the motivation behind the supply, and hence the social return, differs. In the first case, society benefits from both the research output and the opportunity to utilise the expertise on completion of the higher degree. The second mechanism is viewed as short-term employment to satisfy private consumptive interests, with the student possibly 'benefiting' by the acquisition of a higher degree in marine science. The social return to this mechanism differs in that the social return is the research output generated during the 'employment' period, as well as the opportunity for the acquired expertise to be fully utilised (as for the first mechanism), but the expertise has been 'paid' for. Therefore, the social return to the investment would only be received if the expertise were to be fully utilised. Hence the labour market drop-out rate approach requires four sets of information on the supply side:

1. The structure of funding for marine science particularly with regard to student support.
2. The determinants of supply. This requires information on the interaction between private demand and the costs of acquiring a higher degree to uncover which supply mechanism dominates.
3. The supply of marine scientists to the labour market in the past.
4. Current employment position of recent graduates, i.e. the labour market drop-out rate.

Section 4.3.1 discusses the development of a methodology to satisfy the required information, while section 4.3.2 describes the implementation of the process.

4.3.1) A methodology for determining the supply of marine scientists

Many students in South Africa receive funding to enrol for a higher degree in marine science. While there is a variety of sources of funding for students, the focus of this study is on the Sea and the Coast funding programmes established by SANCOR, under the auspices of the National Research Foundation (NRF). Therefore a request

was made to the NRF for information regarding funding of these programmes, including research costs, capital expenditure and student support.

The determinants of supply are to be identified through a questionnaire of current students enrolled for a higher degree in marine science. The aims are to establish the interaction of the three factors of the private demand for education and to test the impact of the government's lowering of the credit constraint. Appendix VI provides the questionnaire.

Questions 1 to 5 identify the characteristics of the student. The aim of question 6 is to establish whether any of the current marine science students have previously worked in the labour market for marine scientists. This would have an impact on the individual's knowledge of future employment opportunities and future earnings. If a student has worked previously, the factor of income expectations of the private demand for education is expected to suffer less from incomplete information and hence upward bias (Harmon et al., 2001: 11).

Question 7 aims to discover whether students have attempted to find employment in marine science before commencing their studies, the type of job category and their expected earnings. This tests their knowledge of job opportunities and hence the income expectations factor of the private demand for education. Question 8 tests the relevance of the factors of private consumption and social choice to the supply of marine scientists. Again, within this question, the factor of income expectations is evaluated, by asking the students whether they believe the degree would be useful for any employment opportunity.

Questions 9 to 11 examine the introduction of a credit constraint. The answer to question 11 is important in that many students may be offered part-time work in a university if they enrol for a higher degree, thus indirectly lowering the credit constraint faced by the student. Question 12 explores the areas where most students wish to find employment and their expected earnings. The employment opportunities result from the survey of those employed in the market. The question tests the students' knowledge of the market regarding income expectations. Question 13 and

14 also evaluate the students' knowledge of the types of jobs available and their views regarding future employment.

The results of this questionnaire should effectively reveal the determinants of demand for education and hence the determinants of the supply. The primary focus of the questionnaire reveals the significance of the income expectations factor of the demand for education. If income expectations do not constitute a realistic factor in the choice of education, human capital or signalling theory fail to explain why individuals enrol for a higher degree in marine science.

The supply of marine scientists to the labour market is directly related to the number of students that academics at universities supervise each year. The labour market drop-out rate approach to measuring the social return to investment also requires information on the whereabouts of recent graduates: are they employed as marine scientists? The direct approach to establishing both the supply of graduates and these graduates' possible employment is thus an appeal to supervisors for information regarding the number and current whereabouts of students they have supervised in the past. The assumption that supervisors and students may keep in contact post graduation is justified considering the derivation of the measurement of productivity, where current marine scientists (especially academics) are evaluated within the market according to both the number and quality of students previously supervised (Hecht, 2002).

The appeal took the form of an official letter from the NRF (see Appendix V) to each academic who had received funding as part of the Sea and the Coast funding programmes. The letter provided the list of students having received funding through the supervisor, asking whether they have graduated,²¹ and whether they are now employed as marine scientists in South Africa. This would establish the labour market drop-out rate and hence the social return to individuals acquiring a higher degree in marine science. The success of this method relies on the response of academics to a request from the organisation from which they receive funding. There

²¹ The entry requirement to the labour market for marine scientists is at least a higher degree in marine science.

is an obvious incentive for academics to co-operate with the NRF, and thus the response rate is expected to be high.

4.3.2) Implementation of the methodology

In this section, the validity of the information received from the NRF, the implementation of the student questionnaire and the response of academics to the NRF request is discussed. Furthermore, methods used to overcome any problems with the initial methodology are introduced.

Student support is expected to have a great impact on the supply of marine scientists. Therefore, the information from the NRF is crucial in determining the social return to individuals acquiring a higher degree in marine science. The NRF promptly responded to the request for the data on funding for marine science in the Sea and the Coast programmes, but, while being thorough, the information had one significant weakness: it was not possible to establish whether the full amount allocated to a funded research project was actually used. Such an inability is a setback in evaluating the full effect of student support on the decision of a student to enrol for a higher degree. However, correspondence with the NRF regarding the Sea and the Coast programmes revealed that there were “enough [bursaries] to cover any student who was to apply or be involved in a research project” (Anon, 2002a). This indicates that it would be possible to fund any student interested in marine science, which evidently affects the credit constraint, and in turn the number of students enrolling for a higher degree in marine science. This has implications for the social return to a higher degree in marine science. One glaring oversight of the investments into individuals made by the NRF, however, is that there is no record as to whether students who received funding through the Sea and the Coast programmes actually graduated. This has two repercussions. The first is an inability to establish the direct return to the investment and the second is an inability to use any of the funding information for policy decisions of the type and level of investments to be made. This is discussed further in Chapters 5 and 6.

The student survey took place in three phases. A first attempt to circulate the student questionnaires was made at UCT in May 2002. The Department of Zoology was asked to distribute the questionnaire to its higher degree candidates in marine science.

No returns were received. On enquiry, the department replied that no students had completed the questionnaire. A second attempt took the form of a pilot study of students at Rhodes University. The questionnaire was completed via face-to-face interviews to ensure a high response rate. This pilot study had 11 respondents and thus the findings can be indicative of only a possible trend.²²

Further attempts to increase the sample size of students were made on numerous occasions. The SANCOR student representative for 2003 provided a database of email addresses for students currently enrolled in marine science at the various institutions. This initially seemed useful, but the database proved to be incomplete. The level at which each student was enrolled was not clear; some may have been enrolled for an Honours course and some may even have been in their third year of study. Thus the list could not be relied upon to accurately identify those who were training to become marine scientists according to the definition for this study, which is that the individual is enrolled for a higher degree in marine science through thesis only.

During 2003, SANCOR made attempts to run regional workshops for students with the aim of informing them of the research ongoing in marine science in South Africa. Only one workshop actually took place – at UCT in September 2003. Students from UCT, UWC and Cape Technikon were invited and it proved a useful forum for the distribution and controlled returns of the student questionnaire. Nineteen students fitted the definition used in this research, bringing the total number of students who completed the questionnaire to 31. In comparison to the annual supply of graduate marine scientists (see Table 5.14), this is a significant proportion.

Establishing the supply to the labour market was expected to be a straightforward process, simply one of compiling the responses to the letter of the NRF. The request was sent to 60 academics who had received funding for their research through the Sea and the Coast funding programmes. However, only 17 of the 60 academics replied to the NRF, constituting a 28% response rate. This response rate is exactly the same as for the study of the demographics of the student body of marine science, engineering

²² The results of this pilot study, the analysis of the wage structure, and the effects of the provision of funding on the supply of marine scientists was presented in Grootes (2002a) and Grootes (2002b).

and technology institutions conducted by Akkers et al. (1999), with the same sample size. This result substantiates the opinion expressed in Chapter 1 that there is a distinct lack of interest in research concerning the welfare of students post graduation and is likely to have far-reaching consequences regarding the social return to individuals acquiring higher degrees. This poor response effectively prevented the measurement of the supply of marine scientists to the labour market. However, the problem was overcome by analysing the graduation records of universities for the years that the programmes were in place.

The graduation rolls of UCT and Rhodes University were examined for the period 1995 to 2001. Marine scientist graduates were identified by the thesis titles printed in the roll, and, in turn, this was used to develop the annual supply of marine scientists.²³

Attempts to establish whether these graduates received funding for their studies is central to measuring the effect of government funding on the supply to the labour market for marine scientists. Email requests to the administrations of UCT and Rhodes University were made to gather this information. UCT provided this information. Rhodes University at first refused to make this information available. On later access to the Rhodes database it was found to be inaccurate and inconclusive, and many student records were no longer available electronically. Thus the attempt to establish the number of graduates who received funding at Rhodes was abandoned.

It was not possible to establish the whereabouts and, hence, the labour market drop-out rate of recent graduates using the responses of supervisors to the NRF request owing to the low response, and none provided information of the whereabouts of previous students. Requests to the UCT and Rhodes University alumni offices for contact details of marine science graduates were made in an attempt to overcome this problem. UCT refused the request on the grounds that it is against their policy to release alumni contact details. The information provided by Rhodes University was again inaccurate. Nevertheless, attempts were made to contact recent graduates using

²³ While a margin for error may have led to some individuals being incorrectly labelled as marine scientists, it is equally likely that some marine science graduates may have been identified as having a different qualification. It is assumed that the two sides of the measurement error cancel each other out.

the contact details provided. This was carried out, through a telephone survey, between September and December of 2003.

4.4) Conclusion

The labour market drop-out rate approach to measuring the social returns to education appears to be a simple task of determining whether graduates find employment that utilises their expertise. On the surface, this is exactly what the approach attempts to do, but it is strengthened by examining the demand for and supply of expertise *before* finalising any estimate of the return. By doing so, the approach can take into account factors that are likely to affect the return, such as the government provision of student support.

The methodology has been developed to apply this new approach to the labour market for marine scientists in South Africa. On the demand side, the approach requires three features. The first is a definition of a marine scientist, which is provided here in a comparison of opinions of marine scientists globally. The second feature is the demand for graduates and the third is the wage structure of the market. This is essential in determining the importance of earnings on the choice of students to enrol for a higher degree in marine science.

While the methodology is sound, the hindrance to uncovering the information was the inaccessible nature of marine scientists in South Africa. The representative body, SANCOR, has no complete or accurate record of marine scientists (especially those in consulting initiatives) and certain institutions were unwilling to participate in such a study.

On the supply side, the approach requires four elements. The first is the structure of funding regarding student support. There was no difficulty in acquiring the information from the NRF, but, as mentioned, the weakness in the data is that it is not possible to determine how much of the allocated amount was actually spent each year.

The second feature is the determinants of supply of marine scientists. The methodology is designed to establish which component of the private demand for education is most important. The focus is on income expectations as this is the basis

of choice according to human capital and signalling theories. The structure of the questionnaire could be criticised, but, considering that this study attempts to discern the factors that influence the endogeneity of education, this should be viewed as an attempt to plug the gaps in the existing returns to education literature (Chapter 2).

It would have been a straightforward matter to determine the supply of graduates and their positions of current employment (features 3 and 4), had academics responded to the request from the NRF. The fact that so few responded indicates the failure of academics to recognise the importance of such a study (Section 4.3.1). More alarming, however, is that the NRF has no record of whether the students who receive funding actually graduate. This indicates either that the NRF is unconcerned about, or has a poor understanding of, the effect funding programmes may have on the labour market in South Africa. The NRF should surely want to know whether the students graduate in order to evaluate the efficacy of its investment. These hurdles were overcome by using the graduation rolls of UCT and Rhodes University to generate the supply of graduates, and alumni data to determine the labour market drop-out rate. The latter, again, is hampered by inconsistent records.

In conclusion, the methodology developed to apply the labour market drop-out rate approach is solidly constructed. The problems encountered were more the result of inaccurate, or the complete lack of, records maintained by SANCOR, the NRF and the universities, and the usual difficulties of isolating respondents for questionnaires.

5) Results and analysis

5.1) Introduction

The aim of this chapter is to establish the social return to government investment in the supply side of the labour market for marine scientists. The labour market drop-out rate approach achieves this by focusing on the demand for, the supply of and the utilisation of expertise. Section 5.2 explores the conditions of the labour market, deriving a picture of the demand from the opinions of the respondents in the marine scientist questionnaire. In addition, it explores the importance of knowing what a marine scientist is regarding any existence of a skills gap. Finally, the wage structure of the labour market is presented, applying the extended human capital model to estimate the returns to education.

Section 5.3 focuses on the supply side of the market. It presents a discussion of the funding structure for the Sea and the Coast funding programmes, the supply of graduate marine scientists to the market in recent years and the results of the student survey. These results indicate the effect of the provision of funding on the endogenous choice for education by exposing the factors that dominate the choice of a student to enrol for a higher degree in marine science. Lastly, the social return to government investment is estimated, applying the labour market drop-out rate to graduates from Rhodes University.

Section 5.4 concludes by comparing the conditions of the labour market to the determinants of supply and, hence, the social return to government investment in students at the higher degree level of marine science.

5.2) The conditions of the labour market for marine scientists in South Africa

This section focuses on the demand for marine science graduates. Section 5.2.1 looks at the demand for graduate marine scientists and the employment conditions of those individuals currently employed as marine scientists. Section 5.2.2 explores the possibility of a skills gap between the expertise of the graduate marine scientist and the tasks he or she is expected to perform. Section 5.2.3 introduces the wage structure of the market. An extended human capital model, consistent with the private returns to education literature, is applied to the data from the marine scientist questionnaire.

The results reveal the different factors that have an impact on the earnings of a marine scientist in South Africa. Section 5.2.4 concludes by debating the demand for graduate marine scientists in South Africa.

5.2.1) The demand for marine scientists

The answers to the questions related to the conditions of the labour market for marine scientists in South Africa in the exploratory study and the more detailed survey of marine scientists are combined, as both studies included open-ended questions, allowing marine scientists to express their opinions on the conditions of the market. In total there are 69 respondents.

Employment positions for marine scientists may be separated into five categories:

1. Academic positions at universities.
2. Research institutes such as the South African Institute for Aquatic Biodiversity (SAIAB), and museums.
3. Government departments at the national (MCM) and provincial levels (e.g. KwaZulu-Natal Wildlife).
4. Industry, e.g. commercial fishing, deep sea mining interests and aquaculture initiatives.
5. Consultancies.

However, the opportunities for new graduates, if they wish to remain in marine science are few: the market is inefficient and competition for posts high. The structure of the labour market is inefficient for two reasons, the first being the existence of networks established during the training process (Britz, 2002; Hecht, 2002). While networks may benefit those involved, they also prevent the free flow of information and choice through the labour market. It is difficult to evaluate the full effect of these networks as well as whether they operate as an efficient sorting and employment allocation mechanism.

Opinions point to particular benefits for students involved in applied rather than fundamental science research. Those involved in research related to business opportunities, especially aquaculture, appear to benefit from a lower risk of unemployment as marine scientists. This view is highly contested among academics,

especially between those at UCT and Rhodes University. However, the existence of interest groups will ultimately dictate the route of research the student follows, as he or she needs to fit into a research project an academic is currently running.

The opinions of marine scientists, especially in the consulting category, is that the research project followed by a graduate marine scientist acts as a strong signal of specific competency. Not only do graduates face becoming highly specialised and thus possibly are not absorbed into the labour market, but also being broadly separated into those who have followed a fundamental science route and those following an applied route. An example of the latter is a student currently conducting a Masters degree in marine science of which one of the major contributions is a business plan for an aquaculture initiative.

The second cause of inefficiency is the government policies involving preferred status given to previously disadvantaged individuals (the preference order being black female/male, white female, white male). This has created a major disturbance in the operations of the marine science labour market. As only 15% (Grootes, 2002b: 2) of students in the last five years benefit from preferred status, the competition for new posts not affected by these policies is high. The impact of this legislation is indicated by the difficulty MCM has experienced in filling vacant posts.

Along with the change of government in 1994, many changes occurred in the structure of the labour market. The government-backed Sea Fisheries Research Institute was absorbed into the new arm of the Department of Environmental Affairs and Tourism, MCM, with the objective to “effectively establish management practices for the sustainable use of South Africa’s coastal and marine living and non-living resources” (Augustyn, 2002).

In the creation of this department, the number of marine scientists employed directly by the government has decreased, and the scope of responsibility increased. The former research institute, with a large scope for individual research, has become a sub-department responsible for managing all coastal and marine resources as well as carrying out further directed research. As interviews with previous and current employees indicate, this has caused a massive management and administrative

workload to be ‘dumped’ on scientists who are untrained and not initially employed to deal with such issues (Akkers, 2002; Augustyn, 2002; Morant, 2002). This points to the core of the marine scientist’s function. The definition used in this study, which is supported both locally and internationally, requires a marine scientist to be employed in marine science research alone (Section 4.2.1). This change in focus of the requirements of the marine scientist has created a skills gap, the result being the inefficiencies in the present operating environment of MCM.

Not only has a skills gap been generated by the change of focus in the formation of MCM, but also many qualified scientists resigned as a result of the change in mandate. These scientists have subsequently established consultancies, retired, emigrated, become academics or left the field of marine science. The result is a gap in experience and ability at the department that has yet to be filled (Butterworth, 2002; Pulfrich & Penney, 2002). The government policies of employment have hindered these posts from being filled by suitable candidates, the consequence being that although candidates with the correct credentials exist (Clarke, 2002; Kuun, 2002), the posts have remained open for some time. This has further increased the workload of MCM employees in an attempt to satisfy its mandate (Akkers, 2002; Augustyn, 2002; Morant, 2002). Therefore it can be said that job opportunities in the public sector exist, but they are administrative-based and difficult to obtain.

Opportunities for academic employment at universities are typically few and far between, with openings becoming available only on retirement of current staff or through expansion of departments. There is growing concern in the marine science community that the average age of researchers is increasing, but there are few openings for young individuals to embark on academic careers.

Research institutes, such as SAIAB, are generally funded through the government, and whilst the Oceanographic Research Institute (ORI) is privately run, new jobs at these institutes are generally on a contract basis with little or no opportunity for permanent employment (Govender, 2002; Strydom, 2002). Government departments, as mentioned above, are hindered by mismanagement and restrictive employment regulations.

Interviews with marine scientists in industry have clarified that the industry employs few scientists, preferring to outsource any necessary research to consultancies, thus ruling out employment in established firms. Commercial fishing firms, in particular, use consultancies only if a legal requirement needs to be met. Whilst there is growth in the aquaculture industry, this is a fledgling industry requiring much research into production processes. Moreover, it is likely that as this industry matures, the need for skilled scientists will decrease and that for technicians will increase.

Therefore, the most probable avenue of employment for a graduate marine scientist is consulting firms. However, two factors constrain employment in this sector. Firstly, owing to the structural upheavals within MCM, these firms are unlikely to increase employment until the government has established a secure management arm and legal framework for marine resources in South Africa. The market sentiment towards increased employment in consulting firms, in light of this instability, may be summarised by Clarke's (2002) impression that the consultancy environment is a "high risk work environment where the incentives to increase employment no longer exist".

The second factor that greatly hinders employment expansion in consulting firms is the curricula of universities. They are those of the traditional scientist, steeped in theory analysis and laboratory procedures. In previous years this matched the demand for expertise, but this is no longer the case owing to a shift in demand for expertise and the training lag experienced between expertise demanded by and expertise supplied to the labour market (Kivinen & Ahola, 1999; Strydom & Fourie, 1999).

Significantly, private consultancies demand individuals who are not only competent in conducting the necessary scientific research, but also knowledgeable in the areas of economics, law, management, budgets, etc. Such skills are often considered 'general' in nature and are thus not included in university training programmes. The result is a skills gap between what is demanded and what is supplied. An example of this gap is evident in the case of a PhD qualified marine scientist who works for an environmental impact consultancy. This individual studied undergraduate management courses concurrently with his PhD, and believes that he now spends a mere 10% of his time on marine science and related matters. While efforts have been

made to address this situation at specific institutions, it is not widely acknowledged that a shift in training may be necessary (Britz, 2002).

In reality this skills mismatch pervades the entire marine science labour market. Those employed in government posts are required to manage resources without the necessary training to do so effectively, researchers are required to manage budgets and understand the legal framework and related economics, and those employed as consultants are required to have the full set of skills embodied in marine science, economics, management and law. Initiatives such as the workshop on ‘Training Managers for 21st Century Fisheries’, held in New Zealand in 2001, are required to establish the needs of the labour market and whether these are compatible with the current training structures.

5.2.2) Further exploration of the gap in expertise

The identification of the skills gap is supported by the opinions of all the marine scientists interviewed, particularly those at MCM. Furthermore, the gap is illustrated by the skills required for successful application to all recent vacancies advertised on the SANCOR email distribution list. The most frequently occurring skills required by the job adverts and identified in the interviews are:

- Strong leadership abilities.
- Conflict resolution (communication skills).
- Problem-solving skills.
- Knowledge of marine/natural sciences.
- Knowledge of economics.
- Clear understanding of the existing legal framework.

The first three are typical general skills. According to the marine scientists interviewed, these skills are not developed in the existing training curricula, nor is there emphasis on any of these particular skills in the undergraduate programmes that the trainee marine scientist will have followed. The interviewees added that while there is a need for these skills to be developed, introducing courses into existing training programmes would be difficult, costly and more likely to add to the length of time required to complete a degree.

The latter three skills illustrate the shift in the range of competencies demanded of the marine scientist. Owing to increased awareness of the state of the environment, the realisation of the need for sustainable management of coastal and oceanic resources and recent changes in environmental legislation in South Africa, the spectrum in which marine scientists now operate has expanded. Marine scientists are expected to have an understanding of the legal and socio-economic framework related to management of resources, a knowledge base that is obviously not part of the curriculum for a marine scientist. This shift, however, is not a local phenomenon, but a global situation where marine scientists are becoming increasingly involved in these issues (NRC, 2000: 1–3; Sylvia et al., 2002: 1).

However, according to Branch (2002) these competencies are to be acquired in the workplace and not through a higher degree in marine science. Love (2003) and McQuaid (2003), and the marine scientists in the USA (NRC, 2000), New Zealand and Australia (Sylvia et al., 2002), believe that the scientist should not be involved in such matters, as the sole capacity and applicability of the trained graduate is to carry out research. Considering that the reality is that marine scientists are in these positions, the skills mismatch needs to be urgently addressed.

But is there genuinely a skills gap? A number of the marine scientists, especially those in academia, believe that the failure is on the side of the student. The graduate marine scientist must leave the academic environment aware that his or her supposedly specific expertise can be adapted to a more general environment. Clarke (2002) believes that students do not realise that skills such as report writing, presentation, research and time management are also outcomes of the Masters or Doctorate degree. He feels that students graduate with a narrow mindset, expecting to find employment in their specific field of research or no employment at all.

Opportunities at government departments and universities are scarce, but the opinion of those employed is that other opportunities exist, all requiring some entrepreneurial ideas. Many speak of former students who have succeeded in such ventures, but none speak of the number of students who have not made such a leap, nor do they have any suggestions as to what these opportunities may be. This makes such an opinion

vulnerable and may well be an optimistic response caused by the supply side mechanisms of the labour market which are examined in Section 5.3.

5.2.3) *The earnings of marine scientists*

This section presents the quantitative results of the marine scientist questionnaire, applying the extended human capital equation to establish the returns to various observable characteristics of marine scientists in South Africa. Table 5.1 provides a summary of the average earnings for the job categories as identified in Section 5.2.1.

Table 5.1: Earnings of marine scientists in South Africa

	No.	Ave age	Ave income*	Std deviation	Max	Min
Academic	20	44	217 623	51 471	308 119	151 188
Research	19	39	133 670	61 877	262 500	58 500
Government	11	42	184 009	35 159	245 000	130 000
Consulting	13	40	170 167	73 129	350 000	80 000
Industry	6	37	224 833	119 052	450 000	104 000
Male	54	43	195 822	195 822	450000	81 000
Female	15	35	117 553	46 652	197 226	58 500
Total	69	41	180 537	75 136	450 000	58 500

*while the questionnaire provided a range of incomes, almost all respondents provided their actual earnings.

The average age of those who participated in the survey is 41, with very little variation within job categories. The results show that marine scientists are best paid in industry, but it should be recalled that industry prefers to outsource any research needed to consultants.

Comparing the average earnings of the other four categories reveals a surprising result. Academics receive a higher wage than those employed at research institutes and in government departments, and those in consulting. The average earnings of the academic is approximately 63% higher than that of marine scientists employed in research positions, 28% higher than consultants and 18% higher than government employees. The result is unexpected as, typically, those following careers in the sciences pay a wage premium for doing so (Stern, 1999). The reason for this may be explained by evaluating the earning activities of each job category.

Individuals employed by research institutes, in government departments or in industry receive a set wage package with little or no scope for individual consulting. The

consultant derives his income purely from consulting activities. The consultants interviewed all made it clear that consulting is a risky occupation and that income is highly variable from year to year, an indication of which is the high standard deviation of earnings within consulting (Table 5.1).

The case for the academic is different, where academics have three sources of income:

1. The set wage received from the training institute.
2. Government research grants to be used for research activities.
3. Additional income from consulting.

In this case, the academic is allowed to engage in private consulting as a further source of earnings unavailable to others. While the practice is for academics to receive payment for consulting activities into research accounts, these monies are then used for the purchase of equipment, to cover travel expenses, etc. Income from consulting thus realistically forms a component of the earnings of the academic marine scientist. Therefore, contrary to many other industries, it is beneficial to be employed at a university.

Indications from the survey are that academics may receive higher than reported earnings, as many were not sure of their income from consulting activities and provided (conservative) yearly estimates, further substantiating the view that academia is the highest paid job category within the labour market for marine scientists.

In order to test whether academics actually *do* receive a significantly higher wage, the data from the questionnaires is used to estimate the wage effects of the collected observable characteristics of the individual, following the extended human capital model discussed in Chapter 4:

$$\ln(W) = c + b_1A + b_2R + b_3G + b_4Qual + b_5E + b_6E^2 + b_7J + b_8P$$

where: W = annual income

A = age

R = race

G = gender

Qual = qualification separated into MSc or PhD in marine science

E = experience

J = job category

P = productivity

The variables productivity, race and age are dropped from the equation. The variable productivity fell foul of the weaknesses inherent in its measurement (Chapter 4). Age is dropped in preference for the measurement of experience following the convention of the private returns to education literature and race being dropped because only three of the respondents were not white.

Testing for the effects of education and experience on the levels of earnings yield the results presented in Table 5.2. The model estimates the return for an individual obtaining a PhD compared with a Masters degree in marine science.

Table 5.2: Effect of education and experience on the log of wages

Variable	Coefficient	
C	11.55200	(100.6331)
PhD over MSc	0.322295	(3.131587)*
Experience	0.034033	(1.987223)**
Experience ²	-0.000676	(-1.229304)

(N = 68, R² = 0.294459. Figures in parenthesis are t-statistics)
(*significant at the 1% level, ** at the 10% level)

The results follow the expectations of human capital and signalling theories, where education and experience have a positive effect on the wage received by the individual. The individual receives a wage premium of 32% on the log of wages for obtaining a PhD over an MSc and an extra 3.4% for each year of experience, significant at the 1% and 10% levels respectively. The square of experience exhibits the declining effect of experience on the log of earnings as is typical with human capital and signalling experiments, but is insignificant at all levels.

Owing to the low explanatory power of the simple model, it appears that the earnings of marine scientists are affected by some other factor. As Table 5.1 illustrates, those employed by research institutes receive the lowest average income, indicating that the category of employment, and not levels of education and experience, may well

determine the level of earnings. Table 5.3 reports the results when controlling for job category, comparing those who are employed at research institutes to all others.

Table 5.3: Effect of job category on earnings

Variable	Coefficient	
C	11.74471	(96.57094)
PhD over MSc	0.280612	(2.973990)*
Experience	0.020751	(1.254767)
Experience ²	-0.000284	(-0.541983)
Research	-0.343380	(-3.372744)*

(N = 68, R² = 0.409317. Figures in parenthesis are t-statistics)
(*significant at the 1% level)

The inclusion of the job category for those employed at research institutions strengthens the model. The return to acquiring a PhD decreases to 28%, and is still significant at the 1% level. Experience and its square exhibit the expected effects but are now insignificant at all levels. The effect of employment at a research institute compared to all other categories is immediately apparent, with the result being significant at the 1% level. Those who are employed by such institutions suffer a (negative) wage premium of 34%.

Table 5.4 reports the results, now including gender to test for any discrimination in the pay of marine scientists.

Table 5.4: Effect of gender on the earnings of marine scientists in South Africa

Variable	Coefficient	
C	11.52911	(90.68975)
PhD over MSc	0.224503	(2.555203)*
Experience	0.017720	(1.168249)
Experience ²	-0.000286	(-0.596083)
Research	-0.285827	(-3.019760)*
Gender	0.356193	(3.516399)*

(N = 68, R² = 0.513116. Figures in parenthesis are t-statistics)
(*significant at the 1% level)

The return to acquiring a PhD continues to decline, showing a wage effect of 22.5%. Experience and the square exhibit the expected effects but are again insignificant. The effect of working for a research institute has decreased marginally to a negative wage premium of 28.5%, and is significant at the 1% level. There is suggestive evidence of gender discrimination, with a return to being male of 36% at the 1% level

of significance. On first inspection it thus appears that the three factors that strongly affect the earnings of a marine scientist are:

1. The level of education.
2. The category of employment.
3. Gender.

However, the number of women in the sample is disproportionate to the number of men, with only fifteen of the respondents being female. This would overstate the effect of gender on the pay of marine scientists, and, as such, these results should be interpreted with caution. But one cannot ignore the expectation of gender discrimination in the labour market owing to the paucity of women actively employed in marine science. It is clear, through conducting this survey, that few women are actively employed as marine scientists, although the reasons for this were not examined. To remove the measurement error induced by gender, Table 5.5 reports the results of the simple extended human capital equation for men only.

Table 5.5: Effect of education and experience on the log of wages: men only

Variable	Coefficient	
C	11.77372	(76.57541)
PhD over MSc	0.161680	(1.309496)
Experience	0.032695	(1.506651)
Experience ²	-0.000695	(-1.186394)

(N = 53, R² = 0.188889. Figures in parenthesis are t-statistics)

These results indicate that neither education nor experience play a significant role in explaining the earnings of a marine scientist, suggesting that other factors determine the earnings of men in the sample. The earlier results indicate that the job category has a significant effect on the earnings of a marine scientist to the point where those employed at a research institute suffer a wage premium of 34% (Table 5.3), thus it is clear that this would also have an impact on the earnings of men only. Table 5.6 illustrates the effect of job category, comparing those employed by a research institute to all others, for men only.

Table 5.6: Effect of job category on earnings: men only

Variable	Coefficient	
C	11.98194	(84.43038)
PhD over MSc	0.178732	(1.653879)
Experience	0.011016	(0.576213)
Experience ²	-0.000101	(-0.198609)
Research	-0.353456	(-2.826410)

(N = 53, R² = 0.331791. Figures in parenthesis are t-statistics)

Again, education and experience display the expected effects but are insignificant. The return to obtaining a PhD for men is 17.8%, at the 20% level of significance – hardly conclusive. It appears, however, that the factor that most influences the earnings of male marine scientists in South Africa is the category in which they find employment. In this case, those employed by research institutes suffer a wage premium of 35% at the 1% level of significance.

The results for women paint a different picture. While the results have very little statistical relevance considering the small sample size of only fifteen, the results prove interesting, if only to show a particular trend. Table 5.7 displays the results for the simple extended human capital equation of education and experience for women only.

Table 5.7: Effect of education and experience on the log of wages: women only

Variable	Coefficient	
C	11.24669	(47.98675)
PhD over MSc	0.465991	(2.502987)*
Experience	0.036425	(0.837185)
Experience ²	-0.001130	(-0.679114)

(N = 15, R² = 0.393760. Figures in parenthesis are t-statistics)
(*significant at the 10% level)

The return to obtaining a PhD for women is 46.7% at the 10% level. This is substantially higher than the return to a PhD received by men. Experience displays the expected result, but is again insignificant. Controlling for job category further weakens any strength the model may have, but shows the same result as for men: that being employed at a research institute has a negative effect on earnings.

Table 5.8: Effect of job category on earnings: women only

Variable	Coefficient	
C	11.33327	(38.15002)
PhD over MSc	0.434357	(2.031238)*
Experience	0.033241	(0.736008)
Experience ²	-0.000957	(-0.551111)
Research	-0.146621	(-0.679408)

(N = 15, R² = 0.424793. Figures in parenthesis are t-statistics)
(*significant at the 10% level)

The return to obtaining a PhD, when controlling for job category, pays a wage premium of 43.4% at the 10% level. Experience exhibits the expected result but is insignificant. The effect of working for a research institute on earnings reflects the same result as for men, but is far smaller in magnitude, with a negative effect of 14.6%, and is insignificant at all levels.

A comparison of the factors that influence earnings of men and women in the labour market indicates that there is a large discrepancy between earnings, with men receiving a wage premium of 41%. However, this result can be interpreted only as the possible existence of gender discrimination because the results show no statistical rigour, owing to the small number of female respondents. Nevertheless, it is likely that gender discrimination exists, at least in previous employment practices, as currently there are very few women employed as marine scientists in South Africa.

5.2.4) *Conclusions on the conditions of the labour market for marine scientists*

The return to obtaining a PhD for the sample is 28%, when controlling for those employed by research institutes. When separated across genders and controlling for job category, men receive a 17.8% and women a 43.4% return to obtaining a PhD. The lower return to education for men is consistent with the international country specific studies presented earlier where women consistently receive a higher return to education.

The question of whether gender discrimination in the labour market is as strong as the (weak) results suggests requires a far larger sample of women. However, as shown in Section 5.3 (Table 5.14), the number of women receiving funding, compared to men, for a higher degree in marine science has been approximately equal over the period

1996 to 2001. This in time, considering the favourable employment practices for female marine scientists, should erode any currently existing gender discrimination.

Whether there is a demand for graduate marine scientists in South Africa depends very much on the definition and expectations of a graduate marine scientist. The debate of the skills gap between the traditionally trained and the 'modern' marine scientist also depends on the definition of a marine scientist applied. The current consensus in the USA, New Zealand and Australia is that students are trained as researchers and, as such, should be doing just that: research (NRC, 2000; Sylvia et al., 2002). This view is corroborated by the opinions of McQuaid (2003) and Love (2003) but is challenged by Branch (2002) and Clarke (2002). The latter two opinions are that graduates have too narrow an expectation of employment and need to broaden their scope and consider entrepreneurial opportunities.

5.3) The supply of marine scientists in South Africa

The labour market drop-out rate approach states that if an individual receives funding and subsequently does not find employment in the field, there is no social return to the investment in expertise.²⁴ What is the level of student support in marine science? What is the supply of graduates in recent years? And, more importantly, what are the determinants of supply? With regard to the two possible mechanisms of supply (occupation versus employment/private consumption), it is important to establish these answers in order to evaluate the worth of any government investment.

Section 5.3.1 introduces the Sea and the Coast funding programmes. It provides the level of government investment for the years 1996 to 2002 as well as criticisms levelled at the programmes by the marine science community. Section 5.3.2 discusses this funding with regard to the level of student support and the supply of graduates to the labour market for 1996 to 2002. Section 5.3.3 evaluates the determinants of supply represented by the results of the student questionnaire. Section 5.3.4 estimates the labour market drop-out rate and thus the social return to an individual graduating as a marine scientist.

²⁴ Recall that the social return to research output is held constant

5.3.1) Government investment in marine science: the Sea and the Coast funding programmes

The source of funding for the majority of marine science research in South Africa is the NRF, whose aim is worth reiterating: “capacity building and investing in the development of South Africa” (NRF, 2002a). There are a number of funding programmes an academic may apply to for research funding, such as the Marine Living Resources Fund, etc. Owing to the fact that the conditions for a successful application for funding are broadly similar, especially regarding student involvement, the focus is on the Sea and the Coast funding programmes from 1996 to 2002, co-ordinated by SANCOR under the auspices of the NRF.

The Sea and the Coast I funding programme was implemented in 1995 comprising six thrusts. These thrusts were developed through communication with the marine science community and various stakeholders, such as MCM. These six thrusts were:

1. Coastal communities and living marine resources.
2. The coast as a resource.
3. Mariculture.
4. Offshore resources and society.
5. Ocean dynamics and coastal geomorphology.
6. Marine and coastal biodiversity and conservation.

The programme represented a first attempt to include the changing environment of marine science where increasingly marine scientists are engaged in making policy decisions (Section 5.2). As such, the first two thrusts explicitly required inputs from disciplines such as economics, law and management.

While this was a major departure from previous funding programmes, Sea and the Coast I met with mixed success. Evaluations of the programme by Freon, Van der Westhuyzen and Mather (2000) and Siegfried (2002) indicate that problems existed in the areas of adequate and accessible funding, and in the quality of research output, and that very little interdisciplinary work actually occurred.²⁵

²⁵ The problem of the need for interdisciplinary research compared to whether it actually occurs has been the topic of much debate. For a detailed review of research collaboration in South Africa the reader is referred to Mouton (2000).

Both evaluations stated that the number of projects funded was over-ambitious and too little was made available for investment in capital equipment. In a time where technical equipment has become all-important in producing quality research, South African marine science has been “living increasingly off its capital ... for several years” (Siegfried, 2002: 3). This situation appears not to be confined to marine science. Woods (2003: 4) believes that the “funding of capital equipment in South Africa has reached a crisis point and if major capital equipment funding is not made available the entire science research system is likely to collapse”. Woods (2003: 5) further reports that only R3.8 and R2.5 million were made available for the entire country in 2001 and 2002 respectively (see Table 5.10). Table 5.9 presents the total government investment in Sea and the Coast I compared to the portion allocated to capital investment. On average only 4.71% of funding was made available for capital equipment.

Table 5.9: Government investment in Sea and the Coast I, 1996–2000 (in Rands)¹

	Total investment	Capital investment	%
1996	5,417,020	230,823	4.26
1997	5,562,029	287,813	5.17
1998	5,249,916	284,422	5.42
1999	5,023,792	247,708	4.93
2000	3,803,684	142,832	3.76
	27,053,824	1,193,598	4.71

¹NRF, 2002

The programme also received criticism for its direct social return: the quality of the research output. While the first two thrusts were put in place to improve collaboration between disciplines, little or no genuine constructive interaction occurred. This led to a serious weakness in any of the research involving social issues, such as the subsistence fisheries. More severe a criticism, though, is at the fundamental science output levels where the research outputs consisted of “too much mediocre science” (Siegfried, 2002: 5).

As a result of these and other criticisms a revised funding programme labelled the Sea and the Coast II was implemented in 2000. This programme consisted of five thrusts,

incorporating similar aims and objectives to the first programme. The revised groupings were:

1. Coastal and oceanic processes.
2. Ecology, systematics and conservation of marine life.
3. Mariculture.
4. Sustainable marine and coastal resources.
5. Dynamics, exploitation and effects of atmospheric systems.

Table 5.10 presents the total investment compared to the portion allocated for capital expenditure for the years 2001 and 2002.

Table 5.10: Government investment in Sea and the Coast II, 2001–2002 (in Rands)*

	Total investment	Capital investment	%
2001	5,825,499	515,500	8.85
2002	7,524,644	356,784	4.74
	13,350,143	872,284	6.80

*NRF, 2002

As Table 5.10 shows, Sea and the Coast II also fails to address the concerns of low levels of investment in capital equipment, with only a 2.09% increase in funding from 4.71% to 6.80% of total funding.

Although the marine science community was actively involved in the development and criticism of these programmes, it completely ignored any effect the provision of student support may have on the supply of marine scientists to the labour market. Neither of the above-mentioned criticisms took into account the effect of the provision of bursaries on the supply to the market, nor whether these graduates were likely to find employment on graduation. This constitutes a complete neglect of the social return to such investment being the research output *and* the developed expertise. Who is responsible for such a failing is a question which can only be answered by establishing the labour market drop-out rate.

5.3.2) *Government investment in student support*

The Sea and the Coast funding programmes, being NRF initiatives, are based on research output as well as capacity building. Consistent with this policy, the primary

factor affecting an academic's application for research funding is the number of students that may be involved in the project. It is a prerequisite for any application to show capacity to train students at the higher degree level. The funding of research from the NRF should thus be viewed as a direct supply-side intervention as the research funding generates a supply of graduates to the labour market.

The percentage of total funding allocated for student support illustrates the NRF's commitment to capacity building. Table 5.11 presents the percentage of student funding compared to total funding for the years 1996 to 2002.

Table 5.11: Total government investment vs. student funding (in Rands), 1996–2002

Year	Total funding	Bursaries	% Investment in student funding
1996	5,417,020	425,994	7.86
1997	5,562,029	657,540	11.82
1998	5,249,916	1,050,197	20.00
1999	5,023,792	1,179,833	23.48
2000	3,803,684	1,153,000	30.31
2001	5,825,499	877,542	15.06
2002	6,589,344	2,111,000	32.04
Total	37,471,284	7,455,106	19.90

The total amount of student funding for the seven years is R7 455 106, with an average of 19.9% per year. As is shown, the amount allocated to student support has gradually increased. The decrease in 2001 coincides with the completion of a number of research projects under Sea and the Coast I and the introduction of Sea and the Coast II. The amount issued for student support in 2002 reached its highest level at R2 111 000, or 32% of total government investment in marine science through the S&C programmes.

Table 5.12 shows the number of students funded for higher degrees, per institution, each year by the Sea and the Coast programmes, for the years 1996 to 2002. On average, 75 students a year received support for their studies at the higher degree level in marine science.

Table 5.12: No. of students funded yearly from the Sea and the Coast funding programmes by institution, 1996–2001

Institution	1996	1997	1998	1999	2000	2001	Total
UPE	4	5	11	11	10	8	49
UWC	10	7	18	8	7	5	55
UDW	5	5	10	15	10	4	49
UCT	17	26	19	22	24	26	134
Stellenbosch	0	0	4	2	3	0	9
Un. Pretoria	0	2	3	2	4	4	15
ORI	0	0	2	2	3	2	9
WITS	2	4	0	1	1	1	9
SAIAB	0	0	1	1	2	1	5
PE Museum	0	1	1	2	2	1	7
UZULU	1	0	0	0	0	0	1
Rhodes	12	8	14	18	19	12	83
Free State	3	2	4	0	0	0	9
Fort Hare	0	4	5	6	2	1	18
Total	54	64	92	90	87	65	452

Table 5.13 shows that the number of male and female students receiving funding from the NRF is approximately equal over the years 1996 to 2002. This has positive implications for the number of women entering the labour market, assuming that these graduates intend to work as marine scientists. This, together with the preferential employment practices towards women, is expected to increase the number of women in the labour market for marine scientists and erode the differences in earnings between the genders, as discussed in Section 5.2.

Table 5.13: Gender breakdown of students funded by the NRF, 1996–2001*

Year	Female	Male	Total	% Female
1996	36	39	75	48
1997	45	46	91	49
1998	45	40	85	53
1999	26	33	59	44
2000	23	33	56	41
2001	43	30	73	59

*NRF, 2002²⁶

²⁶ Note that comparing the yearly total of male and female students in Table 5.13 to the total yearly number of students funded in Table 5.12 indicate conflicting results. The source for both sets of information is the NRF records for the Sea and the Coast funding programmes. The reason this discrepancy exists can only be a fault in the records provided by the NRF.

The most important question with regard to the social return to the investment in expertise is the complete lack of records as to whether those students who received bursaries actually graduated. According to Siegfried (2002: 3) many students failed to complete their studies “presumably because of the lure of better earnings elsewhere”. Considering that the labour market for marine scientists is not in a position to absorb many graduates (Section 5.2), this statement may well be true. However, it again indicates the ignorance that SANCOR and the NRF display of the effects of student funding on the supply to the market and, hence, the social return to such investment. Why there is no record of these students graduating is inexplicable, as is the lack of response of the academics to the request from the NRF for such information (Section 4.3).

The supply of graduates to the labour market, as represented by the graduation rolls of UCT and Rhodes University, is presented in Table 5.14.

Table 5.14: Supply of graduate marine scientists, 1996–2002

	UCT		Rhodes		Total		Total graduates
	MSc	PhD	MSc	PhD	Msc	PhD	Total
1996	12	4	6	5	18	9	27
1997	8	6	7	3	15	9	24
1998	6	10	8	3	14	13	27
1999	5	6	5	4	10	10	20
2000	9	6	8	3	17	9	26
2001	12	7	3	2	15	9	24
2002	3	6	4	2	7	8	15
	55	45	41	22	96	67	163

UCT and Rhodes University have collectively supplied 163 graduates to the labour market for marine science, with an average of 23 graduates a year. The critical question of the accuracy of these results is whether those who graduated with a Masters continued on for a PhD during the same time period. This would lower the actual number of graduate marine scientists who entered the labour market. This question could only be partly answered by a review of the names of students who received funding for their Masters degree and are currently enrolled for a PhD. The result is that very few students who received funding for a Masters degree continue their studies for a PhD in marine science.

5.3.3) The effects of supply-side intervention on the supply of marine scientists

The question of whether the occupation choice or private consumption mechanism drives the supply of marine scientists is answered by the results of the student survey. The choice of the student to enrol for a higher degree in marine science is based on the interaction of the three components of the private demand for education and the relaxation of the credit constraint, through the provision of bursaries.

If students base their decisions on income expectations, the results of the questionnaire would indicate that students have a strong knowledge of both future job opportunities and future earnings – the occupation choice mechanism of supply and a guaranteed social return in both research output and expertise utilisation.

If students show little or no knowledge of the labour market but indicate an interest in marine science and a willingness to find employment as a marine scientist, the decision is based on both the private consumption factor of the demand for education and optimistic income expectations, owing to incomplete information (Stigler, 1962; Harmon et al., 2001). In this case it is uncertain whether the return on the government investment is received. It is possible that on completion of the higher degree, with the direct social return in the form of research output, the student may be forced to find employment outside marine science. If this occurs there is no social return to the investment in expertise.

If the decision is based purely on the consumptive demand for education, the social returns are the research output and a possible return to the expertise *if* the individual then finds employment as a marine scientist. This issue then relates to the return to government funding and whether students enrol for degrees motivated by personal interest or income expectations. Obviously, the social returns are not the same. If the student bases the decision to enrol for a higher degree on social choice the social return again depends, firstly, on graduation and the research output and, secondly, on employment of the expertise.

However, none of the above situations take into account the effect of the provision of bursaries on the supply. How many students would enrol for a higher degree in

marine science if no funding was to be provided? If this number is high and the knowledge of the market is poor, is this not an indication that the provision of bursaries is the driving force behind the choice to enrol for a higher degree in marine science and, therefore, supply? In this case enrolment may indeed be seen as short-term employment (Section 3.3.2). For the individual the result is possibly a higher degree. For society the end result is the (possible) research output and subsequently the effect the provision of student support has on the supply to the market, and hence the possible utilisation of expertise.

These questions are answered by the student survey. Thirty-one students were involved in the questionnaire, approximately 40% of the yearly number of students funded during the period 1996 to 2001 and 34% greater than the annual supply of graduates to the market. The average age for those in the study is 26 years. Table 5.15 shows the demographic composition of students participating in the study (questions 3 and 4). The majority of the students are enrolled for a Masters degree, 21 students compared to 10 students for a PhD.

Table 5.15: Demographic composition of student respondents

	UCT	Rhodes University	Total	% of sample
Male	11	8	19	61
Female	8	4	12	39
White	11	11	22	71
Black	8	1	9	29

Few students had worked in marine science before enrolling for a higher degree (question 6), only five students have worked full-time previously in marine science. These typically were also the five oldest students in the sample. Ten students, or 32%, have searched for a job in marine science prior to or during their studies (question 7), almost exclusively at MCM. These students were also older than the average age of the sample.

The results for question 8 display the relative importance of income expectations, private consumption and social choice on the final decision to enrol for a higher degree in marine science. The results are reported in Table 5.16.

Table 5.16: Relative importance of the components of the private demand for education

Choice	Number of positive Responses	% positive responses
i. Wished to pursue personal interest	28	90
ii. Persuaded by friend/family	3	10
iii. Asked/persuaded by lecturer	3	10
iv. Undecided career path	10	32
v. Wish to be employed in marine science	28	90
vi. Perceived job opportunities in marine science	17	55
vii. Believed degree useful for any employment opportunity	20	65

The strength of private consumption (i) is shown by 90% of the students indicating that one reason for enrolling was a strong personal interest in marine science. It appears that social choice (ii and iii) plays no role in determining the private demand for education, as only three students (10%) suggested that their decisions were influenced by any outside factors.

An indication that income expectations may not play much of a role in the private demand for education is shown by the number of students who entered the higher degree because of uncertainty of the future (iv), with 10 students (32%) indicating that one factor influencing their decision was a lack of knowledge of what to expect in the future.

Twenty-eight of the students (90%) wish to be employed in marine science (v), the same number of students as those who enrolled due to a personal interest in marine science (i). The same result is recorded for question 12, the control for choice of occupation.

Only 17 students (55%) stated that they enrolled for a higher degree owing to perceptions of future job opportunities. This indicates that income expectations may not be an important factor in the demand for education at the higher degrees level. The majority of students (65%) do, however, believe that their degree will be useful in any employment opportunity. This is an expected perception and is supported by the

returns to education literature, where those with degrees are placed higher up in the job queue of the general labour market. However, as Kuun (2002) stated, there is a certain amount of ambiguity with having such a degree in the South African 'general' labour market owing to specificity. Employers, especially in the private sector, often share the opinion that students specialise themselves out of the labour market (Hikab, 2002) by obtaining a Masters or PhD degree.

Questions 9, 10 and 11 reveal the impact of the provision of funding on the students' decisions to enrol for a higher degree. Twenty-nine of the thirty-one students (94%) receive funding for their degrees. Even more illuminating is the fact that 26 of these students (84%) would not be enrolled in marine science were it not for the provision of bursaries. Of the five who would have enrolled regardless of the provision of funding, two are employed at their respective institutions. The tuition costs for these two individuals would, therefore, be greatly reduced.

Twelve students (39%) are in part-time employment (question 11) such as tutoring or laboratory assistant positions. This has an indirect effect of lowering the credit constraint faced by students when choosing to enrol for a higher degree.

The results of questions 9, 10 and 11 clearly illustrate the effect of funding on the supply of marine scientists to the labour market. The response of 90% of the sample wishing to find employment in marine science is to be expected. Current students are expected to be optimistic about their future possibilities, especially in the case of a poor level of knowledge of job opportunities in the labour market (Harmon et al., 2001). Therefore, it is essential to establish the importance of income expectations as a determinant of the private demand for education (hence supply to the labour market) *before* instituting any policy initiatives. Can it be said, though, that students in marine science base their expectations on optimism? This is answered by the results for questions 12 and 14. Question 12 indicates the institution of preference for future employment as well as any knowledge of the market earnings at these institutions. Table 5.17 reports the number of first responses for each job option (question 12).

Table 5.17: Job preference of students

Employment position	UCT/UWC (N = 29)	Rhodes University (N = 11)	Total	% of sample
University/Academia	4	0	4	13
Research institute	6	0	6	19
Post-doc studies	2	1	3	10
Consultancy	2	11	13	42
Private sector organisation (e.g. De Beers Marine, I & J etc.)	1	1	2	6
MCM or Government	3	2	5	16
Museum	1	0	1	1
Teaching	2	0	2	6

Very few students are interested in post-doctoral studies (10%), even fewer in private sector posts and only one student is interested in a post at a museum. Only four students, all from UCT, are interested in employment in academia. Seeing that academia is one of the better paid job categories (Table 5.1), this indicates a poor knowledge of earnings within the labour market. However, this response may be owing to the fact that academic posts are scarce and students may well look to other areas because of this.

The overwhelming response is for posts in consultancies (43%). The result is affected by the strong preference of the students at Rhodes University. This is caused by an artificially high exposure to the activities of a consulting firm owing to the presence of such a firm within the departmental buildings, and to the students academics openly engage in consulting.²⁷ Few students are interested in government posts. This may be a reflection of the employment practices used by government departments in seeking job applicants, considering the demographic composition of the survey (Table 5.15).

Question 14 asks students to rate their knowledge of job opportunities at different institutions using a 1 to 5 scale, 1 being a high level of knowledge. The results report only those students who consistently rated their knowledge between 1 and 3 as these

²⁷ Recall that the income of academics is likely to be understated due to the conservative estimates of earnings from consulting activities.

students are assumed to have a good knowledge of the labour market. These figures are compared to the expected earnings for each institution as investigated in question 12. For each case the same students who indicated a good knowledge of employment opportunities suggested a figure for expected earnings. Table 5.18 presents the number of students who indicated a strong level of knowledge of future job opportunities, and a comparison of the students' expected earnings to that of the earnings of the marine scientists who participated in the marine scientist survey.

Table 5.18: Knowledge of future job opportunities and expected earnings

Employment position	UCT/UWC	Rhodes University	Total	%	Ave expected income	Marine scientist income
University/Academia	8	2	10	32	144750	217623
Research institute	7	4	11	35	139571	133669
Post-doc studies	7	3	10	32	158286	–
Consultancy	8	8	16	52	161875	170166
Private sector organisation (e.g. De Beers Marine, I & J etc.)	6	4	10	32	183750	192714
MCM or Government	6	2	8	25	141833	184008
Museum	6	2	8	25	112333	–
Teaching	8	0	8	25	106000	102583*

*(entry level salary for teacher employed in government post)

This table shows that few students have any real knowledge of earnings in the labour market for marine scientists. The number of students who have a high level of knowledge of the earnings in consulting fields is artificially high as both UCT and Rhodes University have consulting firms operating from within their departments. Therefore, excluding the expected earnings for consulting, on average 30% of the student body have an accurate perception of earnings in the labour market for marine scientists. The students who are assumed to have a high level of knowledge are the *same* students who have either worked in marine science previously, searched for a job before or during their studies, and are older than the average age of the sample (questions 6 and 7).

Of this 30%, the knowledge of earnings is high, having accurate expectations of earnings for employment with research institutes, consulting, the private sector and

teaching posts. There is a large discrepancy between the expected earnings of academics and the results of the labour market survey. However, the students' expectations are accurate when comparing their expectations to the earnings of academic positions at the junior lecturer and lecturer level. Similarly, the students' expectations of earnings for a government position compare favourably with an entry-level position in government employment.

The results of the questionnaire clearly show the impact of the provision of funding on the supply of graduates to the labour market. However, the results are only a snapshot in time; it is possible that the provision of funding may have (had) a greater or lesser effect in the future (past). An indication of the effect of funding on the supply to the market is a review of whether graduates received funding during their studies. As mentioned in Chapter 4, it was not possible to generate such records from Rhodes University. Therefore, only the results from UCT are presented in Table 5.19, for the same time period as the Sea and the Coast programmes.

Table 5.19: No. of graduates from UCT who received funding, 1996–2002

	No. of graduates	Received funding	Received NRF funding	% Funded	% of funding provided by NRF
1996	16	7	4	44	57
1997	14	10	9	71	90
1998	16	14	8	88	57
1999	11	10	9	91	90
2000	15	9	7	60	78
2001	19	15	11	79	73
2002	9	6	5	67	83
Average				71	76

On average 71% of the graduates received funding for their studies, excluding scholarships for academic merit. Firstly, this indicates the existence of a credit constraint faced by students in the choice to enrol for a higher degree in marine science. Secondly, it indicates the effect the provision of funding has on the supply of graduates. If one assumes the situation found in the student questionnaire, where almost all of the students would not have enrolled for a higher degree were it not for funding, the provision of funding is indeed the driving force behind the supply of

graduates to the labour market for marine scientists. Considering that 76% of the funding was provided by the NRF, not only is funding driving supply, but the government is the principle driving force. Surely this begs even more for a measure of the social return to investment in expertise, in other words, the labour market drop-out rate.

5.3.4) The social return to government investment in student support: the labour market drop-out rate approach

As the student questionnaire and the review of graduate funding details indicate, the supply of graduate marine scientists is principally driven by the provision of state funding. Therefore, if these graduates are not employed as marine scientists, the return to such investment is either negative or zero, warranting a rethink of the funding process. Three events dictate the nature of the return: is it positive, negative or zero? These events are:

1. The student graduates, but then leaves the country. While there is still a social return to the research output, the host country now enjoys the benefits of the expertise for which the home country, South Africa, has paid. This represents a negative social return.
2. The student graduates and finds employment as a marine scientist. This represents a positive return.
3. The student graduates, but finds employment outside the core area of expertise, i.e. not employed as a marine scientist. Whether the social return to the investment is positive, negative or zero thus depends on the quality of the research output.

Establishing the whereabouts of recent graduates, or the labour market drop-out rate, and applying the above three conditions will thus determine the social return to the provision of funding for students at the higher degrees level in marine science. The rate could be determined only for those graduates from Rhodes University owing to the difficulties discussed in Chapter 4. Nevertheless, the results are presented in Table 5.20.

Table 5.20: Labour market drop-out rate of marine science graduates from Rhodes University, 1996–2002

Action post graduation	No. of graduates	% of graduates	Type of social return
Emigrated	19	30	–
Employed as marine scientist	12	19	+
Whereabouts unknown	32	51	?

Nineteen of the graduates from Rhodes University during 1996 to 2002 are no longer in South Africa, representing event 1. This is a confirmed negative social return to the investment in expertise of 30%. Only 12 graduates are confirmed to be employed as marine scientists, representing event 2. This is to be interpreted as a confirmed social return to the investment in expertise of only 19%. The whereabouts of 32 graduates is unknown, representing 51% of the graduates from 1996 to 2002. If one estimates that half of these graduates are employed as marine scientists, the social return to the investment in expertise would increase to 44%. Conversely, if none of these graduates is employed as a marine scientist, the labour market drop-out rate is 81%. Assuming the latter case for those graduates whose whereabouts are unknown, the social return to the government investment in expertise within marine science is *a mere 19%*.

Further discussions with academics about the employment of previous students combined with the poor absorptive capacity of the market (Section 5.2) indicate that while it is likely that some of these graduates are employed as marine scientists in South Africa, this number is small. The majority are likely to have dropped out of the market, being forced to find alternative employment or emigrate. Taking this into account, the social return to government investment in expertise in marine science is estimated to be between 20% and 25%.

5.4) Conclusion

The labour market for marine scientists in South Africa suffers from disequilibrium because of the different factors affecting the demand for and supply of graduates. However, while there are different factors involved, the source is the same for both cases. On the demand side, the government has interrupted the demand for marine scientists with the creation of MCM and the changing mandate expected of marine

scientists. On the supply side, the government has provided student support in the form of bursaries. This has lowered the effect of any possible credit constraint to the point where individuals may enrol for a higher degree in marine science for personal consumptive purposes.

The effect of the changing mandate is discussed briefly and is related to the existence of a skills gap between what marine scientists know and what marine scientists are expected to be capable of. However, this is not a local problem: it is affecting marine science globally. Of importance here, though, is that marine scientists are not trained and do not maintain the knowledge base to be involved either in economic issues of marine science or in the creation of policy for the management of marine resources. This point is made strongly by marine scientists both in South Africa (McQuaid, 2003) and globally (NRC, 2000; Sylvia et al., 2002; Love, 2003).

The earnings of marine scientists also indicate the turmoil of the labour market. While the highest earning job category is industry, the results (Table 5.1) also show that very few marine scientists are employed by industry and the standard deviation of earnings in this category is high. The second highest job category is that of the academic, a result that is contrary to the traditional perception of academics paying a wage premium for following their interests (Stern, 1999; Economist, 2004a; b). However, the source of earnings of the academic is no longer the traditional 'stipend' from a university. Academic marine scientists in South Africa now have three sources of income: the salary from a university, monies for research purposes and earnings from consulting activities, while marine scientists in the other job categories have only one source of earnings. In this case, it is not surprising that academics have higher earnings than others, especially in light of the fact that the earnings reported by academics are conservative (Section 5.2.3).

The attempt to establish the determinants of earnings of the marine scientist revealed surprising results, according to human capital and signalling theory, but not to the earnings as reported in Table 5.1. There is little benefit for men acquiring a PhD over an MSc, with a return of only 18%. Controlling for job category, though, the results show that working for a research institute yields a negative wage premium of up to 35% for men, when compared to all others. The results mollify human capital and

signalling theory by illustrating the theoretical expectations of the theories, but indicate that the level of education plays a minor role in determining the level of earnings of marine scientists. Rather, the level of education should be seen as a playing card to enter the labour market, where the requirement is a higher degree. On entry, however, it is no longer education that influences earnings but the institutional structures within each employment category.

The influence of government intervention in the supply side of the market by the provision of bursaries is immense, to the extent that the income expectations of human capital and signalling theories fail to explain the choices made by students to enrol for a higher degree in marine science. This has significant implications for the social return to this investment, as is shown by the results of the labour market drop-out rate.

Of the students currently enrolled for a higher degree, 84% would not be studying were it not for the provision of bursaries. Considering that on average 71% of graduates received funding for their studies for the years 1996 to 2002 (Table 5.19), it is likely that the majority of these past graduates would also not have enrolled if funding (through bursaries) was not provided. Therefore the question is whether the provision of funding alleviates a credit constraint in terms of supply to the market or in terms of allowing individuals to satisfy their personal interest in marine science.

Of the students enrolled, 90% made the choice owing to some level of interest (Table 5.16), yet only 55% made the choice owing to perceived job opportunities, already indicating that future earnings is not a determining factor in the endogenous choice of education. Further indications that future earnings plays little role are the results shown in Tables 5.17 and 5.18. Few students have a preference for a particular type of employment as a marine scientist, and only those who are older than the average age have any real knowledge of future earnings in the labour market (30% of the student body). Therefore, it is clear that the reason why students enrol for a higher degree is to satisfy the private consumption component of the private demand for education, and this occurs owing to the extensive provision of bursaries by the government.

The end result of this is an artificially increased supply to the labour market for marine scientists, with the concurrent low social return. As measured by the labour market drop-out rate, the social return is estimated to be approximately 20% to 25% (Section 5.3.4). These results indicate that the supply mechanism of the human capital and signalling hypothesis, that is future earnings (occupational choice mechanism), fails to explain the endogenous choice of education and hence supply. It is thus the private consumption mechanism that dominates the supply of marine science graduates to the labour market – the reason why the social return to expertise utilisation is so low.

6) Conclusion and recommendations

The aim of this research was to develop a manageable and easily applicable approach to estimate the social return to education given the current situation of funding in South Africa, using the labour market for marine scientists as a case study. The intention was to produce an approach that would aid those in policy decisions. The results of the approach indicate a paltry social return on government investment in expertise of 20% to 25%, with a further 30% confirmed loss in expertise overseas (Table 5.20). But, is this approach robust? Is it a valid approach on which to base funding allocations?

The labour market drop-out rate approach has its source in a flaw in both the private and social returns to education literature, that of ignoring the endogenous choice of education. It is often discussed how the endogenous choice of education may affect the estimates of both social and private returns to education, yet no attempt has yet been made to quantify this effect. As discussed in Chapter 2, one reason for this may be the preoccupation of researchers with graduates' earnings rather than graduates' interaction with the economy and the source of funding for their studies. This is most likely caused by the availability of earnings data (at least in developed countries) and the ease of use of (especially) the OLS regression technique to estimate the private returns to education. This has led, as Blaug criticised in 1976, to many researchers playing the number crunching game rather than fully analysing the determinants of supply to a labour market. Establishing graduates' behaviour may be too irksome ...

So too have the social returns approaches failed in this area. If students choose to enrol for a higher degree owing to the provision of funding rather than a desire in the subject a selection problem exists, which is likely to have a negative effect on the quality of individuals enrolling (Section 3.3.2). This would lead to substandard research output that may be more a waste of resources than a social benefit. Given the criticism of the Sea and the Coast funding programmes being primarily based on the quality of research output (Section 5.3.1), the endogenous choice of the student to enrol for a higher degree becomes that much more important.

The labour market drop-out rate approach to measuring the social return to individuals acquiring a (higher) degree provides a solution to this problem. Firstly, it is an accounting framework, which prevents it from being attacked on any theoretical grounds. It is obvious that if an individual conducts research for a higher degree, the social return is both the research output and the knowledge and skills developed through the research process. Higher degrees, being specific in nature, lead to the development of specific expertise and if this expertise is not utilised there is a social loss to the investment in the development of such expertise (Section 3.2). This new approach focuses on the use of expertise and, as such, provides a more accurate estimate of the social return to individuals acquiring a higher degree than comparing the costs of provision of tuition to the earnings of graduates in the future (Section 2.3.2). The weakness in this approach is in its dealings with the quality of research output where the return is set as a constant and then ignored (Section 3.2). However, further research in this area can easily adapt the methodology to include measures of the quality of research output. The trade-off between expertise utilisation and research output thus becomes a matter of policy for those who fund research rather than any measurement flaw in the social returns to education.

The approach is simple, all it requires is the whereabouts of past graduates: are they employed in their relative fields of expertise? This form of locating past graduates may be easily applied by any funding agency as a rough measure of the efficacy of funding programmes based on expertise utilisation. The measurement, however, is strengthened by dealing with the effect of the endogenous choice of education on the enrolment of individuals for (higher) degrees. The choice of the individual to enrol for a higher degree, or the private demand for education, is the determinant of supply of expertise to the labour market. Failing to understand this link leads to a failure of any policy to 'correct' perceived shortages of expertise within an economy.

The link between the private demand for education and the supply of expertise must be fully incorporated into any funding programme. This requires the private demand for education to be analysed according to private conditions as the student makes his or her decision to enrol for a degree based on private expectations of any benefit for doing so. This requires the incorporation of human capital and signalling theories to explain the choices made by students (Section 3.3.1). However, in order to fully

evaluate the determinants of the private demand for education, not only are the opinions and knowledge of the students' choices needed, but also the conditions of the labour market which are expected to affect such a choice. This requires knowledge of the wage structure of the market and of future job opportunities. The labour market drop-out rate approach as introduced here includes all these factors.

The process of testing the labour market drop-out rate exposed a number of glaring weaknesses in the administration of government bursaries. First and foremost is the fact that the NRF has no clear policy on the utilisation of the expertise it is responsible for developing. While the condition for successful application for research funding is the number of students who may participate in a research programme, there are no checks and balances to evaluate whether an increased supply of expertise to the labour market is warranted, in other words, socially beneficial. As raised earlier (Section 3.3.1), the question of whether funding should be allocated to active researchers or to student support is important in determining the social returns to government investment. If there is a shortage of expertise it is beneficial to the state to provide student support. If there is a shortage of either research or high quality research, but a large body of researchers, that is another matter entirely.

In the case of marine science in South Africa, the NRF bases its funding decisions on the opinions of the SANCOR steering committee, a committee that is largely dominated by academics (Section 4.2.2). Herein may lie the source of the problem. Active researchers require higher degree students to work under them to conduct basic scientific research (Freeman et al., 2001; Griffiths, 2002; Clarke, 2002). These researchers also need students in order to be successful in receiving government research support. This represents a conflict of interest between the advice given by the academics on the committee to the NRF from a social and a private viewpoint. The perception of academics is that there is a shortage of marine science students (Grootes, 2002a; b). As Tables 5.12 and 5.13 show, however, the number of students enrolled in marine science has remained relatively constant over the period 1996 to 2001, as has the supply of graduate marine scientists to the labour market (Table 5.14). Hence, why the perception? The perception may well be a result of the NRF lacking a clear goal in terms of capacity utilisation of the very capacity it funds to develop.

An indication of how the current funding structure may well impact on the social return received to the government provision of student support is provided by this quote from an email regarding a possible job opportunity:

Please pass on [all relevant information] to appropriate contacts you may have [students etc.]. I know it is a double-edged sword for grantholders in that they need more students yet they have to ensure that the students they train get jobs. In the end it's the students' choice, I think (Anon, 2002b).

The source of this email was the NRF itself. This quote explains the current system of why students enrol for a higher degree, especially in marine science. Firstly, grantholders are successful in application only if they can attract students. This requires funding, hence the NRF, but as the results in Section 5.3.3 show, it is the provision of funding that influences the choice of the student to enroll above any other. This situation can only represent a trap for both grantholders (academics) and students. The grantholder needs students if his or her source of funding is the NRF, hence the incentive to inform SANCOR that more funding is needed for students, but students are influenced by the provision of funding and not by future job opportunities. Given the current labour market conditions this would lead to a low social return as measured by the labour market drop-out rate: an exact result of this study (Section 5.3.4).

In order for the NRF to defend its funding structure and to comply with its mandate of “capacity building and investing in the development of South Africa” (NRF, 2002a), it is emphasised that clear policy choices need to be made. The labour market drop-out rate shows that the return on investment in capacity development in marine science is only 20% to 25%, and the criticism of the quality of research output from the Sea and the Coast funding programmes indicates that not much ‘development’ is occurring either. For the NRF to succeed in either arena, a realisation of the effects of its funding actions needs to take place. The labour market drop-out rate approach shows the effects of funding on the labour market while the continued call for renewed and increased levels of funding for capital investment (Section 5.3.1) indicates the negative effects that the actions of the NRF are having on the future quality of research output.

The NRF, therefore, has three options in funding research in South Africa. Each option must be clearly stated and adhered to if any social returns are ever to be received. The first option is to focus on the quality of research output. This would involve having a clear understanding of the weaknesses in the quality of current research output and what the causes are. If the cause is inadequate capacity of current researchers, the NRF should invest in training these individuals, as they are responsible for training students in the future. If the cause is a lack of resources, such as capital equipment, money should be provided to ensure that this does not play a hindrance in the development of research in South Africa.

The second option is to focus on student support. Focusing on student support would obviously divert funding from research budgets and is likely to have a negative effect on research capacity in the future. This option should not be viewed as an alternative manner of funding academic development in South Africa as the scope of research at institutions would be extremely limited.

The third option, as suggested in the introduction of this work, is to create a delicate balance between research funding and student support. This is the preferred option as active research needs both established researchers and students. The NRF, however, if it is ever to achieve its mandate, should change its focus in the manner of funding to that of actually utilising the capacity it funds to develop. In looking at student funding, the NRF should establish whether there is a need for additional expertise in a particular area *before* providing student support. Not doing so would lead to social losses rather than social gains.

Ensuring capacity utilisation, in other words whether graduates find employment for their expertise, entails the NRF overcoming the selection problem discussed in Section 3.3.2. This could be accomplished by applying two distinct approaches in allocating funding for student support. The first is a graduate contribution scheme, and the second is a manipulation of the current system of providing bursaries.

A graduate contribution scheme can be tailored in any number of fashions, but the principle is that the graduate pays back the costs of tuition over an extended period of time on completion of the degree. The effect would be to limit the number of students

enrolling to only those who make the occupational choice to become, for example, a marine scientist. This would lower the number of students enrolling each year, but is likely to increase the quality of students enrolling and thus result in a higher quality of research output. This system does not suffer from any discriminatory problems as the repayments are drawn from earnings in the future and not currently available funds. The system, being flexible, may be tailored to take into account each individual's financial situation on completion of a degree. The point of this scheme is that the graduates are expected to find employment in their respective fields of expertise as only those who desire to work in such a field choose to enrol. This guarantees a high social return in terms of capacity utilisation and could be easily measured using the labour market drop-out rate approach.

The NRF may also adjust its current manner of awarding bursaries to limit the number available and increase their value. This would encourage competition within the student body, typically with only those of the highest calibre being awarded a bursary. This technique would force enrolments to be based on the occupational choice mechanism as only those who truly wish to continue in their chosen line of study will compete for such bursaries. This option, however, suffers from two weak points. The first is that the selection problem of students choosing to enrol for private consumption is not completely eliminated. It is still possible for individuals who have a strong private consumptive demand for education to compete for the available bursaries, without any intention to pursue a career in their chosen path of study. This obviously reduces the social return in terms of expertise utilisation. The second weak point is that bursaries control the supply of expertise to the market with the concomitant possibility of negative social returns as described in Section 3.3.2.

The first funding approach is better equipped to ensure a positive social return according the labour market drop-out rate, as only those who base their decisions on the occupational choice mechanism enrol for a higher degree. The second approach, the provision of bursaries, may well have some positive aspects, but it removes any market forces in the determinants of the demand for and supply of expertise to the labour market.

As far as research into these issues goes, it is imperative that the NRF views the provision of student support as a long-term investment, monitoring whether the expertise it invests in is actually utilised. A good beginning would be to update and maintain its records as to whether those students who receive funding actually graduate. Further, the NRF should require that either the supervisor or the university report the graduation of any student who has received funding. Secondly, the whereabouts of these graduates should be ascertained to establish whether their expertise is being utilised in their current employment position and if not, why not. Thirdly, the NRF should impress upon institutions and academics alike that funding is provided from a national standpoint rather than for individual researchers to compete for available funding, as Dennison (2000) so strongly attests (Chapter 1). The aim should be to focus on high quality outputs in terms of graduates and research output rather than a high number of mediocre outputs. This would require a change in ethos of researchers and institutions to drive for quality and not quantity.

The labour market drop-out approach is a viable and easily manageable approach to evaluating the returns of any investment made by a government agency in terms of the provision of student support as it takes into account the social return of both the research output and potential human capital utilisation. The NRF, as the chief government agency for funding research and development in South Africa, is in a position to use, adapt and develop this model to easily estimate the social returns to the investments made and as such determine best-option funding structures. Further research by the NRF and others is encouraged in this area so as to provide decision-makers with a framework that ensures a system that allocates taxpayers' money to the greatest social benefit.

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Appendix I:
Catalogue of impacts of schooling, nature of impacts,
and evidence on magnitude of level and value of impact
(Haveman & Wolfe, 1984: 382–386)

Channel of impact of schooling	Economic nature of impact	Nature of existing research on magnitude of impact	Status of economic benefit estimates
1. Individual market productivity	Private; marketed; human capital investment	Extensive research on the magnitude of market earnings impact, by demographic group and type of schooling	Increments to marginal value products, reported as rates of return. Producers' surplus neglected
2. Non-wage labour market remuneration	Private; marketed and non-marketed; human capital investment	Some research on differences in fringe benefits and working conditions by education level	Rough estimates of true returns to schooling 10 to 40 percent greater than rate of return estimates indicate.
3. Leisure	Private; non-marketed; consumption	Wage rate differences identified in 1. form shadow prices which could be used to value leisure.	
4. Individual productivity in knowledge production	Private; non-marketed; human capital investment	Some evidence that schooling increases productivity in the production of additional human capital.	No firm evidence on the extent of value
5. Non-market individual productivity (e.g. do-it-yourself)	Private; non-marketed; human capital investment	Some evidence of education-induced reduction in female home production time, but increase in quality; no evidence for males	No estimates of economic value
6. Intra-family productivity	Private; some external effects; both marketed and non-marketed; human capital investment	Relationship between wife's schooling and husband's earnings, apart from selectivity is well established	No estimates of economic value
7. Child quality through home activities	Private; some external effects; both marketed and non-marketed; human capital investment	Substantial evidence that child quality in several dimensions is positively and significantly related to mother's and father's education	No significant evidence of economic value except intergenerational earnings effects
8. Own health	Private; modest external effects; partially marketed; human capital investment and consumption	Evidence that own schooling positively and significantly affects health status and, on an aggregate level, that more education decreases mortality	Little evidence on economic value; except indirect evidence via earnings, weeks worked a, and life expectancy
9. Spouse and family health	Private (within household); modest	Evidence that own and spouse's schooling	Little evidence on economic value; except

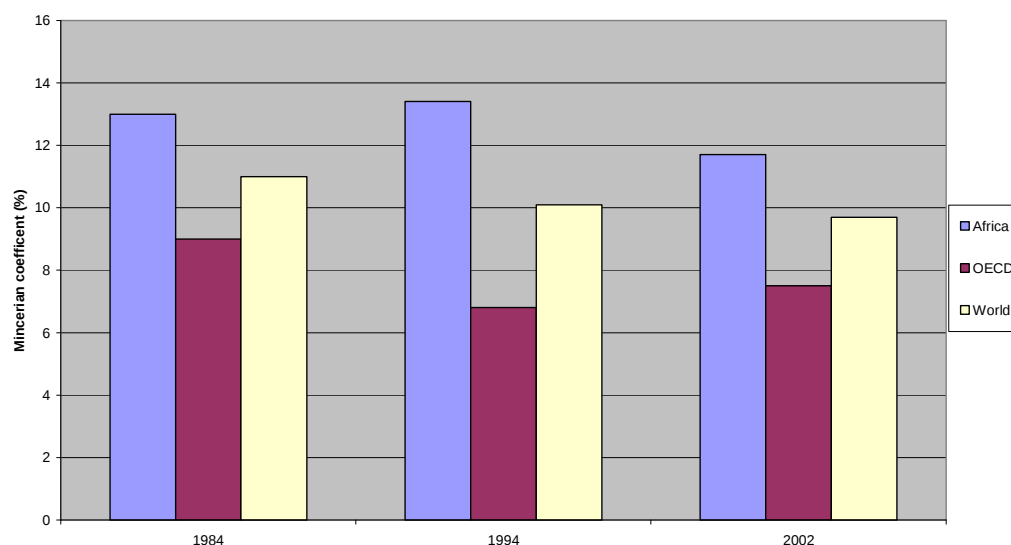
	external effects; partially marketed; human capital investment and consumption.	positively and significantly affects health status and, on an aggregate level, that more education decreases mortality	indirect evidence via earnings, weeks worked, and life expectancy
10. Fertility (viz. changed tastes for children)	Private (within household); non-marketed; consumption	Evidence suggests that schooling reduces desired family size	No estimates of economic value
11. Entertainment	Private; non-marketed; consumption	Education appears to be consumed for its intrinsic value, and possibly to broaden forms of entertainment enjoyed	No estimates of economic value; perhaps impossible given nature of taste change, except through influence on economic growth
12. Consumer choice efficiency	Private; some external effects; non-marketed; human capital investment	There is evidence that education alters budget allocations in the same direction as income, implying the existence of a positive efficiency effect	No estimate of the value of increased efficiency
13. Labour market search efficiency (including migration)	Private; minor external effects; non-marketed; human capital investment	Some evidence that job search costs reduced with improved information and knowledge, and job and regional mobility increases	No estimate of the value of increased efficiency
14. Marital choice efficiency	Private; minor external effects; non-marketed; consumption	Some evidence of improved sorting in the marriage market and positive assortative mating by intelligence	No estimate of the value of increased efficiency
15. Crime reduction	Public good	Evidence that education is, ceteris paribus, positively associated with reduced criminal activity	No estimates of economic value
16. Social cohesion	Public good	Impressionistic evidence of a positive relationship with education	No estimates of economic value
17. Technological change	Public good	Limited evidence that education influences economic behaviour in terms of research and development	No estimates of economic value
18. Income distribution	Public good	Evidence on the direction of impact of education on income inequality is mixed	No estimates of economic value
19. Savings	Private; some external effects; marketed productive factor	Holding constant income and other savings determinants, education appears to be positively associated with saving rates	No estimates of economic value
20. Charitable giving	Both private and public; non-marketed	Evidence that education increases both money and time donations	No estimates of economic value

Appendix II: Empirical results of private returns to education from around the world

Since the 1970s, the private returns to education using either standard human capital or the extended method have been estimated for almost every country for which data is available. This appendix presents the returns to education globally and then per the various relevant economic groupings with the aim of distinguishing which levels of education are most rewarded in the different regions. The global picture is followed by a comparison of the returns to education in the developing and the developed world. The developing world is represented by Nigeria, China and Brazil for which recent studies are available, while the developed world is represented by the OECD countries.

Establishing the global private returns to education is valuable in order to establish the correlation between the levels of economic development and the private returns to the different levels of education. Following the traditional human capital equation, the value of the rate of return to education coefficient on income is presented in Figure AII.1 for an 18-year period.

Figure AII.1: A comparison of the Mincerian coefficient of years of schooling: Africa vs. the OECD



Source: Psacharopoulos (1985: 588; 1994: 1329) and Psacharopoulos & Patrinos (2002: 15)

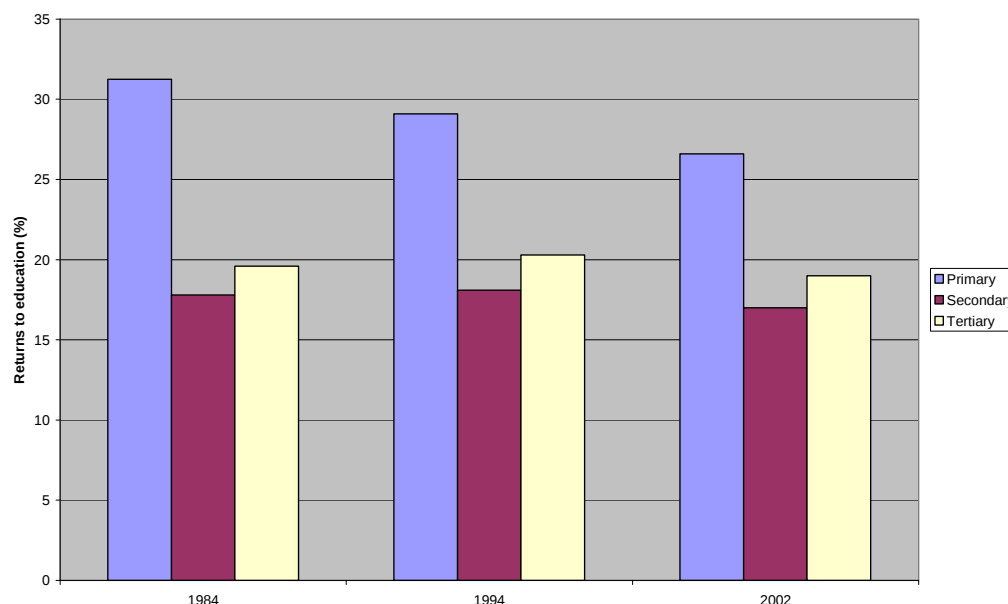
The graph illustrates that education is most rewarded in regions of lower economic development, namely Africa. The private Mincerian returns to education have varied slightly between 1984 and 2002, with the general trend showing a decline in the returns to education. The effect of an additional year of education on earnings in Africa was a wage premium of 13% in 1984, 13.4% in 1994 and a decline to 11.7% in 2002. The effect of an additional year of education on earnings in the OECD countries was a wage premium of 9% in 1984, 6.8% in 1994 and 7.5% in 2002. The global private returns to education were wage premiums of 11% in 1984, 10.1% in 1994 and 9.7% in 2002.

One reason for the decline is the increasing number of individuals who are receiving or acquiring education globally. As the signalling hypothesis suggests, as more individuals obtain a signal, the value of the signal becomes eroded and a new signal needs to be acquired.

Figure AII.2 illustrates the signalling approach to evaluating the private returns through discrete levels of education. Education is separated into three levels: primary, secondary and tertiary education. The results are to be interpreted as the effect primary education has on the earnings of an individual compared to one who has not finished primary education, the effect secondary education has on the earnings compared to one with only primary education, and the effect tertiary education has on the earnings of an individual with only secondary level education.

The figure shows that the level of education which receives the largest return is primary education, followed by tertiary education. The returns to education using the extended human capital wage equation – that is using discrete levels instead of years of education – corroborates the findings of the Mincerian coefficients, that over the 18-year period the returns to education have decreased slightly, which is evident only in the returns to *primary* education.

Figure AII.2: Global private returns to education, 1984–2002



Source: Psacharopoulos (1985: 586; 1994: 1328) and Psacharopoulos & Patrinos (2002: 14)

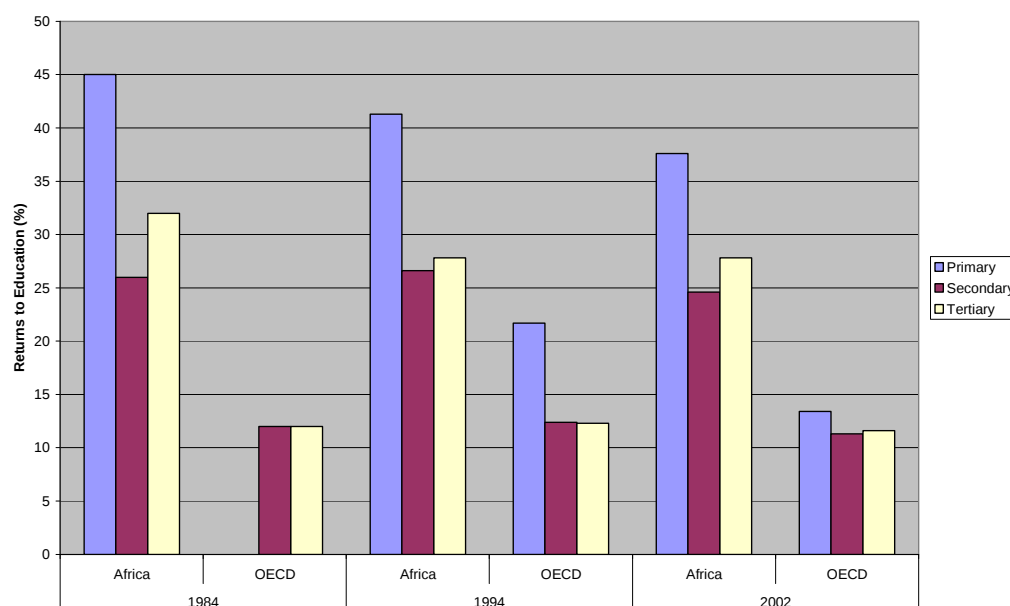
Primary education receives the highest private return, but decreased from 31.25% in 1984 to 26.6% in 2002. This is an indication of the increase in global access to primary education. A rise in the numbers of individuals with similar qualifications or years of schooling effectively increases the competition for jobs and thus erodes the value of the signal and puts downward pressure on wages and hence the returns to education.

There has been no real change in the global private return to secondary education. The return to secondary education in 1984 was 17.8%, 18.1% in 1994 and 17% in 2002. What is of importance is that globally there is a higher return to primary than secondary education – the wage effect of obtaining secondary education is less than that of acquiring primary education. This may be caused by skills or educational mismatches within the labour market for those above primary education. There has also been no real change in the global private returns to tertiary education, with the returns of 19.6% in 1984, 20.3% in 1994 and 19% in 2002. Returns to tertiary education are thus higher than the returns to secondary education.

However, these figures are misleading in that the incidence or the returns to education is affected significantly by the level of development of an economy. This is

illustrated by the importance growth literature places on education as a prerequisite for growth, and is reflected in returns to education across different levels of economic development. Figure AII.3 compares the developed world – the OECD countries – to the developing world – Africa.

Figure AII.3: Incidence of private returns to education: Africa vs. OECD



Source: Psacharopoulos (1985: 586; 1994: 1328) and Psacharopoulos & Patrinos (2002: 14)

The differences between the returns to education in the two groupings are evident. While there is still a high return to primary education in Africa, the return to primary education in the OECD countries is low and declining more quickly.

Moreover, there is a trend for tertiary education to have a higher return than secondary education. The return to tertiary education is highest in developing countries at 32% in 1984, and 27.8% in 1994 and 2002. The returns to tertiary and secondary education in the OECD countries are virtually the same over the 18-year period. This may indicate market equilibrium of the supply and demand of individuals with certain levels of education within the labour market in these countries. This implies that the private marginal benefits of higher (and secondary) education equal the marginal private costs of higher education, regardless of whether the human capital or signalling is used. This may be a reflection of the attainment of an equilibrium level of tertiary education graduates in the OECD countries, further

indications of which can be found in the social returns to higher education for the OECD countries. This is covered in the discussion of macroeconomic returns to education.

The high private return to tertiary education in Africa indicates a high demand for skilled individuals and little or no substitution between those with high and low skills. However, in the OECD countries the return to higher education has fluctuated from 12% (1984) to 12.3% (1994) to 11.6% (2002) – hardly a significant change. This indicates a saturation of graduates in the labour market to the extent that rates of substitution between individuals with higher and secondary education are now being calculated.

The discussion now turns to the private returns to education of particular developing countries, beginning with Brazil. Blom et al. (2001) present a comparison of the rates of return using the traditional human capital wage equation of 1982 and 1998. They find that the return to one additional year of schooling has dropped from 13.9% in 1982 to 12.8% in 1998, a decrease of 8% (Blom et al., 2001: 191). They attribute this to a change in the skills demanded in the labour market, and the institutional structure of the labour market, particularly at the minimum wage level. What is of greater importance is the spread of the decrease in the returns to education. Using the extended human capital wage equation, estimating returns to education²⁸ across the three education levels, they find that the return to primary education has dropped by 26%, while the return to tertiary education has increased dramatically from 16.2% to 24%, a massive 24% increase. The findings of Blom et al. (2001) are summarised in Table AII.1.

Table AII.1: Returns to education in Brazil, 1982 vs. 1998

Completed level of education	Return to education in 1982 (%)	Return to education in 1998 (%)	% change
Primary	10.9	8.1	-26
Lower secondary	11.4	7.1	-35
Upper secondary	16.7	15.5	-8
<i>Tertiary</i>	<i>16.2</i>	<i>24</i>	<i>+24</i>

Source: Blom et al. (2001: 191)

²⁸ Recall that as soon as a dummy variable is inserted as the measurement of education, the result is to be interpreted as a return to the dummy variable, not a rate of return.

These results differ from those of Africa as a whole in that there is a progression of the returns to education across each education level, where primary education has the lowest return and tertiary education the highest. This is also in contrast to the trends of the OECD countries, where primary education receives a higher return than secondary and tertiary, while the difference in returns between secondary and tertiary are negligible.

Studies on education in Nigeria have yielded similar results (Azizkpono, 2003). Azizkpono (2003), using the extended human capital wage equation yields the results presented in Table AII.2, using data for 1995.

Table AII.2: Returns to education in Nigeria, 1995

Completed level of education	Returns to education (%)		
	Male	Female	All
Primary	30.89	34.17	30.75
Secondary	41.24	46.17	43.65
Tertiary	62.75	76.83	68.17

Source: Azizkpono (2003: 17)

These results mirror the Brazilian situation in that the returns to education increase as the level of education increases. As in Brazil, the premium received for completing tertiary education is large and greater than any other level of education. These results are also contrary to the trend suggested by the data for Africa as a whole.

Studies conducted in China report a growing return to education over the last 20 years (Heckman & Li, 2003). The data used is cross-sectional data from a continuous cross-sectional study from 1992 to 2002. The extended human capital wage equation shows that the return to obtaining a tertiary qualification in China is approximately 29.29%. Using IV analysis to establish any differences between the two techniques shows a return to a tertiary degree of 56.09%, a questionable result. Attempting to account for features for which neither human capital nor the signalling methodology accounts, such as the choice to enter the tertiary degree, or the endogeneity of choice and the effects of it, Heckman and Li (2003) find a return of approximately 43% to the tertiary degree.

Jones (2001) measures the returns to education to employees in the manufacturing industry in Ghana. Following the extended human capital wage equation, the estimates for each level of education are presented in Table AII.3.

Table AII.3: Returns to education in Ghana, 2001

Completed level of education	Returns to education (%)
Primary	29.7
Secondary	55.5
Tertiary	90.7

Source: Jones (2001: 71)

The average return to an additional year of schooling for those working in the manufacturing industry of Ghana is 7.1%. This result is also the return to productivity if firms hire an individual with successively higher years of education. Jones (2001) suggests that this result illustrates that education has a direct effect on productivity – the main point of the original human capital literature. Productivity effects also increase through the different levels of education, with tertiary education having the largest impact on productivity. The results for Ghana follow the same pattern as those for Brazil, Nigeria and China. Tertiary education is again the most highly rewarded level of education.

A global comparison of the returns to education in Africa to the OECD countries suggests that the level of education receiving the highest return is primary education. The results for Brazil, Nigeria, China and Ghana dispute this, presenting a return to education that increases, in some cases dramatically, for each successive level of education completed. The fact that these results are recent may well explain the difference between the global and individual country trends.

The finding of the private return to education being highest at the tertiary level suggests that investment in higher education is worthwhile for the individual. It also indicates a strong demand for and a shortage of individuals with high levels of education, as suggested by Blom et al. (2001) with regard to Brazil.

The results support the earlier conclusion regarding the returns to tertiary education in developing countries – a high demand and little substitution of labour between

education levels. If substitution were to occur, the return to tertiary education would not be of such magnitude. The private returns to tertiary education far outweigh the private marginal costs, which has implications for the social or macroeconomic returns to tertiary education in developing countries, where there will be a social return if the individual first benefits. Clearly, the individual benefits significantly from tertiary education, thus the social or macroeconomic returns to tertiary education in the developing countries are expected to be high.

The empirical studies conducted on returns to education in developed countries are different from those conducted in developing countries. These studies generally include far more explanatory variables to the extent of estimating whether smoking as a teenager affects both the returns to education and the wage (Chevalier and Walker, 1999). The studies provide estimates of the rates of return to education – the original human capital wage equation – as well as measures of returns across different education levels – the extended wage equation.

However, the estimates usually focus on the returns of tertiary as compared to secondary education. In the developed world it is realistic to assume that every individual *has* received primary education, thus returns to primary compared to no primary education would not be justified. Moreover, the studies on countries in the developed world focus on the different types and quality of education. Many studies provide returns to education for a vocational versus an academic qualification, as well as across the different faculties offering a tertiary degree. The studies are extensive and focus on a variety of social issues possibly because individuals in developed countries can obtain different types of education at different levels. But, recalling the criticism of ‘researchers’ playing the number-crunching game, it is more likely because large data sets, such as the General Household Survey in United Kingdom (UK), are available.

The global picture of returns to education provided in Figure 2.1 shows that the private returns to education in developed countries are lower than those developing countries at all levels. The discussion now moves to centre on the returns to education in particular developed countries, namely the OECD countries and then focuses on the returns to education studies conducted in the UK.

The effect of an additional year of education on earnings for individuals in OECD countries was a wage premium of 9% in 1984, 6.8% in 1994 and 7.5% in 2002 (Psacharopoulos, 1985; 1994; Psacharopoulos & Patrinos, 2002). Table AII.4 presents rates of return or Mincerian coefficients for a number of countries. The interesting feature is the variety of rates of return across these countries.

Table AII.4: Rates of return to an additional year of education: OECD countries

	Rate of return to education: Men		Rate of return to education: Women	
Australia	0.0509	<i>0.0042</i>	0.0568	<i>0.0071</i>
Austria	0.0364	<i>0.0033</i>	0.0621	<i>0.0049</i>
Bulgaria	0.0495	<i>0.0100</i>	0.0624	<i>0.0091</i>
Canada	0.0367	<i>0.0072</i>	0.0498	<i>0.0083</i>
Czech Republic	0.0291	<i>0.0069</i>	0.0454	<i>0.0077</i>
Germany	0.0353	<i>0.0020</i>	0.0441	<i>0.0036</i>
East Germany	0.0265	<i>0.0032</i>	0.0450	<i>0.0041</i>
Great Britain	0.1299	<i>0.0057</i>	0.1466	<i>0.0069</i>
Hungary	0.0699	<i>0.0053</i>	0.0716	<i>0.0051</i>
Israel	0.0603	<i>0.0069</i>	0.0694	<i>0.0077</i>
Italy	0.0398	<i>0.0025</i>	0.0568	<i>0.0036</i>
Japan	0.0746	<i>0.0066</i>	0.0917	<i>0.0151</i>
Latvia	0.0363	<i>0.0136</i>	0.0482	<i>0.0113</i>
N. Ireland	0.1766	<i>0.0111</i>	0.1681	<i>0.0127</i>
Netherlands	0.0331	<i>0.0025</i>	0.0181	<i>0.0050</i>
New Zealand	0.0424	<i>0.0050</i>	0.0375	<i>0.0058</i>
Norway	0.0229	<i>0.0025</i>	0.0265	<i>0.0032</i>
Philippines	0.1194	<i>0.0197</i>	0.2086	<i>0.0330</i>
Poland	0.0737	<i>0.0044</i>	0.1025	<i>0.0046</i>
Rep. of Ireland	0.1023	<i>0.0051</i>	0.1164	<i>0.0081</i>
Russia	0.0421	<i>0.0042</i>	0.0555	<i>0.0043</i>
Slovakia	0.0496	<i>0.0070</i>	0.0635	<i>0.0078</i>
Slovenia	0.0892	<i>0.0104</i>	0.1121	<i>0.0091</i>
Spain	0.0518	<i>0.0071</i>	0.0468	<i>0.0099</i>
Sweden	0.0367	<i>0.0047</i>	0.0416	<i>0.0047</i>
Switzerland	0.0427	<i>0.0065</i>	0.0523	<i>0.0143</i>
USA	0.0783	<i>0.0045</i>	0.0979	<i>0.0058</i>
Average	0.0606		0.0740	

Note: Figures in italics are robust standard errors. All equations include a quadratic in age, year dummies and union status. These results are generated from ISSP data for various years.

Source: Chevalier and Walker (1999: 5)

The highlighted figures are for those countries in the OECD to receive a rate of return of 10% or greater, only three of which are in Europe. The average return for males in the OECD countries is 6.06%, while for females it is 7.40%, with an overall average of 6.73%. This is slightly lower than the results suggested by Psacharopoulos and

Patrinos (2002), a difference most likely caused by the comparison of different data sets and differing functional forms of the wage equation used.

Table AII.5 shows the results, with regard to certain OECD countries that are obtained when the extended wage equation is used to estimate the wage effect of tertiary as compared to secondary education.

Table AII.5: Private return to tertiary education: select OECD countries

Private return to tertiary education (%)	
Australia	14
Belgium	14
Canada	14
Denmark	8
France	20
USA	11

Source: adapted from Chevalier et al. (2002: 69)²⁹

The returns to education in the UK have been calculated by a number of studies over a range of years. Harmon and Walker (1995) use data from 1976 to 1986 to estimate returns to education using both OLS and IV methods. The results illustrate the debate of which technique should be used in estimating the returns to education. The standard OLS method yields a result of 6.13%, while the IV method yields a result of 15.25% (Harmon and Walker, 1995: 1282). The IV results are more than double the OLS results, a common trend in the literature. However, according to Harmon and Walker (1995: 1282), the “IV estimates are much less precise, and the differences from OLS are not statistically different”. The authors propose that the OLS estimates suffer from downward bias due to the endogeneity of the individual’s choice to study further.

Steel and Sausman (1997) report private returns by comparing a degree to an A-level qualification using data from 1989 to 1995. They (1997) find that returns to obtaining a degree for men is between 11% and 14% and up to 20% for women. McIntosh (2002) also compares levels of education using data from 1993 to 2001. Table AII.6 summarises McIntosh’s results.

²⁹ Chevalier et al. (2002) present these figures as rates of return, which they clearly are not if calculated by the extended human capital wage equation. This is a typical example of the misinterpretation of estimates of returns to education. Here they are correctly presented as a return to completed tertiary education in comparison to one with only secondary education.

Table AII.6: Returns to education in the UK, 2002

Completed level of education	Returns to education (%)
Vocation based qualification obtained post secondary level	6–10
Lower Secondary (5 GCSEs) on school-leaving age compared to fewer than 5	28
Upper Secondary (2 A-levels) compared to Lower Secondary	16
Tertiary (Bachelor's degree) compared to Upper Secondary	26

Source: McIntosh (2002)

It is clear that the distribution of the private rates of return in developed countries declines slightly over the number of years of schooling; the return to a tertiary degree is neither as high nor equal to the return to secondary schooling. As suggested by Psacharopoulos (1994), this may well indicate that the marginal return to the investment in education is equal to its marginal cost – equilibrium has been reached in the supply and demand of the various skills and knowledge required in particular labour markets.

In conclusion, the private return to education across successive education levels in the developed world tends to decrease, indicating that investment in successively higher levels yields successively less of a return to the individual. The private return to education in developing countries follows a different pattern in that there is a high return to primary education, a lower return to secondary education followed by a high return to tertiary education. This characteristic was first alluded to by Psacharopoulos (1984: 587) and the recent evidence provided by Blom et al. (2001) for Brazil, Azizkpono (2003) for Nigeria and Heckman and Li (2003) for China indicate that this is still the case.

The fact that tertiary education is rewarded higher than that of secondary education indicates a skills/knowledge shortage of highly educated/skilled individuals in the developing world, and that employment available with secondary education or below requires relatively low levels of education (a possible reason why the return to primary are higher than the returns to secondary education). However, as the study in Ghana indicates (Jones, 2001), education has an effect on productivity and thus this

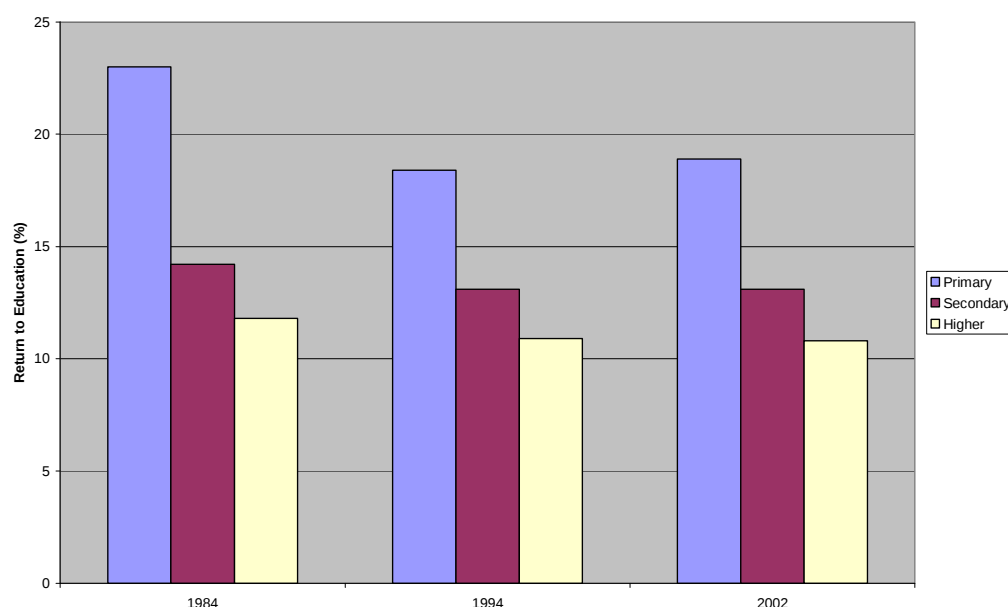
trend may change as levels of education in developing countries rise – the entry level for employment may change from requiring a primary education to secondary education.

Appendix III: Empirical results of social returns to education from around the world

The empirical results of studies following the accounting method of the social returns to education are presented here. Firstly the global social rates of return are introduced followed by evidence of social returns to education for individual countries, namely those in the developed world, particularly the United Kingdom (UK).

The global social returns to education have declined over the 18-year period, 1984 to 2002, in much the same way as global private returns have declined (Appendix II). Global social returns to primary education have decreased from 23% in 1984 to 18.9% in 2002, while social returns to secondary and tertiary education have decreased little, from 14.2% in 1984 to 13.1% in 2002 and 11.8% to 10.8% respectively. This is illustrated in Figure AIII.1.

Figure AIII.1: Global social returns to education, 1984–2002



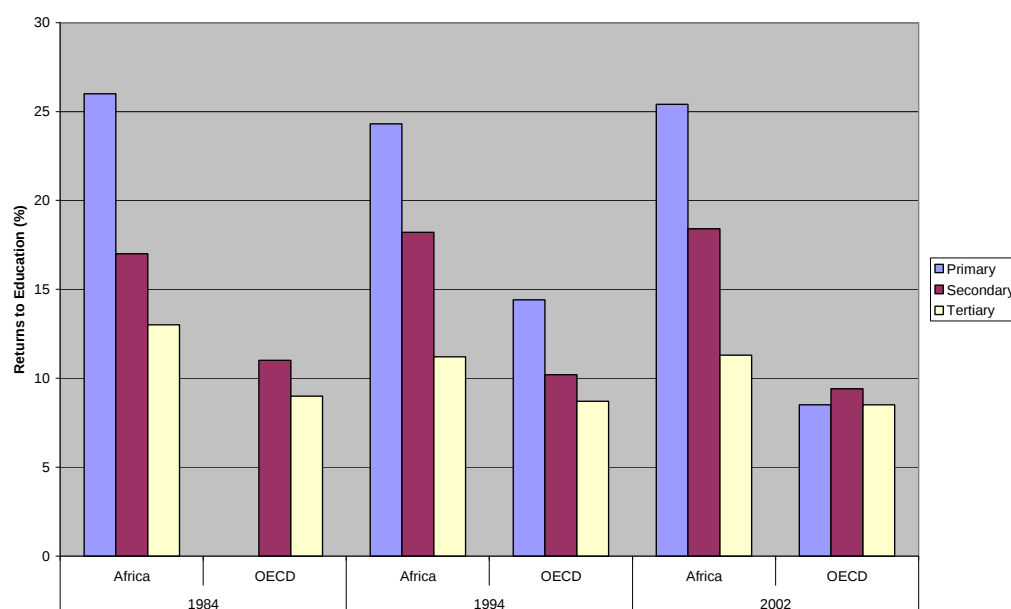
Source: Psacharopoulos (1985: 586; 1994: 1328) and Psacharopoulos & Patrinos (2002: 14)

As the figure illustrates it is still currently socially profitable to invest in primary education, although the return is declining. The increasing number of individuals with basic primary education may serve as an explanation of this trend. As more

individuals acquire the same level, the returns – both private and social – will decline to the point where the social return, using the accounting framework³⁰ may be zero.

Comparisons of the social returns to education across levels of development follow the same trend as for global private returns (Appendix II). Comparing the social returns of Africa and of the OECD countries illustrates that it is most socially profitable for the former to invest in primary education while it is best for the latter it is best to invest in secondary and tertiary education, as is illustrated in Figure AIII.2.

Figure AIII.2: Incidence of social returns to education: Africa vs. OECD



Source: Psacharopoulos (1985: 586; 1994: 1328) and Psacharopoulos and Patrinos (2002: 14)

The high private returns to a tertiary level education in developing countries, as illustrated by Nigeria, Ghana and Brazil, however, may well indicate the developing countries should be benefiting from these individuals. As Jones (2001) shows, higher levels of education have a definite positive effect on productivity. This indicates an increasing social return to education. The fact that the above result does *not* show a high social return to education may be explained by a shortage of highly educated individuals in the labour market (Blom et al., 2001). The shortage would explain the high private returns to education, but as the city-wide methodology (Moretti, 1999) of

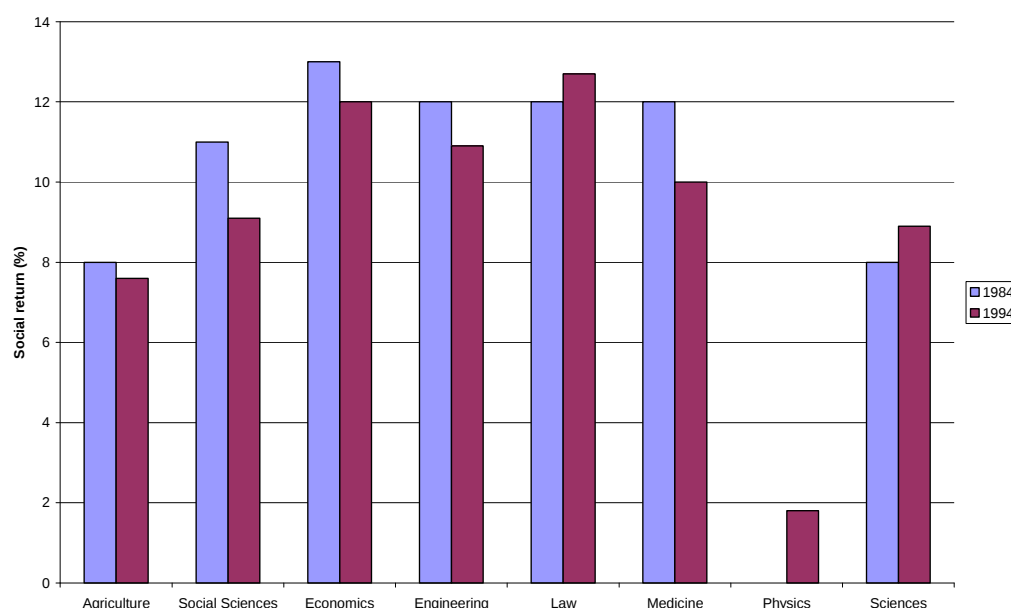
³⁰ Recall that the accounting framework neglects to include the non-monetary social benefits of education, thus there will always be a true social return, but due to the methodology used it is possible that an estimate of the social returns to education may be zero.

measuring the social returns to education suggests, a certain number of individuals with a higher level of education must exist *before* a social return is visible.

The social return to tertiary education in developing countries being approximately 2 to 3% greater than for developed countries could illustrate that the developing countries may be receiving the social returns to more highly educated individuals, and that tertiary education may play an important role in the development and growth of an economy. In the case of Ghana (Appendix II), for example, where the private returns to education are highest at the tertiary level, the country may well begin to receive higher social returns to tertiary education in the future.

Suggesting that tertiary education is vital for growth and that the social returns to tertiary education are likely to increase in developing countries begs the question of what type of tertiary education will receive the greatest social return. The social returns to education by different academic faculties are presented in Figure AIII.3 for 1984 and 1994.³¹

Figure AIII.3: Social returns to education by academic faculty



Source: Psacharopoulos (1985: 590; 1994: 1330)

³¹ Unfortunately the Psacharopoulos and Patrinos (2002) study did not update this information.

The pattern of social returns reflects the differences in the costs of provision of the different faculties and the differences in the pay premia in the labour market. If the cost of provision is high, as in the sciences, and the income of a graduate scientist is low compared to a graduate of social science, and the cost of provision of the sciences is higher than the social sciences, the social return to graduates in the sciences are lower than those to graduates in the social sciences.

Many studies have produced social returns estimates using the accounting framework, comparing the social returns of individuals obtaining tertiary with secondary education as well as the social returns to each type of tertiary degree. In the UK, Steel and Sausman (1997) have determined such a comparison using different ‘alpha’ values to account for unobserved factors of human capital. The average social return is 8%. The results are summarised in Table AIII.1.

Table AIII.1: Social rates of return in the UK, 1997

	Social rate of return (%)		
	Alpha = 0.6	Alpha = 0.8	Alpha = 1
Men	6	8	–
Women	8	10	12
All	7	9	–

Source: Steel and Sausman (1997)

The social rates of return to tertiary education for men in some of the OECD countries are provided in Table AIII.2.

Table AIII.2: Social rate of return to male university graduates, 1995

Social rate of return (%)	
Australia	11
Belgium	9
Canada	9
Denmark	8
France	13
Sweden	9
USA	10

Source: adapted from Chevalier et al. (2002: 69)

Table AIII.3 presents Steel and Sausman's (1997) estimates of the social returns across faculties in the UK for the late 1980s.

Table AIII.3: Social returns in the UK across faculties

Faculty	Social return (%)
Social Sciences	11–11.5
Engineering	5–6.5
Science	4.5–5.5
Arts	—

Source: Steel and Sausman (1997)

More recently, Dutta et al. (1999, in Chevalier et al., 2002: 70–71) using different subject groupings to Steel and Sausman (1997), find that the estimated social returns to the Arts and the Biological Sciences are zero, 7.5% for those grouped within Engineering, Architecture, Mass Communication and Education, and highest at 11.4% for the grouping Medicine, Agriculture, Physical Sciences, Maths and Computing, Social and Business studies, Design and General courses.

Appendix IV: Marine scientist questionnaire

SECTION 1: Personal Details

- 1 Age _____
- 2 Race _____
- 3 Gender _____
- 4 Highest Qualification and Academic Area _____
- 5 Year Obtained _____
- 6 Institution of Employment _____
- 7 Position of Employment _____
- 8 No. of years at present institution _____

- How many years have you participated in the Labour Market for Marine Scientists? _____

- 10 Previous Employment (please tick where applicable)

Where employed	No. of years employed in these categories prior to current position	
academia		
consulting		
research		
government		
industry		
not in marine science		
other (please specify)		

- 11 Do you generate income from **more** than one source?

yes	no

- 12 Current Annual Income from **Permanent Post**:

less than 80000	
betw 80000 & 105000	
betw 105000 & 130000	
betw 130000 & 155000	
betw 155000 & 180000	
betw 180000 & 205000	
betw 230000 & 255000	
betw 255000 & 280000	
betw 280000 & 305000	
betw 305000 & 330000	
betw 330000 & 355000	
betw 355000 & 380000	
> R 380000	

- 13 Estimated Annual Income from other activities:

Consulting:	
Guest Lecturing	

Marking of Theses
Other (please specify)

SECTION 2: Productivity

- 14 Total No. of PhD students supervised
No of PhD students supervised post 1995
Total No. of MSc students supervised
No. of MSc students supervised post 1995
Total No. of journal publications or book chapters (peer reviewed)
No. of journal publications or book chapters (peer reviewed) post 1995
No. of conferences attended: Local
International (incl. SAMSS)
No. of conferences attended post 1995 Local
International (incl. SAMSS)
Ave No. of consulting projects involved with per year
Ave. no. of projects completed per year (if any)
Ave. no. of projects involved with per year (if any)
Ave. no. of projects completed per year (if any)
Ave. no. of projects involved with per year (if any)

SECTION 3: Job Characteristics:

- 15 How important are the following aspects in your current employment?
Strong leadership abilities
Conflict resolution (communication skills)
Problem-solving skills
Knowledge of marine science
Knowledge of natural sciences
Knowledge of economics
Knowledge of existing legal framework
Knowledge of marketing techniques
Knowledge of personnel management
Knowledge of financial management
- 16 What **Field** of Education is most appropriate for your current position?

(please tick one only)

- 1) only your own field of education
2) your own or related field
3) completely different field of education
4) no specific field is required
5) no specific, clearly identified, field yet exists

- 17 What **Level** of education would you believe be most appropriate for your current position?
(please tick only one)

1) Matric

--

2) Bachelor's Degree	
3) Honours Degree	
4) Master's Degree	
5) PhD	

SECTION 4: Conditions of the Labour Market

- 18 In your opinion, do you believe there are job opportunities available for marine scientists in South Africa?

- 19 Have you looked for employment outside marine science in the previous 5 years? If so, where?

- 20 Do you believe the skills provided at University in training as a Marine Scientist, successfully provides the skills required to practise as a Marine Scientist in South Africa?

Appendix V:
Request from the NRF to academics
for information regarding past students

NATIONAL RESEARCH FOUNDATION

PO BOX 2600
PRETORIA 0001
SOUTH AFRICA

TEL: (012) 481 4000
FAX: (012) 349 1179
INT. CODE: +27 12

INTERNET:
<http://www.nrf.ac.za>
EMAIL: info@nrf.ac.za



Direct telephone (012) 481-4107
Direct fax (012) 481-4054
E-mail address annette@nrf.ac.za

22 May 2002

TO SEA AND COAST GRANT-HOLDERS

LABOUR MARKET ANALYSIS OF MARINE SCIENTISTS IN SOUTH AFRICA

In 2001 the SANCOR (South African Network for Coastal and Oceanic Research) Steering Committee commissioned a study of a labour market analysis of marine scientists in South Africa. This task was awarded to Pieter Grootes, an economic student based at Rhodes University, who is undertaking this study in fulfilment of a Masters degree.

To assist Pieter Grootes with his study, the SANCOR Steering Committee is asking you to please provide him with the following information on your past and current masters and doctoral students only:

Past students

- When were their degrees obtained?
- The thesis title
- Are these students employed in the field of marine science? If yes, in what capacity and if no, what are they currently doing?
- Were there any students who failed to complete their degree, for any reason?
- Was there any extra funding needed such as supplementation out of research grants and other sources of funding? If yes, what was the duration of this funding?

Present students

- How many students are you currently supervising?
- The thesis title
- Is there any extra funding needed such as supplementation out of research grants and other sources of funding? If yes, what is the duration of this funding?

For your information enclosed herewith is a list of all grant-holder linked bursaries allocated to you since 1996 within the Sea and Coast Programme. It will be much appreciated if you can send the above information to me before the end of June 2002.

Yours sincerely

Annette Schnetler

ANNETTE SCHNETLER

Appendix VI: Student questionnaire

Please answer **ALL** questions.

1. Institution: _____
2. Age: _____
3. Race: _____
4. Gender: _____
5. Number of years spent studying, i.e. 1997–1999:
Honours: _____
MSc: _____
PhD: _____

6. Have you worked in marine science before starting your MSc/PhD?

If not, go to Q 7.

If so, for whom and for how long?

7. Have you searched for a job in marine science?

	Yes or No	When	For which company	Expected earnings (R)
After Honours				
After Masters				
During PhD				

8. Why are you engaged in further studies in marine science?

Please answer **ALL** options (with the exception of the last) YES or NO.

Wished to pursue personal interest	
Persuaded by a friend/family member	
Asked/persuaded by a lecturer	
Undecided on what career path to follow	
Wish to be employed in the field of marine science	
Perceived job opportunities in marine science	
Believed the degree would be useful for any employment opportunity	
Other (please specify)	

9. Do you receive a bursary or scholarship? _____

If so, is it NRF or other (please specify)? _____

10. Would you be able to afford to study for your MSc or PhD if you did not receive financial support? _____

11. Are you employed at your institution? _____

If so, in what capacity (i.e. tutor, research assistant, lecturer, etc.)?

12. Do you wish to work in marine science on graduation? _____

If so, rank your job preference according to this scale:

1 = most preferred; 10 = least preferred.

Job	Preference rating	Expected earnings (R)
University/academia		
Research institute		
Post – doc Studies		
Consultancy		
Private sector organisation (e.g. De Beers Marine, I & J, Sea Harvest, Richards Bay Minerals, etc.)		
Marine & Coastal Management or Government		
Museum		
Teaching		
Other (please specify)		

13. Do you believe your level of qualification/skills/knowledge would be fully
utilised in the above options?

14. Evaluate your knowledge of job opportunities at the below organizations.

Use this scale for your rating:

1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor; 5 = Very poor.

Job	1	2	3	4	5
University/academia					
Research institute					
Post – doc					
Consultancy					
Private sector organisation (e.g. De Beers Marine, I & J, Sea Harvest, Richards Bay Minerals, etc.)					
Marine & Coastal Management or Government					
Museum					
Teaching					

THANK YOU

Pieter Grootes

Rhodes University

South Africa

Email: p.grootes@ru.ac.za

Appendix VII: Covering letter for interviews with marine scientists



SOUTH AFRICAN NETWORK FOR COASTAL AND OCEANIC RESEARCH

Secretariat: c/o Pavs Pillay, Marine and Coastal Management, P.Bag X2 Roggebaai 8012, Tel. 0214023536, email ppillay@mcm.wcape.gov.za, Chairman: Prof. Peter Britz, c/o Dept. Ichthyology and Fisheries Science, Rhodes University, P O Box 94, Grahamstown 6140, Tel. 046-6038415/6, Email: p.britz@ru.ac.za

10 May 2002

Dear Marine Scientist,

NRF- SANCOR SURVEY ON TRENDS IN POST GRADUATE PARTICIPATON AND FUNDING IN MARINE SCIENCE

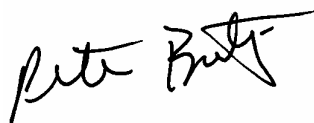
Marine science has been subject to much change in recent years, reflecting societal and institutional processes. Recently concerns were raised within the SANCOR Steering Committee regarding a drop in the number of NRF post graduate bursaries being taken up in marine science. Members felt that this did not reflect a drop in the number of marine science students *per se*, but was an indication of the growth of a more diversified funding base for marine science. However, there is no clear picture available of the structure of marine science funding, research, training and employment in South Africa at the present time. The NRF in collaboration with SANCOR has therefore commissioned a survey to obtain an insight into the trends in the sources of marine science funding and student participation rates. This information will assist in policy making and planning around marine science and will contribute enhancing the traditional strength of our discipline.

Pieter Grootes, an economics student from Rhodes University, is conducting the survey and will use the data to perform a labour market analysis of marine science effort in South Africa. This will include a survey of student perceptions.

For the study to succeed he requires data on marine science funding and post-graduate student participation rates at marine science institutions. I would thus appeal to you to assist Pieter in obtaining this information.

Thank you for your cooperation.

Best wishes
Yours sincerely



Prof Peter Britz
SANCOR SSC Chairman