The Role of Education in the Labour Market: An Empirical Analysis

By

Matthew Haynes

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Abstract

It is generally accepted that a more educated workforce can provide more economic growth. However, the extent to which personal benefits outweigh the social benefits of higher education has become not only an economic issue, but also a political issue. Voicing screening sympathies, Chancellor Kenneth Clarke asked '*why should bus drivers pay for the education of lawyers?*' when cutting student grants in 1993 [*The Economist* 22/4/95].

The screening theories of the 1970's posited that, in some circumstances, if higher education was only signalling and not improving a person's ability, then society may be better off without higher education. A less extreme view is that some component of education acts solely as a signal and is socially worthless.

There has been relatively little attention paid to testing the role of education in the labour market of the United Kingdom and Italy. One reason may be the shortage of suitable data sets available for such tests. This Thesis utilises UK and Italian data sets and aims to redress some of the imbalance in empirical work which tends to centre on data from United States.

It is important to test the educational screening hypothesis in the context both of revisions in UK government policy towards the funding of higher education and the aim of convergence of labour market conditions within the European Union.

The key objective of this Thesis is to investigate the role of education in the determination of wage rates for full-time work in the UK and Italy. The empirical analysis generally supports the hypothesis that education has both a screening and a productivity augmenting role.

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Certificate of Originality

This is to certify that I am responsible for the work submitted in this Thesis, that the original work is my own except as specified in acknowledgements or in footnotes, and that neither this Thesis nor the original work contained therein has been submitted to this or any other institution for a higher degree.

Signed:

Matthew Haynes

September 1996

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Chapter 1

Introduction

The emergence and expansion of graduate loans in the United Kingdom and the simultaneous capping of student grants can be seen as another step in the Conservative government's education policy towards individual funding rather than central funding for higher education. The relationship between higher education and earnings is clear; for example, in 1992 male university graduates in the UK earned £433 a week on average, compared with £277 for men who had only A-levels. What is unclear is how higher education should be funded. As Kenneth Clarke, the Chancellor of the Exchequer, posited when he cut student grants in 1993 'why should bus drivers pay for the education of lawyers?' [The Economist April 22nd 1995 p. 20].

In 1995 student grants were cut by 8 percent in the UK, with a corresponding rise in the size of student loans available in line with estimated inflation. In 1996 all three main UK political parties were discussing the introduction of a 'graduate tax'. For example, the Labour Party presented proposals for higher rates of National Insurance (NI) contributions for graduates and an abolition of student grants, in favour of a scheme of larger loans, to the Dearing committee of inquiry into university funding in the 21st century.[1] In addition, the Committee of Vice-Chancellors and Principles (CVCP) announced in September 1996 that they were recommending to the Dearing committee that the fundamental principle of free tuition for full time university students be abandoned. Under the scheme proposed by the CVCP, students would pay approximately £20,000 over three years towards the cost of their university education (paying maintenance and approximately a third of tuition fees) via a new long-term loan scheme funded by banks. The loans would be paid back to the banks via a supplementary NI levy on graduates of approximately 3% of

[1] Sir Ron Dearing will present the results of the inquiry after the general election in 1997.

taxable income via a collections agency. To date none of the political parties has adopted the idea of repayable tuition fees [see Carvel (1996) for more details].

The CVCP estimate that legislation enabling universities to charge undergraduates for tuition and maintenance costs would save the government approximately £6 billion per year [Carvel (1996)]. Such proposals would appear to be not only a way in which to conserve government resources but also a move towards a 'pay your own way' philosophy as regards higher education. This philosophy is mirrored in other nations and is economically justified, regardless of the government expenditure reduction, under a screening model of education but not a human capital model.[2]

The relationship between annual earnings and education can be seen from Table 1.1 for full-timers working in the UK and Italy. Generally as education increases so too do earnings. For example, a woman working full-time in the UK who has a university degree earns approximately 110% more on average per year than a woman with no formal qualifications.

The human capital and screening models have been developed by labour economists to explain the relationship between education and earnings which generally exists in all economies. While education is partly a consumption good for some individuals, in that they derive non-pecuniary utility from having an education, it also treated by most individuals as an investment in the future. For example, most university students are aware of the direct costs of their education; rent, costs of tuition, textbooks, energy bills and other living expenses, and the indirect costs in the form of foregone earnings. In both models of education these costs are compared to the expected increased earnings derived from having a high level of education. Other examples of expected benefits from having a high level of education are increased job opportunities and higher social status, which may also have a positive effect on earnings levels.

In both models it is also the case that employers will pay those with more education a higher than average wage. Where the models differ is in the assumptions about why a high level of education can lead to increased earnings.

[2] This argument becomes more complex when we allow for the fact that the capital market is imperfect; students may not be able to borrow at the rate of interest which corresponds to the rate of return from the increased education for which they need the loan.

In the human capital model the person who has a higher level of education receives higher earnings because the increased level of education has increased his or her productive ability on the job. In the so called 'strong screening' model the individual who has a higher level of education receives higher earnings because the level of education is a signal of that individual's innate ability which is unchanged by higher education.

Table 1.1: Earnings versus Education for UK and Italian Full-timers by Gender

Country:	UK		Italy	
Education Level	Real Earnings Pounds Sterling		Household Earnings 1000's Italian Lira	
	Male	Female	Male	Female
University Graduate	15351	10855	20435	11730
A-Levels (or equivalent)	9970	6323	16867	11023
No Qualifications	8181	5138	11632	10632

Notes: Calculated from British Social Attitudes Survey 1985-1991 and Survey on Consumption by Italian Families (family heads) 1989 data; UK Real Annual Earnings measured at 1986 prices Italian Household Annual Earnings measured at 1989 prices.

The strong screening model suggests that the relationship between higher education and individual earnings does not include productivity improvement and this may justify a self-funding policy. Conversely, the human capital model suggests that the relationship between higher education and individual earnings does include productivity improvement and therefore national productivity increases, and so central funding from taxation is justified since higher education is benefiting the nation. Finally, in the 'weak screening' hypothesis education both enhances and signals productivity, and the funding options are not so clear.[3]

In the 1990's there is reason to appraise these models theoretically and empirically because of their domestic and international policy implications. The recent proposals in relation to the funding of higher education offer *prima facie* evidence of screening sympathies in the main political parties of the UK. If evidence is found in support of the notion of strong screening then the self-funding policies are justified because there is a divergence between private and social marginal benefit of higher education. However, if evidence is found in

[3] Note that this has ignored the possibility of positive externalities from higher education which are not related to individual productivity. For example, students in higher education who proceed into research opportunities may help develop new technologies and increased levels of knowledge which benefit society as a whole.

support of the weak screening model then the debate should centre upon which certificates are typically acquired as screens (and have little effect on productivity) and which certificate courses augment productivity to a greater extent. Finally, if there is no evidence of any form of screening then self-funding is not justified on the basis of a screening argument. However, even in a no-screening human capital framework, if education is providing the wrong skills for the modern economy, the policy-maker may choose to increase investment in on-the-job training schemes and contract central funding of higher education.

In an international context if educational screening occurs to different degrees in different member states of the European Union (EU) then this will interfere with the aim of labour market convergence outlined in the Treaty on European Union (signed at Maastricht, 7th Feb. 1992). Although some professional qualifications have become comparable across member states, differences in the role of education in the domestic labour markets of member states have been largely over-looked. Under the screening hypothesis, an educational certificate which signals that a worker is of high ability in one member state may not do so in another member state; this may introduce inefficiencies into the levels of labour mobility within the EU.

The aim of this Thesis is to test the conflicting theories of the role of education in the labour market of the UK and Italy. I will estimate the effects of education on full-time wage rates and, using a number of methodologies, test whether these effects are due to the screening and/or human capital role of education. Taking the UK and Italy as examples of EU member states I also aim to illustrate the disparities that lie in the returns to and role of education in their domestic labour markets.

Chapter 2 of this Thesis reviews the main theoretical articles developing the educational screening hypothesis. An asymmetric information problem is presumed to exist in the labour market and this is the basis for the screening models. It is hypothesised that education is used by a worker or job-applicant to signal their individual ability; a characteristic which the employer cannot observe directly until the worker has spent some time in a monitored workplace environment. The theoretical models of Spence (1973), Arrow (1973) and Stiglitz

(1975) are outlined. These models developed the idea that education is used as a signal of ability by workers, or as a screen for ability by firms, rather than the idea that education is solely an investment in human capital.

Chapter 2 also outlines the game theoretical analysis of signalling theory conducted by Riley (1975,1985), Yabushita (1983), Stiglitz & Weiss (1983), and Cho & Kreps (1987). The conclusion of Chapter 2 discusses how such models can compliment later models of wage determination such as union bargaining theory and the efficiency wage hypothesis.

Chapter 3 reviews the empirical work, spanning over two decades, which has been carried out to assess the importance of the educational screening hypothesis in the market for labour. The empirical articles are reviewed according to the methodology used to test the screening hypothesis. The overwhelming indication from the majority of empirical work is that human capital rather than the strong screening hypothesis best explains the earnings-education relationship. However, rejection of the weak screening hypothesis, in which education signals and improves ability, cannot be supported when account is taken of the biases of individual methodologies and data sets used. The overall conclusion is that there is little doubt as to the validity of human capital theory, but that the importance of the informational role of education is still open to debate.

In Chapter 4 the performance of the traditional human capital model in explaining the earnings-education relationship is tested on data for male and female full-time workers from the British Social Attitudes (BSA) Survey 1985-1991, and the results are compared to previous UK estimations.

Chapter 4 outlines the human capital theory of Mincer (1974) which has traditionally been employed to model the effects of education and experience upon earnings. In recent times this model has been challenged by, amongst others, Murphy & Welch (1990) and Psacharopoulos & Layard (1979) and these alternative human capital earnings functions are also outlined. The human capital functions are then estimated using the BSA Survey data and comparisons made between the three models. The hypothesis that the marginal rate of return to years of education is not constant as years of education increase is tested. The effects of certification upon the wage rates of full-timers is analysed and linked to the variation in the marginal rate of return to years of education. The overall conclusion from this Chapter is that although the traditional Mincerian human capital model is a robust model of the effects of education in the determination of earnings, it does not allow for variation in the marginal rate of return to education and the effects of certification upon wage rates.

Chapter 5 and Chapter 6 test the less traditional explanation of the education-earnings relationship; the educational screening hypothesis. The majority of empirical tests of the screening hypothesis reviewed in Chapter 3 used US data. In Chapter 5 and Chapter 6 the screening hypothesis is tested using the BSA Survey data for the UK, and in Chapter 7 using Bank of Italy Survey of Consumption in Italian Families data for 1989.

In Chapter 5, a methodology similar to that of Wolpin (1977), Riley (1979a), Katz & Ziderman (1980), Fredland & Little (1981), Shah (1985), Tucker (1985), Cohn *et al* (1987), and Grubb (1993) is employed. These economists test the educational screening hypothesis by comparing the earnings of self-employed workers, who are used to represent unscreened workers, to the earnings of employees, who have been used to represent screened workers.

Details of the samples of self-employed and employees taken from the BSA Survey data are presented alongside a discussion of the characteristics of the self-employed in the data in relation to the findings of previous UK studies. Goodness of fit and model specification test results for the estimation of full-time wage rate equations for male and female workers are also shown. The expected results under the weak screening hypothesis, where education has a signalling and human capital role, are compared to the actual results from estimating the wage rate functions for the two worker types, and some conclusions drawn from this analysis.

In Chapter 6 comparisons are made between economic sectors, occupations, tenure or education groups which are assumed to be characterised by different levels of educational screening. Two of the hypotheses to be tested in Chapter 6 relate to the strong version of the screening hypothesis as presented by Psacharopoulos (1979). The expected results under the screening hypotheses are compared to the actual results of estimating wage rate equations by occupational class, sector, tenure group or education group.

The overall conclusions from Chapter 5 and Chapter 6 is that there is no evidence to support the strong screening hypothesis in relation to the UK labour market. There is however evidence to support the weak screening hypothesis and human capital theory in relation to the UK.

Chapter 7 tests the screening hypothesis in Italy using data on full-time workers from 1989. This is done by applying methodologies similar to those used in Chapter 5 and Chapter 6. As far as I am aware there has been no attempt to test the screening hypothesis in relation to Italy to date, and there appears to be a general lack of evidence in relation to most of the member states of the European Community. The data set is taken from the 1989 wave of the 'Survey on Consumption by Italian Families' (SCIF) commissioned by the Bank of Italy.

Chapter 7 also investigates the nature of the labour market in Italy. Some background to the economic dualism of the North and South of Italy is given, and regional full-time wage rate equations are estimated and discussed.

The EU has stated that it wishes to open national markets to competition among member states. Despite the adoption of the first Social Action Programme in 1974 many critics believed that labour market reform in member states of the EU was lagging behind the reforms occurring in other EU markets, and the *laissez-faire* approach to the labour market should itself be revised [see Brown *et al* (1996)].

The labour market did not escape the aim of 'convergence' of markets outlined in the Maastricht Treaty, and the subsequent 'Social Charter' which laid down principles regarding the labour market with the aim of making working conditions, levels of social security and worker protection uniform across the labour markets of EU member states.

With the aim of free movement of people between member states the EU established a number of harmonised national qualifications for specific professions; for example the 'right of establishment' was realised for doctors, nurses, dentists, midwifes, architects, vets and pharmacists from one member state working in another member state. In 1988 the EU also established a system of mutual recognition that could be used to compare higher education qualifications, which are legally regulated either by the State or by professional bodies, across member states [see Raban (1991) pp. 5-19].

Although EU directives may eventually lead to certain uniformities in the labour markets of member states, and some qualifications have become comparable across member states, differences in the role of and rate of return to education between member states has been largely over-looked. Chapter 7 therefore presents some comparisons between the labour market for full-time workers in the UK and in Italy in 1989.

The overall conclusion from Chapter 7 is that there is no support for the strong screening hypothesis, and some evidence to support weak screening hypothesis and human capital theory in relation to the Italian labour market. Evidence of labour market dualism is found and differences in the effects of education in earnings determination between the UK and Italy are illustrated.

Finally, Chapter 8 presents general conclusions relating to the analysis of the role of education in determining wage rates in the UK and Italy and highlights potential areas for research in the future.

In summary, this Thesis makes a contribution to labour and education economics by presenting an empirical analysis of the role of education in the labour markets for full-time workers in the UK and Italy; countries which have been neglected in previous empirical literature. Using two data sets this Thesis also illustrates the disparities in the formation of wage rates between these two EU member states.

Chapter 2

The Theoretical Foundations of the Educational Screening Hypothesis

2.1 Introduction

Although the concept of education as a screening device and the possibility of allocative inefficiency can be traced back as far as Young (1958) or Hull & Peters (1969), and the effects of asymmetric information in a market was first elucidated by Akerlof (1970), the foundations for the idea that education could be used by workers to signal their abilities to potential employers are generally attributed to Spence (1973). Spence's (1973) article can be seen as the major catalyst to the theoretical debate and empirical study of the role of education in the labour market which arose in the 1970's. Over this period many notable economists, including Arrow and Stiglitz, debated whether the education-earnings relationship was solely a human capital relationship, where the return to education was a return to the productivity improvement it created, or whether a large portion of education was redundant in the sense that it was only a signal of innate productivity.

In this Chapter I will look at the main theoretical articles developing the screening hypothesis, before reviewing the main empirical studies relating to the subject in Chapter 3. Section 2.2 of this Chapter outlines the asymmetric information problem which is assumed to exist in the labour market and which is the basis for screening models. In Section 2.3 I review Spence's (1973) model and his later modifications, and the models of Arrow (1973) and Stiglitz (1975) which also developed the idea of education as a screening device.

Section 2.4 covers the later developments of signalling theory re-constructed in a game theoretic framework by Riley (1975,1985), Yabushita (1983), Stiglitz & Weiss (1983), and Cho & Kreps (1987). Yabushita (1983) and Stiglitz & Weiss (1983) allow for different orderings of 'moves' in the Stiglitz (1975) model. Essentially, in Stiglitz (1975) applicants acted first by deciding on signalling behaviour, whereas in these later theories the possibility that the firms act first is developed. Riley (1975,1985) shows that if we allow for the idea that firms may wish to test their beliefs about the relationship between signal and productivity, the precise identification of the competitive signalling equilibrium in the Spencian model is a very subtle concept and not as simply defined as Spence first conceived. Cho & Kreps (1987) offer insights in how to identify a dominant equilibrium from the multitude of possible signalling equilibria, and therefore allow us also to comment on the social efficiency of the Spencian model. Section 2.5 draws some general conclusions from these models.

2.2 The Asymmetric Information Problem and Screening

When worker heterogeneity is considered in the labour market economists model the way in which workers convey information about themselves to potential employers. In such models it is usually assumed that workers' heterogeneity can be summed up in one attribute termed 'quality' or 'ability' which is positively correlated with productivity. In the screening models the market is assumed to be characterised by a large number of small competitive profit maximising firms who would like to hire workers who best suit the job in terms of these characteristics.[1]

An asymmetry of information is assumed in that workers can directly observe their individual abilities, whereas the firm cannot, but can acquire indirect information about individual ability. The firm knows the statistical distribution of abilities within the population, but given the limited information at its disposal cannot differentiate between workers for whom it has the same indirect information.

If the firm makes no attempt to estimate the ability of new workers via indirect information and bases the wage paid to them on average expected marginal productivity, there will be an adverse selection problem since this wage will be below the reservation wage of a proportion of applicants. Assuming a positive correlation between a worker's reservation wage and ability, it will be the high ability applicants who will not want to work for the average wage. The firm will therefore be recruiting only low ability workers, resulting in allocative inefficiency since the wage is above the marginal product of labour hired. Low quality workers crowd out the high quality workers from the workforce of such a firm.[2]

If the production technology necessitates the use of both types of worker, the firm offering the average wage may be forced to change the wage setting behaviour towards a scheme of separate high and low wages simply to stay in business. An optimising firm requiring both types of worker in its production process would like to find a way of avoiding this adverse selection problem. On the other side of the market, workers with higher ability will have an incentive to

[1]Note that Spence (1973) first uses a model in which there is one employer and two types of worker, and then expands the analysis in Spence (1976) to a labour market characterised by a large number of identical competitive employers.
[2]This is analogous to the work of Akerlof (1970) concerning the market for used cars where the poor quality used cars crowded the good quality used cars from the market.

reveal their ability if they can get a higher wage by identifying themselves somehow.

A screening process is a selection procedure which picks out applicants who possess a critical amount of a certain observable characteristic which is known as a signal of the hidden characteristic. The amount an applicant possesses of this signal is correlated with expected ability of the worker so that the firm can rank applicants' expected ability on the basis of their endowment of this signal.

A perfect signal would be some characteristic which is perfectly correlated with ability, and ideally has no cost for high ability workers, and a very large cost for low ability workers. However, some cost may be incurred by the signaller and therefore an assumption is made that this cost is negatively correlated with ability. This assumption is made to overcome the moral hazard problem of a low ability applicant having the incentive to masquerade as a high ability applicant and acquire a high wage. An effective screening process should therefore rely on a signal which is accurately correlated with ability in the sense that a low ability worker finds it too costly to acquire the critical level of the signal which indicates high ability.

The most obvious and most studied signal of individual ability is education, and it is generally accepted to be the case that the cost of acquiring education is inversely related to ability. Spence (1973) treats education as a scalar amount i.e. years of education, and in Arrow (1973) the education signal is college graduation. However, Spence does suggest that educational 'level' can be a vector of information and not simply years of education, but also quality of education, certificates, field of study, and grades.

Individuals may invest in education regardless of its signalling role, so the signal is available to firms with no prompting and it can be used by most firms as an indicator of ability since it is easily observable and verifiable. The firm to which a worker applies must trade-off the cost of the screening method it employs with the quality of results it obtains, and since observing education levels costs the firm very little, this screening method is preferred to more costly alternatives. However, the educational screening models assume that educational information is the only potential screen of worker ability that can be employed by the firm. The firm is therefore assumed to be unable to screen on-the-job and cannot offer self-selection contracts contingent upon ability [see Salop & Salop (1976)].

The 'strong screening' hypotheses of Spence (1973) and Arrow (1973) hold that education is used as a signal by workers to inform firms of their ability levels which are not augmented by the acquisition of that education. In contrast, the human capital model holds that education does augment productivity by providing individuals with new skills and developing their latent skills [see Mincer (1974) and Becker (1975)].

Credentialist theories, such as that of Thurow (1975), model the of use educational credentials or trade association membership as a misleading signal of ability [also see the sociological models of Berg (1971) and Dore (1976)]. Thurow reaches a similar conclusion to that of Arrow (1973) in that graduates may be over-employed and enjoy higher earnings than if no screening took place. However, in the credentialing models firms are assumed to be willing to pay a premium to gradutes although they are no more productive than non-graduates and in this sense the models deviate from the normal assumption that firms aim to profit maximise and the result that the screen is accurate in selecting those workers with higher productivities. Any firm paying unwarrented salary premiums to graduates would soon realise it was placing itself at a competitive disadvantage in comparison to rival firms paying salaries in line with productivity [see Rawlins & Ulman (1974) for a review of credentialing theories].

In the 'weak screening' models of Spence (1976) and Stiglitz (1975) workers invest in education both as a way to signal and augment their abilities. Some empiricists tend to develop this model further and allow for the educational signal being a vector of information including years of education, highest qualification held, field of study and quality of education [Taubman & Wales (1973), Rizzuto & Wachter (1979) and Fox (1993) study the effects of schooling quality upon earnings].

Section 2.3 reviews the work of Spence (1973), Arrow (1973) and Stiglitz (1975) which can be seen as the theoretical foundations for screening hypotheses. Section 2.4 reviews the later work of Yabushita (1983), Stiglitz & Weiss (1983), Riley (1985) and Cho & Kreps (1987) in reappraising the work of Stiglitz and Spence. Section 2.5 presents some overall conclusions for this literature survey.

2.3 Early Models

2.3.1 Spence's "Passive Response" Model (1973)

In Spence's (1973) model the typical firm cannot directly observe the ability of the workers prior to hiring, and in which workers fall into two groups; Group 1 have low marginal productivity a_1, and Group 2 have a higher marginal productivity $a_2 > a_1$. Proportion h of the population are in Group 1 and $(1-h)$ are in Group 2.

The firm's inability to perceive a worker's ability until he or she has been hired and has been monitored on the job for a certain amount of time may cause significant adverse selection problems in the functioning of the market. If no signal exists that could be used by workers to show potential employers their individual ability then the risk neutral firm will pay a wage based on expected average ability;

(1) $$w = (1-h)a_2 + ha_1$$

Assuming agreement between the two groups of workers to work at this wage then no adverse selection problem will arise. However it is natural for Group 2 workers to expect to earn a wage at least equal to their marginal product a_2, and given that $a_1 < a_2$ then $w < a_2$. Group 2 will not offer their services in this labour market since their reservation wage has not been met, this leaves a supply of Group 1 workers. In the long run it may be that the firm will realise that it is only attracting low-productivity workers, and will reduce its wage offer to a_1. However in the short run we have assumed that productivity is unobservable, and this means that an equilibrium exists where only Group 1 workers are employed, at a wage higher than their marginal product. This is an example of adverse selection due to asymmetric information.

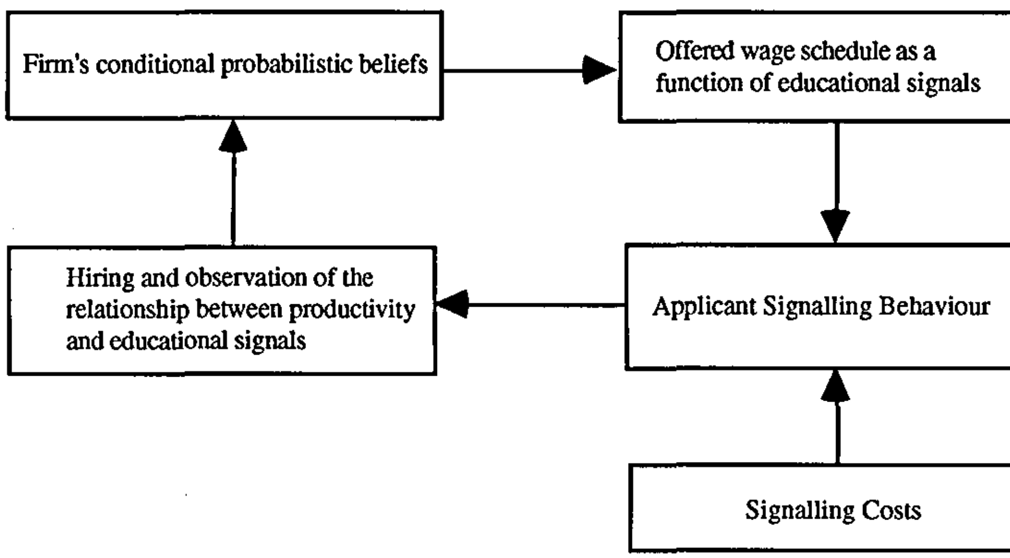
Spence suggests that workers use a particular level of education to prove their ability, in a similar way to that of a used car salesman offering a warranty on a car to prove it is of good quality in Akerlof (1970). Suppose workers in Group 1 obtain a level of education y_1 at a cost c_1y_1, and those in Group 2 a level y_2 at cost c_2y_2, where y_i and c_i are the amount of education consumed and the constant marginal cost of that level of education to a worker from Group i. These costs are not only monetary (such as tuition fees and accommodation costs) but also the cost in time and mental effort. The equilibrium that emerges from this model depends critically on the assumption that costs of the signal are negatively related to productivity, so that $c_2 < c_1$.

The firm will have a set of probabilistic beliefs on which it bases its wage offers. These beliefs are influenced by the firm's observation of the relationship between the workers' signals and indices and their productivity. 'Indices' include such things as race, height and sex, which are presumed to be unalterable by the worker.

The worker makes a signalling decision based on the offered wage schedule and signal costs with the aim of maximising their net income. There is thus an 'informational feedback loop' in the labour market, as shown in Figure 2.1. There will be an equilibrium if the firm's initial probabilistic beliefs after one loop are not disconfirmed by the information input they generate i.e. once any decision by worker or firm in the loop is repeated.

If the firm believes that there is a level of education y^*, such that if $y < y^*$ then productivity is a_1 with a probability of 1, and that if $y \geq y^*$ the productivity is a_2 with probability of 1, then it will offer a worker their respective expected productivity (this wage offer can also include the returns to education as a capital good).

Figure 2.1: Informational Feedback Loop in the Screening Process



Workers faced with the offered wage schedule have to decide how much education to acquire. Note that in this model it is assumed, for simplicity, that education is purely a signalling device and has no effect on a workers' productivity; it is therefore called a strong screening hypothesis.

Consider the situation where the high-productivity workers all get a level of education $y_2 = y^*$, and that low-productivity workers get $y_1 = 0$, and the firm pays workers with $y_i = y^*$ a wage of a_2 and workers with $y_i < y^*$ a wage of a_1. This will be an equilibrium if no party has an incentive to change their behaviour. The firm will be paying each worker a wage equal to their marginal product, it will be maximising returns and will have no incentive to change its behaviour.

The benefit to a worker of obtaining y^* education is an increase in wages $(a_2 - a_1)$ given the firm's offered wage schedule. The benefits are less than the costs for a Group 1 worker if

(2) $\quad (a_2 - a_1) < c_1 y^*$

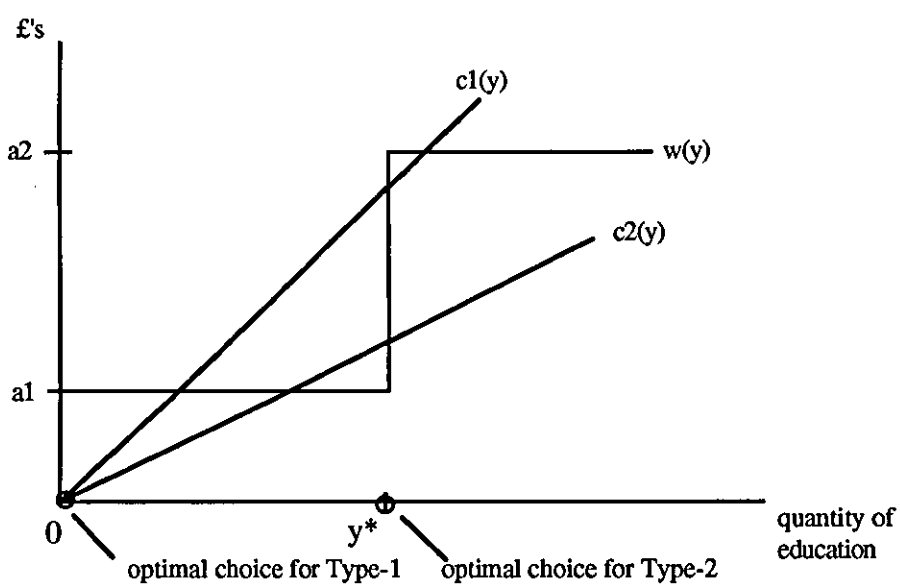
condition (2) holds if the workers will choose $y_1 = 0$ because by doing so they maximise the difference between offered wages and signalling costs. The net benefit is positive for a Group 2 worker if

(3) $\quad (a_2 - a_1) > c_2 y^*$

condition (3) holds if the workers will choose y^* education, since further increases in y_2 above y^* will incur costs with no corresponding benefits.

The equilibrium situation is depicted in Figure 2.2; the conditional wage schedule is $w(y)$ and cost curves are $c_1(y)$ and $c_2(y)$ with $c_2 > c_1$ in postive space. The maximum vertical distance between the wage schedule and costs (i.e. maximum net benefit) occurs at $y_i = y^*$ for Group 2 workers and at $y_i = 0$ for Group 1 workers.

Figure 2.2 : Optimal Choice of Education in a Signalling Equilibrium



Combining conditions (2) and (3) gives y^* in the interval;

(4) $\quad \left[\dfrac{a_2 - a_1}{c_1}\right] < y^* < \left[\dfrac{a_2 - a_1}{c_2}\right]$

Given the wage schedule offered and the assumptions that $a_2 > a_1$ and $c_1 > c_2$ there will be an infinite number of possible values of y^* within the interval in (4), and therefore an infinite number of separating equilibria exist in which the firm is able to make exact point predictions about the productivity of the workers.

The various equilibria are not all equivalent in terms of Pareto's welfare criteria.[3] Increasing $y*$ will hurt Group 2 by reducing the net benefit of signalling, while leaving Group 1 unaffected. A Group 1 worker earns $w=(1-h)a_2+ha_1$ with no signalling, and a_1 with signalling; given that $a_2>a_1$ and that $0 < h < 1$ the Group 1 worker earns less under signalling than without. Spence proves that Group 2 workers are only better off if $h>c_2/c_1$ [see p.365 Spence (1973) for a proof].

Given the signalling equilibrium, the individual may gain from acquiring the level of education $y*$, but it has no effect on productivity and therefore private and social returns diverge. However, education as a signal may be benefiting society in that it allows firms to allocate jobs correctly; a point which is expanded in Section 2.3.5.3 in relation to Stiglitz (1975).

Spence illustrates a pooled equilibrium, with quite different properties from the above equilibrium. Suppose the firms expectations are as follows; if $y_i<y*$ the firm expects the worker is from Group 1 with probability *h*, and from Group 2 with probability 1 - *h*, whereas if $y_i \geq y*$ the firm expects the worker is from Group 1 with probability 1.

If $y_i<y*$ the profit maximising firm will offer a wage based on the average expected productivity of the worker $w=(1-h)a_2+ha_1$, and that if $y_i \geq y*$ the firm offers a wage a_2. As before the only levels of y_i that will be logically selected are 0 and $y*$. The payoff from no education is better than that for acquiring $y*$ education if

(5) $$(1-h)a_2+ha_1>a_2-c_2y*>a_1-c_1y*,$$

and both groups will rationally set $y_i=0$, this implies a lower limit on $y*$ as follows;

(6) $$y*>h(a_2-a_1)/c_2.$$

The firm's beliefs are not being disconfirmed because if no-one is getting $y_i>y*$ average productivity is $(1-h)a_2+ha_1$ which is what it is paying each worker. There is no information forthcoming to the firm to cause a change in beliefs, this is therefore an equilibrium which can be sustained in this simple one

[3]Simply stated Pareto's welfare criteria suggests that there is an improvement in social welfare if one group or person is made better off without any other group or person in society being made worse off.

firm - one market model. The stability of such a pooling equilibrium is reassessed by Riley (1975,85) in a model where there are a number of hiring firms who compete for labour resources, and the equilibrium is found to break down.

If there is no correlation between signal cost and productivity, education could not convey useful information in this market. Spence notes that this negative correlation of costs and ability is a necessary but not sufficient condition for signalling equilibria. Effective signalling also depends on there being "sufficient number of signals within the appropriate cost range". In this model if y_i is only available in discrete units and they are either too far below $y*$ or too far above $y*$ then y_i ceases to be a useful signal.

This basic model gives an account of the informational functioning of the labour market, where there is no competition amongst firms in wage-setting, and by using education as the example of a signal adds to the debate over whether education is over-supplied by society and whether individuals should pay for their education beyond a certain level.

2.3.2 Spence's "Active Response" Model (1976)

2.3.2.1 Introduction

In Spence (1973) the typical firm observes the relationship between signal and worker productivity and responds by paying a wage equal to expected productivity conditional on the signal. The firm affects employee signalling decisions and therefore the observed relationship between education and productivity.

However this behaviour does not take into account the possibility that employers could anticipate the effects of their responses on the signalling behaviour of workers and therefore on the signal-productivity relationship.

If firms know what effect their responses to signals will have on the informational content of signals they will compete on this level as well as on wages, and this may alter the nature of the equilibria and eliminate the inefficiency of the 'passive response model' (PRM). Spence (1976) examines the properties of market equilibria when firms compete with respect to wages and signalling prerequisites, in the 'active response model' (ARM).

The ARM has two main behavioural assumptions. Firstly, firms know the way that the education-productivity relationship may change if and when the conditional wage schedule that determines the returns to a signal changes. Secondly, firms can accurately predict the education-productivity relationship that will appear in the group hired for any wage schedule given the schedules of rival firms.

We assume that there are a large number of identical firms, two types of worker, and a continuous scalar signal y, which now has some effect on productivity (as does type as in the PRM), we say $f_i(y)=$ productivity of Type i person with signal y. This model therefore corresponds to the notion of the weak screening hypothesis by allowing for some productivity augmentation from education. The signalling costs are $c_i(y)$ for Type i and $c_1(y)>c_2(y)$ and $c'_1(y)>c'_2(y)\ \forall\, y$.

Each firm makes wage offers, individuals select an employer and the appropiate educational signal with the aim of maximising net income and are hired. Spence locates equilibria and studies their properties.

2.3.2.2 The Equilibria

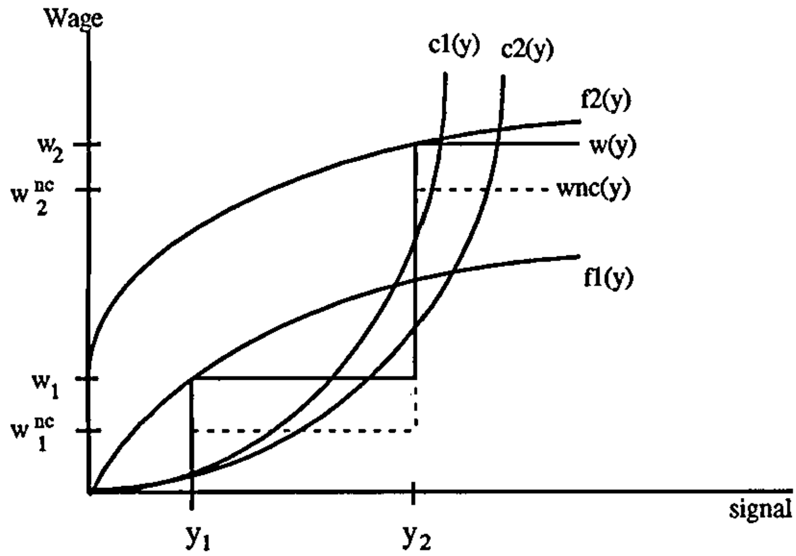
Suppose a firm with no competitors offered the wage schedule $w_i^{nc}(y)$ shown in Figure 2.3 so that those with $y<y_1$ are not hired, those with $y_1\le y<y_2$ are paid a wage $w_1^{nc}(y)$, and those with $y\ge y_2$ are paid a higher wage $w_2^{nc}(y)$. The firm would make a profit, and workers select y to maximise net income $w_i^{nc}-c_i(y)$ in a similar fashion to that explained in Section 2.3.1. Group 1 workers select y_1 to maximise net income and have productivity $f_1(y)>w_1^{nc}$, and Group 2 workers select y_2 to maximise net income and have productivity $f_2(y)>w_2^{nc}$

However, if we introduce a rival firm then the rival could poach all the original firm's workers by raising wages slightly and still make a profit. Competition of this kind would raise wage rates until each type was being paid a wage equal to their productivity, i.e. wage schedule w(y) in Figure 2.3.

If two groups signal differently, each will receive its productivity as wages in a competitive equilibrium, and more generally any collection of people with the same signal will receive its average productivity.

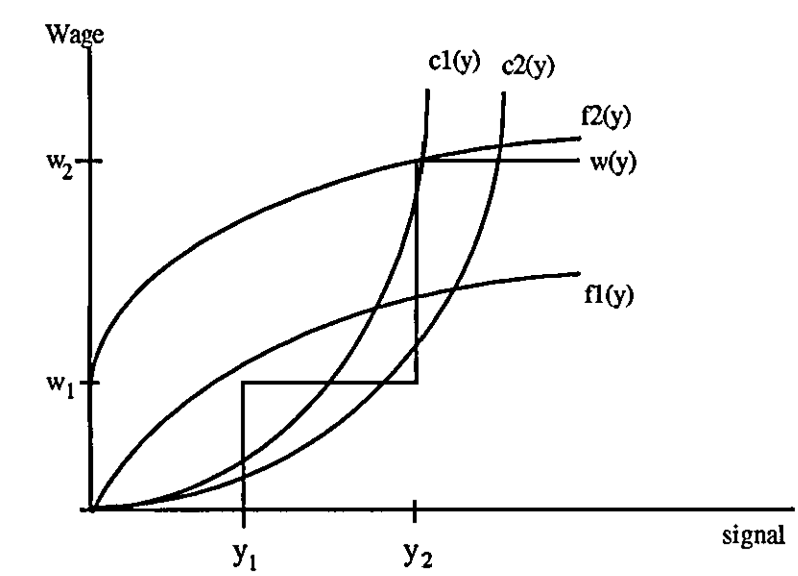
With such a wage schedule, where at the signal levels y_1 and y_2 selected by the two groups the wage paid equals their marginal product, there is no way a rival can outbid on wages alone.

Figure 2.3: Signalling Equilibria With and Without Wage Competition



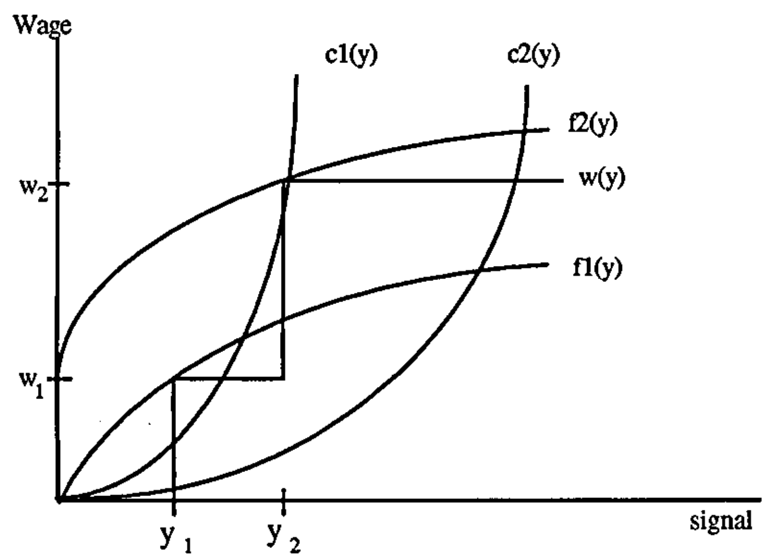
However, a rival willing to shift y_1 and y_2 as well as w_1 and w_2 may be able to poach workers (this was not possible in the PRM). Neither y_1 or y_2 in Figure 2.3 maximises net return to the two groups. Consider Group 1; in Figure 2.4 y_1 is moved to a level at which $f_1(y) - c_1(y)$ is maximised, and w_1 is slightly below $f_1(y)$. If a firm offered the schedule as shown it could poach all of Group 1 away from Figure 2.3 firms, and would make a profit. So the lower productivity group will signal at an 'efficient' level (one that maximises output net of signalling costs) in an equilibrium provided the two types signal differently.

Figure 2.4: Competitor's Wage Revision of w_1 to Slightly Below $f_1(y)$



A similar argument can sometimes be made for the higher productivity group. Figure 2.5 shows an offer schedule that induces each type to invest in efficient levels of y, where net income is maximised and both types are paid a wage equal to marginal product. Note that at y_2 net return to Type 1 is less than it is at y_1, so these workers have no incentive to signal y_2.

Figure 2.5: An Efficient Signalling Equilibrium



Spence suggests that 'efficient levels of investment in the signal and competitive wages can sometimes be achieved as a signalling equilibrium'. However, not all equilibria are efficient.

In Figure 2.6a the wage schedule has its steps at efficient y_i's but Group 1 will rationally pick y_2, because of the shape of its cost function $c_1(y)$. A firm that makes this offer will therefore lose money since $w_2 > f_1(y_2)$, and the schedule will not be an equilibrium. The signal carries no information and this may cause further losses since the firm cannot allocate jobs to workers correctly.

In Figure 2.6b y_2 has been shifted to a point where it is no longer rational for Type 1 to choose $y = y_2$, and where wages equal Type 2's productivity. The two groups rationally choose different y's and the signal carries information. No other wage offer that induces a separating equilibrium will dominate this one without causing the exit of at least one group from a firm making the different offer.

So we have put Type 1 at their efficient point and then pushed y_2 to a point that is inefficient for Type 2 and removes incentive for imitation by Type 1.

However, we cannot conversely put Type 2 at an efficient point and reduce y_1; if y_1 is reduced, y_2 must be increased even more to compensate the reduction in the net return to Type 1 at y_1 that may induce imitation.

Figure 2.6a: Inefficient Signalling Equilibrium where both types choose y_2

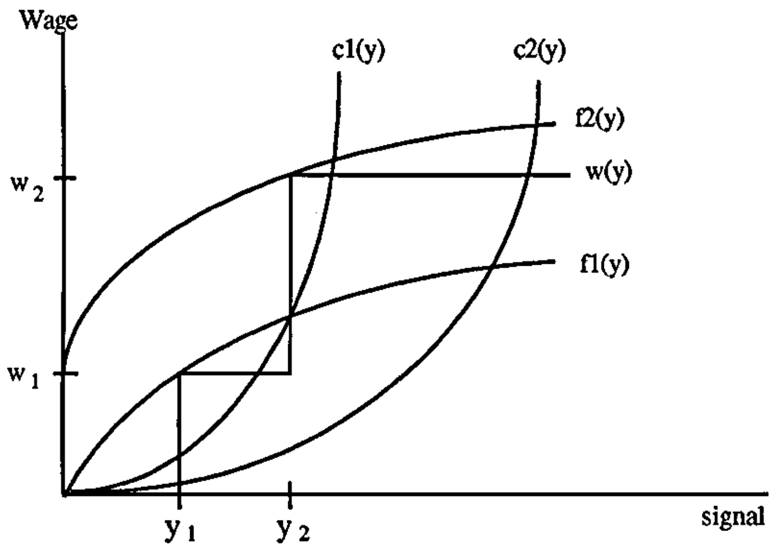
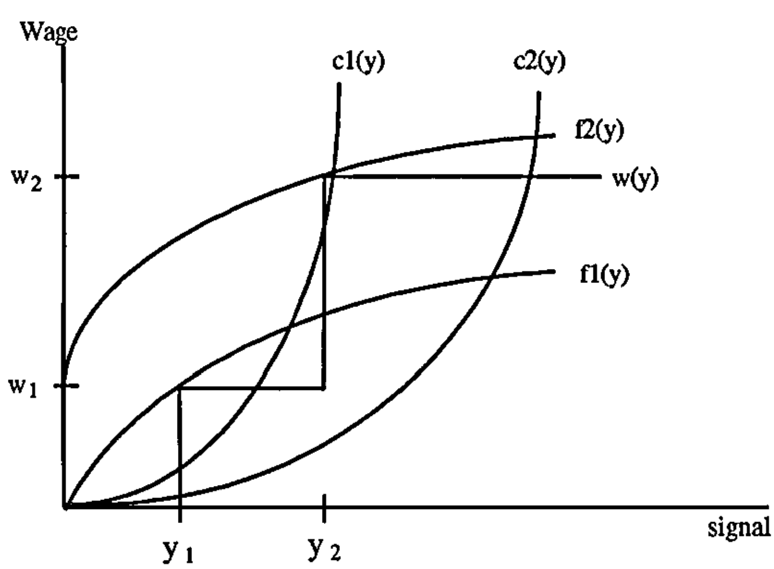


Figure 2.6b: Inefficient Signalling Equilibrium



Spence identifies three types of equilibria involving hiring of both worker types which are mutually exclusive and depend on the shape of the productivity and cost functions. Firstly, two-wage, full-information schedules that induce efficient signal investment (as in Figure 2.5). Secondly, two-wage, full-information schedules that induce efficient signal investment by Type 1 and over-investment by Type 2 (as in Figure 2.6b). Thirdly, one-wage, no-information schedules, where investment is not efficient for either type [see pp. 61-62 Spence (1976)].

2.3.3 Comparison Between PRM and ARM

Provided that wages equal expected marginal productivity given the signalling behaviour of workers, there is an equilibrium in the PRM. The wage schedule w(y) in Figure 2.3 is an equilibrium schedule in the PRM, however it is not an equilibrium in the ARM because neither group is maximising net income, and there is some other schedule that improves both groups' net income over the levels in Figure 2.3. Thus the effect of the ARM is to eliminate from the set of possible equilibria in the PRM any equilibria which are Pareto inferior to some other schedule. However, the elimination of these inferior equilibria does not guarantee full efficiency in the ARM as can be seen from Figure 2.6b where Group 2 chooses education y_2 above the net income maximising level.

The equilibria in the ARM are a subset of the equilibria in the PRM which are not Pareto dominated by other PRM equilibria. Spence (1976) illustraites that more informed and sophisticated competition in signals and wages eliminates some of the inefficiency of the PRM, but the tendency for over-investment in signals in all PRM equilibria is not eliminated in the ARM. Spence says that to escape this over-investment in the signal, wages have to be allowed to deviate from marginal products, but this is inconsistent with competitive behaviour.

2.3.4 Arrow (1973)

2.3.4.1 Introduction

Arrow (1973) differs from Spence's model in that the continuous educational signal y is replaced by a discrete signal; college graduation. Arrow models higher education as a filtering device which provides information in the labour market but does not augment productivity. In essence college graduation acts as a screening device with which firms can avoid the problems associated with the asymmetry of information in the labour market by sorting workers into different ability groups.

The asymmetry of information is defined by Arrow as follows: the firm has a poor idea of applicant ability but can acquire costly indirect information about the unobservable characteristic. The firm also knows the statistical distribution of productivities, but cannot differentiate between workers for which it has the same information [or signal as in Spence (1973)].

In theory after the firm has monitored each worker for some time in the workplace it may be able to observe their marginal products. The extent to which a firm does monitor ability accurately may reduce the value of the education screen, and this is discussed with reference to Stiglitz (1975) in Section 2.3.5.5.

Arrow follows Spence's reasoning in that it becomes a condition for an informational equilibria that the probability distribution of productivities to educational signals believed by firms generates self-confirming behaviour.

2.3.4.2 Model Outline

A worker has three attributes; academic record before college, probability of getting through college y conditional on previous academic record, and productivity z, having a joint distribution and being positively correlated with y. Firms can see whether an applicant has graduated from college or not. College is a double filter; once in selection of students for college entry, and once in grading them pass or fail.

Arrow assumes that the admission system aims to maximise the expected number of graduates by choosing a cut-off probability. The admission system uses pre-college record as a signal of potential college performance so admission is only granted iff $y \geq y_0$ and the probability of graduation of a random college entrant is;

(7) $\quad \bar{y}_e = E(y|y \geq y_0)$.

The expected productivity of a college graduate is

(8) $\quad \bar{z}_g = z_g / N_g$

where;

y_0 = critical graduation probability chosen by college admissions board,

z_g = total product of college graduates per unit of total labour force, and

N_g = proportion of the population graduating.

Graduation has some positive informational value if the productivity of a randomly chosen graduate exceeds that of a randomly drawn member of the population i.e. if $z_g > E(z)$. Admission procedures convey information if

(9) $E(z|y \geq y_0) > E(z)$

and college itself has additional informational content over simply admission if

(10) $\bar{z}_g = E(z|y \geq y_0)$

and since Arrow shows that

(11) $\bar{z}_g - E(z|y \geq y_0) = \dfrac{\sigma_{yz|y \geq y_0}}{E(y|y \geq y_0)},$

where $\sigma_{yz|y \geq y_0}$ is the conditional covariance of y and z given admission, college education conveys information about productivity beyond admission if there is a positive correlation between productivity and probability of graduation among those admitted i.e. (9) and (10) will hold if we assume $E(z|y)$ is an increasing function of y.

2.3.4.3 Social Value of Screening: One Factor Case

Arrow suggests that although higher education may have an informational role it may not be socially worthwhile. In the simplest model of production where all individuals are perfect substitutes, information about productivity has no social value. The total output of society will be $E(z) = \bar{z}$; the high ability workers are assumed to produce more whether or not anyone knows who they are. Arrow is therefore implicitly assuming, in the one factor case, that high ability workers are not crowded out by low ability workers i.e. this analysis is ignoring the idea that information in the labour market may well reduce adverse selection problems.

The private value of college graduation is the difference in wages the individual expects between the employer having no information and the employer using the filter. If the probability of graduation and the difference between the screened wage and the unscreened wage are high enough then it pays a person to incur the cost of being filtered; this is analogous to the signalling decision in the

Spencian model, although in this case acquisition of a certificate is probabilistic. The costs involved are a social waste as worker productivity has been assumed to be unchanged by college education.

Assuming that in equilibrium a proportion of the population attend college and a proportion do not, Arrow shows that everyone could be better off by prohibiting college. Firms know the expected productivities of both sets of workers. Potential college entrants know the probability of graduation of those who enter but not their individual probability of graduation conditional on their record. Colleges on the other hand know both probabilities.

There is a critical level y_0 such that individuals are admitted to college iff $y \geq y_0$; the critical level is determined in this case by demand for college education rather than capacity limits. The firm then pays graduates $\bar{z}_g = \bar{z}_g(y_0)$ as defined earlier. If $\bar{z}_n(y_0)$ is the expected productivity of non-graduates, then;

(12) $\bar{z} = \bar{z}_g(y_0)N_g + \bar{z}_n(y_0)(1 - N_g)$

and N_g as defined previously is a function of y_0 too.

An individual at college graduates with probability $\bar{y}_e$ and fails with a probability $(1 - \bar{y}_e)$. In both states he or she incurs a fixed cost c so that the expected return from college is:

(13) $E(R_c) = \bar{z}_g(\bar{y}_e) + \bar{z}_n(1 - \bar{y}_e) - c$

The return from not going to college is $R_n = \bar{z}_n$. Assuming risk neutral behaviour, equilibrium requires that the two returns are equal; since if $E(R_c) > R_n$ individuals with records slightly less than y_0 would find it profitable to attend college. Thus in equilibrium;

(14) $E(R_c) = \bar{z}_g(\bar{y}_e) + \bar{z}_n(1 - \bar{y}_e) - c = \bar{z}_n$

and we can see that

(15) $\bar{y}_e(\bar{z}_g - \bar{z}_n) = c$

and therefore $\bar{z}_g > \bar{z}_n$ and $\bar{z} > \bar{z}_n$

The income of the non-graduate is lower than before, and the college entrant does not benefit (ex ante) either since $E(R_c) = R_n$. Thus abolition of the filter may help everyone in this case since there is no efficiency gain from college and it creates inequality in ex post incomes.

This conclusion depends on the assumption of free entry to college. If college entry is rationed then (15) becomes an inequality, and entrants may gain on average. The non-entrants still lose out and income inequality is even worse.

If a stronger informational assumption is made in that the potential entrant knows the probability of graduation conditional on his or her record, and y_1 is the smallest record value to give expected returns from filtering at least equal to $\bar{z}$ the expected return with no filtering;

(16) $y_1 = N_g + y_0$,

then Arrow shows that if there are no values of $y > y_1$ then everyone will gain by the abolition of the filter.

The overall conclusion is that abolishing college in this abstract model could make everyone better off if incomes under no screening could be redistributed correctly. Clearly Arrow has assumed that college studies do not augment productivity and has implicitly assumed that the ability to be trained on the job is also unaffected i.e. there are no social gains from education in the form of increased individual output. Arrow does however analyse the possibilty of social returns to college filtering when there are two complementary worker types.

2.3.4.4 Social Value of Screening: Two Factor Case

Arrow shows that if there are two complementary worker types then education has a positive sorting role. Arrow analyses a model in which everyone is able to supply one unit of Type 1 labour, and different workers are able to supply different amounts of Type 2 labour. The supply of Type 2 labour measured in efficiency units is denoted z.

Assume that production requires fixed proportions of the two types of labour. By choice of units we can assume that one unit of each type of labour is needed to produce one unit of output. Suppose there are two groups of people A and B with expected productivities $\bar{z}_A > \bar{z}_B$, and supplies of Type 2 labour are measured in efficiency units. Arrow shows that it can never be optimal to simultaneously employ Group A in Type 1 jobs and Group B in Type 2 jobs.

Total output can be increased by accurate screening provided that its cost is sufficiently low. Arrow shows the gain in output due to zero cost filtering; if $N_A + N_B = 1$ are the population proportions of the two groups, then;

(17) $\bar{z} = N_A\bar{z}_A + N_B\bar{z}_B$

If the filter is not employed, a fraction N_1 of the labour force is randomly assigned to Type 1 jobs and the remaining workers are assigned to Type 2 jobs. The total supply of Type 2 labour in efficiency units is $(1-N_1)\bar{z}$. Efficiency requires that this equals N_1, and therefore the output without filtering is

(18) $N_1 = \bar{z} / (1+\bar{z})$

If the filter is used so that only Group A are assigned to Type 2 jobs, the supply of Type 2 labour is $N_A\bar{z}_A$ and that of Type 1 is N_B. If $N_B < N_A\bar{z}_A$ then some of Group A workers will have to be assigned to Type 1 jobs. That is $N_1 > N_B$ and efficiency requires $(1-N_1)\bar{z}_A = N_1$. So that

(19) $N_1 = \bar{z}_A / (1+\bar{z}_A)$ = output with screening and excess group A labour.

The increase in output is therefore:

(20) $$\frac{\bar{z}_A}{1+\bar{z}_A} - \frac{\bar{z}}{1+\bar{z}} = \frac{\bar{z}_A - \bar{z}}{\bar{z}_A(1+\bar{z}_A)} \cdot \frac{\bar{z}}{1+\bar{z}}$$

If there is a shortage of Group A labour for Type 2 jobs $N_B > N_A\bar{z}_A$, the optimal allocation requires that all Group A are assigned to Type 2 jobs and enough of Group B to make the supplies of the two types of labour equal; $N_A\bar{z}_A + (N_B - N_1)\bar{z}_B = N_1$. So that

(21) $N_1 = \bar{z} / (1+\bar{z}_B)$... =... output with screening and shortage Group A labour.

The corresponding increase in output is

(22) $$\frac{\bar{z}}{1+\bar{z}_B} - \frac{\bar{z}}{1+\bar{z}} = \frac{\bar{z} - \bar{z}_B}{1+\bar{z}_B} \cdot \frac{\bar{z}}{1+\bar{z}}$$

If Group A are graduates and Group B are non-graduates then it has been shown that college education has a positive social value if it is free so that people are screened by passing or failing. Arrow shows that the socially optimal amount of college education will be such that;

(23) $N_g\bar{z}_g \leq 1 - N_g$.

Note that c does not appear in this condition. Thus, even if education is free, it is socially optimal to restrict it so as to improve its screening role.

2.3.4.5 Competitive Equilibrium in the Two Factor Case

If the filter is complete, in that every graduate goes into a Type 2 job and every non-graduate goes into a Type 1 job, and also socially optimal then it is achieved by a competitive market in which college is supplied to everyone willing to pay the cost.

Let w_1 and w_2 be the price per unit of Group 1 labour and the price per efficiency unit of Group 2 labour respectively. Graduates and non-graduates earn $w_2\bar{z}_g$ and w_1 respectively per man. In equilibrium the expected wage of an entrant, net of cost, must equal the wage of a non-graduate, and Arrow shows that this gives the condition [see Arrow (1973), pp 211-212];

(24) $\bar{y}_e(w_2\bar{z}_g - w_1) = c$

Since one unit of each type of labour combine to produce one unit of output, exhaustion of production implies $w_1 + w_2 = 1$. Thus from (24) we see that $w_2\bar{z}_g > w_1$ if $c > 0$. This implies that no graduate is working at a Type 1 job, since none will work for w_1 if they can earn $w_2\bar{z}_g$ The total supply of Group 2 labour by all graduates therefore does not exceed the number of units of Group 2 labour used in equilibrium; which corresponds to condition (23) for optimal allocation.

If the equality held no non-graduate would want to work in a Type 2 job. In this case we must have $w_1 \geq w_2\bar{z}_g$. Conversely, if the inequality held, some non-graduates are doing Type 2 jobs, so $w_1 = w_2\bar{z}_g$. Thus one of the two possibilities must hold in equilibrium, depending on the parameters in the problem:

(25) $N_g\bar{z}_g = 1 - N_g$ and $w_1 \geq w_2\bar{z}_n$

(26) $N_g\bar{z}_g = 1 - N_g$ and $w_1 = w_2\bar{z}_n$

When (25) holds $y_0 = y_0^*$. Let y_e^* be the corresponding value of $\bar{y}_e$ (probability of graduation conditional on admission). If (25) holds we can solve for w_1 and w_2:

(27) $w_1 = \left[\bar{z}_g^* - (c / \bar{y}_e^*)\right] / (1 + \bar{z}_g^*)$

(28) $w_2 = \left[1+(c/\bar{y}_e^*)\right]/(1+\bar{z}_g^*)$

these are the equilibrium wages, and the complete filter is the equilibrium allocation provided $w_1 \geq w_2\bar{z}_n$, from the above in terms of cost this condition becomes:

(29) $c \leq \bar{y}_e^*(\bar{z}_g^* - \bar{z}_n^*)/(1+\bar{z}_n^*) = c_2$

Thus, for c in this range, the complete filter is the competitive equilibrium. Arrow shows that if c is in this range there may be multiple equilibria for some values of c satisfying condition (29), one of which will be the complete filter equilibrium.

The equilibrium condition for choosing college implies that the ex ante expected net income is equal to w_1 for all groups. Comparing w_1 with the expected output in the no-screening case $\bar{z}/(1+\bar{z})$ Arrow shows that when approaches zero, the competitive equilibrium is better than no screen. When $c = c_2$ we can show;

(30) $w_1 = \bar{z}_n^*/(1+\bar{z}_n^*) < \bar{z}/(1+\bar{z})$

Therefore there is a cost level between zero and c_2, call it c_3, such that a complete filter is better than no filter for c < c_3 and worse for $c_3 < c \leq c_2$. Moreover, the complete filter although competitive is not an optimal equilibrium for $c \geq c_3$, and the upper limit on the range of costs c_1 must be below c_3.

Emphasis should be placed on Arrow's conclusions regarding the two factor model since this case is more likely to occur in the modern workplace than the one factor case. As we have seen the social value of complete filtering in the competitive labour market depends upon the size of the cost of graduating from college. Similarly, Arrow shows that for equilibria with incomplete filtering, where some non-graduates are in Type 2 jobs, and where (26) holds, the equilibrium filter is worse for everyone than the absence of college education.

2.3.5 Stiglitz (1975)

2.3.5.1 Introduction

Stiglitz (1975) presents a simple two-type model of the screening process where the high type workers can take a perfectly accurate test again at a fixed cost, in comparison to Spence (1973) where high ability workers have a lower marginal cost of signalling. He shows that the idea of too much screening in equilibrium as presented by Spence and Arrow (1973) is not necessarily correct.

Stiglitz develops the central aspects of screening theory in a general model and analyses the impact of educational screening on income distribution and resource allocation.

2.3.5.2 Model Outline

Stiglitz begins with the most basic of examples of a screening process to aid the clarity of his analysis. He assumes workers can be described by a single attribute θ which is proportional to individual marginal product ρ;

(31) $\rho = m\theta$

we can choose units so $m = 1$. The fraction of the population that is type θ is $h(\theta)$.

Stiglitz assumes an asymmetry of information exists in the labour market such that a worker is fully aware of his or her ability but firms are not, and in the absence of any information firms, assumed to be risk neutral and competitive, treat all workers as if they were the same. The production process is assumed to be such that the productivity of any single worker cannot be measured without the firm incurring large costs. The output per worker is proportional to the average value of θ for those working in the process, since we assume no other inputs.

A worker receives a wage equal to the average value of marginal product of the workforce. If workers with higher θ can be identified they will receive a higher wage in the competitive economy and they therefore have an incentive to find a way to reveal their θ .

Assume two groups of workers with θ_1 and $\theta_2 < \theta_1$, able and less able. Assume a perfect screening device which costs c per individual screened where:

(32) $\theta_1 - \theta_2 > c > \theta_1 - \overline{\theta}$

(33) $\overline{\theta}$ = average value of θ = $h(\theta_1)\theta_1 + [1 - h(\theta_1)]\theta_2$

If the supply of labour is inelastic then the able workers get a discounted wage stream θ_1 and unable workers get θ_2. There are two types of equilibria:

There is a 'No-Screening Equilibrium' if no differentiation is made by firms between workers. All workers will be paid $\overline{\theta}$, the mean productivity of the population. This is an equilibrium because it does not pay the more able individual to be screened. With screening the worker would get $\overline{\theta} - c$ net income and by (32) this is less than the no-screening income $\overline{\theta}$.

There is a 'Full-Screening Equilibrium' if the firm differentiates workers by type. Type θ_1 workers obtain θ_1- c net income, and Type θ_2 workers obtain θ_2 net income, since they know they are less able and do not invest in any screening. In this case it pays the able workers to invest in screening since not to do so would mean they get θ_2 income which by (32) is less than their net income from screening.

Stiglitz indicates four propositions from this example. Firstly, there may be multiple equilibria.[4] Secondly, some equilibria are Pareto inferior to others: in the full-screening equilibrium both groups have lower net incomes than in the no-screening equilibrium; $\theta_1 - c < \overline{\theta}$ from (32) and $\theta_2 < \overline{\theta}$. Thirdly, the presence of less able workers lowers the net income of the more able group in both equilibria; with unable workers present, able workers would get θ_1 (in the full screening equilibrium) this is reduced to θ_1- c, and in the no-screening equilibrium $\overline{\theta}$. The presence of more able workers may increase the net income of the less able group; they get $\overline{\theta}$ instead of θ_2 in the no-screening equilibrium, or θ_2 in the screening equilibrium. Fourthly, if education is used as a screen, ignoring distributional effects, social returns differ from private returns. The gross social return in this example is zero, the net returns are negative (since there is a cost). The private rate of return to education in the screening equilibrium for the able group is;

$$(34) \qquad \frac{\theta_1 - \theta_2}{c} - 1 > 0.$$

Many such equilibria result in one group being made better off than in the absence of screening and another group being made worse off, but total net national output being lower. The equilibria in the example may appear to be Pareto sub-optimal, but caution should be taken; if (32) becomes $\theta_1 - \overline{\theta} > c$ then there is no screening equilibrium and a net welfare loss with the losses from screening to Group 2 exceeding the gains to Group 1. If we outlawed screening and compensated the able group and divided the cost of screening between the population, then everyone would be better off, but there are problems then in identifying the more able group in need of compensation without screening. Thus, even though under screening net national output is lower than in the absence of screening, the equilibrium could be more efficient since compensation

[4]There are multiple equilibria in a different sense to those indicated by Spence. In this case rather than there being multiple screening equilibria, it is possible to have two types of equilibrium under assumptions (32) and (33).

is possible which could make some group better off without making anyone worse off. However since screening may lower net national output and increase income inequality it may still be socially undesirable.

Stiglitz suggests that in a market economy the costs and benefits of screening would be borne by the worker as opposed to the firm. In an economy in which workers do not signal, the wage paid to all in a competitive equilibrium would be equal to the average productivity of all workers. If a firm conducted confidential private research into who was more able, it could earn a return to this private information, by employing the more able workers, equal to the difference between the marginal product of these workers and the average wage. Thus it would pay firms to conduct such research if the costs were sufficiently low. However, if the information became public knowledge the worker would get the benefits; firms bid the wage offered for his or her services up to his or her marginal product.

The worker therefore wishes to have such information become public knowledge and the firm wants it kept secret. If information gathered can become public knowledge the firms will not invest much into this form of research.

The gain from screening to able workers may be at least partially costly to unable workers, and they may wish to avoid making such information about abilities public knowledge. Stiglitz argues that if information is relatively costless, in a competitive environment everyone except the least able worker would have an economic incentive to publicise relevant information. If there are i types of worker, then if the highest ability group Type-i workers can provide information on their ability then the market for Type-i workers would clear with a wage in excess of the average wage (now lower) paid to the rest of the population. Therefore it pays the most able of this remaining sub-population to signal their relatively higher ability and so on, until all but the least able are sorted. But if (i -1) types have been sorted out, then the least able must also have been identified.

So, since workers are able to capture the returns to general information about their skills they are willing to incur costs; in a competitive economy firms that conduct research into general information will be unable to fully capture returns.

There are some conditions under which even the most unable may not willingly wish to pay for general information. Firstly, 'under-rated' workers may prefer self-employment where they can realise the same earnings as they would have done if they had been perfectly screened. Secondly, if self-selection contracts are available then an individual who is fully aware of his or her ability can take on the risk of hiring and training instead of the firm, and work for a low wage until they have proved they are of high ability (assuming ability can be costlessly observed in the workplace). However, many individuals cannot be perfectly sure of their abilities and would avoid taking such risk. Thirdly, workers who are uncertain of their abilities and are very risk averse, may prefer to be paid the average wage rather than risk the chance of being identified as below average in the screening process.

Stiglitz shows that the example used above had several essential assumptions which influence the results;

1. The more able workers are unambiguously more productive than the less able.
2. There are no increases in production from screening workers and labour is inelastically supplied.
3. Workers are fully aware of their own ability.
4. There is no method of on-the-job screening.
5. The screening method is perfectly accurate in identifying workers.
6. The information acquired is general information about ability in all sorts of jobs, rather than specific information about the ability to do a firm-specific task.

2.3.5.3 The Social Benefits of Screening

Under Assumption 2 there is no social return to screening, it merely redistributed output. However, there are cases in which screening may have a social value.

In the absence of screening, able workers are paid less than their true marginal products. Imperfect information acts as a tax on the more able, and a subsidy on the less able. This cross-subsidisation will distort the consumption-leisure decisions of workers. Provided there are 'appropriate tax instruments', if screening costs are low and labour is elastically supplied, everyone can be made better off by screening.

Secondly is the case of matching workers to jobs. It is widely accepted that workers differ in the comparative skills with which they can do different jobs and learn new skills. For example, if a bricklayer has a comparative advantage in carpentry and a carpenter a comparative advantage in bricklaying, there has been a mis-match of people to the jobs and this is inefficient. This is also applicable to firm-specific training where it is more economical to teach higher ability workers new skills than low ability workers. Stiglitz models the situation where there may be too little screening because social returns can be derived from job-matching i.e. by screening for comparative advantage where there are two types of jobs and two types of workers [see Stiglitz (1975), p. 289]

Thirdly, matching abilities of groups of workers in the workplace is important. For example, in an assembly line production process the wage paid to the assembly team will equal average observed marginal product of the workers, this will be below the potential marginal product since low ability workers will hold up the work of the high ability workers. Thus total output could be increased if there were two assembly lines, one for low and one for high ability workers where they work at their own pace and are paid accordingly. This implies some return to homogeneity.

Stiglitz models the situation where there may be too little screening because there are returns to homogeneity which could give social returns. In this case, Stiglitz assumes that output per worker on an assembly line is $\overline{\theta} - \beta\sigma^2$ where $\beta > 0$ and σ^2 is the variance of abilities of the fixed large number of workers on the line. Thus homogeneity will reduce σ^2 and improve output per worker.

The equilibrium involves no screening, and everyone is paid $\overline{\theta} - \beta\sigma_\theta^2$, if we assume the following;

(35) $\theta_1 - \overline{\theta} < \theta_1 - \theta_2 < c < \theta_1 - \overline{\theta} + \beta\sigma_\theta^2$

where σ_θ^2 is the expected variance on the assembly line drawn from an unscreened population.

If a single worker purchases screening, his or her income would be $\theta_1 - \beta\sigma_\theta^2$ - c which is less than $\overline{\theta} - \beta\sigma_\theta^2$. With full screening every worker is better off; the low ability group is paid $\theta_2 > \overline{\theta} - \beta\sigma_\theta^2$ and the high ability group is paid $\theta_1 - c > \overline{\theta} - \beta\sigma_\theta^2$. However, the Pareto-optimal full screening equilibrium is degenerate in a competitive economy since the net income of the high ability workers is less than that of the low ability workers: $\theta_1 - c > \theta_2$.

If $c < \beta\sigma_\theta^2$ it could pay the firms to screen workers if they do not screen themselves, to get output $\overline{\theta}$ rather than $\overline{\theta} - \beta\sigma_\theta^2$. However, it is unlikely that the information could be kept secret in this situation, since assembly line separation would be obvious, so firms could not profit since able workers would be bid away by competitors.

2.3.5.4 Risk Aversion and Incomplete Knowledge

If we relax Assumption 3 and introduce risk aversion to the model, then another reason why there may be too little screening is that workers are unaware of their abilities and are very risk averse. The reason for possible 'market failure' here is that contracts are unavailable that insure for ability [an idea modelled in 'implicit contract' theory; see the survey by Azariades and Stiglitz (1983) for more details].

In such a situation of uncertainty and risk-aversion it is also unlikely that self-selection contracts contingent on ability would help to avoid adverse selection problems. In this situation firms could capture the difference between a workers true marginal product and their self-perceived marginal product or reservation wage, if they could keep their research results secret. However, if other firms use job allocation as a signal of ability [a theory presented in Waldman (1984)] then they may be able to bid away these underpaid workers, and there is no incentive for research. Also, if two firms discover that a worker's productivity is less than the wage paid, the firms will compete against each other and bid up the worker's wage to equal their marginal product, and the returns to research are again equal to zero.

2.3.5.5 On-the-Job Screening

Now consider relaxing Assumption 4 that there was no on-the-job screening. This is likely to screen for slightly different attributes than educational screening, and the return to educational screening is likely to depend on the amount of on the job screening and vice versa. In the absence of on-the-job screening the equilibrium may well be Pareto inefficient.

Assuming workers have two attributes θ and ϕ and that productivity is represented by the function: $f(\theta,\phi)$, that θ is screened for by the educational system and ϕ is screened for on-the-job, and that costs are assumed to be such that it always pays to screen for one and only one attribute. Stiglitz shows that there may be two equilibria, one in which θ is used as a screen and another where ϕ is used as a screen [see Stiglitz (1975), pp. 290-292]. When ϕ is the screen it does not pay to use θ and vice versa. Stiglitz shows that an attempt to eliminate educational screening may just shift the emphasis of screening and make everyone worse off.

This view is shared by Arrow (1973) who also discussed the relation between what he termed 'on-the-job filtering' and 'college filtering'. The value of the college filter is reduced by the extent to which accurate on-the-job screening occurs. The possibility that on-the-job screening exists means that if it is perfectly accurate and Assumption 3 holds then there will be a full-screening equilibrium without expenditure on educational screening. Since accurate on-the-job screening and a self-selection fine system would replace educational screening.

This analysis can be compared to that of Salop & Salop (1976) in which ability-contingent self-selection contracts can negate the moral hazard problem of a worker over-stating their ability on application and no actual screening may need to take place. In Stiglitz's model the no-screening equilibrium comes from the assumptions that the workers know that the firm can precisely screen for ability on the job, that they are fully aware of their abilities, and there is a sufficiently high fine to workers who lie about their ability e.g. the 'fine' could be working for an initial wage lower than that available elsewhere and then being sacked.

In addition to the case where educational signals may be replaced by other signals, the assumption of more sophisticated behaviour on the part of workers when on-the-job screening occurs may give the result of no equilibrium in the model. Stiglitz suggests that if workers are aware of the effect of their signalling behaviour upon other agents then taking the action of others into account may lead to the no equilibrium result [See Stiglitz (1975), pp 290-292 and Rothschild & Stiglitz (1976) on this subject].

2.3.5.6 Educational Screening Mechanisms

The fact that there are other basis on which to screen workers e.g. on-the-job, or via employment history does not detract from the importance of education as a screening device since it is usually the primary determinant of a person's initial job opportunity and hence subsequent screening.

Educational institutions provide information about a person's ability for a number of reasons. The efficient allocation of educational resources requires the identification of individual abilities, since there are returns from finding out who are the faster learners. Part of the social marginal product of educational institutions is finding each students comparative and absolute advantages in different subjects. Additionally, a tutor's reference may be valuable in the eyes of an employer in addition to academic achievements.

There are several mechanisms by which knowledge about individuals collected by institutions is publicised. Firstly, if educational institutions sort for their own purposes, the groups into which a student was sorted may be a signal of individual ability. However, Greenwald (1986) shows that mis-identification problems can stem from estimating individual ability by observing group ability.

Secondly, failing a course in college or not making a grade in secondary school conveys a great deal of information which can badly affect future wage offers the individual receives; grades attained can also convey useful information.

Thirdly, information is conveyed by educational self-selection; if wages are a function of grades completed, and the length of time to complete a grade is a function of ability, then low ability individuals will quit at a lower grade level than higher ability individuals, and completed grades act as a self selected signal of ability.

Alternatively, assume we have a hierarchy of schools where some are for high ability individuals only and others just for low ability individuals. Assuming the schools use a binary grade system and that attending a school for the most able costs a great deal more than attending a school for the less able, then if individuals have full knowledge about ability they would apply to a school in which they are certain they would pass and therefore are self-selected.

The school system will determine the accuracy and efficiency of educational screening. Stiglitz assumes that the more institutions within the system perform their main functions of providing knowledge and skills, the more screening is produced as a joint product. The more accurately a system can determine comparative advantage the more accurately it will indirectly screen for absolute abilities.

However, some individuals are more likely to have high income parents who can afford the range of educational choices available to their children. Even if such income inequality is dealt with by government intervention there would still be important distributional effects from different educational systems resulting from their effectiveness as screening devices for individual ability.

Stiglitz shows that a comprehensive schooling system, where individuals of different abilites can all receive the same levels of education, may allocate too much (too little) resources to screening, relative to the amount that would maximise net national output, depending on whether individuals are informed (uninformed) about their abilities. However, if more able students are able to learn faster than less able students, then it is more efficient to spend more resources on the more able if the aim is to maximise net national output. This is a characteristic of a non-comprehensive education system.

2.3.6 Conclusion

Spence's (1973) 'passive response' model was a two type one firm model of a signalling process which did not allow for competition in wage setting from other firms, a continuum of types or productivity improvement from the education used a signal. The latter characteristic means that it is an example of the strong screening hypothesis were social and private benefits from education diverge. Although simple this model was a powerful in its effects upon economic thinking and stimulated further theoretical and empirical work.

Spence's (1976) 'active response' model differed from Spence's previous signalling model in that it allowed for more than one firm and for productivity improvement from education. Again the type of 'education' used as a signal was not specified although it is assumed in later theoretical and empirical work to mean higher education, or in some cases post-compulsory education. Allowing for more sophisticated behaviour on the part of firms eliminates some of the inefficiency of the 'passive response' model, but the tendency for over-investment in education remains.

Arrow (1973) specifically models higher education as a screening device in the labour market which does not improve productivity. His main conclusion from a screening model where there are two types of worker, but only one type of job, is that if higher education was abolished there could be a Pareto improvement in social welfare. However, when education is used to match two types of worker to two types of job the conclusion is not one of abolishment, but restriction, to improve social welfare.

In contrast, Stiglitz (1975) emphasises that whether there is too little or too much screening depends crucially on the assumptions made about the screening process, the knowledge that workers have about their abilities, the production process, and whether screening is 'job-matching' or hierarchical. Also, attempts to curtail educational screening may just shift the focus of screening with the possibility of increased equity but also inefficiency.

In Stiglitz (1975) there are multiple equilibria in the sense that for certain values of the fixed cost of being screened [in the interval given in condition (32)] an equilibrium where no screening takes place (i.e. a pooling equilibrium) and an equilibrium where screening does take place. In the first stages of analyses by Stiglitz, Arrow and Spence, the screening equilibrium is shown to be Pareto-inferior to the pooling equilibrium. In the Spencian model there are multiple equilibria in the sense that numerous separating equilibria can exist for certain levels of education in the interval given in condition (4), and the efficiency of these equilibria depends both upon the cost of signalling and the ability of firms to compete in their wage setting behaviour. In the latter stages of the analyses of Arrow and Stiglitz it was shown that sorting workers into low and high ability types can have social returns if the technology of production is such that workers have different aptitudes at different jobs; i.e. if screening is job-matching.

The next Section of this chapter explains how these early models were developed in the context of game theory. By changing the order in which firms and workers act in the labour market, or by developing the concept of competition amongst firms in wage setting inherent in Spence's ARM, this later work enabled economists to clarify the question of efficiency of signalling equilibria.

2.4 Game Theoretical Approaches to Educational Signalling

2.4.1 Introduction

In a signalling game Player A, has private information on the basis of which he sends a signal message to Player B, and Player B then responds to this new information. In Spence (1973) Player A is the worker and Player B is two or more competitive firms. We have seen that there is typically a multitude of equilibria resulting from such games, in which neither player has any reason to change their strategy from the strategy they have chosen given the strategy of the other. The equilibria therefore display the conditions necessary for them to be called Nash equilibria.

Generally in signalling models it is the uninformed players (firms) who commit themselves to offers after the fully informed players (workers) have acted; workers are assumed to have full knowledge of their individual productivity whereas the firm is not prior to hiring and has to rely on a signal. However, some theorists have modelled job market signalling when it is the uninformed that are the active players and move first, and these are known as screening models. Whilst signalling models often have multiple equilibria, screening models in contrast tend to have non-existant equilibria if out of equilibrium moves are ignored. Dynamic models which involve simultaneous actions by workers and firms have not been well studied [see Weiss (1995) for details on why these 'sorting' models have little acceptance amongst economists].

In a signalling model the issue is whether a multitude of equilibria can exist, whereas in a screening model it is whether any equilibrium can exist, given experimentation by the firm in its wage setting behaviour. However, in both cases the question that needs to be answered is whether there is one equilibrium that becomes a dominant outcome and if it is a Pareto efficient outcome i.e. can signalling behaviour lead to an efficient outcome.

In many games introducing the multitude of out-of-equilibrium beliefs that can be assumed gives rise to a multitude of equilibria i.e. what makes up an equilibrium is affected strongly by the interpretations that Player B applies to the signal that A might have sent, but in equilibrium does not send. For instance, the screening model of Rothschild & Stiglitz (1976), in which the firm moves first, suggests there may be no equilibrium at all, but this result has been criticised by Riley (1979b) and Wilson (1977) because the equilibrium concept Rothschild & Stiglitz use does not allow for reactions to contracts off the equilibrium path.

Thus work on equilibrium selection in such games turns towards the study of 'justifiable beliefs' for positions off the equilibrium path.

The main papers on the game theory interpretation of educational signalling in the labour market are discussed in this section. Yabushita (1983) and Stiglitz & Weiss (1983) analyse the Stiglitz (1975) screening model; Yabushita (1983) is not strictly a game-theoretical analysis but is included in this section since Stiglitz & Weiss (1983) assess Yabushita's critique using game-theoretical terminology. Both Riley (1985) and Cho & Kreps (1987) analyse the Spence (1973) signalling model using game-theoretical terminology.

2.4.2 Stiglitz (1975) Reconsidered

In the Stiglitz (1975) model the wage strategies chosen by the employer in equilibrium make zero expected profits since free entry and competition are assumed. In the case of no social return to screening it has already been shown that the condition for multiple equilibria (no-screening and full-screening are possible) is that c lies in the interval shown in (36); the notation corresponds to that of Section 2.3.5:

(36) $\theta_1 - \theta_2 > c > \theta_1 - \overline{\theta}$

(37) $\overline{\theta}$ = average value of $\overline{\theta}$ = $h(\theta_1)\theta_1 + [1 - h(\theta_1)]\theta_2$

Stiglitz (1975) assumed that wages are equal to the respective productivities of workers if they are known, and equal to average productivity shown in (37) if they are not known by the firm, and the firm dislikes any other wage policies even if they may be profitable. Under these assumptions if $\theta_1 - \theta_2 \geq c \geq \theta_1 - \overline{\theta}$ there may be both the no-screening and full-screening equilibria.

However, Yabushita (1983) claims that this result would not be true if we assume the firm can adopt other more profitable wage policies. In the full-screening equilibrium assuming (36) holds the more able worker receives a net income of $\theta_1 - c$ and the less able receive θ_2. The employer could make a profit, without any information about the ability of employees from paying a wage w where, $\overline{\theta} > w > \theta_1 - c > \theta_2$.

Under this wage strategy both the more able and the less able workers can be paid more than in the full-screening equilibrium, but the total wage bill does not exceed total output. Since the firm and workers prefer this wage scheme the full-screening equilibrium does not exist as long as $\theta_1 - \overline{\theta} > 0$.

The firm could alternatively choose wages for the more able and the less able workers w_1 and w_2 such that:

$$(38) \quad w_1 h(\theta_1)+w_2[1-h(\theta_1)] \;=\; \overline{\theta} \;=\; \theta_1 h(\theta_1)+\theta_2[1-h(\theta_1)]$$

a zero profit condition, and $w_1 - c > w_2$ the net income of the higher ability workers is more than that of the low ability workers. This type of policy implies that one group subsidises the other.

However, such an equilibrium cannot exist. Consider the following wage sets;

A: $\quad w_1 = \overline{\theta} + \delta > \theta_1$ and $w_2 = \overline{\theta} - \delta < \theta_2$,

B: $\quad w_1 = \overline{\theta} + \frac{1}{2}\delta > \theta_1$ and $w_2 = \overline{\theta} - \frac{1}{2}\delta < \theta_2$,

where $\delta > 0$. If the employer offers wage pair B the less able prefer B to A, but the more able prefer A to B. The wage policy B is profitable for sizes of δ such that $w_2 < \theta_2$ but the employer loses money with A because less able workers move to firms offering B, so that the full-screening equilibrium at A is not viable. For similar reasons, the equilibrium with subsidies from the more to less able cannot exist.

The existence of the full-screening equilibrium results from the behaviour of the firm assumed by Stiglitz. However, the no-screening equilibrium exists under (36), and with a screen with fixed cost c there is a unique equilibrium except when $\theta_1 - \overline{\theta} = c$, where both types of equilibria may exist. As long as there are multiple equilibria Stiglitz's conclusion about Pareto inferiority of full-screening still holds; the more able earn $\theta_1 - c = \overline{\theta}$ in both types of equilibria, and the less able get $\overline{\theta}$ in the no-screening equilibrium and θ_2 under full screening.

The non-existence of equilibria is also alluded to by Riley (1975) in reference to Spence's model with a different screening process. Again the existence of equilibria depends on behavioural assumptions about the firm in the screening process rather than the actual process involved.

Stiglitz & Weiss (1983) reply to Yabushita's critique of Stiglitz (1975). Stiglitz & Weiss re-formulate Stiglitz's model in game theoretic terms, so that the strategy of the firm is the conditional wage offer based on whether the individuals signal. The strategy of the individual is the decision of whether or not to acquire the education that acts as a signal.

An individual accepts the highest wage offered. The payoff to the individual is this maximum wage less the cost of screening they may have undertaken. The payoff to the firm is zero if they do not employ the individual, and if the individual is employed the payoff is the difference between the marginal product of the worker and the wage paid.

One way of viewing the difference between the Yabushita and Stiglitz models is in their assumptions of which of the two players moves first. In the Stiglitz model the informed individual moves first in choosing education level prior to the uninformed firm's wage offer. The individual chooses his or her strategy in the first period, and in the second period the firm offers a wage which is the profit-maximising response to the individual's strategy and given other firms' wage offers.

Thus if no workers screen themselves they all receive a wage equal to expected productivity $\overline{\theta}$, and if Type 1 screen they will be paid θ_1, and the unscreened workers will get θ_2, corresponding to expected productivities. In each case higher wages would incur losses, and a lower wage could not be an equilibrium since other firms would bid away workers up to a point where the wage paid equals marginal product.

If no-one is screening, a high ability worker would only raise their income if their productivity net of screening costs exceeds the productivity of a random draw from the population. Thus if the converse is true i.e. $\overline{\theta} > \theta_1 - c$, there exists a no-screening (pooling) equilibrium. Conversely, a screening equilibrium could exist if the productivity of the most able net of screening costs exceeds the productivity of the least able. Thus, in this model multiple equilibria are a possibility.

This analysis assumes that there are a large number of workers, firms and different worker types such that the strategy of one individual will not affect the wage offers of firms. Workers know that for every signal choice firms will respond in a profit maximising fashion on the basis of other firms action and those signals.

Conversely, Yabushita assumes that the uninformed employers make their wage offers prior to informed workers choosing signals, and the strategies of workers are passive reactions to these wage offers. In this model multiple equilibria cannot exist.

If $\overline{\theta} > \theta_1 - c$ then any supposed full-screening equilibrium would be broken by a firm offering a wage (under no-screening) of $\overline{\theta} - d$ where $d < \overline{\theta} - \theta_1 + c$. The reason why there is no multiple equilibria result is that firms move first and the wage offer determines whether workers screen themselves. Thus there is only a pooling equilibrium; this depends on there being a fixed cost of screening c, and an absence of alternative screening devices. The Yabushita equilibrium is similar to a Nash equilibrium in which workers are not active players in the game.

Thus a second interpretation of the difference between the two models is that Stiglitz (1975) has a model with two active players, Yabushita (1983) has a model with one active player. In Yabushita's analysis workers simply choose the best wage offered i.e. they act rationally but not strategically, they just react to the firms strategy (who takes the reaction of workers as fixed).

The passive worker assumption is only plausible if the screening is some pre-employment test administered by the firm as in Guasch & Weiss (1980). However, in Stiglitz (1975) where the screen is an educational course with a probability of passing positively correlated to individual ability, it seems implausible to him to think that workers passively react to firms' wage offers. It is more realistic to assume that individuals strategically choose whether or not to screen and the firm makes offers conditional on this decision, and this results in multiple equilibria.

Weiss (1983) shows that the problem of multiple equilibria does not disappear with more realistic assumptions such as imprecise knowledge on the part of the individual about his or her ability, imprecise tests, and non-discrete education levels. However, some of the resulting Nash equilibria are implausible and Weiss introduces a more restrictive definition of equilibrium to eliminate these [see Weiss (1983), pp 429-435].

Yabushita's comment concerning returns to homogeneity on an assembly line again assumes that either the firms employ the screening process as in Guasch & Weiss (1980), or that workers passively respond to the wage structure offered by firms. Stiglitz & Weiss (1983) suggest that in adverse selection models it is important to correctly identify who is actively signalling or screening, since only then can you correctly define the equilibrium.

2.4.3 Spence (1973) Reconsidered

2.4.3.1 Introduction

Riley (1975) drops Spence's assumption of price-taking agents and shows that from the set of seperating equilibria that exist in the Spencian model only the Pareto-dominant equilibrium survives experimentation by firms.

The Spencian signalling equilibrium is self-confirming in the sense that the wage paid to workers equals their marginal productivities. Riley suggests that the firm may experiment with wage offers by replacing offers rejected by applicants and to confirm *a priori* beliefs. A wage profile which develops from such experimentation is termed a 'fully-confirmed' equilibrium and Riley shows that only the Pareto-dominant wage profile, in which all workers except the least able buy an education with marginal cost exceeding marginal social product, is such an equilibrium. The least able buy education as if firms could costlessly predetermine ability.

Similarly, Wilson's (1977) insurance model suggests that agents anticipate the response of others when they consider new contracts. The 'reactive' equilibrium which results from this behaviour is an alternative equilibrium concept to the Nash Equilibrium. A set of strategies $s_1^*,\dots,s_n^*$ for n competitors is a reactive equilibrium if

1. For any agent i and any alternative strategy s_i that raises i's payoff there is another agent j who can profit by reacting at the expense of i.
2. There is no further reaction by another agent that can make j's reactions unprofitable.

The equilibrium is reached since agent i will recognise j's incentive to react and will choose s_i^* instead of s_i.

Riley (1979b) argues that of the sets of signal-wage contracts that separate worker types it is the Pareto-dominant set which is such a reactive equilibrium. This equilibrium is unique in that there can be no reactive pooling equilibrium.

However there can be some criticism levelled at assuming such sophistication in the behaviour of firms; for example a thorough knowledge of the signalling process on the part of the firm is unlikely given the 'noise' created by other sources in the labour market affecting the relationship between productivity and education; therefore Riley (1985) provides an alternative analysis of the (non)existance of signalling equilibria.

Instead of modifying the equilibrium concept Riley (1985) modifies the model itself. In contrast to the preceeding literature Riley argues that there is a family of signalling models which give a strong Nash Equilibrium i.e. all price (wage) competition is unprofitable in the absence of reactions by other price-setters.

Riley's model is different from preceeding models in that the implicit assumption that in a world of perfect information all agents would enter the market is dropped. Instead he assumes that a positive proportion of workers would choose not to participate since the alternative wage that they could earn in another market is not being matched or exceeded in the market in question. This modification of the Spencian framework is critical since it means that price competition for workers with the lowest signal level is no longer profitable.

The main aim of Riley (1985) is to define the conditions under which price competition is also unprofitable at higher signal levels. Spence's main assumption was that for education to be a useful signal it had to be less costly for higher quality individuals. The main result of Riley's analysis is that if the proportional rate of decrease of the marginal cost of signalling, with respect to quality, is sufficiently high then a Nash Equilibrium exists i.e. price competition is never profitable.

2.4.3.2 Riley (1985) Model Outline

Each worker can provide one unit of service, and choose signalling level s. Differences between workers are solely encapsulated in the variable $a_i \in A$ which can be seen as ability, thus workers can be described as Type-i.

A contract (s,w) between a firm and worker is payment w in return for signal level s. If a Type-i worker accepts the contract the value of his or her output on the job is $V(a_i,s)$ so the firms profit per worker is

(39) $$\pi(a_i,s,w) = V(a_i,s) - w$$

Higher a_i's give increased $V(a_i,s)$, and assume $V(a_i,s)$ is nondecreasing in s.

Worker preferences are represented by the utility function $U(a_i,s,w)$ where $\partial U/\partial w > 0$ and $\partial U/\partial s < 0$. For each worker there is an alternative opportunity outside this market that gives utility U_R.

Assume also that the marginal cost of signalling i.e.

(40) $$MC_s = \left.\frac{dw}{ds}\right|_U = -\frac{\partial U(a_i,s,w)/\partial s}{\partial U(a_i,s,w)/\partial w}$$

decreases as a_i increases. This ensures that the choice of signal $s(a_i)$, given offers, is nondecreasing in a_i.

A Type-i worker who chooses signal level s has a value to each firm in the market of $V(a_i,s) = a_i$. Each worker has an opportunity to work elsewhere for a wage w_R. The cost of the signal is $C(a_i,s)$, and the net return to the worker given the wage offer (s,w) is

(41) $$U(a_i,s,w) = w - C(a_i,s)$$

Condition (40) therefore becomes a requirement that the marginal cost of signalling $\partial C / \partial s$ is lower for the more productive workers.

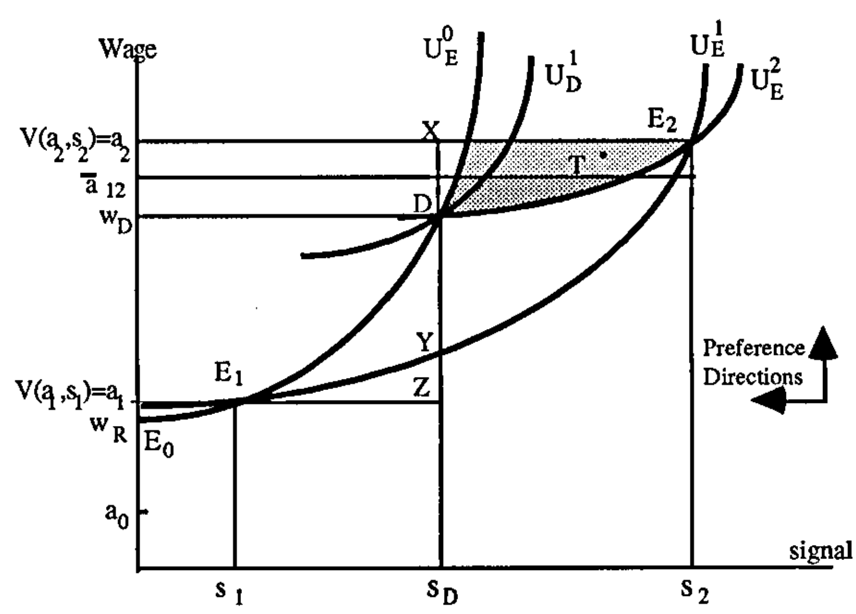
Rothschild & Stiglitz (1976), in the context of a screening model of insurance, showed, for a two type case, that no contract that attracts more than one type can be part of a stable Nash equilibrium.

More generally Riley takes the proposition that a Nash equilibrium contains no pooling of types as given. The emphasis is therefore upon separating equilibria contracts. Riley assumes three types of worker $A = \{a_0, a_1, a_2\}$ and $a_0 < w_R < a_1 < a_2$. Each worker aims to maximise net return by choice of contract (s, w). Riley assumes, as is usual, that if two contracts give the same net return then the indifferent worker will choose the one requiring the lowest s.

As shown in Figure 2.7 $\{E_0, E_1, E_2\}$ are a possible set of separating contracts. A Type 0 worker has the steepest map of indifference curves $U_0 = U(a_0, s, w)$ and chooses E_0. Type 1, with $U_1 = U(a_1, s, w)$, chooses E_1, and Type 2 has the shallowest map of indifference curves $U_2 = U(a_2, s, w)$ and chooses E_2.

Only individuals who have productivity exceeding w_R will choose to signal. Thus the allocation of workers between this and the alternative market is efficient. The profit on each contract is zero, and each Type-i worker is indifferent between contract E_i or contract E_{i+1} chosen by Type-$(i+1)$. Thus of all possible sets of separating contracts the set $\{E_0, E_1, E_2\}$ is Pareto efficient.

Figure 2.7: Pareto Efficient Separating Contract Set



Riley's second proposition is that if the hypotheses of the model are true then from the set of possible separating contracts which are not unprofitable to the firm, there is a unique Pareto-efficient set which has three properties. Firstly, the contracts are characterised by zero profits. Secondly, the allocation of worker types is efficient between those who do and those who do not signal. Thirdly, if the number of types is discrete then if contract E_i is chosen by Type-i the worker is indifferent between this contract and contract E_{i+1}.

However, $\{E_0, E_1, E_2\}$ is not a Nash equilibrium; any offer in both the shaded areas is prefered by both Types 1 and 2. If their average productivity $\bar{a}_{12}$ is as shown, then any alternative contract in the dense shaded area is strictly profitable for the firm to offer.

We can also see why there will be no pooling Nash equilibrium; suppose that Types 1 and 2 choose contract (s_D, w_D). For this to be not unprofitable $w_D \leq \bar{a}_{12}$, but there is always a contract T that is preferred only by Type 0 and is strictly profitable for the firm.

Riley looks for conditions under which the area of profitable alternatives to $\{E_0, E_1, E_2\}$ does not exist. Firstly, if the population proportion of Type 0 who do not signal is sufficiently large, it will not be profitable to make an offer that attracts all types. In this case the whole shaded area is the set of profitable alternatives. Since U_E^2 bounding this set slopes upwards, the most profitable point in this set is D, where there is an intersection between U_E^0 and U_E^2. Holding Type 0 preferences fixed point D can be moved by altering the shapes of the indifference curves of the other types, and we look for a situation with $w_D > \bar{a}_{12}$. This will be the case if XD < $a_2 - \bar{a}_{12}$ i.e. if

$$(42) \qquad \frac{XD}{XZ} < \frac{a_2 - \bar{a}_{12}}{a_2 - a_1} = \frac{h_1}{h_1 + h_2}$$

where h_i is the proportion of Type-i in the population. Since XZ > XY, a sufficient condition for $w_D > \bar{a}_{12}$ is

$$(43) \qquad \frac{XD}{XY} < \frac{h_1}{h_1 + h_2}$$

Riley shows that this reduces to

$$(44) \qquad \frac{\frac{\partial C}{\partial s}(a_2, s)}{\frac{\partial C}{\partial s}(a_1, s)} < \frac{h_1}{h_1 + h_2}$$

Wage competition is unprofitable if (44) holds for all s:

The sufficient conditions for a Nash equilibrium (in the seperable case) are given in Riley's third proposition; suppose that alternative options are such that a majority of low quality workers would, under full information, choose not to enter the market. Then, if the proportional rate of decline with a_i of the marginal cost of signalling is sufficiently large, the Pareto-efficient set of separating contracts is a Nash Equilibrium.

With more than three types the same argument holds for every potential pool between two neighbouring types, and similar results hold for a continuum of types. The analysis is extended by Riley to fit the general case where the utility function is not separable and the value function depends both on type and signal level.

Riley's fourth proposition allows for a direct productivity enhancing effect of the signal and outlines the sufficient conditions for a Nash equilibrium. Suppose that alternative options are such that a large number of low quality workers would, under full information, choose not to enter the market. Suppose also that, the marginal cost of signalling for each of n types is nonincreasing in return to signalling, w. Then the Pareto-efficient set of separating contracts is a Nash equilibrium whenever the proportional rate of decline in the marginal cost of signalling with respect to a_i :

$$(45) \qquad -\frac{\left.\frac{\partial}{\partial a_i}\frac{dw}{ds}\right|_{U(a,s,w)=\bar{U}}}{\left.\frac{dw}{ds}\right|_{U(a,s,w)=\bar{U}}}$$

is sufficiently large.

We can also use Figure 2.7 to illustrate the concept of a reactive equilibrium in Wilson (1977). A firm may take into account the anticipated reactions of others when considering new offers. Consider a new offer D, which will give positive profits and a pooling of types, as an alternative to set $\{E_0, E_1, E_2\}$. There is always a reaction such as T that 'skims the cream'; as a result the initial 'defection' D generates losses while reaction T gives profits on each worker who accepts it. A firm considering contract D will see reaction T as a threat and will therefore not choose to offer D. The Pareto-efficient separating set $\{E_0, E_1, E_2\}$ is then a reactive equilibrium. However, implicit in this concept is the assumption that a rival can react quickly to the announced offer D, and offer T in competition, before the contract D firm yields profits. Thus this non-Nash equilibrium concept is open to criticism on the grounds that assumption of quick reactions of competitors may not be plausible in a dynamic labour market characterised by trade union wage bargaining and long-term labour contracts.

Riley also proves that, for a case where there is a continuum of types, values of the elasticity of the marginal cost of signalling with respect to a_i that give sufficiently large potential gains from signalling also lead to the existence of a Nash equilibrium [See Riley (1985), Propositions 5 and 6].

Riley (1985) shows that the model displays a unique Nash equilibrium, and sufficient conditions for such an equilibrium are satisfied when the returns to those signalling are sufficiently large. The model predicts that equilibrium problems tend to arise only when potential gains from signalling are small.

2.4.3.3 Cho & Kreps (1987) and The Intuitive Criterion

Cho & Kreps (1987) (refered to as C & K henceforth) generalise criteria from previous literature for testing the stability and dominance of signalling game equilibria and apply them to the Spencian model.

In a sequential equilibrium Player B makes some hypothesis about what private information Player A has and how to respond. Varying the hypotheses gives various optimal strategies for Player B, and hence changes the signalling incentives of Player A. Many analysts have used intuitive criteria based on the inferences that Player B should make about Player A's private information from out-of-equilibrium signals [see C & K, p. 181]. If the out-of-equilibrium beliefs of Player B can be restricted then many game equilibria can be eliminated.

Assume that player A's private information is either a or a', and that in equilibrium A sends signal s with probability equal to one. Suppose an alternative signal s' is possible with the following properties;

1. If Player A knows a then they would, compared to the equilibrium outcome, strictly prefer not to send signal s', no matter how Player B interprets this.

2. If Player A knows a' then they would, compared to the equilibrium outcome, prefer to send signal s' if by sending s' Player A could convince Player B that they knew a'.

Condition 1 implies that Player B should not think that the message s' came from a Player A who knows a. Player B should infer from the message s' that Player A knows a'; and therefore if Player A knows a' they should send message s' thus upsetting the original 'equilibrium'.

In the words of C & K it is as if a Player A that knows a', is by sending s' implicitly saying;

"I am sending the signal s' which ought to convince you that I know a'. For I would never wish to send s' if I know a, while if I know a' and if sending this signal so convinces you, then, as you can see, it is in my interests to send it."

C & K refer to the criterion that follows from this as the Intuitive Criterion (IC).

An equilibrium is meant to be a candidate for self-enforcing behaviour that is common knowledge amongst players, so in testing an equilibrium outcome C & K assume that it is common knowledge amongst players and look for contradictions. The IC therefore relies heavily on the common knowledge of the candidate equilibrium outcome, and defections from this 'equilibrium' are seen as a conscious effort to break it.

If there are only two types of worker, C & K show that the Riley outcome is the only equilibrium outcome that survives the IC [see C & K, pp 208-212].

Banks & Sobel (1987) propose 'divinity' tests of signalling equilibria [Also see C & K, pp. 205-206]. These divinity tests subsume equilibrium domination and stability tests and correspond to iterative applications of the two divinty criterion presented by C & K and the dropping of type-message pairs. C & K show that all pooling equilibria fail the Banks-Sobel universal divinity criterion and suggest that of all possible separating equilibria tested with the divinity criterion only the Riley outcome survives.

Although Cho & Kreps show that the IC is not sufficient to give the Riley outcome when there are more than two ability levels, they suggest that the criterion would suffice in the many type case if it was assumed that workers move first in showing firms what education levels they have achieved. In this game there are sequential equilibria in which the equilibrium wage paid to workers is less than their expected value to the firm, and the worker cannot ask for more as this will alter beliefs. When the IC is applied a unique Riley equilibrium is the only one that survives no matter how many worker types exist. However, C & K state that they should not be viewed as justifying the restriction of the Spence model to the Riley outcome. Indeed Hellwig (1985) shows that under different assumptions only Wilson's Reactive Equilibrium survives stability tests.

2.4.4 Conclusion

We have seen that the results of the game theoretic models of the job market signalling depend upon the order of moves in the game and the existance of out of equilibrium beliefs. In Riley (1985) it is the uninformed firms who move first in offering contracts to workers. Stiglitz & Weiss (1983) show that the problem in a re-ordered model, in which the uninformed firms respond to the actions of informed workers, is not the existence of a Nash equilibrium but a multitude of such equilibria. However, Cho & Kreps (1987) argue that the only 'stable' Nash equilibrium is the Pareto-dominant separating wage profile (set of contracts) presented in Riley (1985).

In essence, Riley (1985) shows that, with sufficiently high potential gains from signalling, the stable equilibrium which resulted from experimentation off the equilibrium path by firms was the Pareto-dominant equilibrium outcome. Thus we have a situation where the first best solution, that of full information which common knowledge, cannot be achieved and we have instead a second best solution, the Riley outcome, which although less efficient than the theoretical first best is more efficient than the third best solution; incomplete information with no signalling.

2.5 Concluding Comments

2.5.1 Cost Assumptions and On-the-job Screening

It is the absolute size of the cost of the educational signal which is the critical factor in determining the social value of screening in Arrow's model, and in Section 2.3.5 we have seen that Stiglitz (1975) follows Arrow's cost assumption in deriving a screening equilibrium condition which depends upon the size of a fixed screening cost. This contrasts with Spence (1973) in which it was the relative size of signalling costs between the high and low ability workers which was the critical factor in determining the existence of a screening equilibrium, and in Section 2.4.3.2 Riley (1985) takes Spence's critical cost assumption further in that he assumes that the marginal cost of signalling decreases as worker ability increases.

In terms of the dis-utility associated with increased study to maintain academic performance on the part of low ability individuals, the assumptions of Riley (1985) and Spence (1973) are acceptable. However, if on-the-job screening (or any other alternative screening method) is used by employers in the labour market models then in terms of foregone income Riley and Spence's cost assumptions must be re-considered. Another alternative is a screening process based on previous work experience as indicated on a *curriculum vitae*. The ability-cost relationship may be changed, regardless of the presence of on-the-job screening, since such screening may enable the firm pay seperate wages to high and low ability workers on the point of hiring, thus driving a wedge between the foregone wage costs of high and low ability workers from day one of their studies.

Without on-the-job screening, wages foregone by both low and high ability workers are the same and equated with average marginal productivity of the pooled group [see Equation (1) in Section 2.3.1]. However, if on-the-job screening occurs then the high- and low-ability workers will, after some monitoring period, be paid seperate wages in line with individual rather than group productivity. High ability workers will earn a wage higher than the average wage and low ability workers will earn a wage lower than the average wage. Thus the value of the discounted wage-stream foregone by high ability workers is larger than the value of the discounted wage-stream foregone by low ability workers during their studies. On the basis of wages forgone the cost of educational signalling given the existence of on-the-job may therefore increase as ability increases.

This result depends on the time it takes the employer to accumulate information and reformulate wages, and the time taken to acquire the appropiate educational signal. However, note that it takes approximately three years to complete a degree course, and a starting salary contract between employer and employee may only be written for one year. In terms of a scalar educational signal (years of education) we have seen that it is rational for a worker intending to signal that they have high ability to acquire only the exact minimum level of education they need to secure the higher wage, and therefore both worker types will spend the same amount of years in education if they are both trying to signal the same level of ability. In terms of university graduation as a signal of ability, it is rarely the case that high ability individuals acquire the signal in a shorter period of time than low ability individuals simply because of the way the courses associated with such qualifications are time-tabled at such educational institutions.

The extent to which the cost of signalling in terms of wages foregone outweighs the disutilities assoicated with studying will then determine the direction and size of relative screening costs between the two worker types in Spence (1973), and whether the marginal cost of signalling decreases as ability increases in Riley (1985). The presence of an alternative form of screening may remove possible educational screening equilibria from the labour market models of Spence (1973) and Riley (1985) and it is therefore implicitly assumed that no other forms of worker screening exist in these models.

A simplification in Riley (1985) was that the opportunity cost of signalling was the same across all types; from the above, it seems more plausible that workers with higher ability will have higher opportunity cost. However, Riley states that introducing a reservation utility that varies across types leads to similar conclusions as his original analysis.

2.5.2 Theoretical and Empirical Implications of Later Models of Wage Determination

In the screening models outlined in this Chapter, and the human capital theories of Mincer (1974) and Becker (1975), the wage rates of employees are set by firms to equate with the marginal product of the firms' labour force, which is observed either directly or indirectly, with the aim of maximising profits.

In comparison to the screening hypothesis human capital theory assumes that no informational asymmetry problems occur and that productivity is costlessly observed and wage rates are based upon observed productivity which is augmented by education and work experience. In the screening model the informational problems which occur are alleviated by the observation of signals which are correlated with expected productivity and wage rates are based upon observed educational signals. The aggregate outcome for all firms in the economy in both models is that wage rates are equal to marginal product of labour in each labour market and that all the labour markets clear. The result of market clearance stemming from these models implies that there is no involuntary unemployment in the labour market.

However over the 1980's there was a steady rise in the level of involuntary unemployment in the UK. Several theories have evolved to explain this phenomenon and the apparent downwards wage rigidity in the labour market. The main theories are union wage bargaining theory, efficiency wage theory and search theory.

In the case of union bargaining theory, wage rates may be set above the market clearing level because of the union pressure upon employers to maintain the living standards of working members in the face of expected future price inflation (also increasing in the 1980's) and the threat of interrupted production. However, since existing unionised workers have little concern over the level of employment in their firm, being more concerned about their own job security and rate of pay, employment is seldom bargained over. Thus, although a non-market clearing wage rate can be determined in the bargaining process, employment levels are still chosen by the employer. Assuming the employer is a profit maximiser and given the wage rate that has been agreed upon in the bargaining process the employment level will be chosen such that the marginal product of the last worker employed equals that wage rate. Thus we reach a similar conclusion to the human capital and screening models for the motivation of the firm to measure and equate the marginal product of workers to the wage paid so it may profit maximise, although the union-bargaining model does not result in labour market clearance.

An exception to the union bargaining model where employment is set solely by the employer is the McDonald-Solow model where unions do include employment levels as an issue in the bargaining process. However Layard *et al* (1991) show that this type of bargaining will not be chosen by unions on the grounds of its gross inefficiency and although bargains in the UK have in the early 1980's concerned manning ratios this does not determine employment since the quantity of capital is not normally bargained over and can be changed, as can the number of shifts on each machine [see Layard *et al* (1991), pp. 94-118].

In the efficiency wage models, such as Shapiro & Stiglitz (1984), the productivity of workers depends upon the wage rate they recieve, and therefore the firm choses a wage rate to minimise shirking and this does not necessarily coincide with the market clearance wage rate. Thus involuntary unemployment can occur and in this model acts as a worker discipline device. However the need to know marginal product occurs again if the employer is a profit maximiser, and given the non-shirking wage rate that has been set, the employment level is chosen such that the marginal product of the last worker employed equals that wage rate.

Similarly, in job search models, such as those reviewed by Mortensen (1986), an employer will aim to maximise average profit per worker by setting a wage which varies in relation to an individual worker's reservation wage. Assuming that the firm needs to observe a signal of this reservation wage, and that education levels and reservation wages are positively correlated, then screening theory is still relevant in the context of search theory.

The union bargaining and efficiency wage models give the result that there is a relationship between unemployment levels and wage rates within regional or national labour markets. Recent work on the 'wage curve' has shown a negative relationship between real wage rates and regional unemployment rates for the UK 1973-1990 after controlling for workers individual characteristics and regional effects [see Blanchflower & Oswald (1994)]. Blanchflower & Oswald's (1994) evidence suggests that the traditional neoclassical demand-supply process of wage determination found in human capital theory is fundamentally incorrect, and give support to the efficiency wage hypothesis of Shapiro & Stiglitz (1984).

The variables included in the wage rate equations used in Chapters 4-7 are the possible signals and indices that would be observable by an employer who is trying to determine the productivity of the worker and make a hiring or wage setting decision. A decision will be made not only about the wage rate paid but also about the weekly hours a person is contracted to work. These decisions will affect the recorded wage rate of the employee. In a screening or human capital model these decisions will be based upon observable worker characterstics. In the human capital model productivity is directly observable and directly linked to years of schooling and work experience, and in a screening model productivity is indirectly estimated from educational signals (e.g. qualifications), employment signals (e.g. previous employment), and indices (e.g. gender). In addition to the signals and indices; sex, marital status, years in the labour force, ethnic origin, recent unemployment incidence, years of education, qualifications and quality of education; there are control variables for occupation, union membership, region and year of response in the wage rate equations used in Chapters 4-7.

The inclusion of a dummy variable representing recent unemployment in the estimated wage rate equations for the UK is made to control for signalling and search-cost effects. Recent unemployment may act as a signal of ability in the labour market and may affect the costs of search in that it reduces expected lifetime earnings and may reduce personal wealth.

The inclusion of a union membership dummy variable in the estimated wage rate equations for the UK is made to control for union-bargaining effects. Occupational rank variables are included to control for the characteristics of contracts and hiring practices within jobs which may vary by skill level; for instance the employer's ability to detect shirking may be different in the case of office managers in comparison to manual workers working on a factory line.

Regional dummy variables are included to control for differences in the cost of living, industrial structure, the demand and supply of labour, and the local wage curve relationship in each region. The inclusion of year dummy variables in Chapters 4-6 corrects the nominal dependant variable for inflation, shifts in the national unemployment level in the 1985-1991 period and the national wage curve relationship.

2.5.3 Motivation for Empirical Studies

The strong screening hypothesis posits that productivity is not improved by higher education, but that individual incomes are. Arrow (1973) suggests that in some cases society could be better off if higher education was abolished. Conversely, the human capital model posits that individual productivity and therefore national income are improved by higher education. Thus we have two different policy implications based on the two conflicting schools of thought.

If higher education is found to be solely a screening device for individual productivities then policies advocating self-funding of higher education are justified, since there is no improvement of national income from higher education. If there is no evidence of strong screening then self-funding is not justified on the basis of a screening argument; this would support human capital theory and the central government intervention in the funding of higher education.

If evidence is found in support of the weak screening model, where education generally signals and improves productivity, then the labour market outcome is equivalent to the human capital model, if *every* qualification improves and signals productivity to the same extent.

However, in the context of weak screening there may be courses or qualifications that have different strengths as signals and productivity enhancers. For example, General Studies A-Level is generally viewed as not having a great effect upon student ability but acting as a signal of *a priori* ability, indeed older universities began to reject this qualification in their admission 'points' scheme in the late 1980's, negating even its screening role. In contrast we could say that A-Level vocational and business orientated courses have strong signalling and productivity enhancing roles. Similarly, degrees in the arts are anecdotally viewed as less producitivity enhancing than science degrees, but may be used by employers to the same extent as screening devices.

In this case the debate should centre upon which certificates or courses have a major role as screening devices and which certifcates or courses have a main role of improving productivity; a mixed system of funding would then be appropriate. Chapter 3 surveys the work of empirical economists over the period 1968-1996 in testing the role of education in the market for labour; and we will see that there is little support for the strong screening hypothesis from a majority of these studies.

Chapter 3

A Survey of Empirical Studies of the Educational Screening Hypothesis

3.1 Introduction

This Chapter reviews the empirical work which has been carried out to assess the importance of the informational function of education in the market for labour. It is shown that support for the screening hypothesis has come from three studies using US data, Shah (1985) and Dolton (1985) using UK data, Miller & Volker (1984) using Australian data, Sakamoto & Chen (1992) using Japanese data, and Liu & Wong (1982) using data from Singapore. Contrary results have been found by seven studies using US data, Psacharopoulos (1979) using UK data, Lee (1980) using Malaysian data, Oosterbeek (1992) using Dutch data, Arabsheibani (1989) using Egyptian data and Albrecht (1981) using Swedish data. The overwhelming indication from the latter studies, that human capital theory rather than the screening hypothesis best explains the correlation between earnings and education, is dampened however when account is taken of the biases of methodologies and data sets used. The overall conclusion is that there is little doubt as to the human capital role of education, but the importance of the informational role is still open to debate.

The empirical studies of the screening hypothesis are discussed in five sections according to the methodology used. Section 3.2 refers to early studies which aimed to estimate the returns to educational variables using earnings regressions with a control variable for ability and were conducted alongside, or prior to, the publication of the main theoretical foundations of the screening hypothesis.[1] Section 3.3 refers to tests using comparisons by screening level; this is done either by making assumptions about the level of screening inherent in different economic sectors or by worker type (employees and the self-employed). Section 3.4 refers to comparative tests based upon groups separated by levels of

[1] For a more detailed review of the early studies by Taubman & Wales (1973), Layard & Psacharopoulos (1974), and Haspel (1978), I refer the reader to Whitehead (1981).

same value as found by Mincer (1974). However, the monozygotic earnings-difference results, now controlling for genetics and environment, suggest that years of education have a significantly smaller effect on earnings; the coefficient being 0.027. Thus, the bias in the reported returns to years of education from not controlling for common environment and genetics is estimated as approximately 65%.

Furthermore, Taubman finds that non-common environment for monozygotic twins accounts for approximately 45% of the total variance in log earnings at the age of 50, and approximately 25% of the total variance in years of education. Taubman suggests that genetics account for up to about 41-50% of total variance in earnings and that common environment accounts for up to about 15-18% of the total variance.[4] For total variance in years of education the corresponding estimates are about 40% and 30% respectively, confirming that the more educated are likely to be more able, regardless of education.

The main conclusion that can be drawn from this twin-pair comparison methodology is that the influence of genetics on earnings may far outweigh the influence of education. Thus, irrespective of one's school of thought as regards the reasons for the earnings-education relationship, it would appear that innate ability rather than education, plays the dominant role in determining earnings. Taubman estimates that not controlling for genetics and environment in earnings regressions may bias the estimated effects of years of education or qualifications on earnings upwards by about two thirds. However, Taubman suggests that these results are only strictly applicable to the population that the twins represent, which is white males born between 1917 and 1927 with military service.[5]

3.2.2 The Use of Ability Measures

Although Ashenfelter & Mooney (1968) are concerned with testing human capital theory and do not explicitly investigate the screening hypothesis, which was not

[4] The estimated effects differ between Taubman (1976a) and Taubman (1976b).

[5] Twins studies continue where data can be found; for example, Ashenfelter & Krueger (1994) use a sample taken from interviews at the Twinsburg Festival, Ohio in 1991, one of the world's largest gatherings of twins, and estimate the average rate of return to years of education to be approximately 12-16% using a similar methodology to Taubman (1976a,b).

theoretically formalised at that time, their study does provide some support for the hypothesis. Their sample is a group of male 1958-60 Woodrow Wilson Fellows.[6] 1966 annual salary is regressed on a set of dummies for years in graduate schooling, highest degree level held by respondent, occupation, market experience, field of study, and an ability proxy MAPT.[7]

Ashenfelter and Mooney show that there are significant returns to years of education, but that years of education are highly correlated with degree, profession and market experience variables. Field of study and degree level are found to be significant in determining earnings. Of the four ability proxies available to the authors, only MAPT has any significant impact on income levels; the MAPT coefficient was significant and represented $2.1 for each point in the test score. They suggest that the reason why only MAPT was a good proxy out of the four possibilities is that there is some interaction between MAPT and Field of Study, but show that neglecting such an interaction is unlikely to give spurious results in this model. They suggest that omitting an ability variable for *this* sample of highly educated people has little effect on rate of return results, i.e. mis-specification errors are small. However, later discussion illustrates that in general there are large potential biases connected with omitted ability in education-earnings functions.

Occupation, degree type, and field of study explain more of the variance in earnings, than do years of study; this suggests that employers use degree and field of study as a screening device for ability. Thus, the authors make the conclusion which, along with the publication of theoretical models of educational screening, may have added impetus to moving the focus of empirical analysis in this field away from human capital theory towards the explicit investigation of the screening hypothesis;

> *"...the application of traditional 'rate of return' analysis to the area of graduate education, in which years of graduate education would be*

[6] The Fellowships were awarded to first year graduate students nation-wide in America according to qualifications in arts and science and an interest in college teaching as a future career. Since the sample is homogenous in sex, and generally so in age and market entry time, explicit control of these variables was not necessary.

[7] MAPT relates to a mathematics aptitude score on a scale of 200 to 800 from a Scholastic Aptitude Test of an Educational Testing Service in New Jersey which is deemed a good measure of intellectual ability.

used as the sole education-related variable, would be highly misleading." [Ashenfelter & Mooney (1968) p. 86]

Alongside the publication of the theoretical foundations of the screening hypothesis, Taubman & Wales (1973) published their estimates of the rates of return to education and also explicitly tested the screening hypothesis using the National Bureau of Economic Research Thorndike Hagan (NBER-TH) sample. The subjects in this sample were US Army Air Force volunteers surveyed directly in 1955 and 1969 who were given a number of tests measuring various types of ability.

The net earnings differentials due to education at the two dates are calculated from regressions within occupational categories with independent variables including schooling, age, an ability proxy and socio-economic background variables. In 1955, the yearly earnings of those who had attended college are 10-15% above those who had only attended high school. The differential is 70% for M.D.'s, and 2% for PhD's. In 1969 those who had some college education earn about 17% more than high school graduates of the same ability, those with a degree, some graduate work or a Masters degree earn 25-30% more. From 1955 to 1969 the differentials, independent of ability level, increase at all education levels; the highest increase being for the highest educated.

As found by Ashenfelter & Mooney, of the many ability variables measured in the sample, only mathematical ability has a significant effect on earnings. Over time, the income of workers in the top fifth on the ability scale in this sample had risen at a faster rate than that of workers in the bottom fifth of the scale, and the earnings of workers in the middle of the scale are similar to the average high school graduate. Since the sample is drawn from the top half of the ability distribution, Taubman & Wales suggest that for high school graduates and beyond, ability is a more important determinant of the range of income distribution than is education. They suggest that ability initially has little effect on wages, but that over time the effect grows, and at a faster rate for those with high ability.

Taubman & Wales find that the differences in earnings at a given education level due to college *quality* effects are very large. For example a college drop-out from a college ranked in the top fifth of the ranking order according to the academic rating proposed by Gourman (1967) earns more than anyone not in the top fifth except for those with a three year degree. Similarly a degree holder from a low quality university earns 53% more than the average high school leaver, whereas someone with a degree from a quality university earns 98% more.

One explanation of these findings is that high quality educational establishments may impart different or additional earning skills on their students compared to low quality establishments. Indeed, Spence (1973) suggests that quality as well as the quantity of education may be used as a screen. Moreover, Akerlof (1970) suggests that some *branding* of institutions occurs. For example a firm may expect that an 'Oxbridge' graduate is of higher quality (more reliable, trustworthy, less likely to shirk and so on) than a graduate from other universities. Another example is that a firm of accountants may feel that an applicant with Chartered Institute of Public Finance Accountants (CIPFA) approved training is of higher quality than an applicant with equivalent experience or qualifications who has not been trained under the mantle of CIPFA. The extent to which these quality effects influence the hiring decision of firms may lead to the claim that such hiring criteria are barriers to entry into some occupations rather than screening devices.

The percentage rates of return from education reported by Taubman & Wales show a general decrease in the rate of return as education level increased from the *some college* category (15% rate of return) to the *PhD* (4% rate of return) category. However, the striking result is that the rate of return to a college dropout exceeds that of a graduate. Taubman and Wales suggest that since the college dropouts in their sample were in their mid-20's in 1946, many probably had a family to support and could not afford a college degree in the short run; they may have been pulled from college by their commitments (we will return to this result later). However they did not present data to support this idea. Another possible explanation is that dropouts are pulled from college by attractive offers from firms and that such dropouts are characterised by high levels of ability and are therefore paid high wages.

Compared to an alternative rate of return from common stocks of approximately 10%, the *some college* and *BA certificate* (11% rate of return) categories of education are judged worthwhile, suggesting that dropping out is a more economically rational choice than completing the course at college. Although their analysis ignores education's role as a consumption good, this result is interpreted by Layard & Psacharopoulos (1974) as discrediting the screening hypothesis.

To test the educational screening hypothesis, Taubman & Wales compare the actual occupational distribution with the expected one with free entry at various education levels. Taubman & Wales show that B.A. holders, but not high school graduates, achieve almost the same occupational distribution as would occur with no screening (entering occupations which provide the highest income). The authors conclude that this is due to educational screening with some workers characterised by relatively low levels of education being prevented from entering highly paid jobs. They suggest that up to 50% of the earnings differentials are due to screening and it is thus a very important function of education.

Both Layard & Psacharopoulos (1974) and Riley (1979a) find it difficult to accept that the proxies of ability used by Taubman & Wales capture all the crucial facets of ability, especially when the proposed model is one where firms cannot test accurately for ability and that of the many ability variables measured in the sample, only mathematical ability had a significant effect on earnings.

Arrow (1973) and Wolpin (1977) suggest it is unlikely that we could expect to find a direct measure for ability, especially since to do so would attack one of the foundations of the screening models. If it is assumed that firms cannot measure ability directly and have to rely on signals, then empirical economists cannot suggest that they can do any better. Thus researchers rely on proxy variables for productive ability, and this may lead to 'omitted-ability biases'.

However, economically rational firms may choose to rely on educational signals if the direct ability measures they could obtain are relatively more costly than the educational signal. Indeed, in the previous models outlined in Chapter 2 the educational screening process costs the profit maximising firm nothing, and it follows that, even if direct ability measures were available, if the educational screen is accurate direct ability measures would not be used. The screening hypothesis does not therefore strictly rely on the non-existence of direct ability measures if we can make the assumption that such measures are more expensive than educational screening.

Layard & Psacharopoulos suggest that the non-graduates who are hired for high paying jobs are known by firms to be different, in terms of non-educational ability variables, like motivation, as those with the same ability (as recorded by Taubman & Wales) who are not hired. Layard & Psacharopoulos (1979) go on to challenge the importance of the screening hypothesis and defend human capital theory by comparing three predictions of the screening hypothesis to the previous empirical evidence.

The first prediction that Layard & Psacharopoulos make is that private returns are to certificates rather than years of education. The basis of this so called 'sheepskin' version of the screening hypothesis is that certification from a course conveys more information to a firm about an applicant's ability than just attendance on the course for a number of years, and that wages will increase faster with years of education if the year also has a certificate at the end of it.

To test this idea Layard & Psacharopoulos compare drop-out rates of return to those of course completion from a number of studies; see Table 3.1. Unless Taubman & Wales were hypothesising that firms use years of education rather than certificates as a screen, then their own results would seem to be damaging to the screening hypothesis.

Table 3.1: Rates of Return to Education for US Males: Drop Out vs. Completion

Course	Drop-out Rate of Return (%)	Completion Rate of Return (%)	Source of Results
B.A.	15	11	Taubman & Wales (1973)
B.A. + M.A.	8	8	
High School	7	6	Rogers (1969)
B.A.	12	8	
High School	16.3	16.1	Hanoch (1967)
B.A.	7.1	9.6	
High School	12.3	14.5	Hansen (1963)
B.A.	5.1	10.1	
B.A.	9.5	14.5	Becker (1975)

Source: Layard & Psacharopoulos (1974) p. 991.

In addition Layard & Psacharopoulos point to the negative effect of a Master's on earnings in the article by Ashenfelter & Mooney (1968) which they claim does not support the screening hypothesis in any way. However, the effect is *insignificant* and should be viewed with caution because firstly the Masters involved are for arts and sciences only (e.g. does not include Business Masters) and the time period for which this study applies is short; the certificate may have had an influence in the long run on earnings. In addition it could be the case that firms believe that a Masters certificate is a poor indicator of ability; firms may feel that an applicant who has acquired this non-business Masters is delaying entering the labour market because they have little motivation, whereas the acquisition of a PhD shows commitment to a career path, the extent to which the Masters is an ambiguous signal of ability may be the reason why the coefficient on this certificate dummy is insignificant, whereas that on a PhD is significant in the Ashenfelter & Mooney study.

Layard & Psacharopoulos also consider the claims of Hansen *et al* (1970) casting doubt on high school education as a screen. Hansen *et al* regress the earnings of 1963 draft rejectees on years of schooling, Armed Forces Test Qualification results, and age. Holding the latter two variables constant, they showed that high school graduation did not significantly affect earnings, and they rejected the 'sheepskin' hypothesis at this education level. However there were technical problems in this model and the results must be viewed with caution.

In the light of this evidence, and that cited in Table 3.1, Layard & Psacharopoulos conclude that a screening hypothesis based on educational certificates is not supported by the evidence.

Layard & Psacharopoulos suggest that a second prediction of the screening hypothesis is that the effect of education on earnings, with ability held constant, will fall as worker's experience rises, and firms come to have better information about the worker's true productivity. Ignoring on-the-job training, the authors reject the prediction of falling returns from Taubman & Wales's own results which show that the education effects on earnings rise both proportionately and absolutely with age.

The third observation is that education will not be demanded if cheaper screening methods exist. The authors suggest that the screening hypothesis implies that firms will take on graduates and pay them a high wage because they believe this to be more profitable than employing non-graduates at a lower wage. This is because the firm believes that on average graduates are more able than non-graduates, and the education gained just acts as a signal. This hypothesis implies that the cost of finding able non-graduates is at least as great as the wage differential between the able non-graduates and able graduates.

Layard & Psacharopoulos argue that a private enterprise would have set up an institution for the testing of non-graduates, and since no such institution has evolved they refute the screening hypothesis. However, Stiglitz (1975) contends that no single firm would be willing to embark on such a project given that other firms will poach high ability non-graduates from that company, thus the institution would have to be independent from any production process apart from the production of information at a cost below the pay differential between graduates and non-graduates Wiles (1974) contends that although aptitude tests could be cheap for firms to use, educational screening occurs because the education system is subsidised, and it is therefore relatively cheaper for the firm to use education as a screening device.

On the basis of the evidence cited, Layard & Psacharopoulos conclude that '*... the theory of human capital is not after all in ruins*' and that the screening hypothesis is an insignificant part of the explanation of how education affects wages.

However, Riley (1979a) argues that Layard & Psacharopoulos's observations are inconclusive for a number of reasons. Firstly, screening theorists have never suggested that firms look exclusively at certificates as a signal of ability, but rather a vector of informational variables about workers, such as quality of schooling, grades obtained, and field of study. Given the absence of these variables in some of the empirical work cited by Layard & Psacharopoulos, there is no reason why the rate of return should be lower for drop-outs. Moreover, no distinction is made between those who were pushed from the education system and those who were pulled out by '*superior alternatives*' which tend to increase the average rate of return from dropping out; if a student was offered a lifetime wage prior to graduating which was in excess of the lifetime wage he or she expected to earn after graduating then it is economically rational for the student to drop out.

Secondly, in any signalling game it is a necessary condition of a signalling equilibrium that a firm's probabilistic beliefs are realised. This being the case one would not expect the returns to education to fall with work experience. Indeed screening is presumably used to select able workers for jobs that require a lot of on-the-job-training, and since productivity, and wages, rise sharply in these jobs over time, the observed rise in return to education is, Riley suggests, not surprising.

Thirdly, Riley suggests that Layard & Psacharopoulos's critique is extreme in that they view education under the strong version of the screening hypothesis where education has only one role (as a screen) they do not test the weak version of the screening hypothesis where education also has a productivity enhancing role. Since there was no analysis of the trade-off between screening cost and productivity enhancement by Layard & Psacharopoulos their critique says nothing useful about the costs of screening via education if it also had a role as a human capital investment.

3.3 Comparisons by Level of Screening

3.3.1 Occupational Screening Levels

The main implication of the screening hypothesis is that more education is gained by workers than in a situation where firms could perfectly observe ability without reference to signals. So for a given ability level, screened workers would acquire more education than non-screened workers if the screening hypothesis is correct.

Wolpin (1977) attempts to isolate the signalling component of the rate of return to education by using self-employed people as representing the unscreened group. Wolpin uses the NBER-TH sample and utilises the composite ability measure which is based on seventeen ability tests for the US Army Air Force. He finds that the mean ability levels and education levels (measured as years of education) of the self-employed and employees do not differ significantly [see Wolpin (1977) p. 956 for a table of results]. If, as the ability measure suggests, the two groups are of similar innate ability, and if these groups do proxy for screened and unscreened workers, then Wolpin concludes that this result indicates '*only a minor screening function*' for education.

However, the result of similar mean education levels between the two groups is not particularly surprising because decisions about education come before the employment decision, and the choice of education in reality does not rest entirely on employment aims. Wolpin's work does not control for other entries in the utility function of individuals when considering education; for example workers of any ability level may place great emphasis on trying to achieve a social norm education level for his or her perceived class in society, they may follow a family norm, or they may invest in education with the aim of helping others with monetary returns being a secondary consideration, e.g. teachers and nurses.

From a purely monetary perspective there are two reasons why further education will be acquired even if an individual aims to be self-employed when leaving compulsory education. Firstly, because he or she cannot be sure that their plans will come to fruition and they may need to signal their ability in the labour market in the future or to work for an employer prior to self-employment. Wolpin crudely corrects for hedging by using only a sub-sample from the NBER-TH sample of individuals whose first and last reported occupations over a 20 year period was self-employment in a non-professional occupation, and compared them to a similar sub-sample of stable salaried employees. Secondly, Lazear (1977) suggests that certain professionals may acquire additional qualifications in order to signal to their potential client base the quality of their services, thus raising the overall level of education in the self-employed group. If the self-employed group is dominated by these highly paid occupations having higher quality of schooling than employees, then doctors, lawyers and other professionals may receive a larger return per year of education because of service-quality signalling differences. However, a parallel argument can be made in that employees in similar professions may also wish to signal quality of service to potential clientele of the firm that employs them. Indeed, Tucker (1987) fails to find support for Lazear's hypothesised 'consumer screening' role for education amongst professional groups. However, it is common practice to omit professional occupations to avoid possible biases due to consumer screening, when testing the screening hypothesis.

Another explanation of high education amongst the self-employed is that they are screened by government agencies or banks, so that not all those who wish to become self-employed can and those that do may be educationally screened to a certain extent by these institutions.

A reason why we may observe low levels of education for the self-employed may be because of self-selection; individuals who have invested incorrectly in the educational signal act rationally in becoming self-employed to enhance income in a sector where education level is unimportant in determining earnings. Grubb (1993) suggests that this may occur even when there is a higher risk involved in self-employment, because the highly educated may be more risk averse and choose salaried positions despite the higher returns in self-employment.

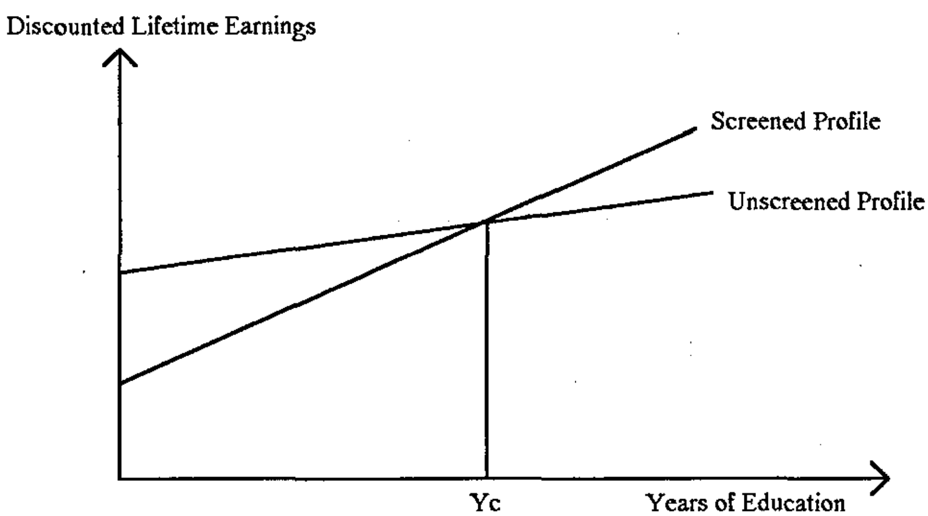
Wolpin's results also suggest that education has a larger impact on the earnings of the self-employed. This is because the two groups acquire a similar amount of education even though the self-employed in the NBER-TH sample appear to be more able. However, earnings from self-employment will include some element of non-labour returns (such as profit or returns to capital), so the earnings differential between the self-employed and employees is biased upwards and this may invalidate this result.[8] Riley (1979a) suggests that this result may in fact be consistent with his version of the educational screening model.

Riley (1979a) presents a theoretical model of the screening process on the basis of which he then tests for the expected observable differences between screened and unscreened workers using data from the Current Population Survey (CPS) 1971-1975.

[8] Rees & Shah (1986) find that there is little difference between the earnings of employees and the self-employed in their data; the self-employed are found to have 'inferior' human capital but earn more from it in comparison to employees, and there is evidence to suggest that the earnings differential can be attributed to a return on self-employed capital.

In Riley's (1979a) model individuals either accumulate education for some unscreened job or continue in college and later accept a screened job. The main finding from his model is that the discounted lifetime earnings functions of workers choosing screened jobs, for any given education level below Y_C, are below those for unscreened workers, as depicted in Figure 3.1. The cross-over level of education, Y_c, is determined by the difference in size between the private rate of return to education for screened and unscreened workers; it is a theoretical requirement that the individual return to education must be at least as high in the screened sector in comparison to the unscreened sector [see Shah (1985) pp. 122-123]. The cross-over point is assumed to lie outside the sample range in both Riley's (1979a) and Shah's (1985) empirical analysis.

Figure 3.1: Predicted Discounted Lifetime Earnings Functions from Riley (1979a)



Instead of using intuition to divide occupations into screened and unscreened categories Riley lets the data 'speak'. Logarithmic earnings functions with education measured in years and control made for experience and socio-economic factors are estimated for different occupations. The CPS data was then split into sub-samples I, II, III and IV as shown in Table 3.2, with equal numbers of occupations in each, according to mean education and the size of the estimated vertical intercept in the estimated discounted lifetime-earnings function. Riley assumes that a higher intercept term implies a higher earnings function.

Table 3.2: Riley's Occupational Groupings

	Occupational Intercept	
Mean Education	Low	High
Low	III	II
High	IV	I

Individuals choosing screened jobs could work in unscreened jobs with higher discounted lifetime earnings functions and lower education. A comparison of groups II and IV is therefore made, with sub-sample II representing the unscreened group and sub-sample IV representing the screened group. Riley suggests that the occupations appearing in the sub-samples give moderate support for the screening hypothesis [see Riley (1979a) Tables 2 and 3 for details].

Riley also tests four predictions from his model. Firstly, education must be effective to be used as a screening device; it must be a good predictor of actual productivity or earnings, if not firms will soon use other screens. Accordingly the earnings function for the screened group is expected to fit the data better than that for the unscreened group. Secondly, the model predicts that individuals choose between an unscreened job with less education (higher lifetime earnings function) and a screened job requiring more education; Riley therefore expects a negative correlation between estimated intercept and mean level of education across occupations. Thirdly, Riley's model predicts that for occupations characterised by the same mean levels of education the earnings of the self-employed will be higher than those of employees. Fourthly, since the screening device in this particular model is assumed only to yield a prediction of productivity which is correct on average, as other information on productivity accrues wages are expected to change in line with measured productivity so there should be a tendency for the difference between actual and predicted earnings to increase with tenure.

Generally Riley's expected results are confirmed and support his screening hypothesis. He suggests that the weak screening hypothesis, where education signals and improves productivity, offers a more complete explanation of wage determination than human capital theory.

Shah (1985) employs Riley's methodology on data from the 1973 UK General Household Survey. With the self-employed representing the unscreened sector, it is found that they have an estimated lifetime earnings function above that for private employees representing the screened sector; this is what is expected from Riley's screening model. However, rejection of the screening hypothesis may not follow since non-labour income effects have not been controlled for in Shah's regressions.

Shah also splits occupations into screened and unscreened groups I to IV; as with Riley (1979a) the occupations found to fall into the group II were occupations that one would expect to be unscreened, and those that fell into group IV were occupations one would expect to be screened [see Shah (1985) p. 121 for details]. The correlation between estimated occupational intercept and mean level of education by occupation was found to be significantly positive, which refutes the Riley's screening hypothesis. However, the correlation was reversed in the upper tail of the education distribution, and so Riley's screening hypothesis is not rejected by Shah for occupations with mean education levels in excess of about 10.5 years. This would suggest that educational screening is based upon high school and university education.

Separate earnings function regressions for the screened and unscreened sub-samples show the coefficient on education in the screened group is larger than that in the unscreened group, and the earnings profile of the latter group is above that of the former group over the sample range of education levels. Both these results are consistent with educational screening, and thus Shah indicates *tentative* support for the screening hypothesis.

Shah (1985) and Riley (1979a) compared occupations with high earnings and low education (presumed to be unscreened) with occupations with low earnings and high education (presumed to be screened). However, a large proportion of the occupations assumed to be characterised by high screening levels were teachers and other underpaid professional and semi-professionals, suggesting that non-monetary returns and consumer-screening may have interfered with the construction of sub-sample IV.

Katz & Ziderman (1980) present a comparative test of the average education levels of screened and unscreened groups within similar occupations, using data from the Israeli Labour Force Study 1973-77. They follow Wolpin's analysis in that they use the self-employed as representing unscreened workers, however their model allows for a human capital as well as a screening function for education and includes an occupational dimension largely ignored by Wolpin.

The hypotheses that Katz & Ziderman test are that for higher level occupations, needing large human capital investment, education levels are higher for employees than for the self-employed, and that the converse is true for low level occupations. Obviously certain intermediate occupations may exhibit education levels for both groups that are approximately equal.

Katz & Ziderman's results generally match the results expected from their specific model. Occupations where average skill level required is high (scientific, academic, technical and professional workers for example) show employees having a significantly higher mean level of education than the self-employed. Occupations where average skill level required is low (labourers, drivers, and unskilled manual workers for example) show employees having a significantly lower mean level of education than the self-employed [see Katz & Ziderman (1980) Table 1 p. 85 for details of their occupational ranking system]. Again, an argument can be made that individuals do not know *ex ante* whether they will succeed in being self-employed. However, Katz & Ziderman claim that their results '*are sufficiently robust to withstand the effect of hedging*' (although no explicit proof is given), and this may also explain why the differences in education levels between the two groups are significant but minimal.

Fredland & Little (1981) use data from the US National Longitudinal Survey (NLS) in a test of the screening hypothesis in which the returns to education and training for the self-employed are compared to those of employees. They choose total family income as the dependant variable because it is a variable common to both groups of workers, education is measured in years of formal education, and other variables include control for demographic and family background effects. The returns to education between the self-employed and employees are found to differ significantly, with those for the self-employed group being approximately 80% larger. Screening theory generally predicts that the self-employed will invest in less education than employees of the same ability, or that at a given education level the self-employed group will have higher earnings. However, Fredland & Little find that the self-employed have both higher education and higher earnings. When professionals are omitted from the regressions the difference in returns to education disappears rather than is reversed, so we cannot claim that this difference in the returns to education was due to consumer screening of the self-employed group. The result of higher returns to education for the self-employed is inconsistent with the screening hypothesis.

However, as with Riley (1979a), Fredland & Little find that the fit of the earnings regression is significantly weaker for the self-employed. If the human capital effect of education made up a significant portion of the effect of education on earnings we would expect little difference between the fit of the equations for the two groups. This result is therefore supportive of the screening hypothesis.

The overall results of Fredland & Little are therefore mixed and may be adversely affected by the omission of an ability control due to data limitations. Moreover, Tucker (1985) suggests that the total family income measure of earnings is too noisy a measure of a worker's own labour income since it includes other family member's income, returns to family assets and other non-labour family earnings. The lack of control for a situation where these additional components represent different proportions of the total family income of the self-employed and employees may bias Fredland & Little's results.

Cohn *et al* (1987) aim to test the pure screening hypothesis with a methodology based on Katz & Ziderman (1980) and using the 1978 US Panel Study of Income Dynamics (PSID).

The authors follow Katz & Ziderman's suggestion that differential educational investments by occupation and worker type (i.e. self-employed or employees) indicates screening. The null hypothesis is that there are no significant differences in educational investments between self-employed and private employee subsets. The alternative hypothesis is that there are positive differences between educational investments of employees compared to the self-employed for high level occupations (e.g. professionals), and negative differences between educational investments of employees compared to the self-employed for low level occupations (e.g. unskilled manual workers). Their results reject such hypotheses, based on a comparison of the mean education levels of employees versus self-employed workers [see Cohn *et al* (1987) Table 1 p. 291 for full details of their occupational ranking system].

The only significant difference between the two groups is for professional occupations, in which the self-employed have a significantly *higher* mean level of education contrary to the null hypothesis.

This comparison of mean years of schooling between the self-employed and employees as a test of the existence of screening is open to similar criticism as that levelled at Wolpin in that non-monetary returns to education may outweigh monetary returns in the signalling decisions of workers, qualifications rather than years of study may be the screen used by firms, service-quality signalling may be an interference in the professional occupations, and hedging may occur. Their results should therefore not be seen as solid evidence refuting a screening model based upon the use of qualifications as a signal of ability in the labour market.

Grubb (1993) also uses self-employed individuals as representing the unscreened workers. He tests whether credentials and grades are market signals and have higher returns in screened than in unscreened occupations, and uses Heckman's (1979) correction to control for self-selection bias.

Grubb uses the 1972-1986 NLS containing information on education, socio-economic status, on-the-job training, ethnic origin, and several measures of ability including a composite test score TEST, allowing him to omit some of the biases inherent in previous comparative tests which ignore social factors that may influence education or ability, and overwhelm the signalling role of education.[9]

Grubb distinguishes between experience in current job which would affect the signalling value of education, and experience from other jobs. Grubb also includes a measure of 'credits' earned by drop outs from post-secondary courses accumulated prior to leaving, since simply being allowed entrance to an institution may be used as a screen by employers.

Grubb shows that a number of post-secondary qualifications operate as screens by gaining individuals access to jobs where they accumulate labour

[9] Results estimating the value of education as a signal may be biased upwards if no control is included for on-the-job training in regressions; workers with high ability may be selected for on-the-job training.

market experience and on-the-job training. For instance, the extra $3305 p.a. in 1985 total earnings a salaried worker earns compared to high school leavers from having a vocational associate degree vanishes once Grubb controls for labour market experience and on-the-job training. In comparison vocational college degrees have an insignificant effect on self-employed earnings. It may be that firms select applicants with vocational college degrees into jobs requiring on-the-job training because they have lower training costs, compared to high school leavers.

Sub-Baccalaureate certificates (indicating a level of education below university standard) and academic associate degrees have no significant effect on the earnings of either group [see Grubb (1993) p. 132 for a definition of these certificates]. In contrast the returns to Baccalaureate (university) degree's are substantially higher in the unscreened positions than in salaried employment contrary to the screening hypothesis. This finding is compounded by the results for course credits for drop outs. Grubb concludes that university degrees and vocational credits earned within 4 year colleges are valuable not only as signals, but are 'intrinsically' productive. Such evidence supports a weak version of the screening hypothesis in which university and 4 year college education signals and augments a worker's productivity.

High school grades appear to be used as screens of ability with significant positive returns for salaried workers which persist when labour market experience and on-the-job training are controlled for. This relationship is not present for the self-employed and suggests that high school performance is used as a screen but is not intrinsically valuable. Such evidence supports a strong version of the screening hypothesis in which high school education signals, but does not augment a worker's productivity.

Grubb shows that allowing for the possibility of self-selection into self-employment, using Heckman's (1979) correction for incidental sample truncation, makes no significant differences to any of the results discussed. However, throughout the analysis TEST appears to be an inaccurate ability proxy since it is consistently insignificant, and we would therefore expect some omitted-ability bias to be present in these results.

Tucker (1985) decomposes the gross earnings differential between a sample of self-employed and private employees from the 1981 PSID and calculates the percentage of the earnings differential due to different sources.[10] Tucker's dependant variable is the natural log of 1980 *own-labour* income; this omits bias from the self-employed group typically receiving returns from capital assets.[11] In the estimated earnings functions the estimated coefficients on education, an intelligence index, race, sex and a socio-economic status dummies are higher for the self-employed, and the estimated coefficients on on-the-job training, experience, hours of work, years in current job and marital status are higher for employees [see Tucker (1985) p. 323 for a description of each variable and table of results]. The earnings equation differential between the two groups is significant, and a higher R^2 for the employee sub-sample is consistent with the screening view that this group are generally more screened than the self-employed. Tucker estimates that the average employee in the sample earns 1.256% more in 1980 than the self-employed worker.

Tucker shows that the self-employed advantage from formal education, intelligence, race, sex and socio-economic variables in the contributions to the earnings differential between the two groups, is more than offset by the employees' advantage from on-the-job training, experience, hours of work, tenure and marital status.

Tucker assumes that under screening the coefficient on years of education in the estimated earnings function will be greater in size and more significant for the screened group. However he finds that the coefficient is slightly higher for the unscreened group, and coefficients for both groups are significant, the self-employed have an advantage in terms of rate of return from years of education and employees are not gaining relatively more from their stock of education; Tucker therefore rejects the screening hypothesis.

Tucker bases his tests of the screening hypothesis solely on years of education completed; as argued previously this basis is open to criticism, and

[10] Professionals are again omitted from the sub-samples of private employees and self-employed workers.
[11] The use of logarithmic terms is common practice in human capital literature, but whether it is appropriate to screening analysis is open to debate [Grubb (1993) pp. 131-132].

although Tucker suggests that his results are a stronger rejection of the hypothesis than Wolpin (1977) or Fredland & Little (1981). To discredit a screening hypothesis based upon the use of qualifications, Tucker would have to make the strong assumption that each year of education completed is accompanied by grading or certification which is common knowledge in the labour market.

3.3.2 Sectoral Screening Levels

The theoretical distinction between the 'weak' and the 'strong' version of the screening hypothesis is generally taken to mean that in the strong version of the screening hypothesis education has only a screening function, whereas in the weak version it also has a productivity augmenting role.

Psacharopoulos (1979) interprets the strong screening model as predicting that the wages of university graduates will be in excess of their actual productivity, and will remain at this level even as tenure increases. In contrast, in the weak model he suggests that wages of university graduates will be revised downwards towards their actual productivity. Whether firms pay irrational wages initially on hiring (the weak version where education is both a signal and a human capital investment) or continuously after hiring (the strong version where education is only a signal) is tested by Psacharopoulos using 1975 UK General Household Survey data on approximately 5000 employed males.

Psacharopoulos's methodology is to compare the rate of return to education between competitive and non-competitive economic sectors, which are assumed to be characterised by different levels of screening; in later literature this type of sectoral methodology is referred to as a 'P-test'. Distributive trades are assumed to be the competitive sector and public administration to be the non-competitive sector. Psacharopoulos assumes that screening is more likely to occur in non-competitive economic sectors, where wage scales are bureaucratic and linked to education and where wages can deviate from marginal product, which is difficult to measure, persistently over time. He expects the wages in the competitive sector on the other hand are largely determined by traditional market forces.

Psacharopoulos shows that, regardless of economic sector, the mid-to-early earnings ratios become higher as education increases.[12] This differential in earnings growth is more pronounced in the competitive rather than the non-competitive sector. Thus age-earnings profiles by level of education in a sector where productivity is important seem to contradict the strong screening hypothesis.

Psacharopoulos admits that no allowance is made for other factors that influence earnings, and that no ability measure is available in the data he uses. By not controlling for ability a potential source of bias is introduced since higher returns to higher levels of education may simply be reflecting efficient screening in that those with higher ability have acquired higher levels of education compared to those with lower abilities.

Psacharopoulos's human capital earnings functions explain nearly double the earnings determination in the competitive sector compared to the non-competitive sector. Also, the returns to years of education are higher in the competitive sector compared to the non-competitive sector; this refutes the strong hypothesis. Psacharopoulos concludes that education must have an inherent productive value since it is valued more in the competitive sector.

Lee (1980) follows the methodology of Psacharopoulos (1979) to test the strong version of the screening hypothesis in that he compares the rates of return to education in competitive and non-competitive sectors of the Malaysian economy. However, Lee uses examination grades at the end of primary education to proxy for ability.[13] Education level is measured in terms of the highest educational certificate held by the worker.

Lee finds that, in comparison to the public sector, the coefficients on the educational certificate dummies are generally significantly higher in the private sector, the private sector shows a significantly higher return to ability, and that even after on-the-job screening is accounted for as tenure increases, that the private sector continues to place a higher value on education. These results are consistent with those of Psacharopoulos (1979) in that they refute the strong

[12] 'Mid' career corresponds to ages 36-45 and 'early' to less than or equal to 25.

[13] The limitations of this specific proxy are discussed in Lee & Psacharopoulos (1980).

version of the screening hypothesis and show that education has an inherent productive value, and can be seen as stronger evidence than Psacharopoulos (1979) since some potential omitted ability bias has been removed.

Cohn *et al* (1987) use PSID data and follow Psacharopoulos's methodology for testing the 'strong' screening hypothesis. Cohn et al test whether mid-to-early career earnings ratios fall as years of education increase, and if mid-to-early career earnings ratios are higher for the non-competitive sector.

Returns to education are found to be generally higher in the government sector, but a number of other sectors show rates of return as high or higher, and there is no discernible pattern of decreasing rates of return as competitiveness increases. Mid-to-early occupation earnings ratios generally rise, rather than fall, with the exception of the government sector, and there is no evidence that the mid-to-early occupation earnings ratios are consistently higher in the less competitive sectors from their results. Thus the authors find no evidence in support of the strong screening hypothesis.

Ziderman (1992) applies a P-test to two Israeli data sets; the 1983 Census of Population and Housing (CPH) and the 1977 Labour Mobility Survey (LMS). The government sector is taken as the non-competitive sector and the trade sector as the competitive sector. Mincerian earnings functions are estimated for each sector and analysed with inconclusive results. However, the author suggests that a *prima facie* case can be made in support of the weak screening model in relation to Israel from this work and Katz & Ziderman (1980). Similarly, Lambropoulos (1992) applies a P-test to Greek data for 1977, 1981 and 1985, and given the constraints of the data set employed, finds no support for the strong screening hypothesis.

All the P-test literature cited above assumes that the choice the sector of employment is exogenous; they do not control for the fact that by splitting their data sets into sectoral sub-samples they are incidentally truncating the pooled sample. However, Arabsheibani & Rees (1996) estimate a two-stage Heckit model, using General Household Survey 1985 data for the UK, to correct for the self-selection bias in the estimated returns to education which may be present in previous literature. They find no evidence in support of the strong screening hypothesis, since the estimated rate of return to schooling in the private sector is actually significantly higher than that estimated for the public sector. Haynes & Sessions (1996) replicate the Heckit analysis of Arabsheibani & Rees (1996) on data from the British Social Attitudes Survey 1985-1991, and arrive at the similar conclusion of rejecting the strong screening hypothesis.

Ziderman (1990) does register some doubts regarding the rationale behind the P-test methodology of analysing mid-to-early-career earnings ratios. The assumption is that screening implies irrational behaviour on the part of employers in paying wage rates to educated employees in excess of their productivity. But the screening models, as outlined in Chapter 2, generally involve profit maximising firms who pay wage rates equal to productivity. Therefore, the ratio test may be unable to shed any light on whether the higher educated workers higher wage rates are due to productivity augmentation by education or higher innate productivities.

3.4 Comparisons by Education or Tenure Levels

3.4.1 Efficient versus Inefficient Years of Education

Oosterbeek (1992) bases his test of the screening hypothesis on the information signalled by a divergence of actual years of education from 'efficient' years of education. For a given university course, 'efficient' years of study is the number of years nominally needed to obtain a degree. Oosterbeek posits that this divergence influences earnings, with the direction of the influence dependant on the school of thought.

Human capital theorists, for example, would suggest that the more time spent obtaining a degree should increase earnings since education augments productivity and the extra study time will lead to more thorough understanding of the course. Rushing through the degree, on the other hand, would result in less understanding and have a negative influence on earnings. In contrast, Oosterbeek suggests, the screening school predicts that obtaining degrees in less (longer) than the nominal time would signal above-average (below-average) productivity and positively (negatively) influence earnings.

Oosterbeek uses a sample of 1377 Dutch economists in 1987, and uses average test score in secondary education as an ability proxy. He finds that for a student of any ability a longer period of study increases earnings. The estimated coefficient represents a rate of return to one extra year of study of economics of approximately 8%. This supports the human capital prediction that a student of any ability will find it profitable to spend longer than the nominal required time studying for their degree, and it therefore refutes the screening hypothesis that short study duration will enhance earnings.

This result appears to contradict the result of Layard & Psacharopoulos (1979) indicating that drop-outs have a higher rate of return to their education than those who complete courses; both Oosterbeek and Layard & Psacharopoulos claim to discredit the screening hypothesis but with contrary results. However, the claim that a contradiction exists should be made with caution as we have seen that Oosterbeek was testing his own specific screening hypothesis based on efficient versus actual years of education rather than the more conventional 'sheepskin' hypothesis.[14]

Oosterbeek & Groot (1994) develop this methodology further by decomposition of actual years of schooling into effective years, repeated years, skipped years, inefficient routing years and dropout years. Inefficient routing years refers to years spent on an educational path within the Dutch educational system which could have been avoided by correct routing, repeated years are years spent repeating classes, skipped years are years spent skipping classes, and dropout years are years spent in education without graduation from a course. This division of the 'schooling' variable is used to provide further evidence in the human capital versus screening debate.

The authors suggest that repeated years will have a negative effect on earnings in the screening model, since it is a 'bad' signal to employers, and a non-negative effect in the human capital model. If the repeated year leads to increased understanding of a subject then there may be a small positive effect on earnings in the human capital framework.

[14] Indeed, the two countries and samples in question are also different. The non-zero returns to dropping out in the US may be to some extent a result of the credit system which operates in the US educational system.

Conversely, skipped years will have a positive effect in the screening model and a non-positive effect in the human capital model. Inefficient routing years will have no effect on earnings in the screening model since they convey no useful information to employers, and in the human capital model they may have a positive effect if human capital is heterogeneous. The sheepskin argument of the screening models predicts that years of education without graduation from a course will have no effect on earnings, whereas the human capital model predicts a positive effect.

Oosterbeek & Groot use a detailed panel data set from surveys in 1952 and 1983 of Dutch workers. The authors find that skipped years have a significant negative effect on earnings, failing courses has a neutral effect; and dropout years have a significant positive effect on earnings. This result is analogous to that for drop-outs in Layard & Psacharopoulos (1974). These results provide strong support for the human capital model and refute the screening hypothesis.

3.4.2 Ranking in the Distribution of Education by Age Cohort

Sakamoto & Chen (1992) give evidence supporting a credentialist theory with reference to Japan. Sakamoto & Chen estimate logarithmic income functions for Japanese males, which allow for both human capital and screening effects of education on income, using cross-sectional data from 1955, 1965 and 1975 Social Stratification and Mobility Surveys.

The number of years of education completed is interpreted as the human capital effect of education. The percentile ranking in the distribution of years of education for the respondents age-cohort is interpreted as the screening or credentialist effect of schooling.

The human capital effect of years of schooling on log-income is found to be reduced by approximately a third when the screening function of education is included in the regressions. They also find that over the sample period there seems to have been an increase in the role of education as a screen and a reduction in the value of education as a human capital investment; the net effect on log-income of years of schooling fell from 4.04% to 3.02% while the net effect of percentile grading according to years of education and prestige of the university attended rose from 0.31% to 0.41%. Japanese universities prestige can be measured by the entrance-exam score needed for admission, and has been found to be used by Japanese firms as a screening device by Miyahara (1988).

They suggest that the human capital model of education without allowing for screening effects is unable to explain fully the relationship between education and income in Japan, and they find support for Thurow's (1975) credentialist 'job-competition' theory.

Kroch & Sjoblom (1994) also posit that if education is a signal, then the typical firm could base its wage setting or hiring decisions upon the position of the individual in the distribution of education in their age cohort. In a similar way to Sakamoto & Chen (1992), Kroch & Sjoblom estimate logarithmic earnings functions with the percentile ranking of the worker in the distribution of years of education, within their race-gender category's age cohort, representing the screening element of education, and years of education representing the human capital element of education. The authors use eight different samples from CPS 1973 and PSID 1967-80 data, separated on the basis of gender and racial origin.

From analysing the samples from the panel data under a range of earnings function specifications Kroch & Sjoblom find that years of education has a consistent significant positive effect on earnings, but that the percentile ranking measure does not. Although the evidence is ambiguous, since in some cases the rank is significant in determining earnings, it gives more support to the human capital theory than the signalling theory of education. The estimated earnings functions for white females and non-white males from the PSID data do give some support to the weak screening hypothesis, but Kroch & Sjoblom conclude that overall the signalling role of education is small in comparison to its human capital role.

3.4.3 Comparisons by Level of Tenure

Tucker (1986) tests both the strong and weak versions of the screening hypothesis using US data from the 1980 PSID. Following the example of Lee (1980) Tucker controls for ability using the proxies available in the PSID data. Tucker finds a significant positive coefficient for tenure in his earnings function regressions for school leavers and university graduates, and in line with rejection of the strong screening hypothesis the coefficient is greater for university graduates. The tenure squared coefficients are approximately equal and significant which is consistent with education being productivity enhancing. Workers with larger stocks of formal education earn higher relative wages even after employers have had time to observe performance on the job, thus discrediting pure screening theories of education and lending support to human capital theories.

Tucker (1986) re-examines Psacharopoulos's claim that few would dispute the existence of weak screening in the labour market, using earnings regressions for four tenure groupings.[15] Under weak screening Tucker expects both the size and precision of the coefficient on years of education to decline as firms gather more and superior information about the true productivity of workers through observation. However, he shows that in this sample the rate of return to education remains relatively stable as tenure increases, and declines slightly only after tenure exceeds twenty years. On the basis of this finding Tucker rejects both the strong and the weak versions of the screening hypothesis.

Tucker justifies his assumption that individual hiring-wage decisions are based only on years of formal education completed by saying that the US education system does not use standardised certification of students (on which starting salaries can be based). However, previous theoretical and empirical literature suggests that the hiring or wage setting decision is based on a vector of educational information including certificates or grades which acts as a signal of productivity and not merely the single years of education measure.

Grubb (1993) also tests the Psacharopoulos's (1979) strong and weak versions of the screening hypothesis. For high school grades, the only obvious screen from Grubb's results, the interaction terms between experience (as a proxy for tenure) and the screen are insignificant, implying that grades are used in both the strong and weak senses in screening for ability. However, note that human

[15] Less than one year with current employer, 1-5 years, 5-20 years and over 20 years.

capital theory suggests that education increases the 'ability to learn' on the job so there may be positive interaction; this indicates a potential ambiguity in results.

Liu & Wong (1982) argue that the relevant test of educational screening effects in the determination of wage rates should be in reference to educational certificates rather than years of education. The authors assume that the information about individual ability conveyed by the years of education of an applicant is not sufficiently accurate for the purposes of making the dual hiring and wage offer decision rather than just a hiring decision. Years of schooling may only act as a predictor of the probability of being employed in a particular occupation and the associated average wage rate. If this is the case then it is not surprising that previous empirical tests based on years of education as a screening device predicting individual wage rates have been inconclusive.

Since workers may be screened more than once and work in more than one job in their lifetimes information about individual productivity will accrue as general labour market experience increases. Liu & Wong follow Psacharopoulos's (1979) reasoning that, if this information is freely available to all firms and the skill requirement for each firm is non-specific, then certification as a screening device may be replaced by this alternative information. However, Liu & Wong suggest that, for firms where the skill requirements are firm-specific, wage screening by certification will be used even for individuals who have had previous work experience.

Liu & Wong use data from a Singapore labour force survey in 1974 sponsored by the Spencer Foundation, the Ford Foundation and the International Labour Organisation. The authors estimate logarithmic wage rate functions for male Chinese employees in the sample divided into tenure groupings according to years of experience with a specific firm and then years of general labour market experience. The authors find returns to certificates fall as both types of tenure increases, and that the effect of high level certificates on wage rates persists longer as tenure increases than the effects of lower level certificates. These results provide evidence supporting Psacharopoulos's weak screening hypothesis via certificates among manufacturing employees in Singapore.

3.5 Comparisons by Education Utilisation Groups

Wiles (1974) proposed that the wages or salaries of workers in occupations related to their educational qualifications should be compared to the wages or salaries of other workers with the same qualifications, but who are working in areas not directly related to their education. If a premium is paid to the group who are utilising their education (working in areas directly related to their qualifications) then the strong screening hypothesis is rejected. However, if the qualification gets a premium irrespective of its relevance to the jobs people are employed in, then the strong screening hypothesis cannot be rejected. Given the detailed data-sets necessary to apply the Wiles test it is unsurprising to find that there appears to be only three articles which apply this methodology to data on university graduates.

Miller & Volker (1984) use the Wiles (1974) methodology to test the screening hypothesis. Miller & Volker (1984) follow the suggestion made by Blaug (1976) that the Wiles test best applies to starting salaries and apply the test to the starting salaries of a sample of Australian university graduates in the fields of economics and sciences. Miller & Volker's estimates provide support for the screening hypothesis since a premium is paid to graduates regardless of the relevance of their qualification to their job. Miller & Volker conclude that on the basis of comparisons made for economics and science graduates screening was '*alive and well in Australia*' [Miller & Volker (1984) p. 125].

Dolton (1985) applies the Wiles test to a sample taken in 1977 recording data on approximately 4000 first-degree graduates of universities and polytechnics in the UK based on pass lists for 1970, and finds evidence in support of weak screening. Earnings equations were estimated for two sub-samples determined by the response to a question relating to the vocational relevance of the respondent's degree subject in their first job. Following Miller & Volker, Dolton expects under the human capital model to find that graduates with relevant degrees had a higher estimated rate of return to education, whereas under the strong screening hypothesis he expects no significant difference.

Dolton finds that there is generally no significant difference between the estimated earnings functions of the two sub-samples, however, he rejects the strong screening hypothesis as it appears that certificates do have a productivity enhancing role. Dolton suggests that;

> "*...there are reasonable grounds to support a compromise interpretation of the education-income association which gives credence to both human capital and screening theory but supports an extreme version of neither.*" [Dolton (1985), p. 32]

Arabsheibani (1989) uses a random sample of Egyptian university graduates from 1978 to investigate the Wiles (1974) methodology, and, following Miller & Volker, applies it to the starting salaries of graduates separated by field of study. Arabsheibani finds that a premium is paid to graduates working in jobs where their education is relevant. This supports the human capital model of education and rejects the strong version screening hypothesis for Egyptian graduates.

3.6 Comparisons by Level of Alternative Information

The article by Albrecht (1981) appears to be unique in that it analyses the hiring process of the employer to test the screening hypothesis. Albrecht analyses a probit model in which applicants are characterised by their education and the amount of information the hiring firm has about them. The firm is assumed to be unable to employ self-selection contracts and uses education as a screening device. In the model the firm has to depend more heavily on education as a signal when screening applicants about which it has little a priori information.

The firm is expected to give a positive weight to education in the hiring procedure and if part of this weight is due to an informational role then the weight should be expected to fall if alternative information is available. Albrecht therefore expects interaction between education categories and a priori information categories, and a test of the hypothesis that a firm does not use education as a screen can be expressed as a test for zero interactive effects.

Albrecht uses a data set based on applicants for blue collar jobs at a Volvo factory in June 1978. The critical split level between high and low education is assumed to be Gymnasium graduation.[16] There are three possible recruitment sources; recommendation by a Volvo employee, Swedish Labour Market Board referral, or application from newspaper advertisements. The first source is assumed to be the high informational category, the others the low informational category.

Albrecht's results show that completion of the gymnasium, Swedish or Finnish nationality and being male significantly increase the probability of being hired.[17] Having a Volvo employee's reference, age and residence are insignificant determinants. The education-information interaction effects are insignificant; Albrecht concludes that Volvo's hiring decisions give no support for the hypothesis that education is used for informational purposes in the hiring process. From his results it is equally apparent that the company does not appear to give any significant weight to information category, as defined by Albrecht, in the hiring process.

However, in using the hiring decision of the company as the dependant variable in his model Albrecht has introduced a potential source of bias in his results. The decision to hire depends not only on the variables listed above, but also upon the interview performance of an applicant, a factor which has not been controlled for. It is probably the case that the number interviewed i.e. passing through the educational filtering process, does not correspond to the number hired i.e. passing through the second screening process. The omission of an interview performance variable may have biased results away from the role of education as an information source since undoubtedly there is much alternative information to be gathered from an interview.

[16] The Gymnasium is attended for three years (ages 16 to 19) in Sweden.
[17] However, it should be noted that only approximately 11% of the sample are female.

3.7 Conclusion

In conclusion we can see that there is a mass of empirical work which seems to discredit the educational screening models, and support the human capital theory of education as augmenting ability. However, we would be wrong to conclude on the basis of the results discussed that education has no informational role in the labour market beyond it's role as a productive investment. There are three main reasons for scepticism.

Firstly, many of the articles refute only the fact that the role of education is not solely informational. As noted earlier the founding theoretical articles of Spence, Arrow and Stiglitz viewed education as having *only* an informational role for clarity of analysis. Indeed the later articles of Spence allow for a human capital role alongside its informational role, and Arrow explicitly states that he is merely applying Okun's Razor. In this light it could be said that some of the empirical investigators of the screening hypothesis are testing too strong an hypothesis and in putting their tests into the context of a human capital *versus* screening debate have ignored the middle ground. Investigation of the screening hypothesis should allow for the productivity enhancing role of education alongside its informational role, i.e. empiricists should test the weak version of the screening model.

Secondly, it should be noted that by pitching the two schools of thought against each other some empirical research has tended to test only the informational role of *years* of formal education. However, such tests say little about the role of the educational credentials as a signal of ability, and it is more likely that in reality a personnel officer within a company will not be counting years but certificates acquired by an applicant. Thus, couching tests of the screening hypothesis in terms of earnings or wage-rate functions with years of education as the main independent variable can also result in misleading evidence.

Moreover, when credentials are used to measure education level in some cases there is a misinterpretation of the screening hypothesis in that the screening model is mistaken for a model of credentialism, in which wage rate differentials are not related to productivity differentials.

Thirdly, attention can be drawn to the inaccuracy or the lack of ability proxy variables used in the studies of the screening hypothesis. Notable in the discussion of the problems associated with ability proxies are Taubman (1976a,b) and Griliches (1977). Taubman found that not controlling for genetics and family background in earnings-education regressions may cause a over-estimation of coefficients of up to two thirds, since a significant proportion of the variance in earnings can be attributed to these factors. Using NLS data, Griliches (1977) showed that the assumed positive omitted-ability bias in estimation of earnings coefficients in earnings regressions may actually be insignificant or even reversed. Thus the authors suggest that we should be wary of studies that attempt to measure the rate of return to education but do not control fully for socio-economic or family background effects, since the reported coefficients may be biased, and furthermore this bias may be indeterminate.

However, Weiss (1995) contends that in sorting models (screening or signalling models) firms cannot directly observe the attributes that affect worker productivity that are omitted from the standard wage equation. Firms use education as an indirect estimator of the unobserved attributes. The estimated coefficient on education is fully capturing the effects of this estimation process and would not be affected by the inclusion of additional explanatory variables that the firm cannot directly observe, but that the researcher can. Weiss suggests that even the use of instrumental variables does not reduce the effects of unobserved characteristics on estimates of the returns to education, since those characteristics are not observed by firms. This argument equally applies to other worker characteristics such as house ownership status, housing tenure, number of dependant children, drug use, alcohol and cigarette consumption patterns, which the typical firm would be unable to directly observable. Indeed, a majority of the P-test literature reviewed in this Chapter use simple Mincerian earnings functions to estimate the effect of education on earnings and have no control for demographic or regional characteristics of an individual.

In addition, results of testing the screening hypothesis seem to suggest that the screening hypothesis may apply to some countries rather better than other countries. For instance evidence of screening was found to exist for the Israel, Japan, Singapore and Australia, but not for the Greece, Malaysia, the Netherlands, Sweden and Egypt. Mixed results were found for the UK and the USA. The extent to which education is used as screen must surely depend both on the nature of the educational systems and the labour markets in these countries. For example, some countries may have a policy of employing only university graduates as civil servants, some countries may have a system of 'closed shops' operating amongst professionals requiring certain job-related qualifications, and some countries may place more emphasis on alternatives to education as a screen in their labour markets. One cannot generalise the result of no evidence for screening in Country A to Country B if the two countries have dissimilar education systems or labour markets. In addition we can see that there seems to be a lack of evidence in relation to Western European countries such as France, Germany, Italy, Spain and Portugal.

Given these overall criticisms and the problems associated with individual studies one must suggest that the evidence as to whether an informational component of education exists is not conclusive one way or the other. However, what we can say from the results of using the methodologies presented here is that there is little evidence in support of the idea that education has no human capital role i.e. there is little support for the strong version of the screening hypothesis.

Chapter 4

Application Of Human Capital Models To British Social Attitudes Survey 1985-1991 Data

4.1 Introduction

In *The Wealth of Nations* (1776) Adam Smith observed:

> "...*When any expensive machine is erected, the extraordinary work to be performed by it before it is worn out, it must be expected, will replace capital laid out by it, with at least the ordinary profits. A man educated at the expense of much labour and time to any of these employments which require extraordinary dexterity and skill, may be compared to one of those expensive machines. The work which he learns to perform, it must be expected, over and above the usual wages of common labour, will replace to him the whole expense of his education, with at least the ordinary profits of an equally valuable capital*" [reprinted in Smith (1976), pp. 113-114].

Smith's insight, developed nearly two centuries later in the 1950's by economists such as Becker and Mincer, was that a number of activities that human beings undertake can be analysed in a similar fashion to physical capital in a framework of investment theory. Human capital investment in education and training has since received much theoretical and empirical attention from labour economists.

The purpose of this Chapter is to estimate human capital earnings equations for male and female full-time workers who responded to the British Social Attitudes (BSA) Survey in the period 1985-1991. Before testing the educational screening theories discussed in Chapter 2 we can initially study how well the traditional human capital model fits this UK data set, and compare the results to previous studies conducted in the UK.

Psacharopoulos & Layard (1979) relax implicit assumptions in Mincer's work regarding independence of earnings function parameters from educational level. Psacharopoulos & Layard's analysis differs from Mincer's in that they assume that three underlying parameters of the Mincerian model; the rate of return to experience, the fraction of earnings forgone by increased education, and the rate of change of investment ratio; are functions of education level.

Murphy & Welch (1990) accept the independence of the three parameters from education level and develop the Mincerian model in a different direction. Concerned with how well the traditional quadratic function performs empirically, Murphy & Welch develop an earnings function which is a quartic function of experience. The authors find that this function fits Current Population Survey (CPS) data more accurately than the Mincer's (1974) quadratic earnings function.

4.2.2 Mincer (1974) Schooling Model

Mincer begins his analysis with the assumption that additional years of education accumulated by an individual requires postponement of labour market entry and therefore reduces the earnings span of the worker. The present value of the worker's lifetime earnings at the start of schooling is given by the formula:

$$(1) \qquad V_S = Y_S \sum_{t=s+1}^{n} \left(\frac{1}{1+r} \right)^t$$

where

n	=	the length of the individual's life
Y_S	=	earnings per annum of a worker with s years of schooling
V_S	=	the present value of lifetime earnings
r	=	discount rate
t	=	time in years; 0,1,2... n.

Assuming a continuous function the formula becomes:

(2) $$V_S = Y_S \int_s^n e^{-rt}dt = \frac{Y_S(e^{-rs} - e^{-rn})}{r}$$

where e is the base of natural logarithms.

Similarly, the present value of lifetime earnings of a worker with s-d years of education, where d is non-negative is given by:

(3) $$V_{S-d} = \frac{Y_{S-d}(e^{-r(s-d)} - e^{-rn})}{r}$$

The ratio of annual earnings after s years of education to annual earnings after s-d years of education, $k_{s,s-d}$, is found by letting $V_s = V_{s-d}$:

(4) $$k_{s,s-d} = \frac{Y_s}{Y_{s-d}} = \frac{e^{r(n+d-s)} - 1}{e^{r(n-s)} - 1}$$

We can see that $k_{s,s-d}$ is

1. Greater than unity - people with more education earn more,
2. A positive function of r - the differential in earnings due to the extra years of schooling is larger the higher the rate of return to schooling,
3. A negative function of n - the differential is greater the smaller the lifetime of the individual.

If we hold working life span constant then $k_{s,s-d}$ is found to be constant. If n is the fixed life span then:

(5) $$V_s = \frac{Y_s e^{-rs}(1 - e^{-rn})}{r}$$

(6) $$V_{s-d} = \frac{Y_{s-d} e^{-r(s-d)}(1 - e^{-rn})}{r}$$

and from equalisation of present values we get:

(7) $$k_{s,s-d} = \frac{Y_s}{Y_{s-d}} = \frac{e^{-r(s-d)}}{e^{-rs}} = e^{rd}$$

If $k_{s,0} = Y_s / Y_0 = k_s$ then $k_s = e^{rs}$ is the earnings ratio between a worker with s years of education and a worker with no years of education. Taking natural logarithms gives;

(8) $$\ln Y_s = \ln Y_0 + rs \qquad \text{(MS)}$$

this function shows that percentage additions to earnings are proportional to absolute differences in schooling; the logarithm of earnings is a strict linear function of the time spent in education. Thus a worker with no schooling is assumed to earn Y_0 every year of his or her life and if the worker has one year of education this raises earnings by a proportion r.

4.2.3 Mincer (1974) Human Capital Earnings Function

The interpretation of experience (or age) profiles of earnings as a result of investment behaviour enabled Mincer (1974) to expand the schooling model, outlined in Section 4.2.2 above, to allow for post-education investments in human capital. Mincer (1974) shows empirically that earnings nearly double after 20-30 years of experience within each schooling group. Mincer states that since age interacts with education in determining earnings a linear additive formulation with no interaction between these two variables is inadequate. Within his data there is far less of an interaction between experience and education than between age and education; the experience profiles of log-earnings are nearly parallel between schooling groups.

A log-earnings function with years of work included is presented by Mincer as follows, and allows for the concave relationship between experience and earnings:

(9) $\ln E_t = \ln E_s + \beta_1 x - \beta_2 x^2$

where;

x	=	the workers years of experience in the labour market
E_S	=	the worker's earnings after s years of schooling

Using the schooling model: $\ln E_s = \ln E_0 + rs$ this function becomes:

(10) $\ln E_t = \ln E_0 + rs + \beta_1 x - \beta_2 x^2$

Human capital theory shares a common assumption with screening theory in that the worker will equate the marginal cost with the marginal revenue from increased investments in education (or other forms of human capital), in order to optimise utility. Optimisation theory would suggest that investment in human capital declines over the lifetime of the worker beyond an early point, since marginal costs would rise in excess of marginal revenue [see Mincer (1974), pp. 11-16] However, there is no guide to the specific functional form of this behaviour. Mincer considers the following specification for the relationship between experience and dollar investments (C_x) and 'time equivalent' investment ratios (k_x);

(11) $C_x = C_0 - \frac{C_0}{T}x$

(12) $k_x = k_0 - \frac{k_0}{T}x$

where:

C_0	=	net dollar investment by the worker during the initial period of experience $x = 0$,
k_0	=	investment ratio during the initial period of experience $x = 0$,
T	=	total period of positive investment.

The investment ratio k_j is the ratio of investment expenditure C_j to gross earnings E_j in period j. This can be measured as a 'time equivalent' as the fraction of time the worker devotes to the improvement of earning power; for example the time equivalent (in years) of investment between the tenth and fifteenth year of experience is $k_{10-15} = (\ln Y_{15} - \ln Y_{10}) / r$ [see Mincer (1974), pp.72-74 for more details]. Treating investment and earnings as continuous functions of time gives the following function:

$$(13) \quad E_t = E_s + r_x \int_{j=0}^{x} C_j dj$$

where:

E_t	=	Gross earnings at time t,
E_s	=	Earnings from s years of schooling only,
j	=	length of working life,
r_x	=	the rate of return to non-school investment.[2]

Equation (13) shows that gross earnings at time t are equal to earnings from s years of schooling plus the return from non-school investments which, from Equation (11), is assumed to decline as x increases. The logarithmic version is as follows:

$$(14) \quad \ln E_t = \ln E_s + r_x \int_{j=0}^{x} k_j dj$$

Substituting (11) into (13) and (12) into (14) transforms (13) and (14) into functions of years of experience. If the investment ratio is assumed to fall linearly over time, as in Equation (12), then the gross log-earnings function becomes:

[2]The rate of return to non-school investment is assumed by Mincer to be constant over all levels of x and s.

$$(15) \quad \ln E_t = \ln E_s + r_x k_0 x - \frac{r_x k_0 x^2}{2T}$$

If we define net earnings as $Y_t = E_t - C_t$ and the logarithm as $\ln Y_t = \ln E_t - \ln(1-k_t)$ then the net earnings function becomes:

$$(16) \quad \ln Y_t = \ln E_s + r_x k_0 x - \frac{r_x k_0 x^2}{2T} + \ln(1-k_t)$$

The logarithmic function is preferred to other functional forms, from an econometric viewpoint, as it minimises the need for interactive terms. Using Equation (12), and substituting for $\ln E_t$ using the schooling model, the earnings function for the population can be specified as;

$$(17) \quad \ln Y_t = \ln E_0 + r_s s + r_x k_0 x - \tfrac{1}{2} r_x b x^2 + \ln(1-k_0 + bt)$$

where:

$$(18) \quad b = \frac{k_0}{T}$$

In this Chapter we will use data on pre-tax earnings per annum and hours worked per week for each worker. We must, therefore, transform the log-earnings function (17) into a gross log-wage rate function for full-timers, by assuming they are paid for 52 weeks of the year, as follows:

$$(19) \quad \ln W_t = \ln\left(\frac{Y_t}{52h}\right) = \ln Y_t - \ln 52h$$

Substituting for Equation (17) gives;

(20) $\ln W_t = \ln E_0 - \ln 52h + r_s s + r_x k_0 x - \frac{1}{2} r_x b x^2 + \ln(1 - k_0 + bt)$

where h is the number of hours worked per week. This is estimated by:

(21) $\ln W_t = \alpha + \beta_1 s + \beta_2 x + \beta_3 x^2 + u_t$

where:

α	=	$\ln E_0 - \ln 52h + \ln(1 - k_0 + bt)$
β_1	=	r_S
β_2	=	$r_x k_0$
β_3	=	$-\frac{1}{2} r_x b$

4.2.4 Murphy & Welch (1990) Quartic Human Capital Function

An alternative estimation model is developed by Murphy & Welch (1990) from the traditional Mincer (1974) quadratic earnings function. The general model developed by Murphy & Welch (1990) (referred to as M&W below) is a quartic function of accumulated human capital as follows:

(22) $\ln Y_{sxt} = \alpha_{st} + \beta_{1st} z_{yxt} + \beta_{2st} z_{sxt}^2 + u_{st}$

where;

(23) $z_{sxt} = \alpha' + \beta_1' x + \beta_2' x^2$

and;

s	=	Education group
x	=	Years of experience
t	=	Year of observation

The parameters in Equation (22) are allowed to change over time and across the schooling groups, whilst those in Equation (23) are constants. On simplification M&W have the following model for estimation:

$$(24) \quad y_{ixt} = \alpha + \beta_1 x + (\beta_2 + \beta_1 \phi)x^2 + 2\phi\beta_2 x^3 + \phi^2 \beta_2 x^4$$

where ϕ = 1/60 in M&W. This value is a constraint chosen by M&W to give a peak in the earnings function at 30 years of experience, which is consistent with the average profiles from the CPS data set. This constraint will not be included in the generalisation of this formula applied to non-grouped BSA Survey data.

M&W use 1964-87 CPS data and find that the standard quadratic empirical model underestimates early-career earnings growth by 30-50% and overstates mid-career growth by 20-50%. Their quartic formulation performs more accurately in fitting the data. The quartic model is consistent with the human capital theory prediction of a declining rate of earnings growth, but rejects the assumptions of constant rates of return and linearly declining investment (M&W p. 227). M & W conclude that the quartic provides a better estimate of the true earnings function than does the traditional quadratic, a claim that will be tested later in this chapter.

4.2.5 Psacharopoulos & Layard (1979) Interactive Human Capital Function

Psacharopoulos & Layard (1979) (referred to as P & L below) develop a model which drops the assumption made by Mincer that the parameters k_0, b and r_x are independent from s; the education level:

$$(25) \quad \ln Y_{it} = \ln E_0 - k_0 + r_s s_i + (r_x k_0 + b + \tfrac{1}{2} r_x b)x - \tfrac{1}{2} r_x b x^2 + u_{it}$$

where;

$$(26) \quad k_x = k_0 - \frac{k_0}{T}x = k_0 - bx$$

and individual differences in the parameters k_0, b and r_x are accounted for in the error term u_{it} [see P & L, p. 46].

Although independence of the parameters from schooling may be inferred from the apparent parallel nature of log-earnings profiles for schooling groups in the data-set employed in Mincer's early work, P & L suggest that we should be more rigorous with the model specification. They make the following simple assumptions and substitute them into the function above: Firstly, P & L assume that the rate of return to experience is increases as years of education increases;

(27) $r_{xi} = r_1 + r_2 s_i$,

where r_1 and r_2 are constants and r_{xi} is the rate of return to experience (x) and s_i is the number of years of education, of individual i. Under this assumption an individual with more education will gain a higher monetary return from learning on-the-job or from a job related training scheme.

Secondly, P & L assume that the fraction of potential earnings foregone at the start of labour force participation increases as years of education increases;

(28) $k_{0i} = k_1 + k_2 s_i$,

where k_1 and k_2 are constants, and k_0 is the investment ratio during the initial period of experience $x = 0$ for individual i.

Thirdly, P & L assume that the rate of change of the fraction of potential earnings foregone at the start of labour force participation increases as years of education increases;

(29) $b_i = b_1 + b_2 s_i$,

where b_1 and b_2 are constants, and b_i is the rate of change of the investment ratio of individual i. Little intuition is supplied by P & L regarding these assumptions, but they suggest that there is no reason why Mincer should assume that the three parameters k_0, b and r_x do not vary in relation to years of education.

Substituting (27), (28) and (29) into the Mincerian function gives the following model:

$$
\begin{aligned}
(30)\qquad \ln Y_{it} &= \ln E_0 - k_1 + (r_s - k_2)s_i + (k_1 r_1 + b_1 + \tfrac{1}{2}r_1 b_1)x_i - \tfrac{1}{2}r_1 b_1 x_i^2 \\
&\quad + (k_1 r_2 + r_1 k_2 + b_2 + \tfrac{1}{2}r_1 b_2 + \tfrac{1}{2}r_2 b_1)s_i x_i + (k_2 r_2 + \tfrac{1}{2}b_2 r_2)s_i^2 x_i \\
&\quad - \tfrac{1}{2}(r_1 b_2 + r_2 b_1)s_i x_i^2 - \tfrac{1}{2}r_2 b_2 s_i^2 x_i^2 + u_{2it}
\end{aligned}
$$

Psacharopoulos & Layard (1979) use this estimating equation and present results, based on 1972 UK General Household Survey data, which do not support the hypothesis implicitly made by Mincer (1974) that the parameters k_0, b and r_x are independent of schooling [see P & L, p. 493, Table III]. A wage rate function similar to Equation (30) will be tested using a different UK data set and the results compared to those of P & L.

4.2.6 Models to be Estimated

We initially have three candidate models; a traditional Mincerian quadratic function (M), an adaptation of the M & W quartic function (MW) to include education as an explanatory variable, and an adaptation of the P & L function (PL).[3] The models estimated for the BSA sub-samples of male and female full-time workers are:

$$(31)\qquad \ln W = \alpha_1 + \beta_1 YOED + \beta_2 YILF + \beta_3 YILF^2 + \varepsilon_1 \qquad\qquad (M)$$

$$(32)\ \ln W = \alpha_2 + \beta_4 YOED + \beta_5 YILF + \beta_6 YILF^2 + \beta_7 YILF^3 + \beta_8 YILF^4 + \varepsilon_2\ (MW)$$

[3] For brevity this Chapter only considers these three functional forms. Other functional forms can be chosen to give the required curvature in age-earnings profiles; for example, Mincer estimates a Gompertz function, see Mincer (1974) pp. 90-96 for more details.

$$\ln W = \alpha_3 + \beta_9 YOED + \beta_{10} YILF + \beta_{11} YILF^2 + \beta_{12} YILF.YOED + \beta_{13} YOED^2.YILF + \beta_{14} YOED.YILF^2 + \beta_{15} YOED^2.YILF^2 + \varepsilon_3 \quad (33) \quad \text{(PL)}$$

where:

W	=	hourly wage rate derived from real (*or* nominal) annual gross earnings divided by hours worked in a week and 52 weeks for full-timers,
α_j	=	a constant term,
β_j	=	a constant coefficient,
$YOED$	=	years of full-time education,
$YILF$	=	years in the labour force,
ε_j	=	is an error term, assumed to be normally distributed with an expected value of zero.[4]

However, given the amount of additional information we have at our disposal in the BSA Survey data we can also estimate more detailed versions of the log-wage rate functions above:

$$(34)\ \ln W = \alpha_{41} + \beta_{16} YOED + \beta_{17} YILF + \beta_{18} YILF^2 + B_1 d + \varepsilon_4 \quad \text{(M')}$$

$$(35)\ \ln W = \alpha_5 + \beta_{19} YOED + \beta_{20} YILF + \beta_{21} YILF^2 + \beta_{22} YILF^3 + \beta_{23} YILF^4 + B_2 d + \varepsilon_5 \quad \text{(MW')}$$

$$\ln W = \alpha_6 + \beta_{24} YOED + \beta_{25} YILF + \beta_{26} YILF^2 + \beta_{27} YILF.YOED + \beta_{28} YOED^2.YILF + \beta_{29} YOED.YILF^2 + \beta_{30} YOED^2.YILF^2 + B_3 d + \varepsilon_6 \quad (36) \quad \text{(PL')}$$

where:

d	=	set of control variables,

[4]If nominal gross earnings data is used in constructing the dependant variable then dummy variables will be included to control for the response year.

B_j = vector of parameters.

The control variables contained within d are dummy variables for marital status, union or staff association membership, ethnic origin, unemployment in the past five years, the UK region in which the respondent is resident, and a control for occupational skill level. In these equations the proxy for accumulated post-education human capital x is years in the labour force, *YILF*, and the proxy for s schooling is years of full-time education, *YOED*.

Separate wage rate equations are estimated for male and female full-time workers. Separation of workers into male and female sub-samples is justified at each stage by a Gujarati (1970) dummy variable test to show that wage determination occurs in separate markets for men and women; details of the tests are shown in Appendix 4.2.

4.3 The Sample from the BSA Survey 1985-1991

The sample used to estimate earnings functions is a pooled data set taken from the BSA Survey 1985-1991. The BSA Survey is an annual survey initiated in 1983 by the Social and Community Planning Research and funded by the Monument Trust. Additional contributions are also made by the Countryside Commission, Department of the Environment, ESRC, Marks and Spencer Plc, the Nuffield Foundation and Shell UK Ltd. The data is derived from a cross-sectional sample of individuals, aged 18 and over, living in private households whose addresses were on the electoral registrar. 114 Parliamentary constituencies were selected from among all those in Great Britain on the basis of the Registrar General's Standard Regions.

From each constituency a polling district was randomly selected. Addresses were chosen from these districts by treating the listed electors as circular with a fixed interval and marking the name of the individual on which the sampling interval landed. This methodology ensured a probability proportionate to the number of listed electors. Where possible these electors were chosen for the survey. Where there was a difference between the register record and the current household members, the interviewer selected one respondent randomly. The BSA Survey has two sections. The main section is a interviewer-administered questionnaire; the second section is a self-completion section [Brown *et al* (1994)].

Table 4.1: Descriptive Statistics for Full-time Workers by Gender

Sample:	Males (N=5418)		Females (N=2781)		
Variable Name	Mean	Standard Deviation	Mean	Standard Deviation	T-Statistic
Age	39.327	12.330	36.444	12.106	10.145*
Years of education	16.734	2.021	17.038	2.027	-6.436*
Nom. Gross Earnings	12209	6924.7	8114.9	4724.1	31.516*
Real Gross Earnings	10453	5599.3	6843.1	3640.3	35.142*
Hours worked per week	45.626	10.770	38.865	6.824	34.613*
Years in Labour Force	22.593	12.914	19.406	12.602	10.750*
Married	0.749	0.006	0.601	0.009	13.449*
Divorced/widowed	0.048	0.003	0.124	0.006	-11.023*
High Level Occupation	0.353	0.006	0.314	0.009	3.523*
Mid Level Occupation	0.301	0.006	0.502	0.009	-17.827*
Low Level Occupation	0.346	0.006	0.185	0.007	15.155*
Self-employed	0.176	0.005	0.066	0.005	15.700*
Union Membership	0.422	0.007	0.448	0.009	-2.247*
Recent Unemployment	0.197	0.005	0.187	0.007	1.093
African	0.011	0.001	0.017	0.002	-2.142*
Asian Chinese	0.018	0.002	0.019	0.003	-0.319
White European	0.163	0.005	0.153	0.007	1.181
Unclassified race origin	0.808	0.005	0.812	0.007	-0.437
East Anglia	0.038	0.003	0.035	0.003	0.689
East Midlands	0.063	0.003	0.060	0.005	0.538
London	0.094	0.004	0.111	0.006	-2.371*
North East	0.045	0.003	0.047	0.004	-0.406
Northern Ireland	0.119	0.004	0.129	0.006	-1.291
North West	0.090	0.004	0.107	0.006	-2.418*
Scotland	0.075	0.004	0.081	0.005	-0.955
South East	0.190	0.005	0.166	0.007	2.715*
South West	0.080	0.004	0.067	0.005	2.166*
Wales	0.040	0.003	0.040	0.004	0.000
West Midlands	0.080	0.004	0.090	0.005	-1.522
Yorkshire/Humberside	0.085	0.004	0.067	0.005	2.973*

Notes: * Difference between means is significant at the 5% level or better.

No satisfactory educational certification variables are available prior to 1985, and no survey took place in 1988, therefore the data is for 6 rather than 7 years. The BSA Survey over the years 1985-1991 covered approximately 15000 individuals; of these 9998 were working, of which 8199 were in full-time employment, and had usable records. Following Blanchflower (1991) the nominal yearly gross-earnings data was converted from the original open-ended groupings into band midpoints using UK General Household Survey statistics as a guide, and then adjusted for inflation using 1986 as the base year for a measure of *real* gross-earnings; we therefore have two possible dependant variables for the estimation of wage functions; real gross hourly wage-rates and nominal gross hourly wage-rates. Summary statistics for full-time male and female workers in the BSA Survey data are shown in Table 4.4.1; Appendix 4.1 contains a description of the variables used.

Some interesting significant sample mean or sample proportion differences are shown in Table 4.1. We can see that on average male full-timers are significantly older, have less years in education, earn more per annum and work more hours per week than their female counterparts. A significantly higher proportion of male full-timers are married, and a significantly lower proportion are divorced/widowed in comparison to female full-timers. A significantly higher proportion of female full-timers work in the middle level occupations, and significantly lower proportions in high and low level occupations in comparison to male full-timers (see Appendix 3.1 for details of the occupational groupings). A significantly higher proportion of male full-timers are self-employed, and a significantly lower proportion are union members in comparison to female full-timers.

4.4 Results

4.4.1 The Mincerian Wage Rate Functions

The results of estimating the Mincerian schooling function (MS) for full-time male workers are shown in Columns 2 and 3 of Table 4.2; the logarithms of nominal wage rates are regressed on years of education and dummy variables indicating the response year. The dummy variables for year control for price effects which will affect the real value of nominal wages in each year and also control for trends in labour supply and demand which may influence wage bargaining and employment in the UK. The explanatory power of this equation is very low as indicated by an R-squared adjusted of 0.168.

Table 4.2 : Mincerian Equation Estimates for Male Full-timers (N=5418)

Variable Name	Equation (MS)		Equation (MR)		Equation (MN)	
	Est. Coef.	T-Ratio	Est. Coef.	T-Ratio	Est. Coef.	T-Ratio
YOED	0.089	24.999*	0.105	29.067*	0.105	28.803*
YILF	--	--	0.045	21.850*	0.044	21.768*
YILF^2	--	--	-0.00074	-17.706*	-0.00074	-17.608*
D1985	-0.445	-15.544*	--	--	-0.423	-14.528*
D1986	-0.336	-13.755*	--	--	-0.329	-14.121*
D1987	-0.307	-12.268*	--	--	-0.302	-12.544*
D1989	-0.155	-6.6138*	--	--	-0.143	-6.411*
D1990	-0.049	-2.032*	--	--	-0.042	-1.779*
Constant	0.210	3.317*	-0.897	-13.256*	-0.560	-7.769*
Adjusted R^2	0.168		0.195		0.252	
Variance of Estimate	0.280		0.253		0.252	

Notes: * Significant at the 5% level or better, Mean of dependant variable = 1.511 (nominal), 1.368 (real), All regressions have standard errors corrected according to White's (1980) heteroscedasticity-consistent covariance matrix except Equation (MS).

The results of estimating the Mincerian human capital equation (MR) for real wage rates of full-time male workers are shown in Columns 4 and 5 of Table 4.2. Using nominal wages and dummy variables to represent the year in which the data was collected gives the (improved) results for equation (MN) shown in Columns 6 and 7. The addition of years in the labour force and its square as explanatory variables in the Mincerian human capital function estimates raises both the R-squared figure and the size of the coefficient on the years of education variable in comparison to the schooling model. The magnitude of the coefficient was reduced in estimation of equation (MS) by the omission of years in the labour force with which years of education is negatively correlated.

The estimated rate of return to years of education in equation (MN) is approximately 10.5% which accords with the P & L result of a 10% rate of return to years of education in the UK. P & L find that maximum earnings occur when experience reaches around 30 years, in formulation (MN) maximum wages also occur at approximately 30 years of experience (P & L, p. 493).[5] However, Harmon & White (1995) estimate the average rate of return to years of education for male workers in the UK to be approximately 16% using instrumental variables estimation technique on Family Expenditure Survey data for the period 1978-

[5]Maximising the function $W = c + 0.044x - 0.00074x^2$, where x is experience and c is the sum of all other effects, implies an optimal value of $x = 29.7$.

1986. Harmon & White (1995) suggest that ordinary least squares estimation of earnings functions give estimated rates of return to education which are biased downwards.

The nominal wage equation (MN) estimate shows a higher adjusted R-squared and a lower estimate variance than the real wage equation (MR); we reject this formulation, and concentrate on nominal wages as the correct dependant variable.

The results of estimating the Mincerian schooling equation (MS) for full-time female workers are shown in Columns 2 and 3 of Table 4.3. The explanatory power of this equation is low as indicated by an adjusted R-squared figure of 0.246, however females appear to fit this model better than their male counterparts as indicated by the higher adjusted R-squared.

Table 4.3 : Mincerian Equation Estimates for Female Full-timers (N=2781)

Variable Name	Equation (MS)		Equation (MR)		Equation (MN)	
	Est. Coef.	T-Ratio	Est. Coef.	T-Ratio	Est. Coef.	T-Ratio
YOED	0.098	21.681*	0.107	22.815*	0.105	22.414*
YILF	--	--	0.029	11.296*	0.028	11.068*
$YILF^2$	--	--	-0.0005	-9.448*	-0.0005	-9.290*
D1985	-0.483	-13.176*	--	--	-0.446	-12.416*
D1986	-0.441	-14.153*	--	--	-0.422	-13.885*
D1987	-0.379	-12.161*	--	--	-0.371	-12.191*
D1989	-0.212	-7.172*	--	--	-0.200	-6.950*
D1990	-0.077	-2.624*	--	--	-0.071	-2.502*
Constant	-0.183	-2.265*	-0.989	-11.483*	-0.578	-6.459*
Adjusted R^2	0.246		0.191		0.282	
Variance of Estimate	0.233		0.223		0.221	

Notes: * significant at 5% level or better, ** significant at the 10% level,
Mean of dependant variable = 1.254 (nominal), 1.103 (real).

The results of estimating the Mincerian human capital equation (MR) for real wage rates of full-time female workers are shown in Columns 4 and 5 of Table 4.3. Using nominal wage rates gives the (improved) results for equation (MN) shown in Columns 6 and 7. We can see that on average females earn a lower wage rate per hour than males ceteris paribus; the average (log) real wage rate for men is 1.368 compared to 1.103 for women. Again we can see that the addition of years in the labour force and its square as explanatory variables in the estimated equation (MN) raises both the adjusted R-squared figure and the size of the coefficient on the years of education variable in comparison to the schooling model.

The estimated rate of return to years of education in equation (MN) for females is approximately 10.5% the same as that for males. However, we can see that the returns to experience differ by gender, and in formulation (MN) maximum wage rates for females occur at approximately 56 years of experience.[6] It is interesting to note that females appear to fit these simple wage rate equations better than males as indicated by higher adjusted R-squared figures in Table 4.3 compared to Table 4.2.

Table 4.4 shows the results from the estimation of the more detailed wage equation (M') for male and female full-time workers. Control is made for marital status by the inclusion of the dummy variables indicating whether the respondent is married (or living as married) or divorced/widowed; the reference state is that of a single person. Marital status is included as an explanatory variable for two reasons; firstly marital status will affect the labour supply decision of a worker since the individual is involved in earning household income in conjunction with their spouse; for example, this may affect the worker's willingness to work overtime. Secondly, it has been suggested in the absence literature that married workers may be considered more reliable and conscientious than there single counterparts, and this may positively influence their earnings; however, there is empirical evidence to suggest that female workers with dependant children are more likely to be absent [see Brown & Sessions (1996), p. 36-37].

[6]Maximising the function $W = c + 0.028x - 0.0005x^2$, where x is experience and c is the sum of all other effects, implies an optimal value of $x = 56$.

Table 4.4: Mincerian Equation (M') Estimate for Full-timers by Gender

Gender:	Males (N=5418)		Females (N=2781)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Married	0.164	8.804*	0.0001	0.005
Divorced/widowed	0.123	3.624*	0.055	1.825**
Recent Unemployment	-0.143	-8.897*	-0.111	-5.449*
East Anglia	-0.102	-3.404*	-0.0004	-0.009
East Midlands	-0.130	-4.700*	-0.160	-3.806*
London	0.088	3.553*	0.166	5.576*
North East	-0.107	-3.492*	-0.141	-3.322*
Northern Ireland	-0.276	-9.088*	-0.162	-4.832*
North West	-0.167	-6.688*	-0.101	-3.198*
Scotland	-0.105	-4.104*	-0.144	-4.178*
South West	-0.160	-6.087*	-0.168	-4.043*
Wales	-0.207	-5.758*	-0.214	-4.938*
West Midlands	-0.104	-4.006*	-0.074	-2.290*
Yorkshire/Humberside	-0.142	-5.633*	-0.134	-3.844*
Union Membership	0.097	7.585*	0.115	6.978*
Self-employed	-0.200	-8.091*	-0.371	-6.701*
High Occupation Class	0.243	12.718*	0.242	11.698*
Low Occupation Class	-0.156	-9.298*	-0.233	-10.637*
African	-0.109	-1.674**	-0.027	-0.434
Asian / Chinese	-0.252	-3.942*	0.079	0.972
Unclassified Race	0.032	0.790	0.082	1.708**
Years of Education	0.051	12.288*	0.056	11.326*
Years in Labour Force	0.027	12.534*	0.022	8.091*
YILF^2	-0.00051	-12.178*	-0.00044	-7.118*
1985 dummy	-0.520	-19.305*	-0.478	-14.822*
1986 dummy	-0.398	-18.469*	-0.454	-15.324*
1987 dummy	-0.361	-16.402*	-0.374	-12.623*
1989 dummy	-0.151	-3.972*	-0.121	-2.794*
1990 dummy	-0.063	-2.957*	-0.063	-2.343*
Constant	0.555	6.263*	0.277	2.671*
Adjusted R^2	0.393		0.438	
Variance of Estimate	0.204		0.173	
Mean Log-wage	1.511		1.254	

Notes: * Significant at 5% level or better, ** Significant at 10% level,
White's (1980) standard error correction is used.

The dummy variable for recent unemployment indicates whether the BSA respondent has been unemployed within the previous five years. Greenwald (1986) presents an asymmetric information adverse selection model of the labour market in which applicants who have previously been unemployed are expected by prospective employers to be low skill from their association with the unemployment pool. The wage such workers receive from their employers who rely on paying an average productivity wage after employing this possibly inaccurate screening device will be lower than that received by those with no unemployment history. Taubman & Watcher (1986) also suggest that an actual 'scarring' effect occurs with unemployment where skills are lost and therefore future earnings impaired i.e. unemployment amounts to a negative human capital investment. Whichever of the two theories is correct in reality is not the subject of this Chapter, suffice to say that a record of unemployment may have a negative effect on wages and therefore we should control for such an effect in our human capital equation estimations.

The dummy variable indicating whether or not the respondent is self-employed is included since there is much evidence to suggest that the self-employed exhibit a different investment behaviour to that of employees in relation to education duration [for example see Wolpin (1977), Katz & Ziderman (1980)]. The self-employed are traditionally viewed as being less risk averse than employees, [for empirical evidence testing this point see Blanchflower *et al* (1988a)], and we may therefore expect that they may invest in education differently than other workers.[7]

Union membership is controlled for in the regressions by the inclusion of a dummy variable which indicates if the BSA Survey respondent was, at the time of the study, a member of a trade union or staff association. Trade unions can act to increase wages while leaving productivity unchanged and therefore restrict output, or they may influence work practices so that output is actually increased.

Metcalf (1988) suggests that unions may reduce labour productivity if they are allowed to operate restrictive work practices (closed shops), are involved in adverse industrial action (strikes), if unionised firms invest less than their non-unionised counterparts, or there is a lack of co-operation between workers and management. Productivity may be increased by unionisation if firms faced with a high labour factor price substitute more productive capital for labour, if unions reduce X-inefficiency by monitoring work practices and if they reduce worker exploitation and interact fruitfully with management rather than antagonistically. The overall net effect however has been found to be a reduction in labour

[7]For further details on the differences between the self-employed and employees in this sample see Chapter 5.

productivity in unionised firms in the UK [see Metcalf (1988) for a brief survey of UK studies].

In contrast the effect of unionisation on wages is positive with union members having higher average wages than similar non-union workers. Blanchflower & Oswald (1988) survey a number of recent studies and find that union members' wages are approximately 10% higher than those of non-unionised workers *ceteris paribus*. Metcalf (1988) suggests that it is the closed shop that is the source of this differential, but that increased legislation in the 1980's have undermined the practice. Blanchflower & Oswald (1988) show that union members are also more likely to receive occupational pensions, sick pay, meal vouchers, and longer holidays in comparison to non-unionised workers.

Trade union membership peaked in the UK in 1980 at approximately 56% of employees [see Elliot (1991), p.198, Table 7.2], and has been in decline since then due to trade union legislation, economic recession and the changing industrial structure of the UK (such as increased service sector activity, increased use of physical capital and increased participation by female part-timers); trade union membership in the UK in 1990 was approximately 39% of employees [see Adnett (1996), p.27, Table 1.7]. The percentage of male and female full time workers (self-employed and employees) who were members of staff associations or trade unions over the sample period for this BSA Survey data set was on average approximately 43%. The average non-union wage over the period for these workers was approximately £4.01 per hour, and the union wage approximately £4.37 per hour, representing a premium of approximately 9% from union membership. The effect of union membership *ceteris paribus* upon wage rates can be estimated from the coefficient on the union membership dummy variable in the wage rate equation estimates.

Wage rates depend to a large extent upon the beliefs and behaviour of the employer and we therefore include the ethnic origin dummy variables representing Asian or Chinese, African, and unclassified race to control for possible racial biases in the hiring and pay structures of UK firms (the reference category is White or European). These variables will also help to control for any asymmetries of information regarding job vacancies and differences in the mobility of labour within different ethnic communities.

Regional dummies are included in the regressions to take account of spatial differences in living costs, labour mobility, and in the supply and demand positions of regional labour markets.

Occupational effects are accounted for in the regressions by the inclusion of two occupational classification dummy variables showing whether the worker is in high or low level jobs (the reference category is middle level occupations). These dummy variables are constructed on the basis of the workers' reported Goldthorpe-Heath social classification; as the rank number increases the classification moves from high-skill labour, involved in professional and management jobs, to low-skill agricultural jobs (see Appendix for details of the occupational ranking involved). Including the two dummies will help to control for the differing pay structures in operation within these different occupations to reduce possible bias in the estimated effect of post-school investment on earnings; employers in low-skill industries may have a different view about an applicant's or employee's market experience than their high-skill counterparts and may also be more or less able to measure productivity directly.

From Columns 3 and 4 in Table 4.4 we can see that being married (or living as married) has a significant positive effect on the wage rates of male full-time workers, as does having been married, as indicated by the dummy representing divorced or widowed. The difference between the coefficients on these two variables is not statistically different from zero, i.e. both these states are equivalent in their positive impact on wages in comparison to a single male worker. In comparison if we look at Columns 4 and 5 of Table 4.4 we can see that being married is insignificant in the determination of wage rates for female full-time workers, whereas being divorced has a positive effect on their wage rates.

Having been unemployed in the previous five years has a significant negative effect on wage rates; reducing the wage rate by approximately 14% for men, and 11% for women. In general all regions of residence in comparison to the South East have a negative impact upon wage rates with the exception of residence in London. Union or Staff Association membership enhances wage rates by approximately 10% and 12% above non-union members for men and women respectively.

Being self-employed actually reduces a worker's wage rate by approximately 21% for men, and 37% for females. Although the self-employed on average earn relatively more than employees they work more hours per week; from Table 5.1 in Chapter 5 we can see that the self-employed work approximately 10 hours more per week than employees.

The positive and significant coefficient on the dummy variable representing high occupational class for both sexes reflects the higher wage rate which is generally paid to professional and management occupations in the UK; the impact is approximately 24% higher wage rates for both women and men, in comparison to middle level jobs. The negative and significant coefficient on the dummy variable representing low occupational class for both sexes reflects the lower wage rate which is generally paid to the lower skilled occupations in the UK; the impact is 23% compared to 16% lower wage rates for women as compared to men.

Being of Asian or Chinese ethnic origin in comparison to White or European origin has a significant negative impact upon wage rates of male full-timers; reducing wage rate by approximately 25%. There is a similar negative effect on wage rates for men with African ethnic origin of approximately 11%. The negative impact of Asian or Chinese ethnic origin upon wage rates may be a result of the lack of information about opportunities available to minority communities or racism on the part of employers in the hiring of workers. Neither of these ethnic origin dummy variables are significant in determining the wage rates of female full-time workers.

Years of education have a positive impact upon wage rates; the estimated percentage increase in wage rate for each year of education is approximately 5% for men and 6% for women. This estimate is significantly lower than the estimate from equation (M) which was 11%, the reduction being due in part to the inclusion of additional explanatory variables. We can compare this education-effect to the effect of years in the labour force (i.e. potential post-education human capital investment) which is estimated at approximately 3% for men, and 2% for women. The coefficients on the variables representing years of education and years in the labour force are significantly different from each other, indicating that each year of education has a larger positive impact on wages than does each year of labour market experience.

4.4.2 The Murphy & Welch Wage Rate Functions

The results from the estimation of the quartic wage function (MW) for male and female full-time workers are shown in Table 4.5 and Table 4.6, where the dependant variable is the natural logarithm of real gross wage rates in Columns 2 and 3 and the dependant variable is the natural logarithm of nominal wage rates in Columns four and five of each table.

Table 4.5: Quartic Wage Rate Equation (MW) Estimates For Males (N=5418)

	Real Wage Rate Equation		**Nominal Wage Rate Equation**	
Variable Name	**Estimated Coefficient**	**T - Ratio**	**Estimated Coefficient**	**T-Ratio**
YOED	0.105	29.212*	0.105	28.939*
YILF	0.107	14.116*	0.106	14.061*
YILF^2	-0.0048	-9.778*	-0.0048	-9.719*
YILF^3	0.952E-4	7.979*	0.942E-4	7.911*
YILF^4	-0.718E-6	-7.519*	-0.709E-6	-7.437*
1985	--	--	-0.423	-14.573*
1986	--	--	-0.329	-14.230*
1987	--	--	-0.302	-12.617*
1989	--	--	-0.145	-6.495*
1990	--	--	-0.043	-1.817*
Constant	-1.137	-15.622*	-0.798	-10.364*
Adjusted R^2	0.204		0.260	
Variance of Estimate	0.250		0.249	
Mean ln w	1.368		1.511	

Notes: * Significant at 5% level or better, White's (1980) standard error correction is used.

As with ~~the~~ Mincerian function we can see ~~that~~ the higher adjusted R-squared figures of 0.260 for men and 0.304 for women indicate that the simple nominal log-wage quartic function fits the data better than the real log-wage function. We can also see that the simple nominal log-wage quartic function fits the data better than the Mincerian formulation (MN) with an adjusted R-squared of 0.252 for men and 0.282 for women, and just as well as the Mincerian function with the schooling year dummies (MD) with an adjusted R-squared of 0.260 for men and 0.292 for women. Moreover, the coefficients on $YILF^3$ and $YILF^4$ are statistically significant, which supports the view that the quartic function may fit earnings data better than the Mincerian quadratic function.

Table 4.6: Quartic Wage Rate Equation (MW) Estimates For Females (N=2781)

Variable Name	Real Wage Rate Equation		Nominal Wage Rate Equation	
	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
YOED	0.107	23.164*	0.105	23.598*
YILF	0.129	11.727*	0.127	12.634*
$YILF^2$	-0.0083	-9.634*	-0.0082	-10.308*
$YILF^3$	0.211E-3	8.435*	0.211E-3	8.989*
$YILF^4$	-0.186E-5	-7.696*	-0.188E-5	-8.194*
1985	--	--	-0.436	-12.415*
1986	--	--	-0.409	-13.429*
1987	--	--	-0.363	-11.653*
1989	--	--	-0.192	-6.247*
1990	--	--	-0.062	-2.093*
Constant	-1.304	-14.296*	-0.899	-9.745*
Adjusted R^2	0.216		0.304	
Variance of Estimate	0.217		0.216	
Mean ln w	1.103		1.254	

Notes: * Significant at 5% level or better.

Estimating the more detailed nominal wage rate function (MW'), using a heteroscedasticity-consistent covariance matrix for both sexes gives the results shown in Table 4.7, which are an improvement in comparison to the Equation (MW) estimates. From Table 4.7 we can see that the effect of including $YILF^3$ and $YILF^4$ as explanatory variables in the log-wage rate function is now only marginal; R-squared is 0.398 for males and 0.451 for women for the quartic equation (MW'), and the variance of the estimate is only slightly reduced in the quartic relative to the results for the Mincerian equation (M'), which was characterised by an adjusted R-squared of 0.393 for men and 0.438 for women (see Table 4.4). The inclusion of additional explanatory variables has reduced the superiority of the quartic function over the Mincerian function in explaining wages.

Table 4.7: Quartic Wage Rate Equation (MW') Estimate for Full-timers by Gender

Gender:	Males (N=5418)		Females (N=2781)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Married	0.132	6.741*	-0.027	-1.307
Divorced/widowed	0.094	2.716*	0.027	0.905
Recent Unemployment	-0.142	-8.862*	-0.102	-5.051*
East Anglia	-0.104	-3.512*	-0.005	-0.117
East Midlands	-0.127	-4.648*	-0.163	-3.918*
London	0.081	3.288*	0.152	5.094*
North East	-0.111	-3.620*	-0.147	-3.507*
Northern Ireland	-0.282	-9.342*	-0.179	-5.326*
North West	-0.169	-6.819*	-0.109	-3.514*
Scotland	-0.108	-4.225*	-0.138	-4.043*
South West	-0.160	-6.080*	-0.171	-4.158*
Wales	-0.207	-5.821*	-0.218	-5.128*
West Midlands	-0.103	-3.976*	-0.082	-2.557*
Yorkshire/Humberside	-0.146	-5.802*	-0.134	-3.870*
Union membership	0.092	7.208*	0.110	6.729*
Self-employed	-0.206	-8.267*	-0.369	-6.687*
High Level Occupation	0.241	12.633*	0.233	11.274*
Low Level Occupation	-0.157	-9.380*	-0.230	-10.730*
African	-0.106	-1.647*	-0.044	-0.755
Asian/Chinese	-0.254	-4.000*	0.071	0.861
Unclassified Race	0.033	0.814	0.075	1.583
Years of education	0.052	12.426*	0.058	11.758*
YILF	0.078	10.141*	0.102	10.736*
$YILF^2$	-0.374E-2	-7.978*	-0.654E-2	-9.050*
$YILF^3$	0.759E-4	6.861*	0.168E-3	8.001*
$YILF^4$	-0.582E-6	-6.681*	-0.149E-5	-7.402*
1985	-0.519	-19.274*	-0.474	-14.808*
1986	-0.399	-18.601*	-0.446	-15.184*
1987	-0.362	-16.543*	-0.371	-12.639*
1989	-0.152	-3.995*	-0.120	-2.815*
1990	-0.063	-2.995*	-0.056	-2.106*
Constant	0.366	3.956*	0.106	0.098
Adjusted R^2	0.398		0.451	
Variance of Estimate	0.203		0.169	
Mean ln w	1.511		1.254	

Notes: * Significant at 5% level or better, ** Significant at 10% level, White's (1980) standard error correction is used.

4.4.3 Psacharopoulos & Layard Wage Rate Functions

Table 4.8 shows the results of estimating Equation (PL) corresponding to P&L's model specification. All the coefficients on the interactive terms which are omitted from the traditional Mincerian formulation are significant for both sexes, they display the same magnitude and sign pattern as in P&L's results and therefore support P&L's contention that the implicit assumptions behind the traditional Mincerian log-earnings function should not go unchallenged.

Table 4.8 : P & L Equation Estimates (PL) for Full-timers by Gender

Gender:	Males		Females	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
YOED	0.123	11.471*	0.101	8.183*
YILF	-0.394	-4.874*	-0.252	-1.985*
YILF^2	0.009	4.206*	0.006	1.670**
YILF*YOED	0.051	5.411*	0.030	2.086*
YOED^2*YILF	-0.001	-5.319*	-0.788E-3	-1.915**
YOED*YILF^2	-0.001	-4.412*	-0.676E-3	-1.660**
YOED^2*YILF^2	0.314E-4	4.229*	0.171E-4	1.460
1985	-0.411	-14.015*	-0.435	-12.381*
1986	-0.324	-13.968*	-0.415	-13.406*
1987	-0.297	-12.359*	-0.370	-11.787*
1989	-0.134	-6.006*	-0.194	-6.268*
1990	-0.033	-1.411	-0.071	-2.374*
Constant	-0.920	-4.850*	-0.548	-2.436*
Adjusted R^2	0.257		0.285	
Variance of Estimate	0.250		0.222	

Notes: * Significant at 5% level, * Significant at 10% level, Mean ln w = 1.511 (males), 1.254 (females) , males use White's (1980) standard error correction.

The estimated wage rate equation (PL'), set out in Table 11, represents a more detailed formulation of P&L's model allowing for additional influences upon wages such as marital status, union status and region of residence; the additional variables correspond to those added to the traditional Mincerian function in Section 4.4.1 of this Chapter. The main result of significant interactive terms between years in the labour force ~~and~~ years of education still remains.

Table 4.9: Detailed P & L (PL') Wage Rate Equation Estimates for Full-timers by Gender

Gender: Variable Name	Males Estimated Coefficient	Males T-Ratio	Females Estimated Coefficient	Females T - Ratio
Married	0.162	8.540*	-0.001	-0.062
Divorced/widowed	0.118	3.427*	0.054	1.772**
Recent Unemployment	-0.143	-8.882*	-0.108	-5.255*
East Anglia	-0.099	-3.287*	0.001	0.024
East Midlands	-0.129	-4.690*	-0.158	-3.737*
London	0.090	3.640*	0.165	5.563*
North East	-0.105	-3.436*	-0.139	-3.277*
Northern Ireland	-0.275	-9.061*	-0.167	-4.947*
North West	-0.163	-6.551*	-0.099	-3.154*
Scotland	-0.104	-4.061*	-0.139	-4.026*
South West	-0.160	-6.070*	-0.169	-4.059*
Wales	-0.205	-5.717*	-0.217	-4.998*
West Midlands	-0.101	-3.886*	-0.072	-2.235*
Yorkshire/Humberside	-0.139	-5.520*	-0.131	-3.753*
Union membership	0.098	7.645*	0.115	6.996*
Self-employed	-0.200	-8.069*	-0.371	-6.679*
High Level Occupation	0.241	12.661*	0.243	11.672*
Low Level Occupation	-0.150	-8.854*	-0.228	-10.241*
African	-0.120	-1.819**	-0.033	-0.550
Asian/Chinese	-0.265	-4.108*	0.069	0.846
Unclassified R. O.	0.029	0.724	0.080	1.662**
Years of Education	0.048	4.621*	0.046	3.893*
Years in Labour Force	-0.230	-3.202*	-0.131	-1.188
$YILF^2$	0.511E-2	2.673*	0.242E-2	0.774
YILF*YOED	0.029	3.464*	0.016	1.228
$YOED^2$*YILF	-0.802E-3	-3.314*	-0.378E-3	-1.040
YOED*$YILF^2$	-0.640E-3	-2.823*	-0.277E-3	-0.758
$YOED^2$*$YILF^2$	0.179E-4	2.697*	0.614E-5	0.583
1985	-0.511	-18.764*	-0.473	-14.723*
1986	-0.396	-18.350*	-0.451	-15.165*
1987	-0.358	-16.287*	-0.375	-12.665*
1989	-0.147	-3.859*	-0.118	-2.710*
1990	-0.056	-2.629*	-0.062	-2.312*
Constant	0.593	3.156*	0.441	2.012*
Adjusted R^2	0.395		0.439	
Variance of Estimate	0.204		0.173	

Notes: * Significant at 5% level, ** significant at 10% level, Both use White's (1980) correction.

From the coefficients reported in Table 4.12 it is possible to calculate estimates of the parameters r_1, r_2, k_1, k_2, b_1 and b_2, which summarise the assumptions made by P & L;

$$r_{xi} = r_1 + r_2 s_i \qquad (27)$$

$$k_{0i} = k_1 + k_2 s_i \qquad (28)$$

$$b_i = b_1 + b_2 s_i \qquad (29)$$

Using six equations [constructed by comparing the compound parameters in Equation (36) to the estimated coefficients in Table 4.9] to find six unknowns (r_1, r_2, k_1, k_2, b_1 and b_2) and employing the computer package *Mathematica* we can estimate the underlying parameters. In each case there are two sets of solutions and only the more realistic set of solutions is reported in Table 4.10.[8] Results are not reported for female full-time workers as none of the estimated coefficients used to calculate the underlying parameters in the wage function are statistically significant.

Table 4.10 : Parameter Estimates for the P & L Equation for Male Full-timers

Parameter	Estimate from P & L (1979)	Estimate from (PL')
r_1	**-0.313**	-1.757
r_2	**0.0491**	0.146
k_1	**0.767**	0.131
k_2	**-0.033**	-0.00537
b_1	**0.0337**	0.00582
b_2	**-0.00145**	-0.000245

Source (Column 2): P & L, p. 493.

From Table 4.10 we can see that for someone with 10 years of education the rate of return to each year of experience is approximately;

-1.757 + 1.46 = -3% (18%)

and for someone with 16 years of education the rate of return to experience is approximately;

-1.757 + 2.336 = 58% (50%).

[8]The less 'realistic' solution of the set of simultaneous equations gives negative (positive) figures where we would intuitively expect postive (negative) figures.

The figures in brackets are the equivalent rates of return estimated by Psacharopoulos & Layard (1979) using 1972 General Household Survey data. If we assume that the BSA Survey and GHS data are both representative of the UK population as a whole, these results suggest that there has been a spread in the returns to experience over education categories over the 1980's; those with ten years education experiencing negative returns and those with sixteen years of education experiencing average returns of approximately 58% rather than 50% to each year of experience. Those with lower levels of education appear to have negative or near zero returns to experience, whereas those with higher levels of education appear to have higher positive returns to experience. Dynamic factors such as modernisation of production processes and increased sophistication of the nature of wage schemes may be the cause of such changes. For example, it is increasingly the case that workers in management jobs, who on average tend to have higher levels of education, are offered company share options at certain stages of tenure, the profits from which will add to the individual income variable used to construct the hourly wage rate. The negative rate of return to experience for those workers with less than approximately 12 years of education in the BSA Survey sample implies that a minimum education is required before experience can be expected to positively influence wage rates.

The investment ratio, the level of expenditure on training (in the form of foregone earnings) over the level of gross earnings, in the first year of work for a worker with 10 years of education is approximately;

$$0.131 - 0.0537 = 8\% \qquad (44\%),$$

and the investment ratio in the first year of work for a worker with 16 years of education is approximately;

$$0.131 - 0.0859 = 5\% \qquad (24\%).$$

This shows that levels of expenditure on training in the form of foregone earnings have changed significantly since the 1970's, and, as in P & L, that those with higher education invest less, as a percentage of gross earnings, in non-schooling human capital.

The investment ratio falls each year for a worker with 10 years of education by approximately;

0.00582 - 0.00245 = 0.3% (1.9%),

and the investment ratio falls each year for a worker with 16 years of education by approximately;

0.0582 - 0.000245(16) = 0.2% (1%),

again these are lower figures than those estimated by P & L, and indicate that the rate of change of the investment ratio does not appear to differ significantly between education groups in the BSA Survey sample.

4.5 Tests for Variation in the Marginal Rate of Return to Years of Education and the effects of Certification

4.5.1 Introduction

The possibility that the marginal rate of return to years of education is not constant is allowed for by introducing dummy variables for the various years of schooling into the estimated wage rate equations. The continuous variable for years of education is now omitted from the equations. The dummy variable for 9 years of education, S9, is the minimum level of education and the omitted reference category, and the dummy for 15 years of education is constant (no-one in the sample left full-time education at the age of twenty). The pattern of cumulative returns is now shown by the coefficients on the dummy variables S10 to S17.

4.5.2 Estimated Wage Rate Equations and Test Results

The traditional Mincerian human capital model assumes that the marginal rate of return to years of education (MRE) is constant, and so in the estimated wage rate functions (MS), (MR) and (MN) any variation in the marginal rate of return will be absorbed by the constant term. We can control for variations in the marginal rate of return to years of schooling by substituting dummy variables representing the number of years of education completed in the place of the continuous variable for years of education.

Table 4.11 and Table 4.13 below show the results for male and female full-time workers of estimating the Mincerian wage rate function with schooling dummies (MD), the Mincerian wage rate function with schooling dummies plus variables representing marital status, union status, ethnic origin, occupation and regional effects (MD').

From Table 4.11 we can see that the average return to years in the labour market for male and female full-time workers is approximately 5% and 3% respectively for each year of experience.

The estimated coefficients on S10 to S17 show the cumulative returns to 10 to 17 years of education completed. We can see that for males the return to the 10th year of education in insignificant and then that each year adds to the positive impact that schooling has upon wage rates with the exception of the 17th year of education. By the 16th year the return is approximately 68%, but then falls to approximately 53%. For females S10 has a negative impact on wage rates and then as years of education increases up to 13 years the return becomes positive and significant, and increases to approximately 50% by the 16th year. The return appears to then falls to approximately 40% in the 17th year, however this is not significantly different from the return in the 16th year in this subsample. If we test the significance of differences between coefficients on the years of education dummies we get the results shown in Table 4.12, where s10 to s17 correspond to the estimated coefficients on the dummy variables S10 to S17.

Table 4.11: Estimated Mincer-type Equation (MD) for Full-timers by Gender

Gender: Variable Name	Males		Females	
	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
YILF	0.049	21.551*	0.033	11.818*
$YILF^2$	-0.00082	-16.850*	-0.0006	-9.982*
S10	-0.061	-1.336	-0.212	-2.831*
S11	0.141	3.023*	-0.023	-0.306
S12	0.278	5.397*	0.123	1.560
S13	0.367	7.039*	0.172	2.160*
S14	0.374	6.078*	0.139	1.546
S16	0.675	13.240*	0.501	6.323*
S17	0.527	8.494*	0.404	3.224*
1985	-0.413	-14.115*	-0.439	-12.214*
1986	-0.327	-14.136*	-0.424	-13.978*
1987	-0.300	-12.499*	-0.371	-12.271*
1989	-0.131	-5.849*	-0.185	-6.408*
1990	-0.027	-1.144*	-0.062	-2.196*
Constant	0.944	18.668*	1.102	14.169*
Adjusted R^2	0.260		0.292	
Variance of Estimate	0.249		0.218	

Notes: * significant at 5% level or better, regression for males uses White's (1980) standard error correction.

Table 4.12: T - Statistics for Hypotheses Regarding Cumulative Returns to Years of Schooling in Equation (MD)

Null Hypothesis	Males	Females
s11-s10=0	10.076*	6.463*
s12-s11=0	5.251*	5.225*
s13-s12=0	2.551*	1.395
s14-s13=0	0.139	-0.539
s16-s14=0	6.475*	6.073*
s17-s16=0	-3.175*	-1.275

Notes: * significant at the 5% level or better, s10-17 correspond to coefficients on the dummy variables S10-17.

The explanatory power of function (MD) for both sexes is low as indicated by the adjusted R-squared figures of 0.260 (males) and 0.292 (females). It is interesting to note that female full-time workers appear to fit this simple Mincerian wage rate function better than their male counterparts as indicated by the higher adjusted R-squared figure.

Table 4.13: Estimated Wage Rate Equation (MD') with Schooling Dummies

Gender:	Males (N=5418)		Females (N=2781)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Years in Labour Force	0.031	12.420*	0.025	8.364*
YILF^2	-0.563E-3	-11.333*	-0.504E-3	-7.106*
S10	-0.042	-1.012	-0.111	-1.573
S11	0.088	2.064*	0.013	0.183
S12	0.141	2.976*	0.106	1.420
S13	0.178	3.664*	0.092	1.206
S14	0.206	3.648*	0.130	1.490
S16	0.344	6.979*	0.292	3.799*
S17	0.253	4.290*	0.229	2.296*
Married	0.159	8.461*	-0.412E-2	-0.202
Divorced/widowed	0.116	3.414*	0.050	1.667**
Recent Unemployment	-0.145	-9.055*	-0.109	-5.294
East Anglia	-0.099	-3.318*	0.149E-2	0.033
East Midlands	-0.128	-4.656*	-0.162	-3.827*
London	0.088	3.590*	0.163	5.464*
North East	-0.109	-3.566*	-0.141	-3.3635
Northern Ireland	-0.276	-9.096*	-0.171	-5.095*
North West	-0.164	-6.563*	-0.097	-3.095*
Scotland	-0.107	-4.190*	-0.145	-4.174*
South West	-0.159	-6.070*	-0.169	-4.082*
Wales	-0.204	-5.706*	-0.222	-5.129*
West Midlands	-0.100	-3.847*	-0.073	-2.280*
Yorkshire/Humberside	-0.141	-5.590*	-0.136	-3.902*
Union member	0.096	7.503*	0.115	7.009*
Self-employed	-0.200	-8.101*	-0.369	-6.657*
High Level Occupation	0.236	12.308*	0.238	11.286*
Low Level Occupation	-0.151	-8.889*	-0.223	-10.036*
African	-0.123	-1.885**	-0.039	-0.633
Asian / Chinese	-0.257	-4.006*	0.072	0.891
Unclassified R. O.	0.030	0.742	0.076	1.587
1985	-0.511	-18.760*	-0.473	-14.919*
1986	-0.397	-18.425*	-0.455	-15.370*
1987	-0.358	-16.320*	-0.375	-12.687*
1989	-0.143	-3.729*	-0.114	-2.651*
1990	-0.052	-2.423*	-0.056	-2.097*
Constant	1.268	20.064*	1.157	13.195*
Adjusted R^2	0.396		0.441	
Variance of Estimate	0.203		0.172	
Mean ln *w*	1.511		1.254	

Notes: * significant at the 5% level or better, ** significant at 10% level, White's (1980) standard error correction is used.

Table 4.13 shows the results of estimating a more detailed Mincerian wage rate function for the same male and female BSA sub-samples. From Table 4.13 we can see that the earnings function (MD') is superior to (MD) in explaining the determination of full time wage rates of male and female workers as indicated by higher R-squared and lower variance of estimate values than in the estimation of function (MD).

The estimated coefficients for the schooling dummy variables S10 to S17 show the effect upon the worker's wage, *ceteris paribus*, of having between 10 and 17 years of education. We can see that the schooling dummies generally have a more significant effect in the wage rate determination of male full-time workers compared to female full-time workers.

When testing for variations in the marginal percentage effect of years of education on wage rates we can test the following null hypotheses;

H_0's:	s11 - s10 = s12 - s11	(H1)
	s12 - s11 = s13 - s12	(H2)
	s13 - s12 = s14 - s13	(H3)
	s14 - s13 = s16 - s14	(H4)
	s16 - s14 = s17 - s16	(H5)

where s10 to s17 are the coefficients on the dummy variables S10 to S17.

Thus the null hypothesis in each case is that the size of the differential in coefficients between yearly schooling dummy variables remains constant as years of schooling increases i.e. that the MRE is constant.[9]

The results of testing the hypotheses for the Mincer-type functions containing schooling dummy variables are shown in Table 4.14. The simple model (MD) shows a number of years in which the appropriate null hypothesis should be rejected, as indicated by significant *t*-statistics, i.e. there is evidence to suggest that the marginal rate of return to years of education is not constant. For example, we can see that for the Mincerian function (MD) for male full-timers there appears to be a significant difference between the marginal rate of return to schooling between the 11th and 12th year, the 14th and 15+16th year, and the

[9] Note that in the more detailed wage rate equations the coefficient on education is strictly interpreted not as 'the rate of return to education' but as the percentage increase in wage rates for each year of education; in this section the terminology 'MRE' is used in a broad sense.

15+16th and 17th year.[10] There appears to be three changes in the marginal rate of return to education for males as years of schooling increases.

Once control variables are introduced into the wage rate function the Null Hypotheses (H4) that the marginal rate of return to years education is constant between the 14th and 15th year cannot be rejected for either gender. However, the previous significant *t*-statistics leading to rejection of H1 and H5 for male full-timers, and H2 and H5 for female full-timers are still apparent.

Table 4.14: T-Statistics for Mincer-type Equations with Schooling Dummies by Gender

Model	Sample	Null Hypothesis	T - Statistic
(MD)	Males	H1	1.806**
		H2	0.880
		H3	1.173
		H4	-3.267*
		H5	6.287*
	Females	H1	0.954
		H2	1.731**
		H3	1.034
		H4	-3.412*
		H5	4.495*
(MD')	Males	H1	2.401*
		H2	0.347
		H3	0.121
		H4	-1.348
		H5	3.444*
	Females	H1	0.795
		H2	2.113*
		H3	-0.754
		H4	-1.182
		H5	2.335*

Notes: * significant at the 5% level or better, ** at 10% level.

The results of testing for the variation in MRE presented in this Section are duplicated when similar wage rate equations are estimated using the Murphy & Welch and Psacharopoulos & Layard formulations with schooling dummies included. The significant *t*-statistics shown in Table 4.14 match the occurrence of significant variation in MRE in the other two model specifications.[11]

[10] 15+16th year here represents the two years of schooling between dummy variables s14 and s16.

[11] A similar methodology can be found in Hungerford & Solon (1987) and Belman & Heywood (1991); the authors use a spline model with schooling dummies and find significant variations in the marginal rate of return to schooling in years associated with certification; supporting the 'sheepskin' screening hypothesis.

The significant variation in the MRE revealed in all three human capital models by these hypothesis tests may be due to the fact that no control is being made for certification effects upon wage rates. For example the significant change in MRE in the 12th year of education in functions (MD) for males may be due to the fact that no control is made for O-level or GCSE acquisition which occurs at this time. Following authors such as Ashenfelter & Mooney (1968) and Liu & Wong (1982), Section 4.5.3 aims to clarify the situation by replacing the schooling dummies with dummies representing the highest educational qualification held by the BSA Survey respondent.

4.5.3 The Effects of Certification Upon Wage Rates

We have seen from Sections 4.5.2 to 4.5.4 that the marginal rate of return to years of education appears to be non-constant as years of education increases. The aim of this Section is to illustrate the effects of certification upon wage rates, since this may be the main cause of these shifts in the MRE as years of education increases. The detailed wage-rate functions are re-estimated where the schooling dummy variables are replaced by dummy variables representing the highest formal educational certificate held by the worker. We will see that certification has a significant impact upon wage rates, and by estimating the previous schooling dummy regressions for workers with no formal qualifications we may test the hypothesis that it is certification which is causing the MRE shifts.

4.5.3.1 Unqualified Workers and the Returns to Years of Schooling

From Table 4.15 we can see that the dummy variables representing 10 to 14 years of schooling are no longer significant determinants of the wage rates of either gender; this is in marked contrast to the results shown in Table 4.13 for unqualified plus unqualified workers by gender, where the dummy variables were significant in the determination of wage rates for male full-timers but not for female full-timers.

Conducting the same hypothesis tests on the differences in MRE as years of education increase gives the results shown in Table 4.16. We cannot reject the null hypotheses in any of the tests and so we cannot reject the overall hypothesis that MRE is constant for unqualified workers.

Table 4.15: Estimated Mincer-type Equations (MD') for Full-timers with No Formal Qualifications by Gender

Gender:	Males (N = 1524)		Females (N = 640)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
YILF	0.026	4.976*	0.020	2.355*
YILF^2	-0.520E-3	-5.506*	-0.368E-3	-2.477*
S10	-0.053	-0.977	-0.029	-0.328
S11	-0.047	-0.766	0.027	0.277
S12	-0.096	-1.091	0.063	0.387
S13	-0.128	-1.203	0.103	0.229
S14	0.274	1.288	--	--
Married	0.198	5.075*	0.035	0.627
Divorced/widowed	0.153	2.391*	0.082	1.213
Recent Unemployment	-0.147	-4.724*	-0.096	-2.000*
East Anglia	-0.161	-3.086*	-0.029	-0.270
East Midlands	-0.135	-3.089*	-0.019	-0.240
London	0.150	3.151*	0.215	3.009*
North East	-0.033	-0.560*	-0.218	-2.392*
Northern Ireland	-0.351	-6.086*	-0.179	-2.284*
North West	-0.107	-2.173*	-0.017	-0.248
Scotland	-0.158	-3.180*	-0.046	-0.598
South West	-0.218	-4.438*	-0.113	-1.342
Wales	-0.248	-3.866*	-0.131	-1.373
West Midlands	-0.082	-1.782**	-0.020	-0.293
Yorkshire/Humberside	-0.085	-1.857**	-0.095	-1.220
Union	0.121	4.891*	0.101	2.632*
Self-employed	-0.202	-4.403*	-0.337	-4.536*
High Level Occupation	0.160	3.306*	0.242	4.181*
Low Level Occupation	-0.136	-4.531*	-0.169	-4.290*
African	0.019	0.191	0.021	0.126
Asian / Chinese	-0.169	-1.575	0.141	0.834
Unclassified R. O.	0.182	2.529*	0.216	1.884**
1985	-0.456	-8.943*	-0.523	-7.194*
1986	-0.303	-6.968*	-0.425	-6.938*
1987	-0.216	-4.809*	-0.368	-5.784*
1989	-0.122E-2	-0.018	-0.051	-0.477
1990	-0.028	-0.619	-0.174	-2.909*
Constant	1.087	9.311*	0.890	4.715*
Adjusted R2	0.232		0.218	
Variance of Estimate	0.202		0.186	
Mean ln w	1.267		0.986	

Notes: * significant at the 5% level or better, significant at the 10% level, male regression uses White's (1980) correction.

The results shown in Table 4.15 and Table 4.16 lend support to the hypothesis that it is certification effects that are causing the MRE shifts that have been found to occur at particular levels of education, in Section 4.5.2. The second part of this Section involves the estimation of wage rate functions by gender with the inclusion of highest certification dummy variables in the place of the schooling year dummy variables.

Table 4.16: T-Statistics for Estimated Mincer-type Equations for Full-timers with No Formal Qualifications by Gender

Model	Sample	Null Hypothesis	T - Statistic
(MD')	Males	H1	0.645
		H2	-0.097
		H3	-1.521
		H4	--
		H5	--
	Females	H1	0.133
		H2	-0.007
		H3	--
		H4	--
		H5	--

Notes: '--' denotes where a hypothesis could not be tested.

4.5.3.2 The Effects of Certification upon Full-time Wage Rates

From Table 4.17 we can see the results of estimating wage rate functions which include certification effects rather than years of study effects for male and female full-timers. The dummy variables representing the highest formal educational qualification held by the respondent are all significant in the estimated wage equation for both males and females. For example, possessing a degree level certificate as the highest held increases the wage rate of male and female workers, *ceteris paribus*, by approximately 44% and 47% respectively above those with no formal qualifications. In contrast, possessing CSE certification as the highest held increases the wage rate of male and female workers, *ceteris paribus*, by approximately 12% and 8% respectively above those with no formal qualifications.

Table 4.17: Estimated Wage Rate Equations including Highest Qualification Dummies by Gender

Gender:	Males (N = 5418)		Females (N = 2781)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
YILF	0.027	12.608*	0.022	7.927*
$YILF^2$	-0.512E-3	-12.395*	-0.434E-3	-7.030*
Degree	0.435	15.333*	0.470	12.823*
Nursing	0.172	2.388*	0.289	7.987*
Teaching	0.232	3.699*	0.388	8.248*
Academic / vocational	0.170	2.953*	0.299	4.477*
HND	0.321	11.194*	0.349	4.383*
Trade / business	0.304	11.112*	0.202	4.117*
Apprenticeship	0.193	10.065*	0.166	6.073*
A - levels	0.202	8.250*	0.151	4.051*
O - levels	0.142	6.743*	0.123	4.210*
CSE's	0.121	3.700*	0.076	1.879**
Married	0.163	8.936*	-0.379E-2	-0.187
Divorced / widowed	0.123	3.652*	0.045	1.497
Recent Unemployment	-0.143	-8.967*	-0.109	-5.382*
East Anglia	-0.104	-3.521*	-0.521E-2	-0.117
East Midlands	-0.128	-4.676*	-0.165	-3.926*
London	0.102	4.148*	0.163	5.556*
North East	-0.120	-3.924*	-0.150	-3.625*
Northern Ireland	-0.249	-8.349*	-0.156	-4.768*
North West	-0.167	-6.771*	-0.109	-3.500*
Scotland	-0.106	-4.157*	-0.152	-4.463*
South West	-0.164	-6.296*	-0.179	-4.330*
Wales	-0.199	-5.625*	-0.204	-4.701*
West Midlands	-0.097	-3.777*	-0.081	-2.565*
Yorkshire / Humberside	-0.149	-5.935*	-0.137	-3.941*
Union membership	0.096	7.544*	0.104	6.287*
Self-employed	-0.189	-7.668*	-0.379	-6.832*
High Level Occupation	0.209	10.741*	0.210	9.634*
Low Level Occupation	-0.132	-7.730*	-0.191	-7.963*
African	-0.073	-1.162	-0.037	-0.615
Asian / Chinese	-0.236	-3.734*	0.084	1.067
Unclassified R. O.	0.025	0.626	0.074	1.582
1985	-0.532	-20.344*	-0.487	-15.367*
1986	-0.388	-18.294*	-0.448	-15.378*
1987	-0.349	-16.001*	-0.376	-12.846*
1989	-0.159	-4.256*	-0.127	-3.001*
1990	-0.080	-3.877*	-0.067	-2.542*
Constant	1.245	24.057*	1.090	17.822*
Adjusted R^2	0.409		0.451	
Variance of Estimate	0.199		0.169	
Mean ln *w*	1.511		1.254	

Notes: * significant at the 5% level, ** at the 10% level, White's (1980) correction is used.

If we compare the results shown in Table 4.17 to those shown in Table 4.4 and Table 4.13, for previous equations, we can see that this estimated equation which includes certification has higher R-squared and lower variance indicating that it explains the variation in wage rates more accurately. What this model allows for is not only the effect of years of education upon wage rates but also the effects of certificates upon wage rates. The subject of the next two Chapters is to test the mechanism by which certification and years of education increase workers' wage rates.

Table 4.18 and Table 4.19 present the order in which the highest educational certificates held fall in relation to their estimated positive effects upon the wage rates of male and female full-time workers respectively. We can test the significance of the differences in the returns to the highest qualifications held shown in Table 4.18 and Table 4.19.

Testing the differences apparent from Table 4.18 we find that for male full-timers, the holding of a degree has a significantly higher positive effect on wage rates than the holding of any other certificates in comparison to being unqualified. Holding an HND has a significantly higher positive effect on wage rates than holding any of the lower certificates in comparison to being unqualified, and similarly for the trade/business qualifications. Teaching qualifications give higher returns than O-levels or CSE's but are equivalent in their effect upon wage-rates of male full-timers in comparison to holding qualifications within the group running from A-levels to academic/vocational qualifications. The positive effect on wage rates of male full-timers is not significantly different for O-levels and CSE's in comparison to being unqualified.

Table 4.18: Ranking of Certificates in Descending Order of the size of the estimated rate of return for Male Full-timers

Certificate	Estimated Return
Degree	0.435
HND	0.321
Trade / business	0.304
Teaching	0.232
A - levels	0.202
Apprenticeship	0.193
Nursing	0.172
Academic / vocational	0.170
O - levels	0.142
CSE's	0.121

Table 4.19: Ranking of Certificates in Descending Order of the size of the estimated rate of return for Female Full-timers

Certificate	Estimated Return
Degree	0.470
Teaching	0.388
HND	0.349
Academic / vocational	0.299
Nursing	0.289
Trade / business	0.202
Apprenticeship	0.166
A - levels	0.151
O - levels	0.123
CSE's	0.076

Testing the differences shown in Table 4.19 we find that for female full-timers holding a degree has a significantly higher positive effect on wage rates than holding any of the other certificates in comparison to being unqualified. Holding an HND has an equivalent positive effect on wage rates in comparison to holding a certificate from the group running from academic/vocational to trade business certificates. Teaching qualifications give higher returns than nursing qualifications but are equivalent in their effect upon wage-rates of female full-timers in comparison to holding an HND or academic/vocational qualifications. Holding a nursing qualification has a significantly higher positive effect on wage rates than holding any of the certificates ranked below it in Table 4.19. The positive effect on wage rates of female full-timers is not significantly different for apprenticeship certificates and A-levels in comparison to being unqualified. Again the positive effect on wage rates is not significantly different for O-levels and CSE's in comparison to being unqualified for female full-timers.

4.6 Conclusion

Mincerian wage rate functions were estimated for male and female full-timers who responded to the BSA Survey 1985-1991. The estimated average increase in wage rates for each year of education was estimated as approximately 5% for men and 6% for women with the inclusion of additional explanatory variables. This figure is significantly lower than the estimate from the simple Mincerian function which was approximately 11%, and the rates of return estimated for the UK in previous studies approximately equal to 10% [Psacharopoulos & Layard (1979)] and 16% [Harmon & Walker (1995)].

It was found that the inclusion of additional explanatory variables reduced the superiority of the quartic Murphy & Welch (1990) function over the Mincerian function in explaining the variation in full-time workers' wage rates. Estimation of the Psacharopoulos & Layard (1979) function gave results showing significant interaction between years in the labour force and years of education, but different results from those of P&L in the estimation of the underlying parameters of the model.

Significant shifts in the marginal rate of return to years of education were found in all of the human capital models. The shifts in the marginal rate of return to years of education were found to occur in years which would normally be characterised by the obtainment of educational certificates such as O-levels and A-levels. It was proposed that controlling for certification effects in the human capital functions could allow for the variation in the marginal rate of return to education.

We found that an estimated wage rate equation that included dummy variables representing the highest certificate held by the BSA Survey respondent instead of years of education as a measure of education level explained the variation in wage rates for full time workers more accurately. This model allows for not only the effect of years of education upon wage rates but also the effects of certificates upon wage rates. The subject of the Chapter's 5 and 6 is to test the possible screening role that certification and years of education may have in increasing full time wage rates in the UK.

Appendix 4.1: Variable List and Descriptions

Table 4.20: BSA Sample Variables; Description and Derivation

Variable	Description	Derived from the BSA variables
Hours	Hours worked per week by respondent	EJBHOURS, EJBHRCAT, SJBHOURS, SJBHRCAT
Self-employed	1 = Respondent is self-employed 0 = Respondent is an employee	RECONPOS, RECONACT, REMPLOYE
	Highest Qualification Held Dummy variables HQD'S;	
Degree	1 = highest formal educational qualification held is a University / CNAA degree or diploma. 0 = lower qualification is HQ	EDQUAL1-16
Nursing	1 = HQ is a Nursing qualification. 0 = lower qualification is HQ	EDQUAL1-16
Teaching	1 = HQ is a Teacher Training qualification. 0 = lower qualification is HQ	EDQUAL1-16
Academic/ vocational	1 = HQ is any other academic or vocational qualification. 0 = lower qualification is HQ	EDQUAL1-16
HND	1 = HQ is a BEC higher, HNC or HND 0 = lower qualification is HQ	EDQUAL1-16
Trade/ business	1 = HQ is any other technical or business qualification. 0 = lower qualification is HQ	EDQUAL1-16
Apprenticeship	1 = HQ is a Trade Apprenticeship, Royal Society of Arts or similar clerical qualification. 0 = lower qualification is HQ	EDQUAL1-16
A-Levels	1 = HQ is an A-Level, overseas school leaving cert. C&G Advanced / Full Technical level, BEC Ordinary, ONC or OND qualification. 0 = lower qualification is HQ	EDQUAL1-16
O-Levels	1 = HQ is a CSE Grade 1, O-level, C&G craft etc. qualification. 0 = lower qualification is HQ	EDQUAL1-16
CSE's	1 = HQ is a CSE Grade 2-5 qualification. 0 = lower qualification is HQ	EDQUAL1-16
No Quals	1 = no formal qualifications are held. 0 = a formal qualification is held (Reference category for HQD's)	EDQUAL1-16, NOEDQUAL
	Other Characteristics;	
Recent Unemployment	1 = Worker has experienced a spell of unemployment within the last 5 years 0 = Not been unemployed in the last 5 years	EUNEMP, SUNEMP
Months Unemployed	Total number of months that respondent has spent in unemployment in the last 5 years.	EUNEMPT, SUNEMPT
Years in Labour Force	Years in the labour force experienced by the worker	RAGE, YOED
Years of education	Years of education experienced by the worker	EDQUAL1-16, TEA, RAGE
Private education	1 = Individual attended private primary or secondary school 0 = Individual did not attend private school	RPRIVED

Gender	1 = Male 0 = Female	RSEX
Divorced / widowed	1= Separated, divorced or widowed 0 = other marital status	MARITAL,MARRDNOW, MARRIED, MARSTAT
Married	1= Married or living as married 0 = other marital status	MARITAL,MARRDNOW, MARRIED, MARSTAT
Union Member	1 = Worker is a TU/Staff Association member 0 = Not a TU/SA member	UNIONSA
Asian / Chinese	1 = Worker has Asian / Pakistani / Indian / Chinese / Oriental ethnic origin 0 = other ethnic origin	RACEORIG, ETHNICAT, ETHNICGP
African	1 = Worker has Black / African / West-Indian / Caribbean ethnic origin 0 = other ethnic origin	RACEORIG, ETHNICAT, ETHNICGP
White / European	1 = Worker has White / European ethnic origin 0 = other ethnic origin (Reference category for ethnic origin)	RACEORIG, ETHNICAT, ETHNICGP
Unclassified racial Origin	1 = Respondent is of unclassified racial origin 0 = Respondent has a definite ethnic origin	RACEORIG, ETHNICAT, ETHNICGP
High Occupational Class	Worker's Goldthorpe-Heath social classification is high or low skill Professional & Management occupation	RGHCLASS
Middle Occupational Class	Worker's G-H social classification is; Routine Office, Sales & personal, Small public business, Farmers, Manual foreman and similar jobs (reference category for occupational class)	
Low Occupational Class	Worker's G-H social classification is; Skilled manual, Semi/unskilled manual, or Agricultural employees	
	Regional Dummy Variables;	
East Anglia	1 = worker lives in East Anglia 0 = lives elsewhere	PANO
East Midlands	1 = worker lives in the East Midlands 0 = lives elsewhere	
London	1 = worker lives in London 0 = lives elsewhere	
North East	1 = worker lives in the North East 0 = lives elsewhere	
North West	1 = worker lives in the North West 0 = lives elsewhere	
Northern Ireland	1 = worker lives in Northern Ireland 0 = lives elsewhere	
Scotland	1 = worker lives in Scotland 0 = lives elsewhere	
South East	1 = worker lives in the South East (not London) 0 = lives elsewhere (Reference category for region)	
South West	1 = worker lives in the South West 0 = lives elsewhere	
Wales	1 = worker lives in Wales 0 = lives elsewhere	
West Midlands	1 = worker lives in the West Midlands 0 = lives elsewhere	
Yorkshire / Humberside	1 = worker lives in Yorkshire / Humberside 0 = lives elsewhere	

Notes: All variables were available 1985-1991 with the exception of SUNEMPT which was only recorded for the period 1985-87.

Appendix 4.2:

Dummy Variable Tests for Separation of Wage Rate Equations by Gender

This Appendix outlines the tests undertaken to prove that male and female full-timers wage rates are determined separately i.e. that market segmentation by gender occurs. The fact that the separate male and female regressions presented in this Chapter are generally heteroscedastic means that we cannot employ the simple Chow test based on the sum of squared errors of the two regressions.[12] Gujarati (1970) presents an alternative to the Chow test which is employed here to show differences by gender.

The dummy variable approach presented by Gujarati (1970) in this application involves pooling the data and running a single regression including a dummy variable showing whether the BSA respondent is a man and including interactive variables between gender and all the explanatory variables used in the two separate male and female regressions. The number of observations equals 8199 throughout and all regressions employ a heteroscedasticity-consistent covariance matrix since they fail heteroscedasticity tests.

A parsimonious approach is adopted for the more detailed wage rate equations in that we move from general to specific modelling by dropping interactive variables which are not significant from the regression and then re-estimating the pooled wage rate function. The results are robust in the sense that the estimated coefficients which are significant in the initial run remain significant and hold very similar value in the second run.

Significant *t*-statistics on the gender dummy or interactive dummies show where there are differences between the wage rate determination of male and female full-timers. A significant F-statistic indicates a rejection of the hypothesis that all the coefficients in the regression are zero.

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[12]Where Chow tests were employed the F-statistics were highly significant and indicative or market segmentation by gender, but these results are viewed as unreliable because Chow's assumption of homoscedastic variance of error terms does not hold.

From Table 4.21 we can see that being male significantly effects the rate of return to years of experience and its square, but there is no significant gender effect for the effect of years of schooling on wage rates. From Table 4.22 we can see that the gender dummy is significant, and there are significant interactions between gender and marital status, residence in East Anglia, London and Northern Ireland, being self-employed, being in a low level occupation and being Chinese or Asian.

Table 4.21: Estimated Mincerian Schooling and Human Capital Models with Gender Effects

Equation:	(MS)		(MN)	
Variable	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Male	0.393	3.882*	0.018	0.159
Years of Education	0.098	22.420*	0.105	23.214*
Years in Labour Force	--	--	0.028	10.268*
YILF^2	--	--	-0.528E-3	-8.242*
1985	-0.483	-13.269*	-0.446	-12.616*
1986	-0.441	-13.992*	-0.422	-13.710*
1987	-0.379	-11.951*	-0.371	-11.815*
1989	-0.212	-6.682*	-0.200	-6.471*
1990	-0.767	-2.506*	-0.071	-2.398*
Male*YOED	-0.869E-2	-1.559	-0.313E-3	-0.054
Male*YILF	--	--	0.016	4.786*
Male*YILF^2	--	--	-0.213E-3	-2.780*
Male*1985	0.038	0.801	0.023	0.501
Male*1986	0.105	2.625*	0.094	2.423*
Male*1987	0.072	1.783**	0.069	1.734**
Male*1989	0.056	1.426	0.057	1.498
Male*1990	0.028	0.708	0.029	0.771
CONSTANT	-0.183	-2.297*	-0.578	-6.611*
Adjusted R^2	0.228		0.293	
Variance of Estimate	0.264		0.242	
F - Statistic	187.368*		201.235*	

Notes: * significant at 5% level, ** significant at 10% level, Mean ln w = 1.424.

From Table 4.23 and Table 4.24, we can see that these gender effects are occurring with each model of wage determination. Being male as opposed to female has a positive effect on wage rates of full-timers of 17-19% higher wage rates, as does being a self-employed man as opposed to a self-employed woman. Being a married man rather than a married woman leads to 14-18% higher wage rates, males living in one of the three regions showing significant gender effects have 7-13% lower wage rates than women in these areas, and being an Asian or

Chinese man rather than woman results in approximately 30% lower wage rates. Note that all these effects assume all other things are equal.

Table 4.22: Estimated Mincerian Wage Rate Equation (M') with Gender Effects

Variable	Estimated Coefficient	T - Ratio
Male	0.191	9.529*
Years of Education	0.053	16.490*
Years in Labour Force	0.025	14.801*
YILF^2	-0.468E-3	-13.943*
Married	-0.738E-2	-0.405
Divorced / widowed	0.081	3.586*
Recent Unemployment	-0.133	-10.418*
East Anglia	-0.231E-2	-0.054
East Midlands	-0.140	-6.046*
London	0.166	6.348*
North East	-0.120	-4.823*
Northern Ireland	-0.152	-5.567*
North West	-0.143	-7.293*
Scotland	-0.120	-5.845*
South West	-0.162	-7.282*
Wales	-0.212	-7.552*
West Midlands	-0.095	-4.645*
Yorks. / Humberside	-0.139	-6.739*
Union member	0.106	10.474*
Self-employed	-0.384	-6.999*
High Occupation	0.243	17.210*
Low Occupation	-0.239	-11.341*
African	-0.077	-1.698**
Asian / Chinese	0.054	0.730
Unclassified R. O.	0.051	1.637
1985	-0.506	-24.032*
1986	-0.417	-23.854*
1987	-0.366	-20.687*
1989	-0.138	-4.787*
1990	-0.063	-3.776*
Male*married	0.180	8.407*
Male*East Anglia	-0.097	-1.964*
Male*London	-0.078	-2.475*
Male*Northern Ireland	-0.132	-4.251*
Male*Self-employed	0.191	3.226*
Male*low occupation	0.083	3.486*
Male*Asian/Chinese	-0.295	-3.293*
Constant	0.339	4.962*
Adjusted R^2	0.432	
Variance of Estimate	0.194	
F - Statistic	169.772*	

Notes: * significant at the 5% level, ** 10% level, Mean ln w = 1.424.

Table 4.23: Estimated M & W Wage Rate Equations with Gender Effects

Equation:	(MW)		(MW')	
Variable	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Male	0.100	0.835	0.17209	3.698*
Years of Education	0.105	23.598*	0.054	16.895*
Years in Labour Force	0.127	12.634*	0.100	10.667*
$YILF^2$	-0.821E-2	-10.308*	-0.649E-2	-9.055*
$YILF^3$	0.211E-3	8.989*	0.167E-3	8.042*
$YILF^4$	-0.188E-5	-8.194*	-0.149E-5	-7.464*
Married	--	--	-0.015	-0.777
Divorced / widowed	--	--	0.062	2.679*
Recent Unemployment	--	--	-0.129	-10.154*
East Anglia	--	--	-0.751E-2	-0.178
East Midlands	--	--	-0.138	-6.026*
London	--	--	0.152	5.835*
North East	--	--	-0.125	-5.030*
Northern Ireland	--	--	-0.168	-6.130*
North West	--	--	-0.147	-7.541*
Scotland	--	--	-0.120	-5.854*
South West	--	--	-0.163	-7.348*
Wales	--	--	-0.211	-7.630*
West Midlands	--	--	-0.096	-4.759*
Yorkshire / Humberside	--	--	-0.141	-6.908*
Union member	--	--	0.099	9.836*
Self-employed	--	--	-0.371	-6.796*
High Occupation	--	--	0.239	16.954*
Low Occupation	--	--	-0.230	-11.082*
African	--	--	-0.082	-1.850**
Asian / Chinese	--	--	0.047	0.620
Unclassified R. O.	--	--	0.047	1.536
1985	-0.436	-12.415*	-0.504	-24.016*
1986	-0.409	-13.429*	-0.415	-23.879*
1987	-0.363	-11.653*	-0.365	-20.788*
1989	-0.192	-6.247*	-0.140	-4.863*
1990	-0.062	-2.093*	-0.061	-3.652*
Male*YOED	-0.659E-3	-0.115	--	--
Male*YILF	-0.021	-1.664**	-0.021	-1.746**
Male* $YILF^2$	0.344E-2	3.672*	0.270E-2	3.174*
Male* $YILF^3$	-0.117E-3	-4.441*	-0.902E-4	-3.846*
Male* $YILF^4$	0.117E-5	4.708*	0.907E-6	4.161*
Male*married	--	--	0.138	5.689*
Male*East Anglia	--	--	-0.095	-1.942**
Male*London	--	--	-0.072	-2.291*
Male*Northern Ireland	--	--	-0.122	-3.900*
Male*self-employed	--	--	0.168	2.849*
Male*low occupation	--	--	0.074	3.128*
Male*Asian/Chinese	--	--	-0.292	-3.213*
Male*1986	0.080	2.083*	--	--
Constant	-0.899	-9.745*	0.125	1.696**
Adjusted R^2	0.305		0.440	
Variance of Estimate	0.237		0.191	
F - Statistic	172.408*		150.736*	

Notes: * significant at the 5% level, ** 10% level, Mean ln w = 1.424.

Table 4.24: Estimated P&L-type Wage Rate Equations with Gender Effects

Equation:	(PL)		(PL')	
Variable	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Male	-0.372	-1.2648	0.185	9.313*
Years of Education	0.101	8.183*	0.049	6.315*
Years in Labour Force	-0.252	-1.985*	-0.201	-3.356*
$YILF^2$	0.588E-2	1.670**	0.430E-2	2.660*
YOED*YILF	0.030	2.086*	0.025	3.609*
$YOED^2$*YILF	-0.788E-3	-1.915**	-0.684E-3	-3.410*
$YILF^2$*YOED	-0.676E-3	-1.660**	-0.533E-3	-2.783*
$YILF^2$*$YILF^2$	0.170E-4	1.460	0.146E-4	2.603*
Married	--	--	-0.836E-2	-0.455
Divorced / widowed	--	--	0.077	3.391*
Recent Unemployment	--	--	-0.132	-10.313*
East Anglia	--	--	-0.066	-2.620*
East Midlands	--	--	-0.140	-6.023*
London	--	--	0.163	6.265*
North East	--	--	-0.118	-4.782*
Northern Ireland	--	--	-0.160	-5.883*
North West	--	--	-0.141	-7.165*
Scotland	--	--	-0.118	-5.753*
South West	--	--	-0.162	-7.287*
Wales	--	--	-0.211	-7.543*
West Midlands	--	--	-0.092	-4.530*
Yorkshire / Humberside	--	--	-0.136	-6.615*
Union member	--	--	0.107	10.553*
Self-employed	--	--	-0.385	-7.006*
High Occupation	--	--	0.244	17.260*
Low Occupation	--	--	-0.231	-10.931*
African	--	--	-0.087	-1.905**
Asian / Chinese	--	--	0.039	0.522
Unclassified R. O.	--	--	0.049	1.579
1985	-0.435	-12.381*	-0.498	-23.547*
1986	-0.415	-13.406*	-0.414	-23.624*
1987	-0.370	-11.787*	-0.364	-20.588*
1989	-0.194	-6.268*	-0.134	-4.630*
1990	-0.071	-2.374*	-0.058	-3.477*
Male*1986	0.091	2.364*	--	--
Male*1987	0.073	1.849**	--	--
Male*married	--	--	0.179	8.378*
Male*London	--	--	-0.073	-2.324*
Male*Northern Ireland	--	--	-0.121	-3.922*
Male*self-employed	--	--	0.194	3.265*
Male*low occupation	--	--	0.082	3.441*
Male*Asian / Chinese	--	--	-0.289	-3.214*
Constant	-0.548	-2.436*	0.384	2.679*
Adjusted R^2	0.298		0.434	
Variance of Estimate	0.240		0.194	
F - Statistic	140.065*		157.816*	

Notes: * significant at 5% level ** significant at 10% level, Mean ln w = 1.424.

Table 4.25: Estimated Mincer-type Equation with Certificate and Gender Effects

Variable	Est. Coeff.	T - Ratio
Male	0.141	6.538*
Years in Labour Force	0.025	14.966*
$YILF^2$	-0.473E-3	-14.256*
Degree	0.447	19.843*
Nursing	0.279	9.425*
Teaching	0.383	9.169*
Academic / Vocational	0.228	5.182*
HND	0.325	12.364*
Trade / Business	0.208	4.522*
Apprenticeship	0.183	11.788*
A - Levels	0.191	9.213*
O - Levels	0.135	7.940*
CSE's	0.105	4.157*
Married	-0.026	-1.374
Divorced / widowed	0.022	0.777
Recent Unemployment	-0.131	-10.372*
East Anglia	-0.918E-2	-0.217*
East Midlands	-0.140	-6.111*
London	0.124	6.539*
North East	-0.131	-5.342*
Northern Ireland	-0.147	-5.518*
North West	-0.146	-7.553*
Scotland	-0.125	-6.103*
South West	-0.169	-7.631*
Wales	-0.205	-7.424*
West Midlands	-0.093	-4.623*
Yorkshire / Humberside	-0.146	-7.137*
Union member	0.102	9.992*
Self-employed	-0.385	-7.000*
High Occupation	0.212	14.571*
Low Occupation	-0.196	-8.987*
African	-0.061	-1.374
Asian / Chinese	0.063	0.870
Unclassified Race Origin	0.044	1.459
1985	-0.518	-25.242*
1986	-0.408	-23.735*
1987	-0.358	-20.464*
1989	-0.145	-5.114*
1990	-0.075	-4.612*
Male*Teaching	-0.151	-2.099*
Male*Trade/Business	0.097	1.916**
Male*married	0.206	9.011*
Male*divorced/widowed	0.116	2.810*
Male*East Midlands	-0.091	-1.861**
Male*Northern Ireland	-0.111	-3.696*
Male*self-employed	0.205	3.446*
Male*low occupation	0.070	2.871*
Male*Asian/Chinese	-0.296	-3.396*
Constant	1.097	27.267*
Adjusted R2 = 0.447	Variance of Estimate = 0.189	
F - Statistic = 93.099*	Mean ln w = 1.424	

Notes: * significant at the 5% level, ** 10% level.

Estimating a similar model for the Mincer-type wage rate function including the highest certificate held dummy variables gives the results shown in Table 4.25. The interactive effects discussed above are again significant in this model, with the exception of being male as opposed to female and resident in London. Indeed three more significant interactions can be noted. Firstly being male, as opposed to female, and holding teaching qualifications as the highest held reduces the wage rate earned by approximately 15%. Secondly, being male, as opposed to female, and holding trade or business qualifications as the highest held raises the wage rate earned by approximately 10%. Thirdly, being a male, as opposed to female, divorcee or widower/widow raises the wage rate by earned approximately 12%.

It is widely accepted that men and women operate in separate labour markets and these results support this view. The significant *t*-statistics on the gender dummy and a number of interactive dummies, and the significant F-statistics for each of the detailed models illustrates the segmentation of the labour market by gender. Of particular note is the premium paid to male workers in comparison to female workers in low-level occupations, and the gender-region interactions.

Appendix 4.3:

Year Dummy Variables; Real versus Nominal Wage Rate Equations

This Appendix outlines the intuition behind the inclusion of the dummy variables representing year of response to the BSA Survey questionnaire for each worker and the use of nominal rather than real wage rate formulation.

The results of estimating real wage rate Mincerian functions (MR) and nominal wage rate Mincerian functions (MN) for male and female workers in the BSA Survey sample are shown in Table 4.2 and Table 4.3. It was shown that the nominal wage rate functions were superior in explaining the variation in full-time wage rates for both gender groups in comparison to the real wage rate formulation. The results of estimating Mincerian real wage rate equations with year dummies by gender are shown in Table 4.26. By comparing these results with those in Table 4.2 and 4.3 for Equation (MN), we can see that the use of nominal rather than real wage rates has no significant effect on the size or significance of the estimated coefficients on years of education or years in the labour force and its square, i.e. the Mincerian equation is robust. The decision to use the logarithm of nominal rather than real wage rates as the dependant variable was made due to the superiority of the goodness of fit of regressions based upon the former variable.

The decision to include the dummy variables representing year of response in the simple and detailed wage rate equations was to control for possible yearly effects of omitted variables both on the dependant and independant variables included in the regressions. In the context of variation in the average size of the dependant variable these yearly external effects include price or wage inflation, shifts in the national unemployment level and in the national wage curve relationship.

Table 4.26: Mincerian Real Wage Rate Equations with Year Dummies by Gender

	Males (N=5418)		Females (N=2781)	
Variable Name	**Estimated Coefficient**	**T-Ratio**	**Estimated Coefficient**	**T-Ratio**
YOED	0.105	28.802*	0.105	23.238*
YILF	0.045	21.772*	0.028	10.273*
YILF^2	-0.742E-3	-17.615*	-0.528E-3	-8.241*
D1985	-0.063	-2.144*	-0.083	-2.324*
D1986	-0.015	-0.646	-0.106	-3.412*
D1987	-0.029	-1.194	-0.095	-2.997*
D1989	-0.580E-2	-0.259	-0.060	-1.930**
D1990	-0.647E-3	-0.027	-0.027	-0.905
Constant	-0.876	-12.129*	-0.900	-10.265*
Adjusted R^2	0.196		0.195	
Variance of Estimate	0.253		0.222	
Mean ln w	1.368		1.103	

Notes: * Significant at 5% level, ** at 10% level, both regressions use White's (1980) correction.

In the context of variation in the average size of the explanatory variables these external effects could, for example, include: yearly variation in the hiring behaviour of employers due to changes in the business environment; which would show itself in variation in the effect of age, education and other labour market information upon employees earnings. Secondly; yearly variation in the internal payment schemes of companies due to changes in the business environment, which would have an effect upon the influence occupational category and years in the labour force had on earnings over the sample period. Thirdly; yearly fluctuations in the influence of union membership in the wage-bargaining system. One would intuitively expect that the influence of unions upon earnings would decline as union membership and coverage declined in the UK over the sample period. Fourthly; yearly fluctuations in the regional market effects of demand and supply for labour.

Chapter 5

Self-employed Versus Employees; A Comparative Test Of The Screening Hypothesis Using UK Data

5.1 Introduction

In previous tests of the educational screening hypothesis self-employed workers have been used to represent unscreened workers whilst employees have been used to represent the screened workers; Wolpin (1977), Riley (1979a), Katz & Ziderman (1980), Fredland & Little (1981), Shah (1985), Tucker (1985), Cohn *et al* (1987), and Grubb (1993) share the common methodology of comparing screened to unscreened worker types.

The educational screening hypothesis has been largely tested using this methodology on US data. In this Chapter I aim to test a weak educational screening model using the British Social Attitudes (BSA) Survey data and a similar methodology to that of Wolpin (1977), Katz & Ziderman (1980), Fredland & Little (1981) and Cohn *et al* (1987). The weak screening hypothesis allows for both human capital and informational effects of education in the determination of wages.

Section 5.2 outlines the theoretical reasoning underpinning the methodology employed to test the weak screening hypothesis. Section 5.3 presents some details of the samples of self-employed and employees taken from the main BSA Survey sample used in previous Chapters and a discussion of the characteristics of the self-employed in the BSA Survey data in relation to previous UK studies. Section 5.4 describes the possible model specifications to be employed and then shows goodness of fit and model selection and specification test results for male and female full-time workers. Section 5.5 outlines the hypotheses to be tested and details the results expected under the weak screening hypothesis. Sections 5.6 and 5.7 detail the actual results from estimating the wage rate functions and testing the hypotheses in Section 5.5. Concluding comments are collected in Section 5.8.

5.2 Theoretical Reasoning

Both worker types, that is employees and the self-employed, are assumed to be fully aware of their own abilities; this is the private information an employee would wish to signal to employers. In a weak screening model, such as that presented by Riley (1979a), both worker types are assumed to invest in education for human capital investment to the same degree, but only employees use education as a signal of productive ability to employers. Self-employed workers have no need to signal their ability to prospective employers, and we would therefore expect that self-employed wages are less closely linked to education relative to private employees.

Wolpin (1977) showed that self-employed workers obtained a similar level of education as non-self-employed workers of the same ability in similar occupations, and this was taken as evidence against the importance of education as a screening device. However, the choice of education does not rest entirely on employment aims; Wolpin's model does not allow for other entries into the utility function of individuals when considering education; for example workers of any ability level may place greater emphasis on trying to achieve a social norm education level for his or her perceived class in society, following a family norm, or they may invest in education with the aim of helping others regardless of monetary returns (for example this may be the case for some prospective doctors, nurses, aid-workers and teachers).

Additionally, from a purely monetary perspective, education will be acquired even if a person aims to be self-employed when leaving education, since he or she cannot be sure that their plans will come to fruition and they may need to signal their ability in the labour market in the future. Due to a lack of appropriate data we cannot directly control for such hedging behaviour in this sample, although an attempt is made to control for self-selection using the technique of Heckman (1979) which is detailed in Section 5.4.1.

This empirical work adopts a similar approach for UK data, in that we will look at the possible differences in education acquired by the two worker types, and also at the returns to educational variables given that education has been acquired for whatever reason. A self-employed person gains nothing from education *as a signal* since we assume that he or she has full knowledge of the private information that education signals in the labour market, and thus any return attached to the certificate is in the form of a return to human capital. Conversely an employee will need to signal his or her ability in the labour market and thus will gain a return from the signalling function of the certificate as well as a human capital return.

One caveat is that self-employed workers may be educationally screened by the financial institutions who provide them with credit. Thus if we find a significant difference between the effects of educational variables upon wage rates between the two sub-samples we might consider this to be an under-estimate of the differential, since if education *is* used in the screening process of banks we would expect the differences in returns to education between employees and the self-employed to be smaller than if such lender-screening did not exist.

5.3 The BSA Survey Sample and Characterisation of the Self-employed

The sample used is a pooled data set taken from the BSA Survey 1985-1991 (with 1988 excluded, since there was no survey in this year) covering 1140 full-time self-employed workers, and 7059 full-time employees. The number of employees used in the analysis in this Chapter is reduced as we have omitted workers in the armed forces. Summary statistics for these two sub-samples are shown in Table 5.1 (see Appendix 1 of Chapter 4 for variable list).

From Table 5.1 we can see that the average length of full-time education differs significantly between the self-employed and employees in this BSA Survey sample. Additionally we can see that approximately 31% (from the mean value of the dummy variable representing no formal qualifications) of the self-employed subsample have no formal certification compared to 26% of employees, again significantly different figures.

Table 5.1: Descriptive Statistics for Full-time Employees and Self-employed in BSA Survey Sample 1985-1991

Variable	Employees (N = 7059) Mean	Employees (N = 7059) Standard Deviation	Self-employed (N = 1140) Mean	Self-employed (N = 1140) Standard Deviation	Test Statistic
Real Gross Earnings	9071	5031	10202	6673	-6.697*
Nom. Gross Earnings	10609	6216	12127	8256	-7.274*
Weekly Hours	41.787	8.102	52.907	15.026	-37.161*
Age	37.791	12.325	41.806	11.792	-10.266*
Years in Labour Force	20.922	12.897	25.169	12.285	-10.384*
Years of Education	16.870	2.033	16.637	1.9841	5.131*
Recent Unemployment	0.194	0.005	0.191	0.012	0.192
Male	0.6321	0.006	0.839	0.011	-13.665*
Union membership	0.487	0.006	0.085	0.008	25.428*
African	0.013	0.001	8.77E-3	0.003	1.272
Asian Chinese	0.017	0.002	0.025	0.005	-1.701**
White European	0.161	0.004	0.153	0.011	0.686
Unclassified Race	0.809	0.005	0.814	0.012	-0.422
Degree	0.114	0.004	0.099	0.009	1.469
Nursing	0.033	0.002	0.016	0.004	3.072*
Teaching	0.023	0.002	9.65E-3	0.003	2.967*
Academic/vocational	0.014	0.001	7.89E-3	0.003	1.684**
HND	0.040	0.002	0.028	0.005	2.370*
Trade / business	0.061	0.003	0.071	0.008	-1.373
Apprenticeship	0.158	0.004	0.166	0.011	-0.696
A - Levels	0.103	0.004	0.124	0.010	-2.107*
O - Levels	0.158	0.004	0.145	0.010	1.176
CSE's	0.037	0.002	0.025	0.005	1.936**
No Qualifications	0.257	0.005	0.309	0.014	-3.702*
Private Education	0.109	0.004	0.148	0.011	-3.885*
Professional	0.060	0.003	0.097	0.009	-4.776*
High Level Occupation	0.361	0.006	0.204	0.012	10.369*
Mid Level Occupation	0.302	0.005	0.783	0.012	-31.216*
Low Level Occupation	0.336	0.006	0.012	0.003	22.350*
Married	0.683	0.006	0.797	0.012	-7.822*
Divorced / widowed	0.077	0.003	0.057	0.007	2.334*
Single	0.241	0.005	0.146	0.010	7.106*
East Anglia	0.038	0.002	0.033	0.005	0.890
East Midlands	0.061	0.003	0.068	0.007	-1.014
London	0.102	0.004	0.086	0.008	1.704**
North East	0.049	0.003	0.029	0.005	2.959*
Northern Ireland	0.116	0.004	0.164	0.011	-4.585*
North West	0.100	0.004	0.068	0.007	3.501*
Scotland	0.078	0.003	0.070	0.008	0.942
South East	0.180	0.005	0.195	0.012	-1.204
South West	0.072	0.003	0.097	0.009	-3.012*
Wales	0.039	0.002	0.048	0.006	-1.555
West Midlands	0.086	0.003	0.068	0.007	1.989*
Yorkshire/Humberside	0.080	0.003	0.074	0.008	0.674

Notes: * Difference between means is significant at the 5% level or better, ** difference between means is significant at the 10% level.

Looking at the highest qualification held dummy variables (HQD's) nursing and teaching certification seem to be more frequently obtained by employees than the self-employed. Since we would expect far fewer self-employed nurses and teachers compared to employees the significance of the test-statistic associated with this differential is not surprising.

Six of the highest qualification dummy variables have significantly different mean values between the two groups at the 5% level; the exceptions being Degree, Trade/business, apprenticeships, and O-levels. For example, relatively fewer full-time employees than full-time self-employed workers possess A-levels as their highest certificates. In a screening framework this may be because these certificates are seen by employers as a 'middle ground' qualification and they cannot decide whether the applicant is of high or low ability in comparison to applicants with either a degree or O-levels as their highest certificate, and this uncertainty is reflected in the behaviour of employees.[1] If we calculate the cumulative proportion of employees and self-employed workers who hold HQD's above A-Level standard, we find that the cumulative proportion for employees significantly exceeds that of the self-employed (45% compared to 40%), this may be because employees are more interested in acquiring post-school certification than the self-employed. The significantly higher proportion of employees compared to self-employed holding CSE's as the highest qualification is possibly due to the significant age differential between groups.

It is important to remember that worker-type is identified in each year's BSA Survey questionnaire by the following question read out to all workers by the interviewer;

'In your (main) job are you; (a) an employee, or
(b) self-employed ?'

[1] This may simply reflect the nature of the British educational system in that A-Levels are seen as a step towards acquiring a degree. The lower proportion of employees holding A-Levels as their highest educational qualification may be due to the desire of employees to achieve the next 'step', acquiring a degree, due to traditional social pressures to achieve within the educational system.

Thus the definition of self-employment rests upon what the BSA Survey respondent perceives as self-employment.

The classification of respondents by the interviewer as self-employed would be difficult in many cases perhaps depending more on legal rather than economic definitions. The Thirteenth International Conference on Labour Statistics (1982) defined the self-employed as employers, own-account workers, members of producers' co-operatives and unpaid family workers. However, the legal definition of self-employment is usually connected to owners of unincorporated businesses i.e. not employees of the owners of an incorporated business.

Relying on the respondent may mean that some people may regard themselves as self-employed when by the strict economic definition they are not. However, in testing the screening hypothesis in this comparative methodology we are testing the behaviour towards signalling of the two worker types, and if under the hypothesis a self-employed person need not signal ability via educational variables it is important that the person regards themselves as self-employed regardless of the strict definition, legal or economic, of their activity. Self-definition of worker type by respondents goes some way in accounting for beliefs in the labour market.

A comparison of the summary statistics for the self-employed in Table 5.1 with previous estimates may relieve some anxiety that surrounds the identification of the self-employed in the BSA Survey data. Blanchflower *et al* (1988a) use National Child Development Survey (NCDS) data from 1981 (NCDS sweep 4) and BSA Survey 1985 data and identify a number of characteristics of the self-employed. The self-employed are predominantly male and resident in the South East and Midlands, they typically do not have above average levels of qualifications, and they experience similar levels of unemployment as employees. From Table 5.1 we can see that these results are matched for this data set.

Blanchflower *et al* (1988b) use NCDS sweeps 1 to 4 to identify more characteristics for self-employed individuals of 23 years of age. Most interesting are their findings on ability differentials between employees and the self-employed. The BSA Survey data does not contain any current- or childhoodability proxy variables and since omission of an ability control may cause bias in the estimates of returns to schooling we would hope to see that on average productive-ability (ability that effects productivity and therefore earnings) does not vary significantly between worker types in the UK to ensure that our later estimates are not inaccurate. In speech and reading tests the self-employed were found to perform less well than employees, however bias is apparent as the speech test results have been found to be influenced heavily by gender and the self-employed are predominantly male. In mathematical ability tests the scores of the full-time self-employed are not significantly lower than for employees. Intelligence quotients calculated at the age of 11 show the self-employed to have lower verbal scores but similar non-verbal scores in comparison to employees.

Since previous studies [notably Ashenfelter & Mooney (1968) and Taubman & Wales (1973)] have found that only mathematical ability effects earnings significantly we may conclude as far as this NCDS evidence shows that the self-employed and employees in the UK do not differ significantly in productive-ability. Indeed, Weiss (1995) contends that it is not necessary to include ability variables in modelling the screening process since the firm is unable to directly observe ability. Including variables which the firm cannot directly observe in a model of wage determination will have no significant effects on the estimated coefficients on the variables that the firm can observe and uses as signals of ability.

Blanchflower *et al* (1988b) have further observations relevant to this study. The self-employed group includes a range of occupations from highly paid professionals such as doctors and lawyers, to low paid shopkeepers and farmers. However, average gross weekly earnings are found to be significantly higher than for employees, and that the self-employed work longer hours and at more anti-social times. From Table 5.1 the significant gross earnings and hours worked differential is confirmed from the BSA Survey data; the self-employed workers earn roughly £1100 more in real terms each year than employees, however we can see that the self-employed on average have a significantly longer working week which may explain some of the earnings differential. Blanchflower *et al* (1988b) also found that 6% of full-time self employed were union members in comparison to 46% of employees; this is similar to the BSA Survey data shown in Table 5.1 showing 9% of all self-employed are union or staff association members in comparison to approximately 49% of employees; the test-statistic associated with this differential is significant at the 5% level.

Blanchflower *et al* (1988b) find that those who were self-employed at 23 years of age were twice as likely as employees to have predicted at age 11 their worker type 12 years in the future and that such 'childish predictions' were not random. This is an important result in the context of the screening hypothesis since it is assumed in most screening models that individuals decide upon future employment, and therefore what educational investments to make, on the basis of an offered wage schedule set by potential employers. If the decision to be self-employed is made at an early age prior to acquisition of certification then under the screening hypothesis we would expect such individuals to acquire less certification for signalling purposes in comparison to would-be employees or those who have ambiguous aims. However, exogenous shocks must not be ignored; Blanchflower & Oswald (1990) study a young cohort of self-employed workers in the UK (from NCDS data), and find that an overriding influence upon the worker type choice decision is whether the individual ever received an inheritance or gift. For example, *ceteris paribus*, individuals coming into money in the region of £5000 were approximately twice as likely to chose to be self-employed.

Rees & Shah (1986) apply a simultaneous equation model of worker type and earnings to examine the determinants of self-employment using GHS 1978 data. They find that the probability of self-employment depends positively on the earnings differential between worker types and that age and education are also significant determinants in the choice decision. The effects of education in this study are 'interesting' in that education is found not only to have a greater impact upon the earnings of employees, but also (contrary to the screening hypothesis) to raise the probability of self-employment.

Patterns in the raw data such as those presented in Table 5.1 can give misleading inferences about the effects of education upon wages, since we are not controlling for other factors when comparing mean values. The means are included more for completeness than as evidence for or against screening. To gain a more precise understanding of the differences in educational achievement between worker types and to test whether this can be explained by the weak model we must analyse the individual relationships between educational variables and earnings formally using regression analysis.

5.4 Model Selection

5.4.1 The Heckit Procedure and Candidate Models

Since we are primarily concerned with the estimated rates of return to education for the self-employed and employees in the form of certification or years of education the models estimated for the two subsets in this Chapter are Mincerian wage rate functions. The alternative human capital formulations of Murphy & Welch (1990) and Psacharopoulos & Layard (1979) were found to marginally improve goodness of fit in comparison to the Mincer-type formulations, but the effects on most coefficients are also marginal, only the return to years in the labour force and powers of years in the labour force showed marked differences between the Mincerian and two other formulations. The Mincer-type functions estimated in this Chapter will take the form shown in equations (1) and (2)

(1) $\ln W = \alpha_0 + \alpha_1 S + \alpha_2 X + \alpha_3 X^2 + A_4 d + \varepsilon_1$

or,

(2) $\ln W = \beta_0 + B_1 c + \beta_2 X + \beta_3 X^2 + B_4 d + \varepsilon_2$

where:

W = wage rate derived from nominal annual gross earnings divided by hours worked in a week and 52 weeks for full-timers,

S = years of full-time education,

X	=	years in the labour force,
B_i, α_i	=	are constant coefficients,
c	=	vector of highest qualification held dummy variables (HQD's),
d	=	set of control variables,
B_i, A_i	=	are vectors of parameters,
ε_i	=	error terms; $E(\varepsilon_i) = 0$.

Equation (1) is a simple Mincerian formulation regressing estimated wage rates upon years of education, years in the labour force, years in the labour force squared, and *d* contains dummy variables representing year of response (since the dependant variable is *nominal* wage) and a control for sample selection bias. [2]

The alternative specification, Equation (2), uses highest qualification held to measure educational achievement and the variables contained within *d* are 'indices' such as gender, marital status, union or staff association membership, and ethnic origin; dummy variables to represent possible signalling or human capital effects of unemployment in the previous five years, private schooling at either secondary or primary level; UK Region dummy variables; a control for occupational class, a control for year of response, and a control for self-selection bias.

Following Grubb (1993), sample selection bias is controlled for using the procedure known as the 'Heckit model' suggested by Heckman (1979). The Heckit model corrects the separate wage rate equations estimated for the self-employed and employees for incidental truncation of the sample. There are workers in each type of employment who on the basis of socio-economic characteristics could earn more in the other type of employment. The Heckit model corrects for this fact by calculating inverse Mills ratios, which can be interpreted as the probability a person would choose to work in the opposite type of job if they could, and inserting these ratios into the estimated wage rate equations for each worker type.

[2] As in Chapter 4 real wage rate functions were estimated and found to fit the data less accurately than the nominal formulation with year dummies.

The Heckit model is a two-stage model and is estimated as follows.[3] Stage one is to make a probit estimation of the following model for sector selection:

(3) $I^* = \rho Z + \upsilon$

(4) $I = 1$ if $I^* \leq 0$ (worker is self-employed) or
$I = 0$ if $I^* > 0$ (worker is an employee)

Where I^* is the critical value of the selection criterion which is based on the socio-economic variables in vector Z. Endogenising sector selection implies that expected values of the error terms in the wage-rate functions of the self-employed and employees are no longer equal to zero when an individual is observed to be working in one type of employment, but on the basis of the selection criterion would prefer to be employed in the other type of employment [see Heckman (1979)].[4]

Stage two of the Heckit model involves including inverse Mills ratios, derived from the probit estimation of Equation (3), as explanatory variables in the estimation of the Mincerian wage-rate functions (1) or (2) to estimate the returns to education with worker type selection endogenous. For example using Equation (1), we would estimate the following functions;

(5) $\ln W_{employee} = \alpha_4 + \alpha_5 S + \alpha_6 X + \alpha_7 X^2 + \alpha_8 D + \lambda_1 + v_1$

(6) $\ln W_{self-emp.} = \alpha_9 + \alpha_{10} S + \alpha_{11} X + \alpha_{12} X^2 + \alpha'_{13} D + \lambda_2 + v_2$

where:

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[3] The Heckit model was estimated on the SHAZAM software package using an adaptation of a program written by D. Jaeger (1992); see pp. 258-261 SHAZAM User's Reference Manual.

[4] Also see Lee (1978) who uses a two-stage simultaneous equation model with limited dependent and qualitative endogenous variables to investigate the interactions between union membership and wage rates.

W_i	=	the nominal hourly wage-rate of the individual working in job i,
S	=	years of education,
X	=	years in the labour force,
D	=	matrix of year of response dummy variables,
v_i	=	error terms; $E(v_i) = 0$,

and the inverse Mills ratios are defined formally as follows;

(6) $$\lambda_1 = \frac{-f(\rho Z)}{F(\rho Z)}$$ for the employee wage rate equation,

(7) $$\lambda_2 = \frac{f(\rho Z)}{1 - F(\rho Z)}$$ for the self-employed wage-rate equation.

Where $f(.)$ is the density function of the standard normal variables and $F(.)$ is the distribution function.

5.4.2 Goodness of Fit Results

Earnings functions were estimated for the two sub-samples (self-employed and employees) using the SHAZAM software package at Manchester Computer Centre. For each regression two goodness of fit measures were used; Adjusted R^2 and variance of the estimate. For the model to fit the data well we would want a high R^2 and F-statistic, and a low estimate variance. Log-linear wage rate functions were estimated for male and female, employee and self-employed, sub-samples with goodness of fit results as shown in Table 5.2.

Table 5.2 : Summary of Model Comparisons for Full-time Workers

Gender	Worker Type	Estimated Function	Adjusted R^2	Variance of Estimate	F - statistic
Male	Self-employed	(1)	0.14	0.47	14.46
Male	Employees	(1)	0.34	0.19	245.26
Female	Self-employed	(1)	0.14	0.60	4.20
Female	Employees	(1)	0.34	0.18	150.01
Male	Self-employed	(2)	0.23	0.41	8.68
Male	Employees	(2)	0.48	0.15	111.57
Female	Self-employed	(2)	0.21	0.55	2.39
Female	Employees	(2)	0.48	0.14	65.94

It was decided that female workers would be omitted from this Chapter because the wage-rate functions were inadequate in explaining wage determination for female self-employed workers; this conclusion is reached from looking at the variance of the estimates and F-statistics, and an overall lack of significance in the *t*-ratios of the variables in the regression results. This also means that this Thesis is consistent with previous work on testing the screening hypothesis which concentrates on male full-timers to avoid any gender effects from pooling a sample of male and females.

5.5 Hypotheses and Expected Results

5.5.1 Introduction

The hypotheses that follow are mostly derived from the theoretical and empirical articles that have been reviewed in the preceding chapters. They are constructed to test for differences in the role of education, unemployment, and market experience between worker types. The overall theme of the hypotheses is to test whether there are significant differences between the screened and unscreened workers in the returns to potential screening devices.

Hypotheses 1,2 and 4 are concerned with the weak educational screening hypothesis. Hypothesis 3 is concerned with a screening hypothesis in relation to unemployment incidence following the work of Greenwald (1986), Taubman & Watcher (1986), McCormick (1990) and Ma & Weiss (1993), in which recent unemployment is used as a signal by prospective employers. Hypothesis 5 is similar in that it is concerned with a screening hypothesis in relation to years of experience as a signal of ability. Hypothesis 6 tests the claims of Lazear (1977) that the returns to certification may be biased by inclusion of professional workers in the samples.

5.5.2 Hypothesis 1

This hypothesis follows that of Riley (1979a); for education to be effective as a screening device it must be a good predictor of productivity (and therefore wage rates), if not firms will use other more accurate screening devices. The estimated wage rate function for the screened group (employees) is therefore expected to fit the data better than that for the unscreened group (self-employed workers). Rejection of the following null hypothesis supports the screening model:

H_0: The screened group does not fit the model any better than the unscreened group.

H_1: The screened group fits the model better than the unscreened group.

5.5.3 Hypothesis 2

Both the screening hypothesis and human capital theory infer that we should expect positive and significant coefficients on the highest qualification dummies, schooling quality proxy, and years of education variable. Under the screening hypothesis we would expect higher returns from educational variables for employees. For example, the coefficient on the public school variable may be insignificant in the regression for self-employed wages, in comparison to a positive and significant effect for employees. The dummy for public school may give some indication of quality of education as perceived by employers. This may support the finding in Taubman & Wales (1973) that schooling quality effects were significant in the determination of wages in the private sector, and support the idea that employers look at a vector of educational information as a signal of ability. Rejection of the following null hypothesis supports the screening model:

H_0: Returns to the vector of educational information are not significantly different between worker types.

H_1: Returns to the vector of educational information are significantly different between the worker types.

5.5.4 Hypothesis 3

In a human capital framework the impact on unemployment in the previous five years is expected to have a negative effect on earnings, through its de-skilling effects and impact upon search behaviour. However, differentials may exist between worker-types because of an informational function of unemployment; in a screening model it may be the case that an employee may be 'marked down', through association with the unemployment pool, by a new employer, whereas a self-employed person will not mark themselves down [see Greenwald (1986)]. Conversely unemployment could be actually be a positive signal to some potential employers [see McCormick (1990), Ma & Weiss (1993), and Taubman & Watcher (1986)]. We assume that the potential negative motivation and de-skilling effects are the same for both worker types, and so any differential in coefficients can be attributed to unemployment as a signal in the market for employees.[5] If employees are found to have a less (more) negative coefficient on the recent unemployment variable compared to the self-employed, this may be evidence of a positive (negative) signalling role for recent unemployment in the market for full-time employees. The null and alternative hypotheses are as follows:

H_0: The impact of recent unemployment is not significantly different across worker-types.

[5] Note that we do not know what worker type the respondent was before his or her period of unemployment, or whether, in fact, prior to the reported total unemployment in the previous five years the respondent was already unemployed. This implies that any result indicating a differential between worker types may be due to unobserved differences between the two sub-samples in unemployment duration and previous worker type.

H_1: The impact of recent unemployment is significantly different across worker-types.

5.5.5 Hypothesis 4

In a human capital framework, years of study will have positive effects on wages regardless of whether any qualifications have been obtained, however in the screening models we would expect that the longer a person spends in study without certification the more this is seen as a bad signal; this is explicitly tested by Oosterbeek (1985). We may also test this by constructing a sample of employees with no formal qualifications. We would then expect that the return to years of education for employees with no formal qualifications would be significantly different in comparison to the returns to employees who possess some formal qualification. In a weak screening model we would expect the return to years of education for employees with no formal qualification in comparison to the return to years of education for employees with formal qualifications to be smaller if years of education enhances productivity but gives a negative signal when coupled with the absence of certificates. However we would expect the return to be larger if years of education enhances productivity and is increasingly relied by employers upon as a basis on which decide pay in the absence of other signals. The coefficient on years of education could turn out to be negative for those with no formal qualifications if years of education coupled with no certificates is such a bad signal that it over-rides any productivity enhancing effects years of education may have. Rejection of the following null hypothesis supports the screening model:

H_0: The return to years of education does not differ between those with some formal qualification(s) and those with none.

H_1: The return to years of education does differ between those with some formal qualification(s) and those with none.

5.5.6 Hypothesis 5

In additional to explaining the education-earnings relationship human capital and screening models (based on the use of tenure or general labour market experience) have sought to explain the experience-earnings relationship. For example, Gibbons & Katz (1991) posit that those workers with high levels of tenure who are displaced due to plant closure, or for other reasons beyond their control, will receive higher subsequent wages than those laid-off (i.e. having shorter tenure) since they are seen by other firms to have successfully passed through the first firm's on-the-job screening process. Gibbons & Katz find that this is indeed the case; the differential impact of plant closure and lay-offs is difficult to explain in the context of human capital theory, where tenure represents specific human capital accumulation.

Potential labour market experience, as measured by years in the labour force, is also expected to have some effect on wages in both a human capital and a screening model.

In a human capital model experience proxies for general human capital acquisition, and since we are controlling for unemployment effects, the years in the labour force variable represents positive general human capital acquisition which will enhance productivity and therefore wages.[6]

In a screening framework experience may be used as a signal of ability by employers when deciding upon wage rates. As general labour market experience increases the worker can build up a curriculum vitae recording previous experience in addition to educational achievements. As experience increases the level of information available to the firm which it can use in its hiring and wage determination decisions increases. For example, first time job-seekers may be at somewhat of a disadvantage in comparison to more experienced workers with the same education, because they cannot show a previous employer's reference which gives a previous estimate of ability that the potential employer can observe.

[6] However we do not fully control for all unemployment over the workers lifetime (only in the five years preceding the date of the survey), and the frequency or duration of unemployment is not fully controlled for in the dummy variable representing recent unemployment. The rate of return to years in the labour force may therefore be underestimated due to lack of control for the negative effects of less recent unemployment upon wages.

Thus a difference in the estimated coefficients on the years in the labour force variable between employees and the self-employed may indicate some positive signal effect for employees. Experience may be used as a screen by employers in such a way that although two applicants may have the same ability the one with more labour market experience will be accepted for the job and years in the labour force may therefore influence wage rates through its influence upon job allocation. The null and alternative hypotheses are therefore as follows:

H_0: The positive effect of years in the labour force on log-wages does not differ across worker type.

H_1: The positive effect of years in the labour force does differ across worker type.

5.5.7 Hypothesis 6

The exclusion of professional workers such as doctors and lawyers from data sets when estimating the returns to educational variables and return differentials between worker types has become common practice. Lazear (1977) suggests that self-employed professionals may acquire qualifications in order to signal to their potential client base quality of service, thus raising the average level of education of the self-employed, and biasing the results of comparative studies. We can test such claims by running estimations of wage functions with and without professionals included. If the coefficients of educational variables change significantly with the exclusion of professionals from the data set we cannot reject the following null hypothesis:

H_0: Inclusion of professionals biases the returns to education upwards.

H_1: Inclusion of professionals does not bias the returns to education.

5.6 Actual Results using the Heckit Model with the Simple Mincerian Wage Rate Function (1)

5.6.1 The Probit Sample Selection Model

The probit equation used in the first stage of the Heckit model to estimate the inverse Mills ratios used in estimating Equations (1) and (2) is shown in Table 5.3. The number of observations for this regression is N = 5391 i.e. the whole sample of non-army male full-timers is used.

The reported Likelihood Ratio Test (LRT) statistic is highly significant and indicates that we cannot accept the null hypothesis that the explanatory variables have no influence on choice probabilities in the probit model i.e. that $\beta_2 = \beta_3 = \ldots = \beta_K = 0$ where the betas are the estimated coefficients on the variables included in the probit model. The reported LRT-statistic is found by calculating the following equation;

$$\text{(8)} \qquad \text{LRT} - \text{statistic} = -2\left[\ln \hat{\ell}(\Omega) - \ln \hat{\ell}(\omega)\right]$$

and has a Chi-squared distribution of (K-1) degrees of freedom, where;

K = the number of explanatory variables,

$\hat{\ell}(\Omega)$ = the value of the likelihood function evaluated at the maximum likelihood estimates,

$\hat{\ell}(\omega)$ = the maximum value of the likelihood function evaluated under the hypothesis that $\beta_2 = \beta_3 = \ldots = \beta_K = 0$

In addition, the reported Cragg-Uhler R^2 value appears to show that the probit model performs well in explaining the self-employment selection process. The Cragg-Uhler R^2 is defined formally as follows:

$$\text{(9)} \qquad \text{Cragg-Uhler } R^2 = \left\{\left[\hat{\ell}(\Omega)\right]^{(2/N)} - \left[\hat{\ell}(\omega)\right]^{(2/N)}\right\} \Big/ \left\{1 - \left[\hat{\ell}(\omega)\right]^{(2/N)}\right\}$$

and a Cragg-Uhler R^2 value in the region of 0.3 is generally taken to indicate that the model has a good fit to the data [see Cragg & Uhler (1973) for more details].

Table 5.3: Estimated Probit Model of Self-employment Selection

Variable	Estimated Coefficient	T - Ratio
Degree	-0.306	-2.220*
Nursing	-1.421	-2.681*
Teaching	-0.655	-2.388*
Academic/vocational	-0.581	-2.244*
HND	-0.682	-4.814*
Trade / business	-0.330	-3.188*
Apprenticeship	-0.032	-0.386
A-Levels	-0.230	-2.529*
O-Levels	-0.270	-3.188*
CSE's	0.254	1.488
Years in labour Force	0.035	4.167*
YILF^2	-0.508E-3	-3.308*
Years of education	0.061	2.879*
D1985	-0.196	-1.961**
D1986	-0.254	-3.035*
D1987	-0.131	-1.558
D1989	-0.139	-1.807**
D1990	-0.040	-0.513
Single	-0.010	-0.130
Low Occupation	-2.464	-22.569*
High Occupation	-1.198	-20.092*
Wales/Scotland/N. Ire.	0.085	1.426
North	-0.132	-2.041*
Constant	-1.266	-3.402*
Likelihood Ratio Test	1552.13*	
Cragg-Uhler R^2	0.412	

Notes: * significant at 5% level, ** at 10% level.

The inverse Mills ratios are calculated from this probit model and used as explanatory variables in the estimated wage rate equations for male full-time employees and self-employed workers.

5.6.2 Estimated Wage Rate Functions and Results

The estimated Mincerian wage rate functions for male full-time employees and self-employed are shown in Table 5.4. In both estimated wage rate equations the inverse Mills ratios (lambda's) are significant in the determination of wage rates i.e. in this case incidental truncation of the sample of male full-timers would have biased results if simple one-stage OLS estimation was employed for the simple Mincerian model.

Table 5.4: Estimated Mincerian Equations for Male Full-timers by Worker Type

	Employees (N = 4435)		Self - Employed (N = 956)	
Variable	**Estimated Coefficient**	**T - Ratio**	**Estimated Coefficient**	**T - Ratio**
Years of Education	0.105	29.726*	0.062	4.748*
Years in Labour Force	0.047	24.304*	0.033	4.964*
$YILF^2$	-0.770E-03	-19.474*	-0.601E-3	-5.034*
D1985	-0.431	-16.478*	-0.545	-5.906*
D1986	-0.369	-16.420*	-0.234	-3.075*
D1987	-0.311	-13.471*	-0.337	-4.522*
D1989	-0.164	-7.510*	0.164	-2.365*
D1990	-0.047	-2.090*	-0.052	-0.766
Lambda	-0.152	-6.119*	0.314	5.589*
Constant	-0.579	-8.519*	-0.174	-0.749
Adjusted R^2	0.335		0.140	
Variance of Estimate	0.192		0.459	
Mean ln *w*	1.543		1.357	

Notes: * significant at 5% level, ** significant at the 10% level.

From Table 5.4 we can see that the estimated wage rate function for male full-time employees fits the data more accurately than that for the male full-time self-employed; adjusted R-squared is higher and the variance of the estimate is lower for employees in comparison to the self-employed. We therefore cannot accept the null Hypothesis 1 that the screened group does not fit the model any better than the unscreened group. We must also reject the strong screening hypothesis that education has only a signalling role, since if this was the case then the estimated wage rate equation for the self-employed would display no significant returns to years of education.

Although years of education is significant in both of the estimated wage rate equations shown in Table 5.4 there is a marked difference between the average rate of return to years of schooling by worker type. The average rate of return to years of schooling is approximately 11% per year for employees and approximately 6% for the self-employed. We therefore cannot accept the null Hypothesis 2 that the returns to education are not significantly different between worker types. Indeed, a Chow test to show that the two estimated wage rate equations shown in Table 5.4 are significantly different produces an F-statistic approximately equal to 27.45 which is highly significant indicating that wage rates are determined separately by worker type for full-time male workers.

In relation to Hypothesis 5 we again cannot accept the null hypothesis. The average rate of return to years in the labour force differs by worker type; full-time male employees receive approximately 5% higher wages per year of experience, compared to approximately 3% higher wages per year of experience for full-time self-employed males. The rate of decrease in the marginal rate of return to years in the labour force as years in the labour increases also differs by worker type; the coefficient on years in the labour force squared is approximately -0.77E-3 for employees and approximately -0.60E-3 for the self-employed.

It is important that we employ all the relevant variables at our disposal that could be observed by the firm when modelling the process of wage rate determination, and to this end the more detailed wage rate Equation (2) is estimated in Section 5.7. Estimation of Equation (1) has given us an indication that there are indeed significant differences by worker type in the estimated rates of return to education. In Section 5.7, following Liu & Wong (1982), and the evidence in Chapter 4, we move on to re-formalise the wage determination process in terms of highest formal qualifications held, to allow for variation in the marginal rate of return to years of education and certification effects.[7]

5.7 Actual Results using Detailed Wage Rate Function (2)

5.7.1 General Results

Estimating more detailed wage rate functions for the self-employed and employees using the two stage Heckit model results in the inverse Mills ratios becoming insignificant in determining wage rates for either worker type. Since sample selection bias is found to be insignificant in the more detailed model the lambda terms are dropped from the equation and we use simple one stage

[7] Liu & Wong (1982) argue that wage rate determination is far more likely to be based upon highest certifcate held rather than years of education.

ordinary least squares.[8] The results of estimating the wage rate functions are shown in Table 5.5.

From Table 5.5 we can see that most of the variables are significant in determining wage rates for employees. The coefficients in the log-linear regression can be interpreted as rates of return to a variable. Where the variables are significant in determining wage rates there are marked differences in the magnitude of returns between worker types.

Being married, or being a divorcee or widower, rather than being single has a positive significant effect on wage rates for both worker types. The regional dummy variables all have a negative impact upon wage rates where significant, with the exception of Greater London residence which has a positive effect. The South East dummy is omitted as the reference category and so this pattern of signs is unsurprising and reflects the higher cost of living, higher labour demand and resultant higher wages in London.

Union or Staff Association membership has a positive significant influence on wage rates of employees; increasing wage rates by approximately 10% above the wage rate of a non-union member. There is no such significant effect on the wages of the self-employed. Membership to a union or staff association gives the employee benefits in the wage negotiation process which a non-members would not enjoy. However, Layard *et al* (1991) show that some non-members do gain because their wages are covered by union agreements; since coverage is not indicated by the union membership dummy variable, the coefficient on this variable will be an underestimate of the actual effect of unions upon wage rates.

Occupational classification indicated by the dummy variables for professional and management and skilled/semi-skilled/farm manual jobs, as we would expect, has a significant effect on the wage rates for employees. Professional and management jobs in relation to middle skill clerical jobs increase wage rates of the self-employed by approximately 44% and the wage rates of

[8] It may be argued that the simple Mincerian is a mis-specification of the wage rate formula in comparison to the detailed model including certification dummies, and that the lambda terms are only significant because the omitted certification and regional effects are entering the formulation in a non-linear form.

employees by approximately 16%. Skilled/semi-skilled/farm manual jobs in comparison to middle skill jobs decrease wages by approximately 16% for employees, whereas the effect is insignificant in the determination of self-employed wages.

If ethnic origin is significant in determining wage rates of employees then we would expect significant coefficients on the racial origin dummy variables included in the regressions. Moreover, we would expect under the assumption of race-bias occurring in UK employment that the two 'non-white' dummies to have a negative effect on earnings in comparison to the White/European reference category. In contrast all races may operate in the same 'market' if self-employed, in that their wages are not affected by employer biases and we expect no significance in the coefficients of the race dummies for this worker type. However it may be the case that 'non-whites' are affected by race-bias within the banking system from which they receive loans and from potential customers.

Both African and Asian/Chinese racial origin are significant in determining wage rates for male full-time employees. The negative impact upon log-wages in this case may stem from employer-bias for employees, but in addition motivation and information levels may be lower for this minority group. A possible source of bias for the self-employed could result from the behaviour of the providers of finance towards such individuals. However, we must note that the response rate in the BSA Survey to questions concerning racial origin was poor, and so there may be bias in the estimation of coefficients for these variables due to the responses not matching population proportions.

Table 5.5: Estimated Wage Rate Functions for Male Full-timers by Worker Type

	Self Employed (N=956)		Employees (N=4435)	
Variable	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Married	0.216	3.142*	0.144	7.869*
Divorced / widowed	0.292	2.553*	0.072	2.250*
Private Education	0.009	0.135	0.040	2.024*
Recent Unemployment	-0.175	-3.188*	-0.135	-8.810*
East Anglia	-0.041	-0.330	-0.113	-3.468*
East Midlands	-0.199	-2.110*	-0.101	-3.709*
London	0.087	0.978	0.102	4.320*
North East	-0.309	-2.265*	-0.090	-2.994*
N. Ireland	-0.392	-4.719*	-0.188	-7.009*
North West	-0.139	-1.472	-0.161	-6.881*
Scotland	-0.231	-2.448*	-0.077	-3.063*
South West	-0.221	-2.692*	-0.158	-6.245*
Wales	-0.379	-3.463*	-0.159	-4.858*
West Midlands	-0.003	0.095	-0.108	-4.443*
Yorks/Humberside	-0.296	-3.251*	-0.108	-4.490*
Union membership	-0.060	-0.786	0.103	8.403*
Prof. + Management	0.436	6.737*	0.160	9.088*
Skilled/Semi-skilled /Farm Manual	-0.146	-0.763	-0.155	-9.273*
African	-0.034	-0.146	-0.118	-1.825**
Asian/Chinese	-0.240	-1.290	-0.255	-4.536*
Unclassified R.O.	0.171	1.385	-0.034	-0.864
Degree	0.291	2.976*	0.450	17.735*
Nursing	0.414	0.635	0.152	1.749**
Teaching	-0.129	-0.437	0.273	4.843*
Other Ac./Vocational	-0.364	-1.349	0.222	4.123*
HND	0.207	1.631	0.335	11.567*
Other Trade/Business	0.246	2.647*	0.302	11.728*
Apprenticeship	0.229	3.528*	0.176	8.706*
A-Levels	0.089	1.255	0.228	10.223*
O-Levels	0.168	2.374*	0.137	6.869*
CSE's	0.215	1.541	0.111	3.178*
Years in Labour Force	0.013	1.753**	0.030	14.326*
$YILF^2$	-0.00032	-2.620*	-0.00054	-13.707*
1985	-0.589	-6.458*	-0.522	-22.028*
1986	-0.259	-3.430*	-0.412	-20.042*
1987	-0.323	-4.313*	-0.350	-16.572*
1989	0.025	0.229	-0.224	-6.177*
1990	-0.053	-0.811	-0.089	-4.492*
Constant	1.106	6.856*	1.286	25.955*
R^2 Adjusted	0.229		0.480	
Variance of Estimate	0.412		0.150	
Mean ln *w*	1.357		1.543	

Notes: * significant at 5% level, ** significant at 10% level.

The year dummy variables are all significant in the determination of wage rates of employees and those representing 1985-87 are significant in the determination of wage rates for the self-employed. The reference variable in this case is the dummy variable for 1991 representing whether the observations of the other variables were made in the 1991 survey. Since the dependant variable is based upon nominal earnings in each year we would therefore expect a strong correlation between the size of the estimated coefficients on these dummy variables and the actual national inflation rate in the corresponding year. This is in fact the case, with the correlation coefficient between national inflation (with base 1991=100) and the estimated coefficients on the dummy variables representing 1985-90 for employees calculated as 0.986, implying that the wage rate becomes higher as inflation becomes higher in relation to the inflation rate in 1991. Similar correlations can be found between the size of the estimated coefficients on the year dummy variables and national and male unemployment rates, the correlation coefficients being -0.933 and -0.922 respectively. This implies that as unemployment decreases the coefficients on the dummy variables representing 1985-90 become less negative and so wage rates increase towards the 1991 level. These three correlations are significant at the 5% significance level or better in a one-tail *t*-test.

A Chow test to see if the coefficients in the two regressions are significantly different gives a calculated F-statistic of 6.27 which is significant at the 1% significance level. We can reject the hypothesis that the two estimated functions do not differ significantly; the employee and self-employed sub-samples have significantly different wage functions.

5.7.2 Hypothesis 1 and Actual Results

From the adjusted R-squared measure we can see that the self-employed group (unscreened workers) do not fit the model as well as the employees (screened) group (also see Model Comparison summary results Table 5.2). The result of a weaker fit of the estimated earnings function to the self-employed is consistent with the findings of Riley (1979a), Fredland & Little (1981), and Tucker (1985), and the idea that the self-employed are generally less screened than employees.

5.7.3 Hypothesis 2 and Actual Results

All of the highest certification dummy variables are significant in determining male full-time employees' wage rates. If we rearrange the order of highest certification dummy variables into order of magnitude of return rather than educational stage obtained, we get the ranking of importance for male full time employees shown in Table 5.6. For example the addition to a male full-time employee's wage rate made by holding a degree or equivalent certificate as the highest qualification held in comparison to having no formal qualifications is an increase of approximately 45%.

Table 5.6 : Ranking of Returns from Certificates to Male Full-time Employees

Employees	
Certificate	**Estimated Return**
Degree	0.450
HND	0.335
Other Trade/Business	0.302
Teaching	0.273
A-Levels	0.228
Other Ac./Vocational	0.222
Apprenticeship	0.176
Nursing	0.152
O-Levels	0.137
CSE's	0.111

Moreover, we can test the significance of differences in returns to each highest certificate. The return to degree level certification as the highest held was found to be significantly higher than any of the other HQD's in comparison to having no qualifications. HND qualification was found to be insignificantly different in its effect upon wage rates in comparison to teaching and trade/business qualifications, but significantly higher than the lower ranked qualifications in Table 5.6. The return to teaching qualifications was found to be significantly higher than that estimated for apprenticeship qualifications and those ranked below. Nursing, O-levels, and CSE's were found to be insignificantly different in their positive effects upon wage rates of full-time male employees.

Table 5.7 presents similar ranking of HQD's for the self-employed. Looking at the coefficients on the qualification dummy variables in the estimated earnings function for self-employed males, we see that only the degree, trade/business, apprenticeship and O-levels dummy variables had a significant influence on the wages of the self-employed, compared to all the certificate dummy variables significantly affecting employee wage rates. From tests for significant differences in returns to the four HQD's that influence self-employed workers' wages it was found that they are all equivalent in their positive effect upon the wage rates of the full-time male self-employed in the sample.

The significantly higher returns from all the highest certification dummies to employees except for O-levels and apprenticeships may be attributed to the signalling role that these certificates have in the market for employees. The insignificant difference in returns to O-levels may be due to the lender-screening caveat previously mentioned in Section 5.2. It is possible that banks require a minimum level of education (certification) from self-employed workers applying for finance for their business plans, and this could be O-level standard certification.

Table 5.7 : Ranking of Returns from Certificates to Male Full-time Self-employed

Self-employed	
Certificate	**Estimated Return**
Degree	0.291
Other Trade/Business	0.246
Apprenticeship	0.229
O-Levels	0.168
Nursing	insignificant
Teaching	insignificant
Other Ac./Vocational	insignificant
HND	insignificant
A-Levels	insignificant
CSE's	insignificant

However, conversations with a number of local retail bank branches who are lenders to new businesses suggest that this caveat is weak. Business bankers confirmed that although previous experience, account records and a detailed business plan are used to screen applicants for start-up loans, there is no *explicit* minimum educational requirement that applicants had to meet.[9] There may be

[9] Barclays Bank, Midland Bank, National Westminster, Lloyds Bank, and TSB Business Centre Loughborough.

some correlation between the drawing-up of a sound business plan that will pass lender-screening and certain qualifications, and so there may be hidden educational screening occurring. Indeed the returns to the more vocational certificates; trade/business and apprenticeship qualifications may well be due to this correlation as well as returns to human capital.

A further explanation stems from the relaxation of the assumption that both worker types benefit, in terms of human capital, equally from courses. It is reasonable to think that some courses will be more useful than others to the self-employed in terms of skills that will be needed to run ones own business. It may be that apprenticeships and O-levels impart such specific self-employment skills whereas other courses do not impart any additional useful skills. However, neither explanation explains why there are insignificant returns to some post- O-level certificates.

The return to private schooling is insignificant for the self-employed but equal to approximately 4% for employees; so in terms of quality of education we can reject the null hypothesis. Educational quality as proxied by the private education dummy does appear to have significantly different effects on wage rates by worker type, and so there appears to be a difference in the returns to schooling quality between worker type. Although self-employed workers appear to gain nothing in terms of increased income from attending private schools, the proportion of self-employed BSA Survey respondents attending private school differs significantly from that of employees (15% of the self-employed compared to 11% of employees).

We must however note that the private schooling dummy derived from the BSA Survey questionnaire (showing private schooling at junior or secondary education levels) may not be a good proxy of education quality. With the introduction of league tables for schools with detailed statistics relating to quality, future researchers may have better resources from which to construct an accurate schooling-quality variable.

In general these results can be taken as evidence in support of the weak screening hypothesis, both in terms of educational certification and quality, and we can therefore reject the null of Hypothesis 2.

5.7.4 Hypothesis 3 and Actual Results

There are a number of reasons why unemployment incidence may have an effect on wage rates in both a screening or human capital framework. The first factor which stems from human capital theory is that some de-skilling occurs in that individuals forget useful skills and ability may be eroded, secondly from a psychological perspective an individual may lack motivation as unemployment time increases.

Thirdly in an informational model unemployment history may effect wages in a similar way to the effects of educational achievement. Ma & Weiss (1993) for example develop a signalling theory of unemployment in which employment at an unskilled job serves as a 'bad' signal to firms hiring skilled labour, thus unemployment may in fact be have a positive signalling effect in the determination of wage rates through its job-allocation effects in the market for skilled labour. Alternatively, Greenwald (1986) develops an adverse selection model in which potential employers expect that applicants from the unemployment pool are of lower ability than those who are wishing to change the job they are currently doing. In this model we would expect unemployment to have a negative effect on wage rates since those with an unemployment record may find they cannot attain a highly paid high skill job as they have been 'marked down' by employers.

From Table 5.5 we can see that having been unemployed in the previous five years has a significant negative impact on the wage rates of both worker types. However, the difference in the impact of the dummy variable, representing unemployment in the past five years, between worker types is contrary to expectations. Assuming unemployment has a 'marking' effect we would expect a larger negative coefficient for the male employee group; however, from Table 5.5, we can see that the male full-time self-employed have a coefficient on the dummy variable of approximately -0.175, and employees have a coefficient of -0.135.

A Gujarati (1970) dummy variable test involving estimating a wage rate function for a pooled sample of full-time male workers, with a dummy variable representing that the BSA Survey respondent is self-employed and a dummy variable representing the respondent is self-employed with recent unemployment, indicated that there was no significant interaction between worker type and recent unemployment. On this basis we cannot reject the null in Hypothesis 3, that the impact of recent unemployment is not significantly different across worker-types. It appears that the assumption that the potential negative motivation and de-skilling effects are the same for both worker types and that a differential would occur due to employers' screening by unemployment history is incorrect.

We can look at the impact of unemployment upon wages more closely by the use of an alternative measure of unemployment. In the regression results shown in Table 5.8 the recent unemployment dummy variable has been replaced by a continuous variable which measures the total months of unemployment experienced by the worker in the previous five years before the survey year in which they were questioned. Previous inclusion of this continuous variable for recent unemployment was not conducted because of the reduced coverage of the self-employed sample from 1985-91 with the dummy variable to 1985-87 with the continuous variable. The months of recent unemployment variable is denoted as MRU in Table 5.8.

From Table 5.8 we can see, from the estimated coefficient on the MRU variable, that the negative impact of each month of total unemployment in the previous five years for the male full-time self-employed worker is similar to that for the male full-time employee; approximately 3% lower wage rates compared to 2% lower wage rates. Thus it is not only the event of unemployment in the last five years that has a negative impact upon wages, it is also the duration of that unemployment. For example, a self-employed man who has been unemployed for a total of ten months in the previous five years would have an approximately 30% lower wage rate than if he had experienced no unemployment in the previous five years.

The months of recent unemployment variable does not show consecutive months of recent unemployment, rather it is the sum of all episodes of unemployment over the past five years; unfortunately this means that the inclusion of a square of this variable in the regression to observe the marginal rate of decline of wage rates would be misleading. A Gujarati (1970) dummy variable test showed that there was no significant difference between worker types in the average rate of decline of wages due to months of recent unemployment.

Table 5.8: Estimated Wage Rate Equations for Male Full-timers including Months of Recent Unemployment 1985-87 by Worker Type

	Self-employed (N = 355)		Employees (N=1987)	
Variable	**Estimated Coefficient**	**T - Ratio**	**Estimated Coefficient**	**T - Ratio**
Years in Labour Force	0.025	2.160*	0.032	9.766*
$YILF^2$	-0.451E-3	-2.361*	-0.557E-3	-9.162*
Degree	0.449E-2	0.026	0.321	8.319*
Nursing	--	--	-0.030	-0.259
Teaching	0.229	0.473	0.163	1.697**
Other Ac./Vocational	-0.456	-1.137	0.051	0.642
HND	0.020	0.097	0.248	5.495*
Other Trade/Business	0.250	1.674**	0.242	6.051*
Apprenticeship	0.134	1.191	0.144	4.454*
A-Levels	-0.033	-0.263	0.122	3.501*
O-Levels	0.091	0.763	0.095	3.113*
CSE's	0.466	2.098*	0.106	2.016*
Married	0.230	1.825**	0.123	4.193*
Divorced / widowed	0.373	1.758**	0.104	1.985*
Private Education	0.054	0.517	0.034	1.138
MRU	-0.030	-2.156*	-0.018	-4.856*
East Anglia	-0.134	0.484	-0.090	-1.983*
East Midlands	-0.204	0.144	-0.103	-2.646*
London	0.117	0.393	0.086	2.548*
North East	-0.200	0.365	-0.120	-2.605*
North West	-0.135	0.321	-0.125	-3.637*
Scotland	-0.307	-2.039*	-0.064	-1.748**
South West	-0.211	-1.498	-0.159	-4.293*
Wales	-0.312	-1.919**	-0.170	-3.572*
West Midlands	0.100	0.627	-0.102	-2.890*
Yorks./Humberside	-0.354	-2.396*	-0.111	-3.070*
Union membership	0.048	0.391	0.137	7.192*
Prof. + Management	0.363	3.326*	0.192	6.912*
Skilled/Semi-skilled /Farm Manual	0.219	0.449	-0.179	-6.803*
1985	-0.211	-2.133*	-0.176	-7.269*
1986	0.081	0.967	-0.071	-3.408*
Constant	0.768	4.383*	0.902	18.322*
R^2 Adjusted	0.144		0.397	
Variance of Estimate	0.439		0.161	
Mean ln *w*	1.204		1.379	

Notes: * significant at the 5% level or better, ** significant at the 10% level, '--' denotes where a variable was not available for that sub-sample.

5.7.5 Hypothesis 4 and Actual Results

Following the reasoning of Oosterbeek (1992) it is hypothesised that the return to years of education differs between those with some formal qualifications and those with no formal qualifications. In a human capital framework, years of study will have positive effects on wages regardless the qualifications obtained, however under Oosterbeek's screening model we would expect that the longer a person spends in study without gaining any qualifications the more this is seen as a signal of low ability.

If we focus on the workers detailed in the BSA Survey sample who are reported to have no formal qualifications we can produce distribution tables for education by region and by occupational class. From Table 5.9 we can see that Northern Ireland and Wales have the highest levels of unqualified workers, whereas Scotland and the South East (excluding London) have a more qualified workforce; this may be due in part to migration of qualified workers from Northern Ireland and Wales in search of work and the different educational systems in Scotland and Northern Ireland.

From Table 5.8 we can see a general pattern to the occupation-qualification distribution; the higher the skill level associated with an occupation the less likely it is that an unqualified individual will be working in that particular occupation. This can be interpreted as support for either the human capital theory of education and/or the screening theory of education. In the human capital model the qualifications are a result of a course which has imparted the necessary skills onto the individual in the high level occupation, skills that are not needed for work in lower level occupations. In the screening model the qualifications are needed to signal to employers that the individual possesses the skills needed for work in the higher level job, skills which have (have not) been augmented by the course in the weak (strong) hypothesis, and only individuals with those qualifications will be accepted for the higher level occupations.

Table 5.9 : Regional Distribution of Unqualified Male Full-time Workers

Region	Total Number	Number Unqualified	Percentage of Total Unqualified
East Anglia	207	64	31
East Midlands	346	110	32
London	510	144	28
North East	245	65	27
Northern Ireland	646	223	35
North West	488	125	26
Scotland	408	94	23
South East	1030	253	25
South West	433	111	26
Wales	217	71	33
West Midlands	434	135	31
Yorks. & Humberside	460	129	28
National Total	**5418**	**1524**	**28**

Notes: Calculated from BSA Survey sample.

Table 5.10 : Occupational Distribution of Unqualified Male Full-time Workers

Goldthorpe - Heath Occupational Classification	Total Number	Number Unqualified	Percentage of Total Unqualified
High Level Prof. & Management	971	52	5
Low Level Prof. & Management	939	101	11
Routine Office	326	51	16
Sales / personal	44	11	25
Small p-b with employees	259	80	31
Small p-b without employees	394	150	38
Farmers	100	64	64
Manual foreman etc.	430	151	35
Skilled manual	860	269	31
Semi-skilled / unskilled manual	979	549	56
Agricultural employees	36	24	67
Total	**5418**	**1524**	**28**

Notes: Calculated from BSA Survey sample.

Following Oosterbeek (1992), under Hypothesis 4, we would expect that the return to years of education for employees with no formal qualifications would be significantly different in comparison to the returns to qualified employees, due to the signalling effects of years of education coupled with no qualifications. We test this hypothesis by constructing a sample of employees who have no formal qualifications, estimating their wage function and comparing it to the estimated wage function of qualified employees. The estimated wage functions for unqualified and qualified full-time male employees are shown in Table 5.11.

We can see from Table 5.11 that the return to years of education for male full-time employees with no qualifications is insignificant. Furthermore, the estimated wage equation has a significantly lower R-squared than the estimated equation for qualified employees, indicating that this wage function is inaccurate in explaining the a large proportion of the variation of wage rates calculated for male employees with no formal qualifications in the BSA Survey subsample. We can also see from Table 5.11 that unqualified workers earn a lower average wage than qualified workers, and that in comparison to Table 5.5, most other coefficients are similar between the qualified employees subsample and the larger sample for all employees.[10]

In the weak screening hypothesis we would expect the return to years of education for employees without qualifications in comparison to the return for those with qualifications, to be smaller, negative or insignificant, if years of education enhances productivity but gives a negative signal when coupled with the absence of certificates, and larger if years of education enhance productivity and are increasingly relied by employers upon as a basis on which decide pay in the absence of other signals. From the results in Table 5.9 it appears that years of education may have a negative signalling effect which cancels out positive productivity effects leading to an insignificant total effect upon the wages of employees with no formal qualifications.

A Chow test to test that the two sets of estimated coefficients in the regressions shown in Table 5.11 are significantly different gives a calculated F-statistic of 5.87 which is significant at the 1% level. This implies that wage rates of the qualified and unqualified employees are determined by significantly different functions and the groups may therefore operate in different labour markets.

[10] This result is also consistent with dual labour market theory.

Table 5.11: Estimated Wage Rate Equations for Full-time Male Employees by Education

	Unqualified Employees (N = 1214)		Qualified Employees (N = 3248)	
Variable	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Years in Labour Force	0.025	5.755*	0.034	13.717*
YILF^2	-0.454E-3	-6.181*	-0.623E-3	-12.184*
Years in Education	-0.019	-0.894	0.045	11.169*
Married	0.169	4.550*	0.133	6.254*
Divorced / widowed	0.097	1.715**	0.065	1.655**
Private Education	0.895E-2	0.165	0.048	2.249*
Recent Unemployment	-0.154	-5.076*	-0.129	-7.207*
East Anglia	-0.157	-2.641*	-0.083	-2.137*
East Midlands	-0.054	-1.115	-0.116	-3.540*
London	0.148	3.223*	0.077	2.795*
North East	0.023	0.396	-0.123	-3.533*
N. Ireland	-0.258	-4.963*	-0.160	-5.099*
North West	-0.108	-2.269*	-0.175	-6.491*
Scotland	-0.086	-1.680**	-0.072	-2.518*
South West	-0.142	-2.800*	-0.161	-5.558*
Wales	-0.202	-3.445*	-0.137	-3.454*
West Midlands	-0.063	-1.393	-0.127	-4.375*
Yorks./Humberside	-0.025	-0.551	-0.131	-4.606*
Union membership	0.128	5.353*	0.082	5.726*
Prof + Management	0.141	3.409*	0.177	9.127*
Skilled/Semi-skilled /Farm Manual	-0.151	-5.208*	-0.169	-8.414*
African	0.179E-2	0.017	-0.196	-2.281*
Asian/Chinese	-0.116	-1.051	-0.320	-4.866*
Unclassified R.O.	0.105	1.446	-0.099	-2.122*
1985	-0.457	-9.833*	-0.514	-18.439*
1986	-0.339	-8.335*	-0.432	-18.037*
1987	-0.232	-5.441*	-0.391	-16.059*
1989	-0.094	-1.388	-0.260	-6.013*
1990	-0.021	-0.507	-0.079	-3.463*
Constant	1.387	3.938*	0.784	8.695*
R^2 Adjusted	0.271		0.479	
Variance of Estimate	0.146		0.152	
Mean ln *w*	1.305		1.634	

Notes: * significant at 5% level, ** at 10% level, observations include Armed Forces employees.

5.7.6 Hypothesis 5 and Actual Results

Years in the labour force, which may be interpreted as a proxy for potential experience and therefore 'general' human capital, has a positive effect on the wage rates for both worker types.[11] The years in the labour force squared term indicates

[11] Years in the labour force must be regarded as 'potential' labour market experience since unemployment may have occured which is not controlled for by the dummy variable representing unemployment in the last five years.

that as the return to experience increases at a decreasing rate as experience increases. From Table 5.5 we can see that the curvature of the Mincerian age-earnings profile is more pronounced for employees; coefficient is -0.54E-3 in comparison to -0.32E-3 for the self-employed.

We can reject the null hypothesis 5. The return to years in the labour force is higher for male full-time employees in comparison to the self-employed male full-time workers in the Mincerian model; 3% per year compared to 1% per year. This may reflect the structure of employees wage contracts in reference to age or tenure within UK companies which is not apparent for the self-employed. It may also be partly due to some form of signalling return (i.e. a return to the information carried by age) with the differential between worker types reflecting the lack of such informational return to the self-employed. However, since we have not controlled for tenure in the earnings function estimate, and no such variable is available in the BSA Survey data, we cannot separate these two effects. Thus as far as the informational aspect of experience is concerned the evidence is inconclusive. As far as the human capital aspect of experience is concerned, since we have significant positive returns to both worker types, we can conclude that experience does enhance productivity and therefore earnings.

5.7.7 Hypothesis 6 and Actual Results

From Table 5.5 we can see that being a professional worker has a significant positive influence on the log-wages of the self-employed and employees. There has been much debate over the possibility that professional workers, especially self-employed professionals, may bias the returns to educational variables upwards and therefore invalidate the results of comparative studies of the screening hypothesis.

Lazear (1977) presented a caveat to be applied to comparative studies of the screening hypothesis, that professional self-employed workers may invest in education (certification) beyond human capital needs because they may deal with customers who use certification as a signal of service quality. It is equally possible that professional employees may invest beyond human capital and employer-screening needs because of such consumer screening. We can test for the impact of such consumer-screening by estimating wage rate functions with and without the inclusion of professionals included and comparing the results. If the coefficients of educational variables change significantly with the exclusion of professionals from the data set we cannot reject the null hypothesis.

From Tables 5.12 and 5.13 we can see that the returns to years of educational certificates for both worker types does not appear to alter significantly when professionals are omitted from the regressions. Returns to certification are not significantly different between non-professional employees and all employees. From Table 5.11 we can see that the return to a degree level qualification as the highest qualification held by a non-professional self-employed worker is insignificant whereas it is significant in the regression for all self-employed. There may be some interaction between professionalism and degree level certification.

Thus there is no firm evidence here to suggest that professionalism does effect the returns to education because of consumer-screening. Indeed Tucker (1987) presents an explicit test of Lazear's hypothesis and rejects the notion of consumer-screening. A Gujarati (1970) dummy variable test involving estimating a wage rate for both types of workers including dummy variable interactive terms for interaction between professionalism and qualification level gave the result that only the returns to teaching qualifications were increased by professionalism for both worker types, and that the returns to O-levels were decreased significantly for self-employed professionals.

These results do not contradict the conclusions already derived in this Chapter. Although the return to teaching qualifications is inflated by the inclusion of professionals it remains insignificant in the determination of self-employed wage rates, and although the returns to O-levels are decreased by the inclusion of professionals they remain significant for the self-employed.

Table 5.12 : Estimated Wage Rate Equations for Male Full-time Employees

	Non - professionals (N = 4071)		All Employees (N=4435)	
Variable	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Married	0.142	7.429*	0.144	7.869*
Divorced / widowed	0.074	2.245*	0.072	2.250*
Private Education	0.037	1.768**	0.040	2.024*
Recent Unemployment	-0.133	-8.425*	-0.135	-8.810*
East Anglia	-0.105	-3.109*	-0.113	-3.468*
East Midlands	-0.090	-3.212*	-0.101	-3.709*
London	0.111	4.481*	0.102	4.320*
North East	-0.086	-2.791*	-0.090	-2.994*
N. Ireland	-0.204	-7.308*	-0.188	-7.009*
North West	-0.157	-6.456*	-0.161	-6.881*
Scotland	-0.079	-2.931*	-0.077	-3.063*
South West	-0.156	-5.942*	-0.158	-6.245*
Wales	-0.156	-4.612*	-0.159	-4.858*
West Midlands	-0.107	-4.200*	-0.108	-4.443*
Yorks./Humberside	-0.102	-3.995*	-0.108	-4.490*
Union membership	0.109	8.536*	0.103	8.403*
Prof. + Management	0.159	8.769*	0.160	9.088*
Skilled/Semi-skilled /Farm Manual	-0.156	-9.319*	-0.155	-9.273*
African	-0.107	-1.630*	-0.118	-1.825**
Asian/Chinese	-0.261	-4.386*	-0.255	-4.536*
Unclassified R.O.	-0.012	-0.292	-0.034	-0.864
Degree	0.432	15.252*	0.450	17.735*
Nursing	0.151	1.743*	0.152	1.749**
Teaching	0.266	4.667*	0.273	4.843*
Other Ac./Vocational	0.199	3.559*	0.222	4.123*
HND	0.335	10.518*	0.335	11.567*
Other Trade/Business	0.293	10.973*	0.302	11.728*
Apprenticeship	0.175	8.599*	0.176	8.706*
A-Levels	0.234	10.280*	0.228	10.223*
O-Levels	0.134	6.652*	0.137	6.869*
CSE's	0.107	3.067*	0.111	3.178*
Years in Labour Force	0.030	13.616*	0.030	14.326*
$YILF^2$	-0.538E-3	-13.137*	-0.544E-3	-13.707*
1985	-0.524	-21.250*	-0.522	-22.028*
1986	-0.405	-18.890*	-0.412	-20.042*
1987	-0.347	-15.718*	-0.350	-16.572*
1989	-0.202	-5.429*	-0.224	-6.177*
1990	-0.085	-4.121*	-0.089	-4.492*
Constant	1.262	24.740*	1.286	25.955*
R^2 Adjusted	0.465		0.480	
Variance of Estimate	0.150		0.150	
Mean ln *w*	1.508		1.543	

Notes: * Significant at 5% level, ** Significant at 10% level.

Table 5.13 : Estimated Wage Rate Equations for Full-time Self-employed Males

	Non-professionals (N = 854)		All Self-employed (N=956)	
Variable	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Married	0.208	2.907*	0.216	3.142*
Divorced / widowed	0.338	2.780*	0.292	2.553*
Private Education	0.030	0.412	0.009	0.135
Recent Unemployment	-0.167	-2.993*	-0.175	-3.188*
East Anglia	-0.030	-0.240	-0.041	-0.330
East Midlands	-0.181	-1.885**	-0.199	-2.110*
London	0.124	1.316	0.087	0.978
North East	-0.255	-1.804**	-0.309	-2.265*
N. Ireland	-0.388	-4.480*	-0.392	-4.719*
North West	-0.096	-0.981	-0.139	-1.472
Scotland	-0.233	-2.275*	-0.231	-2.448*
South West	-0.231	-2.649**	-0.221	-2.692*
Wales	-0.391	-3.378*	-0.379	-3.463*
West Midlands	0.024	0.246	-0.003	0.095
Yorks./Humberside	-0.257	-2.668*	-0.296	-3.251*
Union membership	-0.154	-1.829**	-0.060	-0.786
Prof. + Management	0.366	4.672*	0.436	6.737*
Skilled/Semi-skilled /Farm Manual	-0.165	-0.869	-0.146	-0.763
African	0.146	0.584	-0.034	-0.146
Asian/Chinese	-0.321	-1.596	-0.240	-1.290
Unclassified R.O.	0.188	1.456	0.171	1.385
Degree	-0.085	-0.660	0.291	2.976*
Nursing	0.489	0.754	0.414	0.635
Teaching	-0.343	-1.054	-0.129	-0.437
Other Ac./Vocational	-0.327	-1.215	-0.364	-1.349
HND	0.231	1.642	0.207	1.631
Other Trade/Business	0.231	2.268*	0.246	2.647*
Apprenticeship	0.235	3.601*	0.229	3.528*
A-Levels	0.124	1.703**	0.089	1.255
O-Levels	0.185	2.591*	0.168	2.374*
CSE's	0.214	1.542	0.215	1.541
Years in Labour Force	0.014	1.920**	0.013	1.753**
$YILF^2$	-0.353E-3	-2.803*	-0.32E-3	-2.620*
1985	-0.575	-5.887*	-0.589	-6.458*
1986	-0.221	-2.726*	-0.259	-3.430*
1987	-0.307	-3.909*	-0.323	-4.313*
1989	0.051	0.448	0.025	0.229
1990	-0.035	-0.518	-0.053	-0.811
Constant	1.053	6.275*	1.106	6.856*
R^2 Adjusted	0.172		0.229	
Variance of Estimate	0.403		0.412	
Mean ln *w*	1.282		1.357	

Notes: * Significant at 5% level, ** Significant at 10% level.

5.8 Conclusion

Following the methodology of Wolpin (1977), Katz & Ziderman (1980), and Cohn *et al* (1987) wage rate functions were estimated for self-employed and employees in the BSA Survey sample. Significant differences were found in the effects of years of education, years of experience, private education and highest certification levels upon wage rates by worker type.

Both the simple OLS and the two-stage Heckit results are taken as support for the weak screening hypothesis. The result of a weaker fit of the estimated function to the self-employed sample is consistent with the findings of Riley (1979a), Fredland & Little (1981) and Tucker (1985) and supports the hypothesis that education is used as signal of ability by employees. The effect of years of schooling was positive and significant for both worker types, but the estimated return was higher for employees in comparison to the self-employed. All the certificate dummy variables were found to significantly increase wage rates of employees, whereas only degree level, trade and business, apprenticeships and O-level certification were found to significantly effect the wage rates earned by the self-employed. The effect of private schooling was positive and significant for employees but not for the self-employed. These results were taken as evidence in support of the weak but not the strong screening hypothesis, since under the strong screening hypothesis we would expect no significant education effects for the unscreened group (the self-employed).

Years of education was found to have no significant influence on the wage rates of unqualified male employees. Unqualified and qualified employees were found to have significantly different estimated wage rate functions. In light of this, two tentative conclusions are as follows: Firstly it may be that it is certificates rather than years of education that act as a screen in the labour market and that years of education has no productivity augmenting role; or secondly, that increased years of education have such a strong negative signalling effect upon the wage rates of unqualified employees that it outweighs their positive productivity augmentation effects.

The effect of recent unemployment was found not to differ significantly between worker types, and so the hypothesis that unemployment incidence had a role as a screen was rejected. The effect of years in the labour force was found to differ significantly between work types; this may be due to the wage-tenure structure inherent in employee pay schemes, but may also be because experience plays a role as a signal of ability in the labour market. It was also found that omitting professionals does not contradict the conclusions already derived in this Chapter, supporting Tucker (1987) who finds no evidence of the consumer-screening of professionals.

Overall, from this methodology, we have found strong evidence that weak screening occurs in the UK labour market for male full-timers. There is little evidence in favour of the strong screening hypothesis since education is found to have significant effects on the wage rates of the self-employed.

Appendix 5.1: Additional Results

Table 5.14 shows the results of estimating detailed Mincerian wage rate functions for the BSA Survey male full-time employee and self-employed samples. The results of Section 5.7 are generally confirmed by these estimated equations; the estimated wage rate function for the self-employed appears to fit the data less accurately than that for employees, and the returns to education and years of experience differ significantly between worker types.

Table 5.14 : Estimated Mincerian Equations for Male Full-timers by Worker Type

	Self-employed (N=956)		Employees (N = 4435)	
Variable	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Married	0.234	3.402*	0.142	7.647*
Divorced / widowed	0.332	2.903*	0.066	2.016*
Private Education	0.013	0.202	0.044	2.181*
Recent Unemployment	-0.178	-3.263*	-0.134	-8.590*
East Anglia	0.009	0.069	-0.121	-3.640*
East Midlands	-0.170	-1.795**	-0.112	-4.016*
London	0.095	1.066	0.084	3.492*
North East	-0.280	-2.059*	-0.081	-2.662*
N. Ireland	-0.419	-5.051*	-0.211	-7.741*
North West	-0.129	-1.365	-0.163	-6.865*
Scotland	-0.204	-2.164*	-0.082	-3.211*
South West	-0.185	-2.258*	-0.157	-6.116*
Wales	-0.358	-3.268*	-0.171	-5.119*
West Mids.	0.010	0.104	-0.118	-4.749*
Yorks./Humberside	-0.275	-3.027*	-0.106	-4.305*
Union	-0.047	-0.607	0.105	8.442*
Prof. + Management	0.457	7.282*	0.196	11.127*
Skilled/Semi-skilled /Farm Manual	-0.136	-0.708	-0.183	-11.026*
African	-0.028	-0.122	-0.155	-2.344*
Asian/Chinese	-0.270	-1.444	-0.260	-4.543*
Unclassified R.O.	0.195	1.570	-0.027	-0.689
Years of education	0.027	1.919**	0.052	13.796*
Years in Labour Force	0.011	1.607	0.030	14.205*
$YILF^2$	-0.00032	-2.583*	-0.00053	-13.423*
1985	-0.609	-6.691*	-0.508	-20.969*
1986	-0.273	-3.604*	-0.420	-20.064*
1987	-0.343	-4.582*	-0.360	-16.753*
1989	0.029	0.267	-0.216	-5.858*
1990	-0.041	-0.626	-0.072	-3.544*
Constant	0.771	2.773*	0.583	7.116*
R^2 Adjusted	0.219		0.461	
Variance of Estimate	0.417		0.156	
Mean ln w	1.357		1.543	

Notes: * significant at 5% level, ** significant at 10% level.

In terms of years of education the self-employed have wage rates increased by approximately 3% compared to approximately 5% for employees for each year of education. Private education at secondary or primary level significantly increases the wage rates of employees, by approximately 4%, but has no significant effect on the wage-rates of the self-employed. These results can be taken as evidence in support of the weak screening hypothesis.

A Chow test to see if the coefficients in the two regressions are significantly different gives a calculated F-statistic of 2.17 which is significant at the 1% significance level. We can reject the hypothesis that the two estimated functions do not differ significantly; the employee and self-employed sub-samples have significantly different wage functions.

Chapter 6

Further Comparative Tests of the Screening Hypothesis Using UK Data

6.1 Introduction

In this Chapter I continue to test the educational screening hypothesis in relation to the UK labour market using BSA Survey 1985-1991 data. The tests detailed in this Chapter follow the methodologies of Psacharopoulos (1979), Lee (1980) and Cohn *et al* (1987) in which the data is split into sub-samples according to the economic sector in which the respondent works, Katz & Ziderman (1980) in which the data is split into occupational sub-samples, and Tucker (1986) in which the data is split into level of education or tenure sub-samples. In each case comparisons are made between the selected sub-samples which are assumed to be characterised by different levels of educational screening, in a similar fashion to the employee and self-employed analysis of Chapter 5.

Section 6.2 presents the six hypotheses to be tested. Hypotheses 1, 2, 3 and 5 relate to testing the weak version of the screening hypothesis, Hypotheses 4 and 6 relate to testing the strong version [as interpreted by Psacharopoulos (1979)] as opposed to the weak version of the screening hypothesis.

The strong version of the screening hypothesis is generally regarded as the opposite extreme to the human capital model outlined in Chapter 4 in its approach to the role of education in the labour market. In the human capital model education has no informational role and is purely a productivity augmenting process. In the weak version of the screening hypothesis the informational role was added, whilst in the strong version of the screening hypothesis the productivity augmenting role is removed and education is acquired by workers purely for its signalling content.

The strong version of the screening hypothesis, sometimes also referred to as the 'pure' screening model, is that hypothesis presented both by Spence (1973) and Stiglitz (1975) whereby education is solely informational in nature and acts as a signal of innate ability to potential employers. Under the strong version of the screening hypothesis any differences in wage rates by years of education categories, *ceteris paribus*, must be attributed to this screening process. The analysis of Psacharopoulos (1979) differs from previous screening theories in that he assumes in the strong version of the screening hypothesis that firms make an initial wage setting error which is maintained even as tenure increases.

According to Psacharopoulos (1979) in the weak version of the screening hypothesis educational variables, namely years of education and credentials, are used by employers to determine *initial* wage rates for workers i.e. in the language of Spence (1973) the initial wage rates make up the offered wage-education schedule on which workers base their signalling decision. However, in contrast to the strong version of the screening hypothesis as outlined by Psacharopoulos (1979), in his interpretation of weak screening, as tenure increases wage revisions linked to on-the-job monitoring will bring the wage more in line with actual productivity of the worker. Worker productivity is assumed to be augmented by three forms of human capital investment; education, general labour market experience and specific on-the-job experience.

Indeed, this thesis has already shown a link between years of education and years in the labour force (a proxy for tenure) in wage rate determination; Table 4.8 in Section 4.4.3 of Chapter 4, shows a positive and significant coefficient on the YILF*YOED variable in the estimated wage rate functions for male and female workers. This implies that, as years in the labour force increases the effect of education upon wage rates also increases; this can be taken as evidence against Psacharopoulos's strong screening hypothesis. This Chapter extends the analysis by applying a number of further tests of the screening function of education.

Section 6.3 gives details of the results of testing Hypotheses 1 which uses education level data, and separate estimated wage rate functions by occupational group. Section 6.4 gives details of the results of testing Hypotheses 2 and 4 which use mid- to early-career earnings ratios. Section 6.5 presents the results of testing Hypotheses 3 which uses regression analysis to estimate sectoral Mincerian wage rate functions. Section 6.6 presents the results of estimating wage rate functions for employees in different labour market experience groups which can be used to test Hypotheses 5. Section 6.7 presents the results of estimating wage rate functions for employees in different education groups which can be used to test Hypotheses 6. Section 6.8 draws some overall conclusions from the results of these tests.

6.2 Hypotheses and Expected Results

6.2.1 Hypothesis 1

From Table 5.5 in Chapter 5 we can see that occupational effects, as represented by the occupational class variables, are generally significant in determining the wage rates of male full-time workers. The effect of occupational class as well as the effect of worker type upon the returns to education is the subject of the mean-based hypothesis of Katz & Ziderman (1980) (referred to as K & Z hereafter).

K & Z suggest that screening would be characterised by differentials in years of education attained by occupational category and worker type (self-employed or employees), since some workers are more likely to be screened than others. K & Z expect employees to invest more in education than the self-employed for higher level occupations, and that the opposite situation occurs for low-level occupations. Low level occupations are defined as occupations requiring a low level of job-related skills, for example unskilled manual labour, and high level occupations as occupations requiring a high level of job-related skills, for example the professions. In the BSA Survey sub-sample occupations are classified as high- and low-level using the Goldthorpe-Heath classification (see details of this classification in Appendix 1 of Chapter 4).

In a pure human capital model K & Z expect the self-employed to acquire more education on average than employees in similar occupations because the self-employed need to invest in additional 'self-employment skills'. For low level occupations, where skill requirements are low, the self-employed are expected on average to invest in more education than employees for self-employment skills. However, for high level occupations education is assumed to be a joint input into job- and self-employment skills, and education level may not differ by worker type in these occupations.

Alternatively, a pure educational screening model predicts no differential in education for the lowest level occupations between the self-employed and employees, since it follows from such a model that the lowest ability employees choose not to screen, because they find it too costly. As skill requirements increase employees' education will outweigh the education of the self-employed due to screening effects.

Combining both models gives the weak screening hypothesis where education acts as a signal and enhances ability. In such a model K & Z expect that for high level occupations the education of the self-employed is less than that of employees, for low levels the education of the self-employed is higher than that of employees, and that there exists some intermediate level of occupation where education levels are equal between worker types [for more details see K & Z, pp. 81-84]. Thus the null and alternative hypotheses would be as follows:

H_0: There are no significant positive (negative) differences in education between

employees and the self-employed for high (low) level occupations.

H_1: There are positive (negative) differences between the education of employees and the self-employed for high (low) level occupations.

6.2.2 Hypothesis 2

Wage rates in the competitive sectors of the economy are expected to be determined by economic variables such as factor supply and demand conditions, unionisation, and regional wage pressures. Since it is more important to measure productivity in the competitive sector to ensure profit maximisation it also more likely that non-educational screening devices such as up-or-out contracts contingent on ability are used [see Salop & Salop (1976) for a theoretical exposition of this screening device]. We would therefore expect that screening by education is not as apparent in the competitive sectors of the economy as it is in the public sectors where wage rates are determined more bureaucratically, and where wage rates can deviate from worker productivity even as tenure increases, since it is difficult to measure individual productivity in this sector.[1]

In his analysis of the screening hypothesis Psacharopoulos (1979) assumes the distributive trades sector [Standard Industrial Classification number 6 (SIC 6)] to be characterised by competitive wage determination, and the public administration (public non-service) sector to be characterised by uncompetitive wage determination based more upon educational screening. An alternative choice of employment sector in such a comparison of earnings ratios would be the self-employed and employees, where employees are assumed to be screened and the self-employed unscreened.

It does not automatically follow that the sectors used in Psacharopoulos (1979) are characterised by high or low competition in the UK in 1985-1991. Thus, another choice of sector for comparison of earnings ratios and returns to education can be made from calculating, rather than assuming, the level of competition present in certain sectors from data in the Census of Production and comparing the sector with the highest level of concentration to the sector with the lowest level of concentration. Cohn *et al* (1987) conducted such a test using USA sectoral data.

Thus the null and alternative hypotheses would be as follows:

H_0: Mid- to Early-career earnings ratios do not differ between competitive and non-competitive sectors in the economy,

H_1: Mid- to Early-career earnings ratios are higher for the non-competitive sectors.

[1] Note that Blaug (1985) presents an alternative explanation as to why mid-to-early earnings ratios may converge as tenure increases, based upon abour market segmentation theory and the hypothesis that internal markets and statistical discrimination exists in the two sectors to different degrees.

6.2.3 Hypothesis 3

Hypothesis 3 is a continuation of Hypothesis 2, but in this case relates to the estimated coefficients of educational variables in sectoral wage rate regressions, rather than the earnings ratio. Testing this hypothesis using regressions allows us to control for other influences upon wage rates in addition to education. Since screening may be more apparent in non-competitive sectors we might expect, under the weak screening hypothesis, to find higher returns to years of education and the highest qualification held in these sectors compared to competitive sectors.

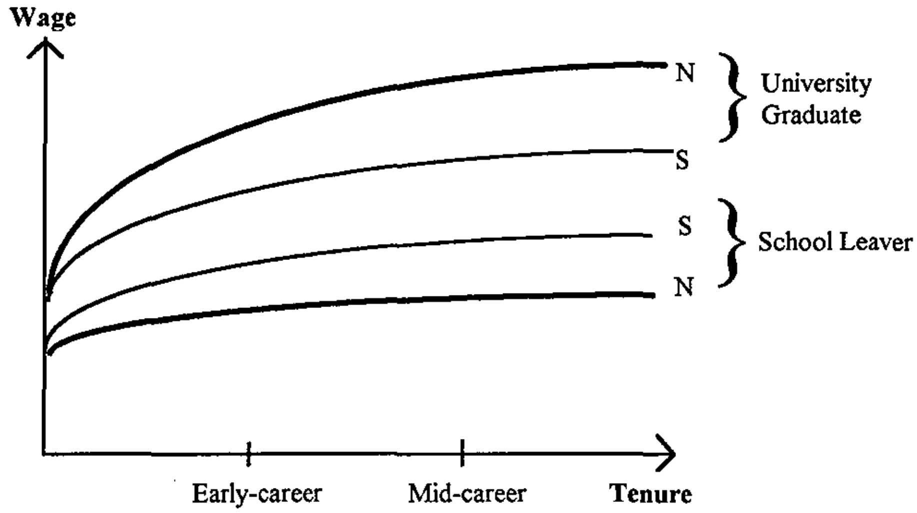
H_0: Returns to educational variables do not vary with degree of competitiveness in the sector,

H_1: Returns to educational variables decrease as degree of competitiveness increases.

6.2.4 Hypothesis 4

The basis for Hypothesis 4 is demonstrated using in Figure 6.1. Under the strong version of the screening hypothesis, education is solely a signal of ability and has no human capital effects. Therefore a university leaver is signalling that his or her productivity is higher than a school-leaver. The initial wage paid to the university graduate is therefore higher than that paid to the school-leaver assuming they are paid in line with their different expected productivities, and according to Psacharopoulos (1979) in the strong version of the hypothesis this pay differential is maintained throughout the working life of the individuals regardless of whether the productivity estimation is correct.

Figure 6.1: Earnings Profiles in the Strong Screening Hypothesis



S = Wage tenure profile under strong version of the screening hypothesis,
N = Wage tenure profile with no screening.

In the strong hypothesis the earnings profiles are less divergent over time than they would be if human capital effects were occurring. Thus, in Figure 6.1 the thin line represents the wage-tenure profiles for the university graduate and the school-leaver under the strong version of the screening hypothesis.

In Figure 6.1 the thick line represents the wage-tenure profiles for the university graduate and the school-leaver if education was not a screening device i.e. if educational was instead purely a human capital investment then the university graduate is more productive than the school-leaver due to acquired skills. According to Psacharopoulos, in the weak version of the model as employers learn more about individual ability, as tenure increases, wage rates of graduates are increasingly divergent from those of school-leavers as it becomes increasingly apparent that they are more skilful than school-leavers.

In the strong version of the screening hypothesis as outlined by Psacharopoulos (1979) university graduates are 'over-valued' in the sense that wage rates are maintained at a level in excess of productivity even as tenure increases. Psacharopoulos (1979) diverges from the signalling equilibrium conditions of Spence (1973) and Riley (1985) who state that in a signalling equilibrium wages must be set equal to individual productivity. In this sense Psacharopoulos's (1979) strong screening hypothesis should be more accurately classified as a credentialist model, rather than a screenist model.

We can see from Figure 6.1 that under the assumption that Psacharopoulos's version of strong screening is taking place for both education types that mid- to early-career earnings ratios would not rise as years of education increase; giving rise to Hypothesis 4, as follows;

H_0: Mid- to Early-career earnings ratios do not rise as years of education increase,

H_1: Mid- to Early-career earnings ratios do rise as years of education increase.

6.2.5 Hypothesis 5

Following Liu & Wong (1982), and Tucker (1986), under the hypothesis that weak screening exists we would expect that as tenure increases the employer would be able to get more (and more precise) information about their employees, we should therefore expect that the size and significance of the estimated coefficient on educational characteristics, which were used as indicators of productivity at the initial hiring point, should decline as tenure increases. Data limitations mean that years of experience in the labour market is used as a proxy for tenure in the analysis of this chapter. Weiss (1995) states that just as turnover declines with tenure as workers acquire more firm-specific human capital, quits decline as experience (and general human capital) increases. Given the fact that quits decline as experience increases we expect that experience and tenure are positively correlated, and one may proxy for the other. Rejection of the following null hypothesis would therefore lend support to the weak screening hypothesis;

H_0: Returns to qualifications do not decrease as years of experience increase,

H_1: Returns to qualifications decrease as years of experience increase.

6.2.6 Hypothesis 6

Following Tucker (1986), the strong screening hypothesis is supported if the tenure-earnings profiles for degree holders and school-leavers do not diverge as tenure increases and employers could learn more about their workers. Conversely, if the profiles were divergent this suggests that higher educated groups are paid relatively higher wages beyond the initial hiring point (i.e. relative productivity and therefore wage rates are increasing due to human capital effects) and the strong screening hypothesis should be rejected.

Rejection of the following null hypothesis would therefore lend support to the strong screening hypothesis;

H_0: Returns to years of tenure increase as education level increases,

H_1: Returns to years of tenure do not increase as education level increases.

By testing Hypotheses 1, 3 and 5 we are testing the weak educational screening hypothesis. In each case, rejection of the null hypothesis would be consistent the weak screening hypothesis, and acceptance of the null hypothesis would be a rejection of the weak screening hypothesis. Hypotheses 2, 4 and 6 test the strong version of the educational screening hypothesis. Rejection of the null in Hypothesis 4 is not consistent with the strong version of the screening hypothesis, and acceptance of the null hypothesis would be consistent with strong, weak or no screening and is therefore inconclusive. Rejection of the null hypothesis in Hypothesis 6 lends support to the strong screening hypothesis.

6.2.7 Ziderman's (1990) Critique of Psacharopoulos's Model

Ziderman (1990) suggests that the P-test methodology of looking for erosion of educational effects with age used by the authors above is based upon a 'faulty specification' of the screening model. In Psacharopoulos (1979), used as a reference for all the later P-test literature, the model tested is one in which firms pay irrationally higher starting salaries to the more educated workers in the absence of alternative information on applicants expected productive ability. The distinction drawn between the weak and strong versions of the model is based upon whether firms continue to pay wages above a worker's productivity even after the worker has been monitored for some time. In the weak version of the screening model it is expected that wages are adjusted downwards in line with observed productivity.

This theoretical framework is in conflict with the previous theoretical literature reviewed in Chapter 2. In the models of Arrow (1973) and Spence (1974), and indeed in the analysis which followed with the advent of game theory, wages paid to workers do not diverge from productivity. In Chapter 2 it was shown that an equilibrium exists in these models only if the expectations of the employer in regard to the education-productivity relationship are confirmed, and given the utility maximising behaviour which is assumed on the part of firms and workers, this only occurs when wages are set equal to productivity.

Firms will only continue to use education as a screen if it can be used to correctly predict the productivity of applicants, and if not, in the context of Spence (1974), corrections are assumed to have been already made in the 'informational feedback loop' so that wages are set equal to productivity in the long run. What Psacharopoulos (1979) appears to be suggesting by positing that firms make an 'initial hiring' mistake (by paying, on average, wages in excess of productivity to highly educated applicants) is that the firm is still within the feedback loop. In the long run, starting salaries rather than subsequent wages would be adjusted downwards as tenure increases once on the job monitoring has revealed any such mistakes.

Ziderman (1990) suggests that the erosion of returns to educational variables with age is an effect of older applicants rather than existing workers with higher tenure. He suggests that the observed erosion of returns with age is due to the accumulation of alternative information which can be used as a screen for productive ability; for example a curriculum vitae of employment history may replace the need to apply the education screen to older applicants.

6.3 Actual Results and Hypothesis 1

6.3.1 Mean Levels of Education and Percentages of Certificate Holders

To test Hypothesis 1 we can present a distribution of mean years of education by occupation and worker type, as shown in Table 6.1. In Tables 6.2 to 6.4 the notation is such that HIGHQ corresponds to having a degree, nursing qualification, teacher training, or another academic or vocational certificate of equivalent merit as the highest qualification held, MIDQ corresponds to having A-levels, HND, an apprenticeship or equivalent trade or business qualification as the highest held, LOWQ corresponds to having O-levels or CSE's as the highest qualifications held, and NOQ corresponds to having no formal educational certification.

According to Katz & Ziderman, if screening occurs we can expect employees with occupations classified at the top (bottom) of the occupational scale to invest in more (less) years of education than the self-employed in similarly ranked occupations. From Table 6.1 we can see that the results do not appear to support this hypothesis; the self-employed in high level jobs appear to invest in significantly more years of education than employees in high level jobs, and there is no significant difference by worker type in mean years of education for low level occupations.

Table 6.1: Distribution of Mean Years of Education by Occupation and Worker Type

	Employees			Self-employed			
Occupation Level	n	Mean years of education	Standard Deviation	n	Mean years of education	Standard Deviation	T-Statistic
High	1714	13.000	2.363	188	13.596	2.270	-3.296*
Middle	858	11.437	1.626	756	11.048	1.479	5.003*
Low	1863	10.790	1.050	12	11.000	1.279	-0.690
All Levels	4435	11.769	2.035	956	11.548	1.946	3.069*

Notes: Calculated from BSA sample; data omits the Armed Forces, * significant at the 5% level.

We can see from Table 6.2 and Table 6.3 that the percentage of both worker types holding high and middle level qualifications generally falls as occupational class decreases, and that percentage of both worker types holding low level qualifications or no qualifications generally rises as occupational class decreases; this pattern is consistent with both human capital and strong screening theory. In Katz & Ziderman's weak screening model we would expect that employees with occupations classified at the top (bottom) of Table 6.2 to hold a higher (lower) percentage of highly ranked qualifications in comparison to the self-employed percentages in the same row in Table 6.3.

Table 6.2: Distribution of Highest Certificate Type by Occupational Classification for Employees

Occupational Class	Percentage of Employees with HIGHQ	MIDQ	LOWQ	NOQ
High Level	33	46	13	8
Middle Level	7	44	22	27
Low Level	2	29	24	45
All Levels	15	39	19	27

Notes: Calculated from BSA Survey sample, data omits the Armed Forces.

Table 6.3: Distribution of Highest Certificate by Occupational Classification for the Self-employed

Occupational Class	Percentage of Self-employed with HIGHQ	MIDQ	LOWQ	NOQ
High Level	41	44	9	6
Middle Level	3	40	18	39
Low Level	0	25	42	33
All Levels	11	40	17	32

Notes: Calculated from BSA Survey sample, data omits the Armed Forces.

The results presented in Table 6.4, from testing the hypothesis that the sample proportions holding each type of certificate at each occupational level are equal, also do not appear give support to Katz & Ziderman's hypothesis.

Table 6.4: Test statistics of the difference between worker types in the proportion of highest certificate type held by occupational class

Occupation Level	Z - statistics for the difference between employees and self-employed in the proportion holding HIGHQ	MIDQ	LOWQ	NOQ
High	-4.722*	1.126	3.417*	2.111*
Middle	4.620*	2.264*	2.740*	-7.407*
Low	4.409*	2.491*	-11.345*	6.800*
All Levels	3.205*	-0.575	1.440	-3.127*

Notes: * significant at the 5% level in a two-tailed test; indicates that we cannot accept the null hypothesis that the proportions are equal for both worker types in the occupational class indicated.

The significant negative test statistic in the high level occupation / high level certificate cell of Table 6.4 indicates that a significantly lower proportion of employees in this occupational class have high level certification in comparison to the self-employed. In addition, the significant positive test statistic in the low level occupation / high level certificate cell of Table 6.4 indicates that a significantly higher proportion of employees in this occupational class have high level certification in comparison to the self-employed. These results are the opposite of those expected under Katz & Ziderman's reasoning about the weak screening hypothesis implying that we cannot reject the null hypothesis of Hypothesis 1.

However, patterns in the data such as those presented in Tables 6.1-6.4, which are based on sample mean or proportion values, may give misleading inferences about the effects of education upon wages, since we are not controlling for other factors when employing such hypotheses tests. To gain a more precise understanding of the differences in educational achievement between worker types and to test whether this can be explained by the weak screening model we must analyse the individual relationships between educational variables and wage rates more formally using regression analysis. The wage rate equations that are estimated use nominal hourly wage rates as the dependant variable, educational variables and experience as the main independent variables and controls made for regional influences, marital status, union status, ethnic origin, and yearly influences (see Chapter 5 for wage rate formulation and Appendix 4.1 of Chapter 4 for a description of variables).

6.3.2 Estimated Wage Rate Functions for Occupational Groups

As a starting point for the regression analysis of wage rate determination in occupational groups we estimate separate wage functions for male workers (pooling self-employed and employees). Table 6.5 shows the estimated wage rate functions for male full-timers where the sample is split into sub-samples depending on the workers' occupational classification.

The main variables of interest in these estimated wage rate functions; years in the labour force, the highest qualification dummy variables, and the variable representing private education; have coefficients which appear to change depending upon occupational class. From Table 6.5 we can see that the average rate of return to years in the labour force appears to be higher for workers in high level occupations in comparison to workers in middle and low level occupations i.e. it appears that general labour market experience has a larger effect on increasing wages in managerial and professional occupations.

The highest qualification held dummy variables above HND level show a general pattern of decreasing returns as occupational classification moves from the professional and managerial to the unskilled occupations, with the exception of the teaching qualification variable. HND's show an increase in returns between high and low level occupations, whereas trade/business, Apprenticeship, A-level and O-level qualifications show a decrease in returns between high and low level occupations. CSE's are insignificant in determining wage rates of male full-timers in all but low level occupations.

From Table 6.1 we can see that the self-employed and employees tend to be concentrated in different occupations, and therefore some of the patterns in returns to educational variables we see in Table 6.5 may be due to the effects of worker type on returns. For instance there are no self-employed routine office, sales, personal service or agricultural labourers, and very few private business workers or farmers are classed as employees.

If we could estimate separate wage rate functions for the self-employed and employees and by occupational group we would be able to test a hypothesis similar to that of Katz & Ziderman (1980) by looking for occupational variations in the returns to high and low level certification. However, given the distribution and relatively small size of the self-employed sample in this BSA Survey sample this was found to be impractical.

Table 6.5: Estimated Wage Rate Equations for Male Full-timers by Occupation Level

Occupation Level: Variable Name	High (N = 1910) Est. Coef.	High T - Ratio	Middle (N = 1633) Est. Coef.	Middle T - Ratio	Low (N = 1875) Est. Coef.	Low T - Ratio
YILF	0.032	8.074*	0.020	4.860*	0.024	8.014*
$YILF^2$	-0.53E-3	-6.555*	-0.44E-3	-5.834*	-0.47E-3	-8.334*
Degree	0.510	10.303*	0.270	3.076*	0.038	0.171
Nursing	0.312	2.865*	0.152	1.573	-0.043	-0.649
Teaching	0.315	4.325*	-0.134	-0.685	0.418	1.847**
Ac. / vocational	0.342	3.853*	-0.030	-0.268	0.076	0.826
HND	0.369	7.362*	0.278	4.355*	0.376	5.509*
Trade / business	0.401	7.994*	0.217	4.123*	0.142	2.261*
Apprenticeship	0.184	3.409*	0.208	5.659*	0.176	7.663*
A - Levels	0.236	4.518*	0.158	3.587*	0.217	6.125*
O - Levels	0.173	3.265*	0.176	4.478*	0.056	2.035*
CSE's	0.083	0.772	0.123	1.587	0.076	2.064*
Married	0.145	4.672*	0.215	5.337*	0.137	5.587*
Divorced/widowed	0.138	2.381*	0.192	2.794*	0.044	0.952
Private Education	0.029	0.993	0.076	2.002*	-0.008	-0.159
Self-employed	-0.178	-5.852*	-0.171	-5.247*	-0.092	-4.273*
Recent Unemp.	-0.082	-1.607	-0.265	-9.084*	-0.094	-0.430
East Anglia	-0.069	-1.505	-0.079	-1.270	-0.130	-2.910*
East Midlands	-0.165	-4.020*	-0.208	-3.429*	-0.034	-0.885
London	0.036	0.875	0.104	2.385*	0.176	4.524*
North East	-0.126	-2.512*	-0.226	-3.202*	-0.055	-1.290
N. Ireland	-0.136	-3.033*	-0.325	-5.395*	-0.257	-5.929*
North West	-0.198	-4.921*	-0.179	-3.423*	-0.132	-3.518*
South	-0.063	-1.603	-0.164	-3.149*	-0.099	-2.413*
South West	-0.158	-3.685*	-0.214	-4.371*	-0.120	-2.946*
Wales	-0.224	-3.621*	-0.275	-3.625*	-0.130	-2.859*
West Midlands	-0.163	-3.724*	-0.009	-0.173	-0.090	-2.337*
Yorks./Humber.	-0.218	-4.817*	-0.194	-3.618*	-0.042	-1.253
Union Member	0.039	1.932**	0.037	1.253	0.174	9.555*
African	-0.148	-0.979	-0.061	-0.558	-0.086	-1.046
Asian / Chinese	-0.107	-1.134	-0.298	-2.700*	-0.323	-2.952*
Unclassified R.O.	-0.050	-0.741	0.108	1.365	0.010	0.204
1985 Dummy	-0.564	-12.322*	-0.536	-9.699*	-0.483	-13.879*
1986 Dummy	-0.425	-11.943*	-0.309	-7.235*	-0.411	-13.084*
1987 Dummy	-0.350	-10.082*	-0.302	-6.559*	-0.361	-11.277*
1989 Dummy	-0.235	-3.738*	-0.060	-0.789	-0.186	-4.129*
1990 Dummy	-0.104	-3.096*	-0.051	-1.207	-0.062	-2.056*
Constant	1.432	15.956*	1.297	12.869*	1.122	16.804*
Adjusted R^2	0.313		0.253		0.340	
Variance of Estimate	0.192		0.262		0.136	
Mean ln w	1.841		1.398		1.275	

Notes: * significant at the 5% level, ** significant at the 10% level, Armed Forces workers are included. Standard errors are corrected using White's (1980) correction.

6.4 Actual Results and Hypotheses 2 and 4

Since Hypotheses 2 and 4 are both tested using mid- to early-career earnings ratios it is convenient to look at the results of testing these hypotheses before looking at the regression results used in testing Hypothesis 3. We will look at each sectoral comparison in the following order; Distribution versus Public Non-services, Self-employed versus Employees, Competitive versus Less Competitive Production Industries, and Private versus Public Sectors.

6.4.1 Distribution versus Public Non-services

Table 6.6 : Mid- to Early-career Earnings Ratios for Male Full-timers in the Distribution and Public Non-service Sectors by Years of Education

	Years of Education		
Sector	**11-12**	**13-14**	**15+**
Distribution (SIC 6)	1.925	2.082	1.869
Public Non-services	1.775	1.853	1.926

Notes: Calculated from BSA data, Mid- to Early-career corresponds to age groups 36-45 and 25 or less respectively.

Table 6.7 : Mid- to Early-career Earnings Ratios for Male Full-timers in the Distribution and Public Non-service Sectors by Certification*

	Highest Formal Qualification			
Sector	**None**	**O-level(s)**	**A-level(s)**	**Degree**
Distribution (SIC 6)	0.911	1.262	0.895	--
Public Non-services	0.928	1.053	1.454	0.901

Notes: * Equivalent certificates in each category are detailed in Chapter 4 Appendix 4.1.

Employing Psacharopoulos's choice of economic sector we have the public non-service sector representing the screened sector and distributive trades sector (SIC group 6) as the competitive unscreened sector. The mid- to early-earnings ratios shown in Table 6.6 have no pattern, being lower in the 11-12 and 13-14 categories and higher in the 15+ category for the public non-service sector in comparison to the distributive trades sector.[2] We cannot therefore reject the null hypothesis and no support for the screening hypothesis comes out of this comparison.

[2] The reported Mid- to Early-career earnings ratio is the ratio of the average real earnings of a 36-45 year old divided by the average real earnings of a 25 or less year old in the chosen sector.

Table 6.7 uses qualification categories; again we expect the public non-service sector to have higher mid- to early-earnings ratios than the distributive sector under the screening hypothesis. The mid- to early-earnings ratios are higher in the 'none' and 'A-levels' categories, but lower in the 'O-levels' category, for the public non-service sector in comparison to the distributive trades sector, and no ratio is available for distributive trade workers in the 'Degree' category. We cannot therefore fully reject the null hypothesis and only limited support for the screening hypothesis comes from this comparison.

6.4.2 Self-employed vs. Employees

The theory behind Hypothesis 2 suggests that mid- to early-earnings ratios should be higher in screened occupations as compared to unscreened occupations. Following the methodology of Cohn *et al* (1987) we take the self-employed as unscreened and employees as screened occupations, and we expect the employees sample to have higher mid- to early-earnings ratios than the self-employed under the screening hypothesis. We can see from Table 6.8 that this is indeed the case over all the education categories; this can be taken as evidence in support of the educational screening hypothesis.

Table 6.8 : Mid- to Early-career Earnings Ratios for Male Full-time Self-employed and Employees by Years of Education

	Years of Education		
Worker Type	**11-12**	**13-14**	**15+**
Self-employed	1.253	1.623	0.888
All Employees	1.850	2.056	1.721

Notes: Calculated from BSA data, Mid- to Early-career corresponds to age groups 36-45 and 25 or less respectively.

Table 6.9 : Mid- to Early-career Earnings Ratios for Male Full-time Self-employed and Employees by Certification

	Highest Formal Qualification			
Worker Type	**None**	**O-level(s)**	**A-level(s)**	**Degree**
Self-employed	0.825	0.822	1.097	1.038
All Employees	1.045	1.216	1.165	1.200

Notes: Calculated from BSA data, Mid- to Early-career corresponds to age groups 36-45 and 25 or less respectively.

Looking at qualifications rather than years of education and using the self-employed (unscreened occupations) and employees (screened occupations) comparison we expect the employees sample to have higher mid- to early-earnings ratios than the self-employed under the screening hypothesis. We can see from Table 6.9 that this is the case over all the qualification categories, and as such can be taken as evidence in support of a screening hypothesis where highest qualification held by an applicant is used as a screen for ability by prospective employers.

6.4.3 Competitive vs. Less Competitive UK Production Industries

We can disaggregate the production sector in the BSA Survey data into the four divisions in the Standard Industrial Classification (SIC) system. Tables 10 and 11 show the mid- to early-career earnings ratios corresponding to each of the 4 industrial sub-divisions at different education levels.

Table 6.10 : Mid to Early Career Earnings Ratios for Male Full-time Workers in Industries SIC 1-4 by Years of Education

Industry	Concentration Ratio (%)	Years of Education 11-12	13-14	15+
Energy & Water SIC 1	57.1	1.792	1.808	1.351
Extraction & Chemicals SIC 2	54.6	1.680	1.319	2.577
Other Manufacturing SIC 4	39.3	1.193	1.119	1.468
Metal goods & Engineering SIC 3	39.2	1.618	1.853	1.910

Notes: Earnings ratios calculated from BSA data; Mid- to Early-career corresponds to age groups 36-45 and 25 or less respectively.

In Table 6.10 the concentration ratio is an average figure for the 1985-1991 period showing the percentage of total gross output produced by the 5 largest employers in each part of the industry at the 3-digit SIC level aggregated to the 1-digit level as shown; calculated from Table 6.13 Report on the Census of Production Summary Volumes (HMSO). The production industries are arranged in ascending order of competition in both Tables 6.10 and 6.11, that is to say that the Energy & Water industry is less competitive, as shown by a higher concentration ratio, than the Metal goods industry.[3] We can see that the Metal goods and Other Manufacturing industries have very similar competition levels, as do Energy & Water and Extraction & Chemicals, over the period 1985-1991, and we could group them together as the more and less competitive sections of UK production industry.[4]

Looking at Table 6.10 in reference to Hypothesis 2 we can see that initially there appears to be higher ratios for the less competitive industries, however moving from the 11-12 to the 13-14 years of education category we see that Industry SIC 3 has the highest ratio. Furthermore, in the 15+ years of education category Industries 3 and 4 have earnings ratios larger in magnitude than that for Industry 1. Again these results are contrary to those expected under the strong screening hypothesis.

As regards Hypothesis 4, we expect mid- to early-career earnings ratios to fall as years of education increase under the strong screening hypothesis. Comparing the 11-12 to the 13-14 years of education category in Table 6.10 we can see that the earnings ratios for Industries 1 and 3 increase whereas the earnings ratios for Industries 2 and 4 decrease. Comparing the 11-12 to the 15+ years of education category we can see that the earnings ratio for Industry 1 has fallen, but that the ratios for the other three industries have risen. Thus, we cannot reject the null hypothesis i.e. there is no support for the strong screening hypothesis from this comparative analysis.

As regards Hypothesis 2, we can see from Table 6.11 that in the 'None' category the more competitive industries (SIC 3 and 4) have higher mid- to early-career earnings ratios than the less competitive industries (SIC 1 and 2). In the 'O-level(s)' category industry 4 has an earnings ratio exceeding that of less competitive sectors. In the 'A-level(s)' category Industry 1 has the highest earnings ratio but Industry 3 has a higher earnings ratio than Industry 2. In the

[3] There are some problems associated with using concentration ratios to measure the level of competition in an industry. For example, concentration ratios take no account of the existance of barriers to entry which will determine the level of contestability in the market by limiting potential competition [see Pollard (1989) for more details]. However, I take a pragmatic approach in that reliable alternatives to concentration ratios to measure competition levels are very difficult to find.

[4] Other Manufacturing SIC 4 covers such industries as food and drink production, textile and leather processors, clothing, tobacco, jewellery, musical instruments, toys, photo-labs and wooden manufactures.

'Degree' educational category results are not available for Industries 1 and 2, so the evidence is inconclusive.[5]

Table 6.11 : Mid to Early Career Earnings Ratios for Male Full-time Workers in Industries SIC 1-4 by Certification

	Highest Formal Qualification			
Industry	**None**	**O-level(s)**	**A-level(s)**	**Degree**
Energy & Water SIC 1	1.030	1.200	1.753	--
Extraction & Chemicals SIC 2	0.924	0.792	1.238	--
Other Manufacturing SIC 4	1.057	1.369	1.093	1.368
Metal Goods & Eng. SIC 3	1.153	1.083	1.341	0.985

Notes: Calculated from BSA data, '--' denotes where full observations were not available, Mid- to Early-career corresponds to age groups 36-45 and 25 or less respectively.

Looking at Table 6.11 in reference to Hypothesis 4 we find that a move from the 'None' to the 'O-level(s)' category results in a decrease in the size of mid- to early-career earnings ratios in industries 2 and 3, but an increase in size for Industries 1 and 4. A movement from 'None' to the 'A-level(s)' category of education gives a rise in earnings ratios for all industries, and a move from 'None' to the 'Degree' category of education gives a rise in Industry 4 and a fall in Industry 3. So again we cannot reject the null hypothesis; there is no support for the strong screening hypothesis.

6.4.4 Private vs. Public Sectors

As regards Hypothesis 2 we can see from Table 6.12 that the earnings ratios are higher for the private sector in comparison to the public sector. This is contrary to the expected result under screening that mid- to early-earnings ratios would be higher in the less competitive sector. If we disaggregate the public and private sectors we find that private non-manufacturing and public non-service sectors generally have higher ratios than the private manufacturing and public service sectors respectively; this is again contrary to Hypothesis 1.

[5] Note that under an efficiency wage model these results could be influenced by rent-sharing in the more concentrated industries.

Table 6.12 : Mid to Early Career Earnings Ratios for Male Full-time Workers in Private and Public Sectors by Years of Education

	Years of Education		
Sector	11-12	13-14	15+
Private Manufacturing	1.730	1.655	1.952
Private Non-manufacturing	2.092	2.341	1.809
Public Services	1.620	2.477	1.314
Public Non-services	1.775	1.853	1.926
Private Sector	1.901	2.126	1.849
Public Sector	1.708	1.873	1.811

Notes: Calculated from BSA data, Mid- to Early-career corresponds to age groups 36-45 and 25 or less respectively.

As regards Hypothesis 4 we can see from Table 6.12 that although mid- to early-career ratios generally increase as years of education increase from the 11-12 to the 13-14 years category, there is no discernible pattern when comparing the 11-12 to the 15+ category ratios. For example the private sector shows a decrease (1.90 falling to 1.85), whereas the public sector shows an increase (1.71 falling to 1.81) in ratios. Private non-manufacturing, public services and private sectors show decreasing mid- to early-career earnings ratios from the 11-12 to the 15+ category. Given these mixed results we cannot reject the null hypothesis.

Table 6.13 categorises mid- to early-career earnings ratios in terms of certification, where O-level(s), A-level(s) and Degree level certificates are the highest qualifications held by the worker in each sector.

Table 6.13 : Mid to Early Career Earnings Ratios for Male Full-time Workers in Private and Public Sectors by Certification

	Highest Formal Qualification			
Sector	None	O-level(s)	A-level(s)	Degree
Private Manufacturing	1.060	1.252	1.296	1.266
Private Non-manufacturing	1.091	1.319	0.873	1.355
Public Services	0.984	1.003	1.232	1.137
Public Non-services	0.928	1.053	1.454	0.901
Private Sector	1.069	1.284	1.109	1.315
Public Sector	0.950	1.016	1.293	1.119

Notes: Calculated from BSA data, Mid- to Early-career corresponds to age groups 36-45 and 25 or less respectively.

As regards Hypothesis 2 we can see from Table 6.13 that the earnings ratios are higher for the private sector relative to the public sector, with the exception of those holding A-levels. This is contrary to the expected result under screening that mid- to early-earnings ratios would be higher in the less competitive sector. As regards Hypothesis 4 we can see from Table 6.13 that mid- to early-career ratios generally *increase* as qualification held improves. Since most sectors show increasing ratios we reject the null hypothesis.

These results coincide with the findings of previous authors who use this methodology; Psacharopoulos (1979) for the UK, Lee (1980) for Malaysia, Cohn *et al* (1987) for the US, Lambropoulos (1992) for Greece, and Arabshiebani & Rees (1996) for the UK, who show that the private sector generally tends to display higher earnings ratios at each education level than the public sector.

6.5 Actual Results and Hypothesis 3

6.5.1 Introduction

Although there is little support for the screening hypothesis from the mean based comparisons we must remember that the earnings data can be influenced by many other factors in addition to education. Figure 6.2 shows a graph of real wages versus years in the labour force for male full-time workers by level of highest certification. We can see that, rather than the smooth lines of Figure 6.1, in reality we have varying wage differentials between education groups as years in the labour force increases, and this is largely due to variables which affect the wage rates of the BSA Survey respondents which are not accounted for in either Tables 6.6 to 6.13, or the Figure 6.1.

A clearer test of the screening hypothesis would be to conduct regression analysis which would account for most of the additional influences upon wage rates in the UK using data from the BSA Survey sample on such things as union status, residence, and marital status.

Figure 6.2 : Real Wage Rate-Experience Profiles for BSA Survey Workers

Notes: Average values for all workers calculated from BSA Survey Data 1985-1991

Accordingly, we test Hypothesis 3 using the results of wage rate regressions for specific economic sectors. The wage rate regressions are Mincer-type earnings functions as used in Section 6.3.2 and with a control made for occupational status. Regressions are conducted for full-time male workers in the appropriate sectors; the self-employed versus employees analysis is omitted as this methodology has been fully covered in Chapter 5. Such comparative sectoral tests have, in recent literature, been referred to as 'P-tests' after the original work by Psacharopoulos (1979).

As in Chapter 5, it was found that, once additional explanatory variables were included in the estimated sectoral wage rate equations in Heckit models, the inverse Mills ratios included to control for sample-selection bias became insignificant (see Chapter 5 for details of the Heckit model). Since we want to include the additional variables to control for regional, racial, marital and occupational effects in wage equations in this Section, the Heckit model is dropped in favour of wage rate equations estimated using one stage log-linear OLS regressions. For details of a P-test between the private and public sectors in this BSA Survey sample which uses the Heckit model with simple Mincerian functions and rejects the strong screening hypothesis, see Haynes & Sessions (1996).

We will look at each sectoral comparison in the following order; Distribution versus Public Non-services, Private versus Public Sector, and Competitive versus Less Competitive Production Industries.

6.5.2 Distribution vs. Public Non-services

First, consider the original P-test of Psacharopoulos (1979), in which we have the public non-service sector representing the screened sector and distributive trades sector (SIC 6) as the competitive unscreened sector. Table 6.14 presents the estimated wage rate equations for male full-time workers in both these sectors.

There are several points of interest in Table 6.14. Six of the regional dummy variables are significant in determining the wage rates of distribution workers compared to three in the public non-service sector. This may reflect the fact that wage rates in the distribution sector are affected more by regional labour market pressures than wage rates in the public non-service sector, which tend to be set in relation to more national labour market trends. In the public sector London residents are paid significantly more than other South East residents, and West counties and Northern Ireland residents significantly less than South East residents.

Union membership increases wage rates by approximately 13% in the public non-services sector, but is insignificant in the wage rate equation for workers in the distribution sector. There also appears to be differences in the effect of occupational classification between sectors; for example high level occupations get 28% compared to 19% higher wage rates, *ceteris paribus*, than middle level occupations in the distribution sector and public non-services sector respectively.

Both Asian, Chinese or African racial origin have a significantly negative impact upon wage rates in the distribution sector, whereas none of the racial background dummy variables has a significant negative effect in the public sector.

The positive effect of years of experience in the labour force and the negative effect of having been unemployed in the previous five years are each comparable across sectors. Each additional year of experience gives approximately 3% higher wages and being unemployed in the last five years gives approximately 16-19% lower wages.

To investigate the hypothesis that the education-wage relationship is stronger in the public non-service sector (the screened sector) in comparison to the distribution sector (the unscreened sector) we will look at the significance and magnitude of the coefficients on the highest qualification dummies in each sector.

Table 6.14: Estimated Wage Rate Equations for Male Full-timers in the Distribution and Public Non-service Sectors

Sector:	Distribution (N=771)		Public Non-services (N=357)	
Variable Name	Estimated Coefficient	T-Ratio	Estimated Coefficient	T-Ratio
Years in labour Force	0.029	4.746*	0.024	3.459*
$YILF^2$	-0.594E-3	-5.347*	-0.480E-3	-3.689*
High Qualifications	0.228	2.448*	0.382	4.147*
Middle Qualifications	0.182	3.524*	0.180	3.806*
Low Qualifications	0.047	0.820	0.033	0.537
Married	0.131	2.257*	0.075	1.190
Divorced/widowed	0.056	0.489	-0.032	-0.335
Private Education	0.118	1.881**	0.102	1.133
Recently Unemployed	-0.155	-3.175*	-0.190	-2.852*
East Anglia	-0.101	-0.853	-0.032	-0.265
East Midlands	-0.112	-1.278	-0.018	-0.221
London	0.203	2.551*	0.214	2.129*
North East	-0.189	-1.816**	0.026	0.318
N. Ireland	-0.105	-1.207	-0.160	-1.581
North West	-0.202	-2.547*	-0.110	-1.293
South	-0.114	-1.375	-0.063	-0.743
South West	-0.222	-2.752*	-0.186	-1.987*
Wales	-0.323	-2.809*	-0.185	-1.792**
West Midlands	-0.125	-1.408	-0.046	-0.556
Yorkshire & Humb.	-0.271	-3.115*	-0.066	-0.874
Union Member	0.074	1.317	0.130	1.977*
Low Occupation	-0.099	-2.001*	-0.196	-3.992*
High Occupation	0.278	5.604*	0.192	3.164*
African	-0.507	-2.409*	-0.188	-1.222
Asian / Chinese	-0.707	-4.202*	-0.145	-0.656
Unclassified R.O.	-0.103	-0.825	0.028	0.230
1985	-0.545	-6.600*	-0.378	-4.698*
1986	-0.370	-5.126*	-0.328	-4.366*
1987	-0.298	-4.243*	-0.258	-3.208*
1989	-0.274	-2.443*	-0.100	-0.846
1990	-0.084	-1.265	-0.813E-2	-0.104
Constant	1.281	8.193*	1.324	7.873*
Adjusted R^2	0.298		0.460	
Variance of Estimate	0.291		0.112	
Mean ln *w*	1.308		1.531	

Notes: * Significant at 5% level or better, ** Significant at 10% level.

From Table 6.14 we can see that high and middle level qualifications show significant positive returns in the estimated wage rate functions for both the sectors, and that low level qualifications are not significant in the wage rate functions. The returns to high level qualifications appear to be higher in the public non-service sector, and the returns to middle level qualifications appear to be equal to approximately 18% in both sectors. The positive returns to education in both sectors leads to a rejection of the strong screening hypothesis unless we look on distribution as being the relatively *less*-screened sector instead of the *un*screened sector when comparing it to the public non-service sector.

Psacharopoulos' hypothesis says nothing about the distinction between specific and general skills derived from different certificate courses, since under the strong screening hypothesis the human capital value (general plus specific investment) of education is zero in both sectors. If we assume that the human capital value of certification courses is equal, but not zero, across sectors then we could say that the differential in returns to high level certification shown in Table 6.14 supports the weak screening model; if that differential were significant.

However, in a Chow test the calculated F-statistic was approximately 1.176 and shows that the estimated coefficients in the wage rate functions of the distribution and public non-service sectors are significantly different from one another only at the 25% significance level (see Appendix for further details). Given the small significance of the F-statistic an alternative test of wage rate equation separation was used; the Gujarati (1970) dummy variable test; this showed that there were no significant interactions between any of the educational variables and sector. Thus we must conclude, on the basis of this methodology and the two separation tests, that there is no evidence in support of the strong or weak screening hypotheses and that we cannot reject the null hypothesis of Hypothesis 3.

6.5.3 Private vs. Public Sectors

Table 6.15 shows the results of estimating wage rate equations for male full-time workers in the private and public sectors. For the private sector we can see that all eleven regional dummy variables have significant negative coefficients, with the exception of London residence, showing lower wage rates in comparison to the South East for private sector workers. London residents working in the private sector have wage rates approximately 13% higher than the remaining areas of the South East. In comparison only four of the eleven regional dummy variables are significant in determining the wage rates of male workers in the public sector of the economy; London residence increases wage rates by approximately 12% and South West, Welsh or Northern Ireland residence decreases wage rates by approximately 9-11%, in comparison to South East residents. This is to be expected if private sector wage rates are determined by regional labour market pressures, and the public sector wage rates are determined more by the state of the national labour market. The effect of unionisation is also lower in the public sector in comparison to the private sector; approximately a 5% compared to a 14% increase in wage rates through union or staff association membership in the public and private sector respectively.

The wage-experience profiles allowing for the additional influences upon wage rates in the regressions, as represented by the similar coefficients on years in the labour force and its square in Table 6.15, have the same shape and vertical intercept for both sectors. Having been unemployed in the previous five years has more of a negative effect on the determination of wage rates in the public sector in comparison to the private sector; approximately a 22% compared to a 14% decrease in wage rates through recent unemployment in the public and private sector respectively.

To test Hypothesis 3 we must consider screening by highest qualification held and look for differences in the returns to the highest qualification held dummy variables between sectors. Under Hypothesis 3 we would expect under that returns to education would be higher in the public sector.

Table 6.15 : Estimated Wage Rate Equations for Male Full-timers in the Private and Public Sectors

Sector:	Private (N=3353)		Public (N=1303)	
Variable Name	**Estimated Coefficient**	**T-Ratio**	**Estimated Coefficient**	**T-Ratio**
Years in labour Force	0.027	10.174*	0.027	7.412*
$YILF^2$	-0.495E-3	-10.149*	-0.498E-3	-7.237*
High Qualifications	0.359	10.882*	0.319	8.375*
Middle Qualifications	0.198	9.635*	0.223	7.423*
Low Qualifications	0.119	4.956*	0.124	3.468*
Married	0.188	7.733*	0.077	2.461*
Divorced/widowed	0.119	2.803*	0.032	0.575
Private Education	0.046	1.804**	0.038	1.173
Recently Unemployed	-0.138	-7.230*	-0.222	-6.806*
East Anglia	-0.113	-2.737*	-0.061	-0.965
East Midlands	-0.175	-5.019*	0.375E-2	0.082
London	0.128	4.174*	0.123	2.897*
North East	-0.135	-3.387*	0.402E-3	0.801E-2
N. Ireland	-0.246	-6.577*	-0.090	-2.001*
North West	-0.195	-6.525*	-0.053	-1.240
South	-0.098	-2.908*	-0.025	-0.603
South West	-0.173	-5.315*	-0.111	-2.549*
Wales	-0.214	-5.001*	-0.091	-1.696**
West Midlands	-0.115	-3.696*	-0.053	-1.135
Yorkshire & Humb.	-0.163	-5.224*	-0.047	-1.098
Union Member	0.143	8.466*	0.049	1.922**
Low Occupation	-0.093	-4.545*	-0.162	-5.681*
High Occupation	0.252	11.781*	0.238	8.322*
African	-0.150	-1.674**	-0.134	-1.240
Asian / Chinese	-0.314	-4.160*	-0.143	-1.402
Unclassified R.O.	-0.016	-0.272	-0.038	-0.613
1985	-0.587	-18.927*	-0.467	-11.532*
1986	-0.406	-14.990*	-0.390	-10.807*
1987	-0.376	-13.612*	-0.338	-9.143*
1989	-0.200	-3.747*	-0.233	-4.121*
1990	-0.086	-3.159*	-0.064	-1.806*
Constant	1.251	18.269*	1.328	16.268*
Adjusted R^2	0.403		0.501	
Variance of Estimate	0.196		0.127	
Mean ln w	1.471		1.614	

Notes: * Significant at 5% level or better, ** Significant at 10% level.

From Table ~~6.~~15 we can see that the estimated coefficients on the high qualification held dummy variable is lower in the public sector (judged to be the screened sector) than in the private sector (judged to be the less screened sector), whereas the estimated coefficients on the middle and low qualification dummy variables are marginally higher in the public sector compared to the private sector.

A Chow Test gives a calculated F-statistic of 1.573 shows that the estimated coefficients in the two wage rate functions of the public and private sectors are significantly different from one another at the 5% level (see Appendix for further details). However, a Gujarati (1970) dummy variable test indicates that the sectoral differences in wage determination lie in differences in the returns to union membership, occupation level, recent unemployment, marital status and region, and not in the returns to education. As in Section 6.5.2 we have no support, from this methodology and the separation tests, for the strong screening hypothesis.

6.5.4 Low vs. High Competition UK Production Industries

We can now consider Hypothesis 3 in reference to the UK production industry for which concentration level data is available. To give larger sample size the four disaggregated production industries (SIC 1-4) have been grouped according to competition level into two pooled samples. The results of estimating Mincerian wage rate functions for these two samples are shown in Table 6.16; where 'Low' and 'High' competition refers to high and low average concentration ratios respectively (reported in Table 6.10). Energy & Water Production and Extraction & Chemical Production are classed as low competition industries, and Metal goods, Engineering and Other Manufacturing as high competition industries.

From Table 6.16 we can see that male full-time workers earn a higher wage in the low-competition industries and that there are marked differences in the estimated earnings equations for the low and high competition industries. Nine of the eleven regional dummy variables are significant in determining the wage rates of full time male workers in the high-competition industries compared to only three significant regional dummy variables for the low-competition industries. This result supports the view that wage rates in the low competition industries are determined more bureaucratically and affected less by regional labour market pressures than wage rates in the high competition industries.

Similarities are apparent in the return to recent unemployment and unionisation; recent unemployment decreases wage rates by approximately 14-

15% and union membership boosts wage rates by approximately 10-11%. The returns to years in the labour force and its square are also comparable between industry groups. However, low occupational class reduces wage rates by approximately 7% in the low competition industries compared to 12% in the high competition industries. High occupational class raises wage rates by approximately 21% in the low competition industries compared to 17% in the high competition industries.

From Hypothesis 3 we expect strong screening to be more apparent in low-competition sectors and under this hypothesis that there are higher returns to the highest qualification held in these sectors compared to high-competition sectors. However, what is immediately apparent from Table 6.16 is that no such inverse relationship exists between competition level and rates of return to educational variables. Indeed, the converse appears to be true; that is the more competitive a sector the higher the returns to education. All three certification dummies in the estimated wage rate function for the high-competition sample have estimated coefficients which are statistically significant, compared to only the variables representing high and middle level certification for the low-competition sample, even though this sample appears to fit the model better than the high-competition sample (as shown by adjusted R-squared). The hypothesis that there are higher returns to certificates in the low-competition sector is rejected.

A Chow test gives a calculated F-statistic of approximately 1.248 shows that the two wage rate functions of the low- and high-competition sectors are significantly different from one another, only at the 25% significance level (see Appendix for further details). A Gujarati (1970) dummy variable test reveals that significant sectoral differences lie in the returns to private education, low level qualifications, and the majority of regional dummy variables.

It is interesting to note that the estimated coefficient on the variable representing private schooling at junior or secondary level is significant in the wage rate function for the low competition sector in comparison to an insignificant estimated coefficient in the high competition sector. Although we have rejected the hypothesis that more educational screening occurs in the low competition sector compared to the high competition sector, the result of differing returns to private schooling may support the idea of screening by educational quality in the low competition sector.

Table 6.16 : Estimated Wage Rate Equations for Male Full-timers in the Low Competition Industries SIC 1+2 and High Competition Industries SIC 3+4

Competition Level:	Low (N=442)		High (N=1292)	
Variable Name	Estimated Coefficient	T-Ratio	Estimated Coefficient	T-Ratio
Years in labour Force	0.023	3.543*	0.023	6.029*
YILF^2	-0.363E-3	-2.964*	-0.433E-3	-6.036*
High Qualifications	0.391	5.105*	0.457	9.504*
Middle Qualifications	0.149	3.133*	0.234	8.606*
Low Qualifications	0.066	1.115	0.177	5.355*
Married	0.108	1.920**	0.149	4.314*
Divorced/widowed	0.069	0.763	0.089	1.572
Private Education	0.153	2.156*	0.181E-2	0.045
Recently Unemployed	-0.138	-2.639*	-0.152	-5.652*
East Anglia	0.129	1.161*	-0.083	-1.420
East Midlands	-0.075	-0.870	-0.154	-3.510*
London	0.128	1.308	0.107	2.164*
North East	0.049	0.655	-0.090	-1.464
N. Ireland	-0.085	-0.843	-0.206	-4.224*
North West	0.129E-3	0.162E-2	-0.168	-4.382*
South	0.134	1.650**	-0.112	-2.075*
South West	0.087	0.893	-0.156	-3.432*
Wales	-0.233E-2	-0.027	-0.272	-4.689*
West Midlands	-0.139	-1.753**	-0.108	-2.801*
Yorkshire & Humb.	0.061	0.898	-0.116	-2.696*
Union Member	0.104	2.568*	0.113	4.988*
Low Occupation	-0.067	-1.308	-0.121	-4.065*
High Occupation	0.206	3.810*	0.170	5.203*
African	-0.036	-0.131	-0.103	-0.775
Asian / Chinese	-0.646	-1.602	-0.195	-1.954**
Unclassified R.O.	-0.208	-1.309	0.026	0.337
1985 Dummy	-0.512	-7.431*	-0.455	-10.622*
1986 Dummy	-0.484	-7.936*	-0.343	-9.705*
1987 Dummy	-0.346	-5.174*	-0.306	-8.067*
1989 Dummy	-0.473	-3.042*	-0.195	-2.668*
1990 Dummy	-0.187	-2.877*	-0.092	-2.580*
Constant	1.528	7.943*	1.286	13.652*
Adjusted R^2	0.442		0.406	
Variance of Estimate	0.128		0.140	
Mean ln w	1.584		1.509	

Notes: SIC 1 corresponds to Energy & Water, SIC 2 corresponds to Extraction & Chemicals, SIC 3 corresponds to Metal Goods, and SIC 4 corresponds to Other Manufacturing.
* Significant at 5% level or better, ** Significant at 10% level.

6.6 Actual Results and Hypothesis 5

Table 6.17 shows the results from estimating Mincerian wage rate functions for full-time male employees. The sub-sample of employees from the BSA Survey data is split into three groups; columns 2 and 3 show results for those employees with 10 or less years of experience in the labour force, columns 4 and 5 show results for those with 20 to 30 years, and columns 6 and 7 show results for those with 40 to 50 years experience.

Before considering the results presented in Table 6.17 we must first note that the wage rate equation becomes increasingly inaccurate in explaining wage rates earned by employees as years in the labour force increases. This can be seen from the declining R-squared values and increasing variance of estimate values for both worker types as we move from the early- to the late-career groups. Earnings functions such as this are traditionally applied to young cohorts, and although the equations estimated contain additional explanatory variables, they fail to capture all influences upon earnings as age increases. Since the late-career group observations are very 'noisy', in the sense that variables not included in the wage rate equation begin to exert more and more of an influence on wage rates, and the estimated equation becomes increasingly inaccurate in explaining variation in wage rates, we must be careful in drawing conclusions based on early- to late-career comparisons.

Secondly, we must note that years in the labour force, or age, has been used in this Chapter as a proxy variable for tenure. We would expect that there is a general positive correlation between tenure and years in the labour force or age. However, it would be unwise to ignore the fact that some individuals in each career group, as defined by years in the labour force or age, may just be starting new occupations. Beyond the first year of experience, those just starting new jobs in each tenure category would on average have lower wage rates, *ceteris paribus*, than those properly categorised. Since the proxy would become less inaccurate as age increased, because the number of individuals changing jobs is assumed to decrease as years in the labour force increases, we would expect that the returns to education would become less underestimated (closer to the true value) as tenure increased.

From Table 6.17 we can see that the impact upon wage rates of marital status, that is the positive effect of being married, increases as years in the labour force increases; approximately 6% in the early career stage compared to approximately 14% by the mid- and the late-career stage. Being divorced or widowed apparently only has a significant positive effect on wage rates for the early-career group, increasing wage rates by approximately 26%.

Regional influences, in comparison to living in the South East, generally decline in the size of their effects upon wage rates as years in the labour force increases, with eight out of the eleven regional dummies becoming insignificant in determining wage rates by the late career stage.

The effect of union or staff-association membership upon the wage rates of male employees is significantly positive and not uniform over the three career-stage groups; the effect of union membership is to raise wage rates by approximately 14% in the early and late career stages, but only by approximately 8% in the middle career stage. Low occupational class has a significant negative impact on wage rates which is approximately uniform over the career stage groups. High occupational class gives no premium over jobs classified as middle level occupations for those employees at an early stage in their careers, then a 25% premium in the middle of their careers and 20% in the latter stages of their careers.

The racial origin dummy variables representing African and Asian or Chinese racial origin are significant in determining the wage rates of young male employees; wage rates are reduced by approximately 27% for African origin and approximately 33% for Asian or Chinese origin compared to the wage rates of Whites / Europeans in the early-career group. The effect of racial origin is insignificant in later career stages, with the exception of Asian or Chinese origin in the late career stage reducing wage rates by approximately 23%.

We assume that the return to education as a human capital investment is constant as tenure increases i.e. any further human capital return is from labour market experience (general human capital investment) or on-the-job training (specific human capital investments); this is a basic premise in Mincer (1974).[6] Thus, under Psacharopoulos's weak screening hypothesis, we can expect that the average wage effect of education decreases as tenure increases, since education's informational component does not hold its value (i.e. earning differential compared to a person with no formal qualifications) as tenure increases and alternative information becomes available to employers.

Table 6.17 : Estimated Wage Rate Equations for Male Employees by Career Stage

Career Stage:	Early (N=1065)		Middle (N=1172)		Late (N=484)	
Variable Name	**Est. Coef.**	**T - Ratio**	**Est. Coef.**	**T - Ratio**	**Est. Coef.**	**T - Ratio**
YILF	0.158	7.760*	0.074	1.107	0.191	1.0032
$YILF^2$	-0.876E-2	-5.070*	-0.160E-2	-1.197	-0.215E-2	-1.0038
Yrs. Education	0.079	10.314*	0.046	6.402*	0.079	4.771*
Married	0.063	2.192*	0.138	2.883*	0.137	1.809**
Div./widowed	0.255	2.742*	-0.986E-2	-0.143	-0.028	-0.288
Recent Unemp.	-0.072	-2.887*	-0.190	-5.553*	-0.162	-3.316*
East Anglia	-0.116	-1.690*	-0.180	-2.905*	-0.040	-0.403
East Midlands	-0.112	-2.163*	-0.198	-3.501*	-0.013	-0.185
London	0.111	2.489*	-0.549E-2	-0.105	0.123	1.678**
North East	-0.133	-2.174*	-0.066	-1.143	-0.020	-0.260
N. Ireland	-0.327	-6.018*	-0.227	-4.387*	-0.973E-2	-0.112
North West	-0.185	-4.087*	-0.125	-2.636*	-0.128	-1.740**
South	-0.174	-3.575*	-0.035	-0.694	-0.095	-1.107
South West	-0.161	-3.035*	-0.162	-3.262*	-0.101	-1.423
Wales	-0.159	-2.441*	-0.164	-2.325*	-0.251	-2.021*
West Midlands	-0.180	-3.672*	-0.149	-3.169*	-0.065	-0.805
Yorks./Hum.	-0.124	-2.589*	-0.138	-2.852*	-0.092	-1.163
Union Member	0.136	5.506*	0.077	3.158*	0.144	3.715*
Low Occ.	-0.150	-4.780*	-0.165	-4.707*	-0.173	-3.857*
High Occ.	0.057	1.579	0.252	7.159*	0.199	3.455*
African	-0.269	-1.995*	-0.280	-1.554	-0.091	-0.461
Asian/Chinese	-0.355	-3.460*	-0.165	-1.470	-0.228	-1.664**
Unc. R. O.	-0.710E-2	-0.094	0.032	0.410	-0.134	-1.185
1985	-0.577	-12.555*	-0.498	-10.271*	-0.360	-4.894*
1986	-0.500	-12.239*	-0.427	-10.321*	-0.394	-5.824*
1987	-0.433	-10.421*	-0.364	-8.512*	-0.278	-4.076*
1989	-0.230	-3.299*	-0.207	-2.860*	-0.291	-2.840*
1990	-0.085	-2.162*	-0.113	-2.909*	-0.066	-0.996
Constant	-0.198	-1.190	0.250	0.295	-3.756	-0.887
Adjusted R^2	0.521		0.394		0.346	
Variance of Est.	0.138		0.159		0.164	
Mean ln w	1.315		1.696		1.459	

Notes: * Significant at 5% level, ** Significant at 10% level, Early, Mid- and Late-career refer to 10 or less, 20-30, and 40-50 years in the labour force respectively.

[6] We also therefore assume that the respondent has not returned to formal schooling at any point in their working life.

From Table 6.17, we can see that the estimated average wage increase for each year of education falls from approximately 8% to approximately 5% then rises back to approximately 8% over the three career stages. In terms of years of education there is little evidence to allow us to reject the null hypothesis of Hypothesis 5.[7] There is little support for Psacharopoulos's weak version of the screening hypothesis from the results of this methodology; following Tucker (1986) we would not expect sustained or increasing returns to years of education as years in the labour force, the proxy for tenure, increases.

The reported mean log-wages in Table 6.17 are consistent with the inverted U-shape of the experience earnings profile in the human capital model, and the Life-cycle Income Hypothesis. Having been unemployed in the previous five years before the year of response has a significant negative effect on wage rates throughout the career stage groups. The negative impact of recent unemployment increases in magnitude as age increases; the estimated coefficient is approximately minus 7% in the early-career stage, approximately quadrupling in magnitude to minus 19% and minus 16% in the mid- and late-career stages.

From the estimated coefficients on the years in the labour force and years in the labour force squared variables in Table 6.17 we can see that only the early-career stage group has a significant positive returns to years of accumulated general labour market experience.[8]

The mid-career stage group shows no returns from increasing years in the labour force within the bounds of the groupings beyond approximately 20 years. The lack of significance of the estimated coefficient on years in the labour force suggests that labour market experience of 21-30 years does not, *ceteris paribus*, increase the wage rate above the level that someone with 20 years of experience would be paid. Similarly, for the late-career stage it appears that experience of

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[7] This result also holds when certification dummies were used instead of years of education, and the returns to private education were in all career stage groups were found to be insignificant.

[8] Note that no control is made within the regressions for unemployment incidence which occurred 6 or more years before the response year, thus the return to years in the labour force may be biased downwards by the recent unemployment dummy variable only partially controlling for unemployment.

41-50 years has no significance return in comparison to the wage rate earned by a man with 40 years of experience.[9]

6.7 Actual Results and Hypothesis 6

Following Psacharopoulos (1979), and Tucker (1986), the strong screening hypothesis is supported if the tenure-earnings profiles for degree holders and school-leavers do not diverge over time. School-leavers in this Section are assumed to be those BSA Survey respondents possessing CSE's, O-levels or A-Levels as the highest qualifications held. A divergent tenure-earnings profile is a rejection of the strong screening hypothesis because it is indicative of employers paying relatively higher wages to the more educated and productive group beyond the initial hiring point.

Table 6.18 shows the estimated wage-rate functions for the two groups in Psacharopoulos' (1979) model (see Figure 6.1 in Section 6.2.4); school-leavers and degree holders, in the private sector. Again we use years in the labour force as a proxy for tenure with the employer, and we can see from Table 6.18 that this variable has a significant positive effect on the size of the wage rates of both education groups. Note that the size and significance of the estimated coefficient on years in the labour force is greater for school-leavers than for university graduates, and that the *t*-ratio associated with the estimated coefficient on the square of years in the labour force is not significant for those with degrees, but is significant for the school-leavers group. Using this methodology, this result would appear to support the strong screening hypothesis in the case of private sector employees.

In the work of Psacharopoulos (1979), Lee (1980) and Liu & Wong (1982) it is assumed that wages in the labour market for private sector employees are determined competitively, and that wages in the public sector are determined less competitively and are more likely to be based upon educational signals. Under

[9] Using dummy variables to represent each year of experience within the bounds of each career grouping confirms the result that the rate of return to years of experience beyond 21 years is insignificant; the marginal rate of return to years in the labour force increases then falls to zero as years in the labour force approaches 21.

this assumption, finding non-divergent wage rate profiles appears to be a strong result.

Table 6.18: Estimated Mincer-type Functions for School-leavers and University Graduates who are Private Sector Employees

Education Level:	School Leavers (N=1023)		University Graduates (N = 249)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Years in Labour Force	0.044	8.785*	0.025	2.875*
YILF^2	-0.817E-3	-8.018*	-0.315E-3	-1.440
Years of Education	0.033	2.306*	0.041	2.078*
Married	0.135	3.408*	0.104	1.718**
Divorced/widowed	0.094	1.078	0.378	2.894*
Private Education	0.046	0.990	0.018	0.331
Recently Unemployed	-0.068	-2.136*	-0.142	-2.406*
East Anglia	-0.169	-2.325*	-0.144	-0.931
East Midlands	-0.084	-1.297	-0.350	-2.730*
London	0.028	0.542	-0.070	-1.047
North East	-0.180	-2.612*	-0.227	-1.605
N. Ireland	-0.306	-5.601*	-0.220	-1.856**
North West	-0.229	-4.494*	-0.266	-2.522*
South	-0.131	-2.295*	-0.183	-2.346*
South West	-0.148	-2.596*	-0.338	-1.843**
Wales	-0.116	-1.561	-0.470	-2.888*
West Midlands	-0.154	-3.035*	-0.087	-1.117
Yorks. & Humberside	-0.149	-2.672*	-0.337	-3.894*
Union Member	0.126	4.320*	-0.065	-0.976
Low Occupation	-0.199	-5.535*	-0.568	-1.796**
High Occupation	0.108	2.837*	0.147	2.006*
1985	-0.549	-10.066*	-0.554	-5.553*
1986	-0.419	-9.091*	-0.436	-5.150*
1987	-0.367	-7.731*	-0.389	-4.701*
1989	-0.146	-3.350*	-0.204	-2.947*
1990	-0.033	-0.702	-0.039	-0.550
Constant	0.812	3.282*	1.096	2.527*
Adjusted R^2	0.447		0.396	
Variance of Estimate	0.176		0.141	
Mean ln w	1.432		1.981	

Notes: * Significant at 5% level, ** Significant at 10% level, Graduates regression uses White's (1980) correction.

However, based on the evidence shown in Section 6.5.3, the assumption that less screening occurs in the private sector is rejected. Moreover, the strong screening hypothesis is actually rejected even if we put the evidence of Section 6.5.3 aside, since running a Gujarati (1970) dummy variable test reveals that the only significant differences between degree holders and school-leavers in this sector lie in the returns to union membership, occupation level and marital status, and not in the returns to years of experience.

Table 6.19: Estimated Mincer-type Functions for School-leavers and University Graduates who are Public Sector Employees

Education Level:	School Leavers (N=330)		University Graduates (N = 243)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Years in Labour Force	0.016	1.984*	0.045	4.235*
YILF²	-0.237E-3	-1.413	-0.780E-3	-3.391*
Years of Education	0.028	1.284	0.024	1.462
Married	0.093	1.459	0.055	0.794
Divorced/widowed	0.120	1.108	0.229	1.526
Private Education	-0.096	-1.281	0.037	0.647
Recently Unemployed	-0.202	-3.311*	-0.201	-2.286*
East Anglia	-0.057	-0.461	-0.162	-1.037
East Midlands	-0.010	-0.108	0.018	0.146
London	0.183	2.135*	-0.486E-2	-0.055
North East	-0.479E-2	-0.049	-0.109	-0.709
N. Ireland	-0.135	-1.628	-0.081	-0.882
North West	-0.077	-0.891	-0.063	-0.671
South	-0.423E-3	-0.481E-2	-0.028	-0.328
South West	-0.066	-0.715	-0.139	-1.389
Wales	-0.075	-0.640	-0.011	-0.093
West Midlands	-0.049	-0.520	-0.335	-3.080*
Yorks. & Humberside	-0.095	-1.118	-0.101	-1.053
Union Member	0.084	1.557	-0.020	-0.364
Low Occupation	-0.135	-2.513*	-0.211	-0.725
High Occupation	0.219	4.185*	0.230	2.027*
1985	-0.571	-6.645*	-0.597	-6.237*
1986	-0.456	-6.045*	-0.520	-6.617*
1987	-0.320	-4.219*	-0.497	-6.477*
1989	-0.222	-3.284*	-0.241	-2.965*
1990	-0.145	-1.884**	-0.151	-1.887**
Constant	1.053	2.677*	1.129	3.057*
Adjusted R^2	0.405		0.412	
Variance of Estimate	0.135		0.117	
Mean ln *w*	1.530		1.961	

Notes: * Significant at 5% level or better, ** Significant at the 10% level.

This analysis is repeated for the public sector, and again the strong version of the screening hypothesis is rejected. Table 6.19 shows the estimated wage-rate functions for school-leavers and degree holders employed in the public sector. Years in the labour force again has a significant and positive coefficient in the wage rate equations for both education groups. In this case note that the size and significance of the estimated coefficient on years in the labour force is greater for university graduates than for school-leavers, and that the *t*-statistic associated with the estimated coefficient on the square of years in the labour force is not significant for the school-leavers group, in comparison to university graduates where it is significant at the 5% level. Thus public sector employees with higher levels of education earn relatively higher earnings even after their employers have had time to observe productivity on the job.

A Gujarati (1970) dummy variable test reveals that there are significant differences between school-leavers and degree holders, who are working in the public sector, in the estimated returns to years in the labour force and its square. This result leads to the rejection of the strong screening hypothesis for public sector employees.

6.8 Conclusion

In this Chapter a number of methodologies were used to test the strong and weak versions of screening hypothesis in relation to the BSA Survey data set. The results of testing these methodologies generally lend no support to the strong or weak version of the screening hypothesis and therefore support human capital theory. Assumptions made in previous P-tests were refuted by the results in this Chapter.

The results of testing the weak screening model as interpreted by Katz & Ziderman (1980) were found to give no support to this model based on an analysis of education levels by occupation level and worker type; however it was found that the self-employed tended to be concentrated in certain occupations and that this may bias results.

There is also little support for the screening hypothesis from applying the P-test methodology of making sectoral comparisons of mid- to early-career earnings ratios and estimated wage rate equations. These methodologies were previously used by, amongst others, Psacharopoulos (1979), Cohn *et al* (1987) and Lee (1980) and the authors generally rejected the strong version of the screening hypothesis.

Testing the strong and weak versions of the screening hypothesis using the methodologies of Tucker (1986) gives results rejecting both versions of the screening model and supporting the human capital model of the role of education.

Ziderman's (1990) critique of the first part of the P-test methodology has been noted in Section 6.2.7. The sectoral wage rate comparisons which form the second part of the P-test methodology in most empirical studies can be criticised for the assumption that competitive sectors are less likely to use educational screens. The hypothesis is that, although productivity is more important in the competitive sectors, it is expected that these sectors will apply alternative means of screening and that productivity is more easily measured than in the non-competitive sectors. For example ability-contingent contracts may be applied to applicants in the competitive sector so less reliance is put upon educational screening. The assumptions that the public sector uses educational screens more than the private sector, and that less-competitive industries uses educational screens to a greater extent than more-competitive industries, were rejected using the BSA Survey data.

In conclusion, using the P-test methodologies and noting the critique of Ziderman (1990) in relation to the simple earnings ratio tests we can say that there appears to be little evidence in this Chapter in support of the strong or weak versions of the screening hypothesis, with the exception of the results of observing earnings ratios by worker type in Section 6.4.2. The results of this Chapter add to the body of evidence which supports the human capital explanation of the education-earnings relationship.

Appendix 6.1:

Details of Chow Tests to show the Independence of Sectoral Wage Rate Equations

Table 6.20 shows the details of Chow tests to test whether the Mincerian wage rate functions estimated for particular industrial sectors are independent from one another i.e. that wage rates in the particular sectors are determined separately. In all cases the number of explanatory variables including the constant term was 39, with the exception of Public Non-services where the dummy variable representing nursing qualifications was omitted.

Table 6.20 : Details of Chow-tests for Independence of Wage Determination

Sector	No. of Observations	SSE	Calculated F - statistic
Distribution (D)	771	215.16	
Public Non-services (N)	357	36.439	1.176**
D + N Pooled	1128	260.50	
Private (PR)	3353	651.83	
Public (PU)	1303	161.83	1.573*
PR + PU Pooled	4656	822.58	
SIC Industries 1 + 2	442	52.321	
SIC Industries 3 + 4	1292	176.36	1.248**
SIC 1+2+3+4 Pooled	1734	234.15	

Notes: * significant at the 5% level or better, ** significant at the 25% level only.

The level of significance indicates at what level we can reject the null hypothesis that the estimated coefficients in the two wage-rate functions are the same for both sectors in question. For example wage determination is found to be separate in the private and public sectors at the 5% level of significance.

Chapter 7

Testing the Role of Education in the Italian Labour Market

7.1 Introduction

In this Chapter I test the screening hypothesis in relation to the market for full-time workers in Italy using 1989 data. This will be done by applying methodologies similar to those used in Chapters 5 and 6 to test the screening hypothesis in relation to the UK labour market. There has been no attempt to test the screening hypothesis in relation to Italy to date; in fact there appears to be a general lack of evidence in relation to most of the member states of the European Community.

From Chapter 3 we can see that previous results of testing the role of education seem to suggest that the screening hypothesis may apply to some countries rather better than other countries. For instance evidence of screening was found to exist for the Israel [Ziderman (1992)], Japan [Sakamoto & Chen (1992)], Singapore [Liu & Wong (1982)] and Australia [Miller & Volker (1984)], but not for the Greece [Lambropoulos (1992)], Malaysia [Lee (1980)], the Netherlands [Oosterbeek (1992)], Sweden [Albrecht (1981)] and Egypt [Arabsheibani (1989)]. Mixed results were found for the UK [for example see Shah (1985) and Psacharopoulos (1979)] and the USA [for example see Riley (1979a) and Layard & Psacharopoulos (1974)]. The extent to which education is used as a screen depends on the nature of the educational systems, labour markets and cultures in these countries. One cannot generalise the results found for Country A to Country B if the two countries have institutional and cultural differences in their education systems and labour markets. The main differences in the education systems and labour markets in the UK and Italy are highlighted in Sections 7.4 to 7.6.

Section 7.2 presents the methodology used in this Chapter to test the screening hypothesis, outlines the earnings function which will be the basis of the analysis and gives details of the hypotheses about the role of education to be tested and the expected results from these hypotheses. Section 7.3 discusses the data set used [the 1989 wave of the Bank of Italy 'Survey on Consumption by Italian Families' (SCIF)].

Section 7.4 describes the nature of the Italian educational system. Section 7.5 investigates the nature of the North-South divide and labour market dualism in Italy. Some background to the economic dualism is given, regional variations in the mean levels of the SCIF sample variables are presented, and separate regional earnings functions are estimated.

The Rome Treaty (1957), which founded the European Economic Community [now known as the European Union (EU)], emphasised the goal of improving living standards and working conditions within member states. In the first major revision of the Rome Treaty, the Single European Act (1987), the EU stated that it aimed to open national markets to competition among member states, these markets are not only those for goods and services, but also financial and factor markets. The markets for labour in member states have since been the subject of a number of EU directives relating to discrimination in the workplace, health and safety and labour mobility.

Despite these directives many critics believed that labour market reform in member countries of the EU was lagging behind the reforms occurring in other EU markets, and the *laissez-faire* approach to the labour market should itself be revised [see Brown *et al* (1996) for further details on the implications of liberalising EU labour markets]. However, the labour market did not escape the aim of 'convergence' of markets within the EU outlined in the Maastricht Treaty (1992) and the 'Social Charter' later detailed principles regarding the labour market. The UK opted out of the Charter which aimed to make working conditions, levels of social security and worker protection uniform across the labour markets of the member countries of the EU.

With this in mind Section 7.6 aims to present some comparisons between the labour market for full-time workers in the UK and in Italy in 1989, since although EU directives may eventually lead to certain uniformities in the labour markets of member countries the role of education in the labour markets of member states has been largely over-looked.

Section 7.7 tests the screening hypothesis in relation to Italy 1989. Some preliminary results from testing the significance of differences in mean values of the sample variables between the self-employed and employees are presented. Then the actual results of estimating earnings equations are compared to the expected results under the hypotheses detailed in Section 7.2. Section 7.8 gives some overall conclusions from the analyses in this Chapter.

7.2 Methodology

7.2.1 The Earnings Function

The following Mincer-type earnings equation is estimated for full-time workers in Italy 1989;

(1) $\ln W = \alpha + \beta_1 c + B_2 x + B_3 x^2 + \beta_4 d + \varepsilon$

where:

W	=	household 'wage rate' calculated from household net disposable income, hours and months worked in 1989 (in 1000's Italian Lira),
α	=	average wage for reference respondent,
c	=	educational certification dummies,
x	=	years of labour market experience, proxied by age,
d	=	vector of regional, marital status and other earner dummy variables.

There is a common problem associated with using age to proxy for years of experience are illustrated below [also discussed in Mincer (1974), pp. 83-85]. Assuming continuous work experience starting immediately after leaving education, we can write:

(2) $A = x + y + b$

where:

A = age

b = age at which schooling began,

y = years of education,

x = years of labour market experience.

The use of age as a proxy for years of experience x in the function leaves out an interactive term derived from expanding the quadratic term in the following function;

(3) $\ln W = \alpha + \beta_1 c + B_2(x + y + b) + B_3(x + y + b)^2 + \beta_4 d + \varepsilon$

The coefficient B_2 will be an over estimate of the returns to labour market experience, since it will include the effect of years of education on wage rates. Similarly the coefficient B_3 will be an over estimate of the effect of increasing experience upon the returns to experience, since;

(4) $(x + y + b)^2 = x + y^2 + 2xy + 2bx + 2by + b^2$

and therefore the estimated coefficient on the quadratic will include the effect of increasing years of education upon the returns education and the four other factors above. However, Blinder (1975) posits that, although Mincer strictly used years in the labour force to measure non-school human capital in his earnings functions, when a wage rate function is used we should be less doctrinaire about the functional form used an base our decision on empirical basis rather than a theoretical one.

The estimated coefficients on the certification dummy variables will be corrected for the effects of years of education by the inclusion of age, and so years of education is not entered as a separate independent variable.

7.2.2 Hypotheses and Expected Results

The hypotheses that follow are carried over from Chapters 5 and 6. They are constructed to test for differences in the role of education in determining wages between groups differing by worker type or education level. Hypotheses 1-4 test the weak version of the educational screening hypothesis, and Hypothesis 5 tests the strong version of the screening hypothesis based on the methodology of Tucker (1986).

Hypotheses 1 and 2 relate to the estimation of wage rate functions for self-employed workers and employees. As in Chapter 5, it is assumed in a weak version of the screening hypothesis that the self-employed have no need to signal their ability to employers and therefore only use education as a human capital investment. In contrast, employees are assumed to use educational both to augment and to signal their ability to would-be employers. In this sense we can refer to the self-employed as the 'unscreened' group and employees as the 'screened' group.

7.2.2.1 Hypothesis 1

Following Riley (1979a), we would expect that for education to be an effective screening device it should be an accurate signal of worker productivity. The wage rate function of the screened group, assumed to be employees, is therefore expected to fit the data better than that for the unscreened group, assumed to be the self-employed. The hypothesis is as follows:

H_0: The screened group does not fit the model any more accurately than the unscreened group,

H_1: The screened group does fit the model more accurately than the unscreened group.

7.2.2.2 Hypothesis 2

Under the weak version of the educational screening hypothesis we would expect higher returns from education for the screened group, assumed to be employees, compared to the unscreened group, assumed to be the self-employed. The self-employed are assumed to be fully aware of their productive ability and education therefore serves no purpose as a screening device for productivity, but may still be valuable as a human capital investment. For employees education is assumed to be valuable not only for its human capital effects on productivity but also its role as a signal in the labour market. The null hypothesis is therefore as follows:

H_0: Returns to education are not significantly higher for employees relative to the self-employed,

H_1: Returns to education are significantly higher for employees relative to the self-employed.

7.2.2.3 Hypothesis 3

Following Psacharopoulos (1979) we assume that the public administration sector is characterised by non-competitive wage determination based upon educational screening devices, and that the private sector is characterised by more competitive wage determination. The SCIF 1989 data does not specifically identify private sector workers and so commercial services and the other services sectors are used to represent the competitive private sector.

In sectors, such as the public administration sector, where wage rates are difficult to measure and determined bureaucratically we would expect educational screening to be in operation. We would therefore expect, under the weak screening hypothesis, to find higher returns to educational variables in such sectors in comparison to more competitive sectors, such as commercial services. The P-test hypothesis is therefore as follows:

H_0: Returns to education do not vary significantly between high and low competition sectors,

H_1: Returns to education do vary significantly between high and low competition sectors.

7.2.2.4 Hypothesis 4

Following Tucker (1986), under the weak screening hypothesis, we would expect that as tenure increases the firm is able to gather more information about individual ability, and we should therefore expect that the size and the level of significance of the estimated rate of return on the certification variables (the initial signals of individual ability) should decline as tenure increases. We can use age as a proxy for tenure, for the reasons stated in Section 6.6 of Chapter 6. Rejection of the following null hypothesis would therefore lend support to the weak screening hypothesis:

H_0: Returns to certificates do not decrease as tenure (proxied by age) increases,

H_1: Returns to certificates decrease as tenure (proxied by age) increases.

7.2.2.5 Hypothesis 5

Following Tucker (1986), the strong screening hypothesis is supported if the age-earnings profiles for university graduates and school leavers do not diverge as age increases. If the profiles prove to be divergent then this rejects the strong screening hypothesis and shows that the higher educated are receive higher earnings beyond the initial hiring point because of human capital effects of education.

Rejection of the following null hypothesis would therefore support the strong screening hypothesis:

H_0: Returns to age (as a proxy for tenure) rise as education level rises,

H_1: Returns to age (as a proxy for tenure) do not rise as education level rises.

7.3 The Sample

The sample used in this Chapter is derived from the 1989 wave of the 'Survey on Consumption by Italian Families' (SCIF) commissioned by the Bank of Italy. The questionnaire is comprised of six main sections which record household characteristics, details of income, saving, consumption, wealth and the banking behaviour of a national cross-section of Italian families.

Using SPSS, from the 1989 data set I have taken a subset of data for household heads who were working full-time.[1] The variables selected were the marital, educational and occupational characteristics of the head of the household.

The response rate regarding individual income of working household heads was poor so family net disposable income data is used as a proxy for individual income of the head of the household with control made for the number of other workers in the household.[2]

In a similar fashion to the BSA Survey sample used in previous Chapters, control can also be made for regional labour market disparities as geographic region is also recorded. The reference categories, unless otherwise stated, are such that α in Equation (1) is the average wage of a single male full-time blue-collar (or, if self-employed, not a professional or entrepreneur) worker living in the south, holding a primary school leaving certificate as his highest qualification and no other workers contributing to household income. Unfortunately, in comparison to the BSA Survey sample used in Chapters 4-6, there is no data regarding union status of workers or racial origin, and no useful data on recent unemployment incidence. See Appendix 7.1 for a description of the variables contained in the SCIF 1989 sample.

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[1] Note: Female workers are omitted from some sections of this Chapter due to data restrictions. The number of female full-time workers in the sample, for which complete records were available, was not large enough to allow the separation of data into the various sub-samples needed for the comparative methodologies in some of the hypotheses tests.

[2] See Appendix 7.2 on the effects of estimating earnings equations for single worker households and the justfication for including multiple worker households in the sample.

Section 7.4 outlines the nature of the Italian education system, and Section 7.5 the nature of the Italian labour market. Section 7.6 presents some comparisons between the Italian labour market and the UK labour market. Section 7.7 presents the results from testing the screening hypothesis for Italy.

7.4 The Italian Education System

The main labour market problems in Italy in the late 1980's were high unemployment rates and low levels of qualifications and education of the labour force. To some extent the latter factors may be due to the severe under-funding of the education system, the minimum leaving age of 14 and subsequent small proportion of students continuing through to university level education [*Employment Observatory Trends* No. 20 (1994)]. Italy, in comparison to the UK, has a higher average government expenditure on each primary-school pupil, but a lower average government expenditure on each student in higher education [*The Economist*, April 22nd 1995, p. 20].

In Italy, non-compulsory nursery education is provided for 3-6 year-olds in both state and private facilities, and the majority of Italian children will have attended such nurseries. School attendance is compulsory for children of the ages 6 to 14 years. Compulsory primary education starts at the age of 6 and continues until children reach the age of 11 year olds. The final year at primary school ends with *Licenza elemetare* examinations, and this primary school certificate admits children to middle school. Middle school education is from 11 to 14 and pupils study for the *Licenza di scuola media*, the Intermediate Certificate.

In a similar fashion to the UK with regards to GCSE's and 'A' level admittance, this intermediate certificate allows access to higher secondary schools. Higher secondary schools teach 14-19 year olds and fall into one of five categories; grammar schools, art schools, teacher training schools, technical institutes and vocational institutes (with more practical courses than technical institutes). Graduation from a higher secondary school allows an individual to apply to universities or allows a graduate from a vocational institute access to intermediate professions.

Italian university courses normally last for at least four years and very few students receive a student grant from the state. Unlike the UK, Italy has no specific student loans system and enrollment fees have to be paid.

Although exam resits are more common in Italy than the UK [Raban (1991) p. 20], figures for 1989 show that approximately 6% of Italians (aged 25-64 years of age) graduated from university, in comparison to 9% of the population in the UK. In comparison, the population proportions with only nursery, primary or lower secondary education as the highest education level are 74% for Italy and 35% for the UK [for more details see OECD (1992) Table C1].

The certification dummies in vector c in Equation (1) represent no certification, intermediate and high school certification and university degree level certification as the highest level of certification held by the SCIF 1989 respondent, and the omitted reference category is primary school certification unless otherwise stated.

7.5 The Italian Labour Market: Dualism

7.5.1 Introduction

Economists tend to view the differences between the labour markets in the North and South regions of Italy as being an example of market dualism where two quite different economies exist within the same country, rather than simply as a regional issue. Foreign occupation until the unification of Italy in 1860 prevented the growth of a culture of public service, particularly in the South where the public administration and service shortcomings in turn impeded economic growth. Italian market dualism has been recognised since unification on the basis of major differences in activity rates, unemployment rates, emigration levels and per capita regional expenditure.

Post-war dualism was documented by Lutz (1962) and has been substantially modified in nature. Lutzian dualism in Italy was characterised by workers in different regions being paid differing wage rates for the same work although they possessed the same characteristics (such as education) and potential productivity [see Allen *et al* (1974) for more details].

The high paid group tended to be state employees or those protected by unions and working in large industries with minimum wage contracts set by a process of collective bargaining. In comparison to non-state employees, state employees enjoyed higher pay, higher pensions, better sick-pay, more holidays, guaranteed job-security and perks which could sometimes be interpreted as corruption [see p.126 Allen *et al* (1974)]

The lower paid group tended to be self-employed persons and hired manual workers attached to very small enterprises with small workforces and not covered by terms of collective bargaining contracts.[3] Thus the size of enterprise was the fundamental basis of Lutzian dualism, and since large industry was concentrated in the North-Centre of Italy and the overwhelming majority of enterprises in the South were small firms, the dualism evolved into a North-South divide.

In the post-war period union membership in Italy, and therefore power in the bargaining process, was relatively low and concentrated in the industrial areas of the North. The abundance of smaller employers in the South, who were encouraged to grow by the state through preferential credit facilities and tax-breaks, therefore had little difficulty in employing non-union labour and under-cutting the minimum wage level set in the Northern areas. Although labour mobility within Italy was severely impeded by pre-war Fascist legislation, this led to much inter-regional and outward migration to Southern Europe and America in the post-war period and severe de-population of Southern Italy.

Law reforms in the 1960's, the rise of union power and the growth in the average size of enterprise workforces diminished the scope for Lutzian dualism. The emergence of 'state economic enterprises' through the 1960's and 1970's led to a substantial increase in the size of the manufacturing industry in the South, relative to the North, both in terms of output and employment. However, the rise in the black market for labour in the South, fuelled by the European heroin market, the inadequacy of the unemployment benefit system and ineffective

[3] Lutz concentrated on the 'cheap-labour' hiring practices of firms with ten or less workers in his treatment of labour market dualism.

regional development policy has maintained the North-South labour market dualism in the 1980's.

There had been some limited progress by the late 1980's in the industrial development of the South East of Italy and Eastern Sicily, but where productivity improvements had occurred, in the metal and chemical industries, it was mainly due to factor substitution i.e. replacing human capital (workers) with new physical capital. Indeed, there was a contraction of traditional industries such as steel, petrochemicals and shipbuilding, leading to structural problems. The resulting unemployment counteracted the improvement in productivity in the South.

In fact Schachter & Engelbourg (1988) conclude that, although the South had tripled its per capita income over the 1950-1988 period and although the North-South divide was no longer expanding, the division was in fact greater in 1988 than when the government initiated its development policies in the 1960's. Indeed, the authors describe the 1985 'Three Year Plan for the South' as a 'symbolic panacea' rather than an effective development policy.

One problem lies in the nature of the Italian labour market. The entrepreneur in the South of Italy is faced with high labour costs relative to labour productivity. In 1984 average output per industrial worker in the South was 75% that of workers in the North, but labour contracts are generally decided on a national basis. This tends to promote the creation of capital-intensive industries in which employment is based on the national rather than the Southern labour market, leading to involuntary unemployment in the legal labour market of the South [see Schachter & Engelbourg (1988)].

In 1989 Italy's main social problem was youth unemployment, particularly in the South, and the gap between living standards in the North-Centre and South. In the North-Centre area the majority of young people are covered by work-training contracts but the rate of unemployment in terms of first job seekers is as high as 50% in some regions of the South. The national unemployment benefit system is such that payments to unemployed youths are very low and the family is expected to look after such youths, if they do not find legitimate work or jobs in the thriving black market for labour [see Jenkins (1988)].

7.5.2 Differences in Variable Means by Region

Italy is characterised by extreme differences in unemployment and living standards by region, and there is much literature to suggest that the country has been a case study of a dual labour market. Table 7.1 shows the differences in the mean levels of variables in the two regions from the 1989 SCIF sample of full-time workers.

Table 7.1: Descriptive Statistics from SCIF 1989 by Region

Region:	North-Centre (N = 1641)		South (N = 1025)		
Variable Name	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	**T-Statistic**
Family Income	41813	23368	33784	22764	8.769*
Months worked	11.955	0.536	11.798	1.090	4.298*
Weekly Hours	40.693	3.937	40.773	4.980	-0.436
Age	43.300	10.250	43.204	10.337	0.234
Sex	0.899	0.007	0.935	0.008	-3.206*
Married	0.831	0.009	0.894	0.010	-4.497*
Single	0.102	0.007	0.067	0.008	3.095*
Divorced / widowed	0.067	0.006	0.039	0.006	3.053*
No formal Education	0.017	0.003	0.048	0.007	-4.647*
Primary Certificate	0.222	0.010	0.278	0.014	-3.277*
Intermediate Cert.	0.338	0.012	0.260	0.014	4.244*
High School Cert.	0.316	0.011	0.302	0.014	0.760
Degree	0.107	0.008	0.112	0.010	-0.403
Blue Collar Occ.	0.336	0.012	0.305	0.014	1.664**
Clerical Occupation	0.277	0.011	0.309	0.014	-1.773**
Middle level Occ.	0.091	0.007	0.077	0.008	1.257
High Level Occ.	0.027	0.004	0.023	0.005	0.638
Agriculture	0.039	0.005	0.080	0.008	-4.526*
Construction	0.138	0.009	0.143	0.011	-0.362
Energy	0.193	0.010	0.139	0.011	3.592*
Commercial / Distrib.	0.168	0.009	0.175	0.012	-0.467
Transport / Commun.	0.080	0.007	0.084	0.009	-0.367
Finance	0.029	0.004	0.024	0.005	0.774
Consultancies	0.032	0.004	0.020	0.004	1.847**
Public Administration	0.134	0.008	0.180	0.012	-3.221*
Other Services	0.188	0.010	0.154	0.011	2.248*
Self-employed	0.270	0.011	0.287	0.014	-0.955
S.E. Professional	0.073	0.006	0.060	0.007	1.297
S.E. Entrepreneur	0.098	0.007	0.114	0.010	-1.316
S.E. Other	0.099	0.007	0.113	0.010	-1.150

Notes: * Significant at the 5% level in a two-tailed test, ** significant at the 10% level, with 2664 degrees of freedom.

The regions included as the 'South' of Italy, known as the *Mezzogiorno*, are Campania, Puglia, Basilicata, Calabria, Abruzzi Molise, and the islands of

Sardinia and Sicily. The regions included as the 'North-Centre' of Italy are Piemonte, Valle d' Aosta, Lombardia, Liguria, Toscana, Trentino - Alto Adige, Friuli - Venezia Giulia, Emilia Romagna, Umbria, Marche, and Lazio. This follows the methodology of Meschi (1995).

From Table 7.1 we can see that there are significant differences in the mean values of some of the variables listed between the North-Centre and South regions. There are significantly more female household heads in the North-Centre region in comparison to the South. Household heads in the South are more likely to be married and therefore less likely to be single, divorced or widowed. Significantly more workers in the South are likely to have no formal qualifications or primary certification as the highest level of qualification held. Significantly more workers in the North-Centre hold intermediate certification whereas the proportions for high-school and degree level certification do not differ significantly by region. Workers in the North-Centre on average work a significantly longer year, but not a longer week, in comparison to workers in the South.

There is a significantly higher proportion of blue collar employees or similar workers in the North-Centre region, a significantly higher proportion of clerical or similar workers in the South, and there is no significant difference in the proportions of middle and top management workers between regions. The proportion of workers who are self-employed in each region does not differ significantly.

As we would expect, the proportion of workers who are active in the agricultural sector of the economy is significantly higher in the South; for example the area of Puglia in the late 1980's was responsible for a major proportion of Italy's olive and citrus fruit crop. The proportion of workers who are active in the energy sector of the economy is significantly higher in the North-Centre; again this is as expected given the poor utility infrastructure in the South. The proportions for commercial, distribution, transport, communications and finance sectors do not differ significantly by region. The proportion of workers in consultancy and other services jobs is relatively higher in the North-Centre, and the proportion of workers in public administration jobs is relatively higher in the South.

Also as expected there is a highly significant difference between average family income between the North-Centre and South of Italy; with families in the South receiving on average approximately 80% of the income of families in the North-Centre.

7.5.3 Differences in Estimated Earnings Equations by Region

Table 7.2 shows the estimated earnings equations for full-time workers in Italy by region. From Table 7.2 we can see that there appear to be a number of significant differences between the estimated earnings equations for the two regions. Being male as opposed to female increases the earnings of full-time workers in the North-Centre region of Italy by approximately 9%, whereas there is no such differential in the South. Self-employment on the other hand appears to uniformly increase earnings in both regions by approximately 20-21%.

The average rate of return to years of age in the North-Centre region is approximately 4% and in the South approximately 3% for each year of age. Decreasing marginal returns to age are present in both areas; the decrease in returns to age as age increases appears to be larger in the North-Centre indicated by the higher estimated coefficient on age-squared.

The positive effect on earnings of having no certification in comparison to primary certification is only significant in the North-Centre region and raises earnings by approximately 19%. The estimated earnings effects of intermediate, high-school and degree level certification are equivalent in both regions, raising earnings by approximately 10%, 28-30% and 51-52% respectively in comparison to a worker holding only primary certification.

The effect of being married is significant in the North-Centre region in the determination of earnings and increases earnings by approximately 14%. In comparison, marital status in the South has no significant effect on earnings in comparison to a single person. Being divorced or widowed is not significant in the determination of earnings in either region.

Earnings in the North-Centre in the construction, energy, distribution, commercial and other services sectors are not significantly different, *ceteris paribus*, from earnings in the agricultural sector. Similarly, earnings in the construction, transport, communication, distribution and commercial services sectors are not significantly different, *ceteris paribus*, from earnings in the agricultural sector in the South. Wage rates in the transport and communications sectors are approximately 14% higher than in agriculture in the North-Centre, whilst earnings in the energy and other services sector are approximately 10-11% higher than in agriculture in the South. Wage rates in the finance sector are approximately 31% higher in the North-Centre and 20% higher in the South than in their agricultural sectors.

The average log-wage converted to lire for each region is 17796 lire per hour in the North-Centre region and 14585 lire per hour in the South. A Chow test to show that the two estimated earnings equations are separate i.e. that the labour market is regionally segmented gives an F-statistic of 4.27 which is significant at the 1% level; this implies that some form of labour market dualism exists.

A Gujarati (1970) dummy variable test revealed that significant regional differences appeared in the effects of marital status, additional workers in the household, and the industrial sector in which the SCIF respondent worked (with the exception of the variable representing the energy sector). This last result implies that workers in the construction, distribution, commercial, transport, communications and finance sectors have higher earnings *ceteris paribus* in the North-Centre in comparison to similarly employed workers in the South. Only workers in the other services sector earn more, *ceteris paribus*, in the South than in the North-Centre region of Italy.

Table 7.2: Estimated Earnings Equations for Italian Full-timers by Region (1989)

Region:	North-Centre (N = 1641)		South (N = 1025)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Male	0.090	2.217*	0.024	0.349
Self-employed	0.207	8.932*	0.200	5.996*
Age	0.039	5.573*	0.028	2.885*
Age^2	-0.00032	-4.070*	-0.00023	-2.075*
No Certification	0.189	2.585*	0.071	1.087
Intermediate Certificate	0.101	3.789*	0.097	2.659*
High School Certificate	0.275	9.808*	0.299	7.916*
Degree	0.512	13.937*	0.519	10.484*
Married	0.135	3.651*	0.00045	0.008
Divorced / widowed	-0.008	-0.164	-0.091	-1.031
Construction	0.054	1.010	0.024	0.421
Energy	0.068	1.308	0.108	1.814**
Distribution/Commercial	0.077	1.461	0.036	0.625
Transport/Communication	0.137	2.353*	0.063	0.965
Finance	0.305	4.143*	0.197	2.020*
Other Services	0.055	1.077	0.096	1.774**
1 Additional worker	0.390	18.946*	0.523	17.689*
2 Additional workers	0.658	16.658*	0.819	10.163*
3 Additional workers	0.864	12.659*	0.992	5.389*
4 Additional workers	1.101	6.600*	0.361	1.234
Constant	1.094	6.973*	1.376	6.130*
Adjusted R^2	0.458		0.450	
Variance of Estimate	0.137		0.166	
Mean ln w	2.879		2.658	

Notes: * Significant at 5% level, ** significant at 10% level.

7.5.4 Conclusion

Comparisons between earnings determination in the North-Centre and South regions of Italy, show little variation in the effect of certification upon family earnings. The estimated rates of return to intermediate, high-school and degree level certification are equivalent in both regions raising earnings by approximately 10%, 28-30% and 51-52% respectively in comparison to a worker holding only primary certification. There appears to be little regional difference in the role of education in the Italian labour market. However, one difference that is apparent is the significant positive earnings effect of having no certification in comparison to primary certification in the North-Centre region; this result is re-examined in Appendix 7.2.

7.6 Comparisons Between the UK and Italy

7.6.1 National Comparisons

It is tempting to compare the estimated rates of return to Italian high school certification and degrees with those estimated in Chapters 4-6 for UK 'A' levels and degrees. However, such comparisons between the estimated rates of return to educational variables in the determination of earnings for the UK and Italy are complicated by the differing nature of the educational systems of the two countries, and the different formulations of the earnings equation estimated in this Chapter as compared to previous Chapters. The problems of different formulation lie in the fact that the dependant variable in the BSA Survey data is individual wage rate and the dependant variable in the SCIF data is family wage rate.

Similarly, since age (which includes years of education) is used as a proxy for labour market experience, we cannot strictly compare the rates of return to age and age squared in Italy with years in the labour force and its square in the regressions for the UK in previous Chapters.[4]

In this section the UK BSA Survey data for 1989 is analysed using a similar formulation that has been applied to the Italian SCIF data. The control variables for racial origin, unionisation, recent unemployment, certification, and occupational class are dropped. Female workers are re-introduced so that we may ascertain the differing effect of gender on wages between the countries. To make the regional dummy variables more comparable the prosperous North region is now the reference category for the Italian regression, since the South East is the reference category for the UK. Since the certificate dummy variables are dropped, because comparisons are meaningless, the coefficient on years of education is an over estimate of the true average rate of return to years of education independent of certification effects. Table 7.3 shows the results of estimating the earnings equation for full-timers in 1989 for the two countries.

[4] The word 'strictly' is used here since there seems to be some debate in human capital literature as to how biased estimated rates of return are when using the age proxy; see Blinder (1975).

From Table 7.3 we can see that the effect of gender upon wage determination differs significantly between countries; being male in Italy increases earnings by approximately 7% compared to 31% in the UK. Self-employment increases earnings of Italians by approximately 19%, but reduces earnings of UK workers by approximately 24%.

Being married or living as married has a significant positive effect upon earnings of workers in both countries; the effect is to raise earnings by approximately 8% in Italy and 14% in the UK. Being divorced or widowed reduces earnings of Italian workers by about 5% and in contrast divorced or widowed workers in the UK have 17% higher earnings.

The rate of return to each year of age is approximately 4% and 6% in Italy and the UK respectively. However, the decline in the rate of return to age as age increases is more marked in the UK; the coefficient on age-squared being approximately double in size for the estimated UK earnings equation in comparison to the Italian estimated equation.

The earnings effect of education (with no control for certification effects) is much higher in the UK; UK workers have an increase in earnings of approximately 10% for each year of education compared to 4% for each year of education for Italian workers.

The regional variations in earnings between prosperous and less prosperous areas appear to be more pronounced in the UK in comparison to Italy. For example earnings in Wales are, *ceteris paribus*, approximately 27% lower than in the South East, whereas earnings in the South of Italy are, *ceteris paribus*, 11% lower in comparison to the more prosperous North. One of the reasons why this result occurs may be due to differences in the way in which wages are set in the two countries. In the UK the system is 'voluntarist' in the sense that the state adopts a *laissez-faire* approach and imposes a minimum amount of labour market legislation upon employers. Where workers are unionised in the UK the unions would tend to agree to a national norm level of wage rates, but then regional market influences are allowed to determine wage rates within the agreed range. In contrast, Italy tends to be characterised by the Roman-Germanic system in which there are stricter rules for wage determination through union bargaining on a national level with state guarantees of minimum levels of remuneration, working conditions and worker unionisation. For example in 1989 the *scala mobile* was still in place in the Italian system; this was an explicit contract which ensured that wage levels would be indexed to inflation expectations to protect workers' living standards [see Brown *et al* (1996) for the implications of these differences in bargaining structure upon EU labour market convergence].

The lack of union membership variable in the SCIF 1989 sample is unfortunate as it means that we cannot control for, or compare, differences in the effects of unionisation upon the earnings of workers in the two countries. However, trade union membership density in the late 1980's was approximately comparable in the UK and Italy, being approximately 40-42% of the workforce [Gunnigle *et al* (1994)]. Although recognition of trade unions by employers was also approximately the same in this period in the two countries, the influence of UK trade unions within labour market negotiations diminished to a greater extent than in Italy in the late 1980's [see Figure 2 in Gunnigle *et al* (1994)].[5]

The difference in mean log wages between the two countries can be attributed to the fact that earnings is measured in the different currencies of each country; thousands of Italian Lire and £'s Sterling. To compare the real earnings earned by workers in the two countries measured in terms of a common currency, purchasing power parity (PPP) figures for 1989 can be used. Purchasing power parity represents the rate of exchange between two currencies which would exist if they were to be exchanged in direct proportion to the domestic price levels prevailing in the two countries. The divergence between PPP and the actual exchange rate indicates the differing price level and hence different cost of living between the two countries.

The PPP for Italy in 1989 with reference to the UK is approximately 2304.54 lire to the pound. The reported mean log-wage rate reported for Italy in Table 7.8 converted to lire is approximately 16297.3 lire and using the PPP figure this is approximately equivalent to £7.07. The mean log-wage rate reported for

[5] One way of comparing the effects of union coverage between the two countries would be to include the regional average level of union coverage as an explanatory variable in the earnings equations for the two countries. However, this thesis is primarily concerned with the role of education in the labour market and regional dummy variables suffice in controlling for regional variations in union coverage.

the UK in Table 7.8 when converted to non-logarithmic form is approximately £4.28. However, note that the Italian figure is a 'household' wage in the sense that approximately 48% of the households in the SCIF sample contain one or more additional workers who will contribute to household income.

Table 7.3: Estimated Earnings Functions for Italian and UK Full-timers (1989)

Country:	Italy (N = 2666)		UK (N = 1666)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Male	0.067	1.916**	0.306	12.350*
Self-employed	0.186	10.806*	-0.236	-7.134*
Married	0.079	2.528*	0.142	4.220*
Divorced/widowed	-0.047	-1.088*	0.174	3.303*
Age	0.036	6.285*	0.056	8.225*
Age^2	-0.00029	-4.519*	-0.00064	-7.782*
Years of Education	0.039	20.719*	0.097	16.502*
East Anglia	--	--	-0.052	-0.706
East Midlands	--	--	-0.158	-2.872*
London	--	--	0.075	1.607*
North East	--	--	-0.150	-2.688*
Northern Ireland	--	--	-0.214	-5.497*
North West	--	--	-0.158	-3.222*
Scotland	--	--	-0.170	-3.304*
South West	--	--	-0.180	-3.527*
Wales	--	--	-0.266	-3.844*
West Midlands	--	--	-0.117	-2.415*
Yorks. & Humberside	--	--	-0.133	-2.657*
Central	-0.056	-2.752*	--	--
South	-0.109	-5.468*	--	--
Island	-0.143	-5.898*	--	--
1 Additional worker	0.447	26.409*	--	--
2 Additional workers	0.717	19.852*	--	--
3 Additional workers	0.899	13.647*	--	--
4 Additional workers	0.931	6.272*	--	--
Constant	0.892	6.948*	-1.438	-9.234*
Adjusted R^2	0.461		0.297	
Variance of estimate	0.152		0.213	
Mean ln *w*	2.791		1.455	

Notes: * Significant at 5% level or better, ** significant at 10% level, '--' denotes that a variable is not defined for that sub-sample.

To allow for the unequal proportions of female workers and additional earners in the two samples the following calculated wage rates and incomes are for male full-timers who are sole earners in both countries, and using PPP figure to convert to Pounds Sterling, gives the following figures:

Italy 1989:	Income = £ 12931	Hourly Wage-rate = £ 6.25
UK 1989:	Income = £ 12503	Hourly Wage-rate = £ 5.38

This indicates that individual incomes and wages rates are higher in Italy than in the UK for full-time workers and illustrates the *sorpasso* (overtaking) of the UK in terms of gross income per capita. The *sorpasso* of the UK in terms of gross national product occurred in 1986 because of the strength of the lira, the rapid expansion of Italian economy over the period 1983-1987, and a re-assessment of Italy's national accounts. This confirmed what many observers had claimed from looking at increasing living standards in the North-Centre, although the South continued to lag behind [see Jenkins (1988) for further details]. Note that real wage *growth* in Italy was lower in 1989 than in the UK [see Figure 14, p. 136, *World Employment 1995*].

7.6.2 Regional Comparisons Between the UK and Italy

Table 7.4 shows the results of estimating earnings equations for the South and North-Centre of Italy. Table 7.5 shows the results of estimating earnings equations for the North and South of the UK. The regions included as South and North-Centre of Italy are the same as in Section 7.5.3. The regions included as the 'South' of the UK are the South East, South West, London, East Anglia, and the East Midlands. The regions included as the 'North' of the UK are Northern Ireland, Wales, Scotland, West Midlands, Yorkshire and Humberside, the North East and the North West. Such division of the country is justified on the basis of regional unemployment levels and Brown *et al* (1994) provide clear evidence of such a North-South divide on the basis of long term unemployment probabilities.

Industrial dummy variables have been introduced to the estimated earnings equations to allow for the fact that the economies of certain geographic areas tend to be dominated by specific industries. In each estimated earnings equation the reference category for industrial sector is the agricultural sector.

From Table 7.4 we can see that there are a number of significant differences between the estimated earnings equations for the two regions of Italy;

these differences are generally equivalent to those described for Table 7.2 in Section 7.5.3. Being male as opposed to female increases the earnings of full-time workers in the North-Centre region of Italy by approximately 9%, whereas there is no such differential in the South. Self-employment uniformly increases earnings in both regions by approximately 21%.

Table 7.4 : Estimated Earnings Equations for Italian Full-timers by Region using Years of Education Variable (1989)

Region:	**North-Centre (N = 1641)**		**South (N = 1025)**	
Variable Name	**Estimated Coefficient**	**T - Ratio**	**Estimated Coefficient**	**T - Ratio**
Male	0.091	2.236*	0.021	0.310
Self-employed	0.214	9.198*	0.207	6.165*
Age	0.039	5.566*	0.026	2.646*
Age^2	-0.00032	-4.046*	-0.00019	-1.756**
Years of Education	0.036	14.334*	0.036	10.809*
Married	0.125	3.371*	-0.011	-0.194
Divorced / widowed	-0.023	-0.471	-0.092	-1.040
Construction	0.045	0.832	-0.00046	-0.008
Energy	0.056	1.059	0.078	1.323
Distribution/Commercial	0.058	1.104	-0.002	-0.035
Transport/Communication	0.120	2.043*	0.036	0.553
Finance	0.291	3.933*	0.177	1.814**
Other Services	0.053	1.040	0.083	1.531
1 Additional worker	0.391	18.876*	0.532	18.010*
2 Additional workers	0.661	16.596*	0.827	10.215*
3 Additional workers	0.865	12.578*	0.971	5.244*
4 Additional workers	1.088	6.472*	0.415	1.412
Constant	0.748	4.669*	1.099	4.860*
Adjusted R^2	0.449		0.443	
Variance of Estimate	0.139		0.168	
Mean ln *w*	2.879		2.658	

Notes: * Significant at 5% level, ** significant at 10% level.

The average rate of return to general human capital, as proxied by years of age, in the North-Centre region is approximately 4% and in the South approximately 3% per year. Decreasing marginal returns to age are present in both areas; the decrease in returns to age as age increases is larger in the North-Centre.

Educational effects appear not to differ regionally; the average earnings effect of each year of education is approximately equal to 4% in both regions. Although this estimated rate of return is biased by the use of age as a proxy for general human capital rather than years in the labour force, or tenure, it gives us a basis for comparison with the UK if we similarly use age as a proxy for general human capital in the earnings equation estimates for that country. Note that these two estimated earnings equations for Italy do not fit the data quite as well as the estimated earnings equations presented in Table 7.2 where certification dummies were included instead of the years of education variable; for example the adjusted R-squared figure for the previous South earnings equation was 45% and here it is approximately 44%.

Marital status is significant in the determination of earnings in the North-Centre; increasing earnings by approximately 13%. In the South being married has no significant effect on earnings, and being divorced or widowed is not significant in the determination of earnings in either region.

Table 7.5: Estimated Earnings Equations for UK Full-timers by Region (1989)

Region:	South (N = 684)		North (N = 982)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Male	0.324	7.896*	0.273	8.464*
Self-employed	-0.275	-4.936*	-0.197	-4.220*
Age	0.055	4.921*	0.062	7.372*
Age^2	-0.00065	-4.801*	-0.00070	-6.869*
Years of Education	0.085	9.095*	0.096	11.902*
Married	0.117	2.080*	0.128	3.122*
Divorced / widowed	0.177	2.077*	0.120	3.087*
Construction	0.482	2.592*	0.323	2.657*
Energy	0.308	1.410	0.527	4.278*
Distribution/Commercial	0.226	1.218	0.121	1.215
Transport/Communication	0.388	2.042*	0.197	1.723**
Finance	0.577	3.115*	0.411	3.882*
Other Services	0.316	1.723**	0.303	3.016*
Other Manufacturing	0.342	1.870**	0.225	2.267*
Constant	-1.594	-5.189*	-1.954	-9.207*
Adjusted R^2	0.271		0.320	
Variance of Estimate	0.218		0.200	
Mean ln *w*	1.557		1.383	

Notes: * Significant at 5% level, ** significant at 10% level.

Earnings in all sectors except transport, communication and finance, are not significantly different, *ceteris paribus*, from earnings in the agricultural sector in the North-Centre. In the South, earnings in all sectors, except the finance sector, are not significantly different from earnings in the agricultural sector in the North-Centre. Wage rates in the North-Centre in the transport and communications sectors are approximately 12% higher than in agriculture. Wage rates in the finance sector are approximately 29% higher in the North-Centre and 18% higher in the South than in agriculture respectively.

From Table 7.5 we can see that there are a number of significant differences between the estimated earnings equations for the two regions of the UK and between the estimated regional earnings equations for the UK and Italy.

In the UK, being male as opposed to female increases the earnings of full-time workers in both regions; by approximately 32% in the South and 27% in the North. In Italy the gender effect was insignificant in the under developed Southern region of Italy, and approximately 9% in the North-Centre region.

In the UK self-employment decreases earnings in both regions; by approximately 27% in the South and 20% in the North. The opposite effect was estimated for both regions of Italy in that earnings were increased by self-employment by approximately 21%. This may reflect a difference in government policy towards small businesses, and the viability of self-employment, between the two countries.

The positive effects of general human capital upon earnings do not appear to vary regionally in the UK; the average rate of return to years of age in both regions is approximately 6% per year. Decreasing marginal returns to age are present in both regions and the decrease in returns to age as age increases are of approximately the same magnitude in both regions. In comparison with Italy it appears that general human capital, as proxied by years of age, has a greater influence upon the earnings of full time workers in the UK.

The effect of years of education appears to differ only slightly by region; the average earnings effect of each year of education is approximately equal to 9% in the South and 10% in the North. Thus in comparison with Italy it appears that years of education has a greater influence upon the earnings of full time workers in the UK. Note that the two estimated equations shown in Table 7.5 do not fit the data as well as the estimated equations presented in Chapter 4-6 where certification dummies were included alongside the years of education variable; the effects of certification on earnings in both countries are being ignored in this section because estimated returns would not be comparable.

Being married in comparison to single is significant in the determination of wage rates in both regions of the UK and increases wage rates by approximately 12-13%; this is comparable to the 13% effect on wage rates in the North-Centre of Italy. Being divorced or widowed is also significant in the determination of wage rates in both regions of the UK, in comparison to Italy where it was insignificant in both regions.

Wage rates in all sectors except the distribution and commercial service sector (and the energy sector in the South) are significantly different from wage rates in the agricultural sector in both regions of the UK. For example, wage rates in the finance sector are, *ceteris paribus*, approximately 58% higher in the South, and 41% higher in the North, compared to wage rates in the agricultural sector. In comparison wage rates in the finance sector in Italy are approximately 29% higher in the North-Centre and 18% higher in the South than in agriculture respectively. The effects of industrial classification of jobs are generally more significant and stronger in the UK in comparison to Italy.

7.6.3 Conclusion

Comparisons between the UK and Italy showed that the average earnings effect of years of education appears to be much higher in the UK; 10% for each year of education in the UK compared to 4% for each year of education in Italy. Using these two countries as examples of EU member states, this implies that EU labour market policies aimed at convergence in wage rates and productivity should also address the issue of the efficiency and equity of educational systems in providing skills and increased earnings for workers in member states.

It was also shown that being male rather than female in the UK increases the earnings of full-time workers by approximately 32% in the South and 27% in the North. In Italy the equivalent gender effect was insignificant in the South, and approximately 9% in the North-Centre region. These results reflect the poor position of female workers in the market for full time employment in the two countries.

Self-employment was found to decrease earnings in the UK by approximately 27% in the South and 20% in the North. Conversely, in Italy earnings were increased by approximately 21% in both regions by self-employment. These differences may reflect national differences in government policy towards small businesses, and the viability of self-employment.

7.7 Testing the Screening Hypothesis for Italy

7.7.1 Differences in Variable Means by Worker Type

Table 7.6 presents the mean values and standard deviations of the variables used to analyse wage rate determination for Italian males in this Chapter. See Appendix 7.1 for a description of the variables contained in the SCIF 1989 sample.

The sample has been further split by worker type so that we may test for significant differences in the mean levels of characteristics between the self-employed and employees.

From Table 7.6 we can see that the self-employed in the sample are significantly older, possess higher net disposable family incomes, work more hours per week and less months per year than employees. The proportion of self-employed workers in the sample who are single, is significantly higher than the proportion of employees.

The proportion of self-employed workers who have no formal qualifications or just primary certification is significantly higher than the proportion of employees. The proportion of employees who have high school certification is significantly higher than the proportion of self-employed workers. These two observations accord with the screening hypothesis that the self-employed are relatively less interested in acquiring education than employees. However, note that the proportions in the two groups who have university degrees are not significantly different, implying that higher education levels do not differ by worker type perhaps due to their human capital value or because self-employment plans may not come to fruition and students are 'hedging'.

Table 7.6: Descriptive Statistics for Male Full-time Workers in Italy 1989

Worker Type:	Employees (N = 1750)		Self-employed (N = 683)		
Variable Name	Mean	Standard Deviation	Mean	Standard Deviation	T - Ratio
Family Income	36701	19473	47193	31615	-11.821*
Months worked	11.909	0.724	11.851	1.001	1.964*
Weekly Hours	40.388	3.423	41.842	6.009	-8.795*
Age	42.854	9.731	45.255	11.385	-4.862*
Married	0.930	0.006	0.899	0.012	2.552*
Single	0.054	0.005	0.076	0.010	-2.050*
Divorced/widowed	0.0154	0.003	0.025	0.006	-1.596
No formal Education	0.023	0.004	0.042	0.008	-2.538*
Primary Certificate	0.233	0.010	0.302	0.018	-3.521*
Intermediate Cert.	0.323	0.011	0.297	0.017	1.240
High School Cert.	0.314	0.011	0.249	0.017	3.157*
Degree	0.107	0.007	0.110	0.012	-0.214
Blue collar worker	0.468	0.012	--	--	--
Clerical Worker	0.375	0.012	--	--	--
Middle level Occ.	0.119	0.008	--	--	--
High level Occupation	0.038	0.005	--	--	--
S.E. Professional	--	--	0.243	0.016	--
S.E. Entrepreneur	--	--	0.391	0.019	--
S.E. Other	--	--	0.366	0.018	--
North West	0.235	0.010	0.204	0.015	1.642**
North East	0.134	0.008	0.206	0.015	-4.419*
Central	0.244	0.010	0.179	0.015	3.446*
South	0.249	0.010	0.264	0.017	-0.765
Island	0.138	0.008	0.148	0.014	-0.637
1 Additional worker	0.418	0.012	0.406	0.019	0.540
2 Additional workers	0.053	0.005	0.060	0.009	-0.681
3 Additional workers	0.014	0.003	0.016	0.005	-0.370
4 Additional workers	0.002	0.001	0.006	0.003	-1.589

Notes: * Significant at 5% level or better, ** significant at the 10% level '—' denotes that a variable is not defined for that sub-sample, a significant test-statistic indicates a significant difference between means in a two-tailed test with d.f. = 2431.

A significantly higher proportion of self-employed workers live in the North East region of Italy in comparison to the number of employees, and a significantly higher proportion of employees live in the North West and central regions of Italy in comparison to the number of self-employed workers. Proportions are not significantly different in the relatively less prosperous Southern and Island regions of Italy.

The proportion of male workers who are defined as self-employed in the SCIF 1989 sample (28%) is in line with the national average of 30% reported for the period 1983-1992; in comparison the proportion of self-employed in the UK which is approximately 10% for the same period [*Employment Observatory Trends* No. 18 (1994)].

7.7.2 General Regression Results

Table 7.7 shows the results of estimating earnings equations for full-timers in Italy in 1989 by worker type. From Table 7.7 we can see that age and age-squared are both significant in the determination of the earnings of both worker types. An additional year of age increases the earnings of employees by approximately 3%, and the earnings of a self-employed worker by approximately 5%. The negative effect of age-squared is higher for the self-employed implying that, *ceteris paribus*, the age-earnings profiles of the self-employed will be more convex in comparison to that of employees i.e. the effect of age upon the earnings declines faster for the self-employed as age increases.[6] The average amount earned by the self-employed per hour is approximately 19087 Italian Lira compared to 15816 for employees.

Being married has a significant positive effect upon the earnings of male full-time employees in comparison to the insignificant effect upon the earnings of the self-employed. Being divorced or widowed has no significant effect upon the earnings of either worker type.

Occupational class has a positive significant effect on the earnings of employees; in comparison to blue-collar workers clerical employees have approximately 14% higher earnings, middle-management have approximately 31% higher earnings, and top management and similar workers have approximately 53% higher earnings. Similarly, in comparison to self-employed assistants and similar self-employed workers, self-employed professionals have approximately 12% higher earnings and self-employed entrepreneurs have approximately 10% higher earnings.

Living in the North West area of Italy appears to have the strongest positive effect on earnings in comparison to living in the South; employees'

[6] Other things being equal the self-employed would always earn a higher wage rate than employees since the age at which the two profiles cross over is calculated as 142; this is done by equating the two quadratic wage equations, in terms of age and age-squared, and solving.

earnings are 12% higher and self-employed earnings are 25% higher than in the South. In the North East employees' earnings are 8% higher, but the earnings of the self-employed are not significantly different form those in the South. Living in the central area of Italy increases earnings of employees compared to those living in the South by 6%, and again the earnings of the self-employed are not significantly affected. Both worker types resident on one of the two Italian islands (Sardinia or Sicily) gain no earnings advantage over those workers living in South Italy; this confirms the traditional classification of the islands as being part of the economically lesser developed South.

Table 7.7: Estimated Earnings Equations for Italian Male Full-timers in 1989

Worker Type:	Employees (N=1750)		Self - employed (N = 683)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Age	0.030	4.675*	0.047	3.597*
Age^2	-0.00027	-3.625*	-0.00039	-2.783*
Married	0.104	2.909*	0.060	0.796
Divorced/widowed	0.011	0.156	-0.077	-0.555
No Certification	0.105	1.963*	0.069	0.698
Intermediate Certificate	0.092	4.100*	0.059	1.156
High School Certificate	0.193	7.202*	0.232	4.008*
Degree	0.331	9.346*	0.457	5.675*
Clerical Employee	0.136	6.503*	--	--
Middle level Employee	0.305	10.563*	--	--
High level Employee	0.532	11.337*	--	--
Self Emp. Professional	--	--	0.119	2.033*
Self Emp. Entrepreneur	--	--	0.095	2.197*
North West	0.120	5.280*	0.249	4.390*
North East	0.077	2.929*	0.085	1.497
Central	0.064	2.907*	0.079	1.347
Island	-0.032	-1.227	-0.070	-1.141
1 additional worker	0.466	27.159*	0.368	8.683*
2 additional workers	0.766	21.139*	0.609	7.263*
3 additional workers	1.033	15.704*	0.608	4.005*
4 additional workers	1.152	7.155*	0.664	2.675*
Constant	1.351	9.820*	1.161	3.909*
Adjusted R^2	0.588		0.316	
Variance of Estimate	0.102		0.238	
Mean ln w	2.761		2.949	

Notes: * Significant at 5% level or better, ** significant at 10% level,
'--' denotes that a variable is not defined for that sub-sample.

As we would expect the effect of 1-4 additional workers in the household is significant for both types of worker. The effect increases from 47 to 115%

higher earnings for employees and 37 to 66% higher earnings for the self-employed, as the number of additional workers in the household increases.

7.7.3 Hypothesis 1 and Actual Results

Under Hypothesis 1 if weak screening occurs we would expect the employees sub-sample to fit the estimated earnings equation in Table 7.7 more accurately than the self-employed sub-sample. This is indeed the case; approximately 59% of the variation in earnings of male full-time employees is explained by the regression, compared to an R-squared of 32% for the self-employed sub-sample. The variation of the estimate is relatively lower for the employee sub-sample again indicating a better fit. We can therefore reject the null hypothesis, giving support to the weak screening model.

7.7.4 Hypothesis 2 and Actual Results

From Table 7.7, we can see that the estimated earnings effect of having no formal certification in comparison to having primary certification is significantly positive and approximately equal to 11% for employees, and is not significant for the self-employed. This implies that the earnings of employees completing the primary stage of education but failing to get the intermediate certification, which concludes the compulsory stage of education in Italy, are actually lower than those employees with no formal certification.

Intermediate certification is also significant in affecting earnings of employees in comparison to the earnings earned by employees with primary certificates; intermediate certification increases earnings, *ceteris paribus*, by approximately 9%. No such positive returns are present for the self-employed holding no educational certification, or intermediate certification in comparison to primary certificates.

High school certification and university degree level certification has a significant positive effect on the earnings of both the self-employed and employees in comparison to those with primary certification. Wage rates are increased by high school graduation by approximately 19% for employees and

23% for the self-employed. Wage rates are increased by university graduation by approximately 33% for employees and 46% for the self-employed. The higher returns to both these certificates for the self-employed is contrary to the screening hypothesis and therefore, although the other two education categories have no effect on the wages of the self-employed, we cannot reject the null hypothesis and there is little support for the screening hypothesis from these results.

Following the 'consumer-screening' hypothesis of Lazear (1977), we might expect that self-employed professionals would acquire qualifications in order to signal the quality of their services to potential clients, thus raising the average level of education of the self-employed and upwardly biasing the returns to certification in the self-employed sub-sample. However, contrary to Lazear's hypothesis, the omission of professionals from the sub-sample of self-employed workers in the SCIF sample was found not to effect the estimated returns to the certification dummy variables in the earnings function.

7.7.5 Hypothesis 3 and Actual Results

Table 7.8 shows the estimated earnings functions for male full-time employees in the public administration and commercial plus other services sectors of the Italian economy. From Table 7.8 there are three main points of interest. Firstly, the returns to general human capital, as proxied by years of age, appear to differ significantly between the two sectors. The commercial/other services sector displays an estimated average increase in earnings due to each year of age of approximately 5% in comparison to 3% in the public administration sector.

The estimated coefficient on age-squared for male employees in the public administration sector is insignificant, whereas the coefficient for commercial/other services sector employees is significant, indicating that low returns to age persist in public administration jobs but fall in commercial service sector jobs in Italy as age increases. This implies that there is apparently a diminishing marginal rate of return to age in the commercial/other services sector but not in the public administration sector.

Table 7.8: Estimated Earnings Equations for Italian Male Full-time Employees by Sector (1989)

Sector:	Public Administration (N = 335)		Commercial / Other Services (N = 398)	
Variable Name	Estimated Coefficient	T - Ratio	Estimated Coefficient	T - Ratio
Age	0.030	1.932**	0.050	3.746*
Age^2	-0.253E-3	-1.429	-0.502E-3	-3.272*
Married	0.156	2.141*	0.103	1.484
Divorced/widowed	-0.318	-1.854**	0.073	0.367
Intermediate Certificate	0.156	1.927*	0.842E-2	0.171
High School Certificate	0.232	2.866*	0.093	1.646
Degree	0.420	4.695*	0.171	2.351*
Clerical Occupation	0.020	0.325	0.183	4.195*
Middle Level Occ.	0.096	1.262	0.413	7.111*
High Level Occ.	0.322	3.041*	0.689	7.319*
North West	-0.277E-2	-0.048	0.190	3.597*
North East	-0.054	-0.864	0.151	2.570*
Central	-0.093	-1.718**	0.161	3.442*
Island	-0.041	-0.675	-0.011	-0.206
1 additional worker	0.444	10.509*	0.472	13.177*
2 additional workers	0.711	5.222*	0.708	9.415*
3-4 additional workers	1.231	5.837*	0.894	6.572*
Constant	1.405	4.025*	0.938	3.477*
Adjusted R^2	0.507		0.597	
Variance of Estimate	0.119		0.102	
Mean ln w	2.844		2.764	

Notes: * Significant at 5% level, ** significant at 10% level.

The second point of interest is the general lack of significance of coefficients on the regional dummy variables in the public administration sector and the large and significant coefficients in the commercial/other services sector. This means, for example, for male employees working in the commercial/other services sector living in the North West increases the amount earned by approximately 19% in comparison to those living in the South, whereas there is no such regional effect for employees in the public administration sector. This may well be due to the fact that public administration wages are negotiated on a national basis with no regional market influences, whereas commercial/other services wages are more likely to be determined on a regional market level [see Allen *et al* (1974) for further details].

The third point of interest from Table 7.8 is that we can reject the null in Hypothesis 3. The estimated rates of return to intermediate and high-school level certification, in comparison to primary certification or no certification, are both positive and significant for the public administration estimated earnings equation, but insignificant in the commercial/other services equation. The certificates appear to hold no human capital or informational value in the commercial/other services sector, whereas in the public administration sector intermediate certification gives approximately 16% and high-school certification gives approximately 24% higher earnings in comparison to those with primary school certificates as the highest obtained.

However, this result does not continue when we look at degree level certification; both groups of employees have their earnings increased significantly by holding degree level certificates. Public administration employees holding degrees have earnings increased by approximately 42%, and commercial/other services sector employees holding degrees have earnings increased by approximately 17%. This result lends support to the weak screening hypothesis since employees in the less screened sector (commercial and other services) appear to benefit less from their education in terms of higher wages than those in the more screened sector (public administration).

A Chow test of the equality of the two sets of estimated coefficients in the estimated earnings functions shown in Table 7.8, gives a calculated F-statistic of approximately 2.22 which is significant at the 5% level, which indicates that the estimated coefficients are significantly different from one another.

A Gujarati (1970) dummy variable test gives the estimated earnings equation for the pooled data shown in Table 7.9. The notation PA**variable* represents a dummy variable showing that the SCIF respondent is working in the public administration sector and is characterised by the *variable*=1, and where such interactive dummy variables are not significant they are omitted from the model.[7]

From Table 7.9 we can see that the apparent sectoral difference in the rate of return to years of age is not significant. However, there are significant sectoral differences in the effects of educational certification, occupational classification and geographic region upon male full-time employees earnings. We cannot

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[7] The dummy variable representing public administration sector employment itself was insignificant in this pooled regression.

accept the null of Hypothesis 3 and therefore conclude that there is some evidence in support of the weak screening hypothesis on the basis of this methodology.

Table 7.9: Estimated Earnings Equation for Pooled Set Including Sector-variable Interaction Dummies

Public Administration, Commercial and Other Services (N = 733)		
Variable Name	**Estimated Coefficient**	**T - Ratio**
Age	0.038	3.809*
Age^2	-0.354E-3	-3.097*
Married	0.135	2.692*
Divorced/widowed	-0.155	-1.209
Intermediate Certificate	-0.015	-0.306
High School Certificate	0.082	1.454
Degree	0.162	2.214*
Clerical Occupation	0.178	3.998*
Middle Level Occupation	0.400	6.715*
High Level Occupation	0.663	6.880*
North West	0.176	3.424*
North East	0.137	2.408*
Central	0.145	3.227*
Island	-0.024	-0.584
1 additional worker	0.461	16.827*
2 additional workers	0.708	10.627*
3 or 4 additional workers	1.011	8.742*
PA*Intermediate Cert.	0.256	3.524*
PA*High School Cert.	0.228	2.913*
PA*Degree	0.335	3.397*
PA*Clerical Occupation	-0.127	-1.803**
PA*Middle Occupation	-0.263	-2.863*
PA*High Occupation	-0.298	-2.166*
PA*North West	-0.155	-2.280*
PA*North East	-0.171	-2.256*
PA*Central	-0.216	-3.521*
Constant	1.154	5.437*
Adjusted R^2	0.557	
Variance of Estimate	0.111	
Mean ln w	2.801	
F - statistic	36.391	

Notes: * Significant at 5% level or better, ** significant at 10% level.

7.7.6 Hypothesis 4 and Actual Results

Table 7.10 shows the results from estimating earnings equations for the 1750 full-time male employees in the SCIF sample. The mean age level of employees is 44 years and so this was chosen to construct the dummy variables representing age-variable interaction denoted '44**variable*' in Table 7.10; where significant these show the effects of being age 44 or above and be characterised by *variable* = 1.

Note that age has been used in this Chapter as a proxy variable for tenure or general human capital accumulation. We would expect that there is a general positive correlation between tenure and years of age. However, as explained in Chapter 6, it would be unwise to ignore the fact that some older individuals may just be starting new occupations. However, those over the age of 44 are assumed to have longer tenure with their present employer and to have built up more experience and alternative information (in the form of a work performance record) about themselves than those who are younger.

The interactive effects of marital status, occupation level, living in the North East or on an Island, and the having additional workers in the household, in conjunction with being aged 44 or over were found to be insignificant in determining wages of Italian full-time male employees. However, there appears to be significant interaction between no certification, intermediate certification, North West residence and Central residence and the dummy variable representing age 44 and over. Residence in the North West or Central regions of Italy and being aged 44 or over increases earnings by approximately 7-8% in comparison to younger employees.

We assume that the return to education as a human capital investment is constant as age increases i.e. any further human capital return is from labour market experience (general human capital investment) or work-related training (specific human capital investments). Under the strong screening hypothesis, we therefore expect that the return to each certificate held (earnings differential compared to a person with primary certification) decreases as tenure increases, since its informational component does not hold its value as tenure increases and alternative information becomes available to employers.

Having no certification and being aged 44 or over reduces the earnings of male employees by approximately 27%. The negative effect of having no qualifications at this age level, in the context of the weak version of the screening hypothesis, may be due to a combination of effects including the bad signal it sends to potential employers, the low level of educational human capital the person holds, and the lack of opportunities for promotion from previous employers earlier in life.

Table 7.10: Estimated Earnings Equations for Full-time Male Employees including Age-variable Interaction Dummies

Employees (N = 1750)		
Variable Name	**Estimated Coefficient**	**T - Ratio**
Age	0.030	4.555*
Age^2	-0.259E-3	-3.474*
Married	0.101	2.845*
Divorced/widowed	0.012	0.174
No Certification	0.290	3.306*
Intermediate Certificate	0.140	5.140*
High School Certificate	0.209	7.755*
Degree	0.349	9.812*
Clerical Employee	0.137	6.600*
Middle level Employee	0.300	10.415*
High level Employee	0.514	10.923*
North West	0.088	3.158*
North East	0.076	2.879*
Central	0.031	1.162
Island	-0.034	-1.315
1 additional worker	0.468	27.344*
2 additional workers	0.769	21.224*
3 additional workers	1.027	15.610*
4 additional workers	1.139	7.094*
44*No Certification	-0.271	-2.505*
44*Intermediate Cert.	-0.094	-2.844*
44*North West	0.076	2.061*
44*Central	0.067	1.886*
Constant	1.348	9.602*
Adjusted R^2	0.591	
F - statistic	111.086*	
Variance of Estimate	0.101	
Mean ln *w*	2.761	

Notes: * Significant at 5% level, ** significant at 10% level.

Having intermediate certification as the highest educational qualification held and being aged 44 or over reduces the earnings of male employees by approximately 9%. Using the methodology of Tucker (1986), the observed lack of increasing returns to high school and degree level certification, and the observed decreasing returns to intermediate certification as age increases over the mean level offers some weak evidence in favour of rejecting the null of Hypothesis 4.

We now move on to Hypothesis 5, another test of the strong hypothesis, used by Tucker (1986), which looks at the returns to tenure between education groups, for more and possibly clearer evidence of strong screening.

7.7.7 Hypothesis 5 and Actual Results

The estimated earnings equations for school-leavers and university graduates working full-time in Italy are shown in Table 7.11. Those with Intermediate or High school certificates make up the school-leavers sub-sample, while degree holders make up the university graduates sub-sample. Occupational classification reference category now corresponds to top management and similar jobs.

Table 7.11: Estimated Earnings Equations for Italian Full-time Employees by Education (1989)

Education Level:	**School - leavers (N = 1238)**		**University Graduates (N = 209)**	
Variable Name	**Estimated Coefficient**	**T - Ratio**	**Estimated Coefficient**	**T - Ratio**
Sex	-0.003	-0.060	0.282	2.658*
Age	0.034	4.322*	0.053	2.459*
Age^2	-0.00032	-3.350*	-0.00050	-2.119*
Married	0.006	0.155	0.099	1.204
Divorced/widowed	-0.102	-1.950**	0.192	1.195
Blue collar/Clerical Occ.	-0.548	-7.409*	-0.282	-4.308*
Middle Level Occupation	-0.299	-3.851*	-0.204	-2.838*
North	0.069	2.707*	-0.049	-0.825
Central	0.007	0.249	-0.009	-0.133
Island	-0.011	-0.340	-0.231	-2.811*
1 Additional worker	0.513	24.535*	0.399	7.261*
2 Additional workers	0.770	14.513*	0.671	4.193*
3 Additional workers	1.137	12.040*	--	--
4 Additional workers	1.297	5.469*	--	--
Constant	2.124	11.682*	1.466	3.047*
Adjusted R^2	0.512		0.481	
Variance of Estimate	0.110		0.114	
Mean ln w	2.740		3.091	

Notes: * Significant at 5% level or better, ** significant at 10% level,
'--' denotes that a variable is not defined for that sub-sample.

We can calculate from the mean log-wage given in Table 7.11 that the average wage-rate is 15487 lire per hour for school-leavers and 21999 lire per hour for university graduates. The family earnings premium to university graduates in comparison to school-leavers is therefore approximately 30%.

Following Tucker (1986), Hypothesis 5 suggests that under the strong screening hypothesis returns to tenure do not increase as education level increases. However, we can see from Table 7.11 that the rate of return to age, the proxy variable for tenure, does increase between the relative low and high education worker sub-samples; representing a 3% and 5% increase in earnings on average per year of tenure respectively. This refutes the strong screening hypothesis.

A Chow test of the hypothesis that the two estimated earnings equations are significantly different i.e. that the labour markets for the two groups are separated gives a calculated F-statistic of 5.51 which is significant at the 1% level.

7.7.8 Conclusion

Using the worker-type comparative methodology to test the role of education in the Italian labour market, we find little support for the screening hypothesis. Intermediate certification increases earnings, *ceteris paribus*, by approximately 9% in comparison to the amount earned by employees with primary certificates. No such positive returns are present for the self-employed holding no educational certification, or intermediate certification in comparison to primary certificates.

High school and degree level certification has a significant positive effect on the earnings of both worker types in comparison to those with primary certification. Earnings are increased by high school and university graduation by approximately 19% and 33% for employees, and 23% and 46% for the self-employed. The higher returns to high school and university level certification for the self-employed is contrary to the screening hypothesis and therefore, although the other two education categories have no effect on the earnings of the self-employed, there is little support for the screening hypothesis from these results.

Using the P-test methodology of Chapter 6 on the SCIF 1989 gives some support to the weak, but not the strong, version of the screening hypothesis. The estimated rates of return to intermediate and high-school level certification, in comparison to primary certification or no certification, are significant and positive in the public administration sector, but insignificant in the commercial/other services sector. The certificates appear to hold no human capital or informational value in the services sector.

However, employees in both sectors have their earnings increased significantly by holding degree level certificates. Holding a degree increases earnings by approximately 42% and 17% for public administration and service sector employees respectively. This result lends support to the weak screening hypothesis since employees in the less screened sector in comparison to those in the more screened sector appear to a lower net benefit from their education.

Using Tucker's (1986) methodology on the SCIF 1989 data provides some tentative evidence in favour of the weak screening hypothesis for Italian employees. The results show a lack of increasing returns to high school and university certificates, and a significant decrease in returns to intermediate certification as age increases over the mean level. Tucker (1986) also suggests that under the strong screening hypothesis returns to tenure do not rise as education level increases. However, the rate of return to age, the proxy variable for tenure, was found to increase between the relative low and high education worker sub-samples, refuting the strong screening hypothesis.

7.8 Conclusion

There appears to be little regional difference in the role of education in the Italian labour market; comparisons between earnings determination in the North-Centre and South, showed little variation in the effect of certification upon earnings. The estimated rates of return to intermediate, high-school and degree level certification are equivalent in both regions. The only apparent regional difference is the positive earnings effect of no certification in comparison to primary schooling in the North-Centre region; explained in Appendix 7.2.

Comparisons between the UK and Italy showed that the average earnings effect of years of education appears to be higher in the UK (10% higher earnings per year compared to 4% in Italy). This implies that EU directives aimed at labour market convergence should address the issue of differences in the efficiency and equity of educational systems in providing skills and increased earnings for workers in member states.

It was also shown that being male rather than female in the UK increases the wage rate of full-time workers by approximately 30%. In Italy the equivalent gender effect was insignificant in the South, and approximately 9% in the North-Centre region. These results reflect the poor position of female workers in the market for full time employment in both member states. Self-employment was found to decrease earnings in the UK and increase earnings in Italy. These differences may reflect national differences in government policy towards small businesses, and the viability of self-employment.

These results imply that EU labour market policies aimed at convergence in wage rates and productivity should also address the issue of the national differences in opportunities for female workers and workers who want to be self-employed.

Using the worker-type comparative methodology, we find little support for the screening hypothesis in Italy. Intermediate certification increases earnings significantly in comparison to the amount earned by employees with primary certificates. No such returns are found for the self-employed with no educational certification, or intermediate certification.

High school and degree level certification has a significant positive effect on the earnings of both worker types in comparison to those with primary certification, and there are higher returns from these certificates for the self-employed. This result leads to a rejection of the screening hypothesis.

Using the P-test methodology gives some support to the weak version of the screening hypothesis. The estimated rates of return to intermediate and high-school level certification, in comparison to primary certification or no certification, are significant and positive in the public administration sector, but insignificant in the commercial/other services sector. However, employees in both sectors have their earnings increased significantly by holding degree level certificates.

Using the tenure group methodology provides some evidence in support of weak screening in Italy. The results show a lack of increasing returns to high school and university certificates, and a significant decrease in returns to intermediate certification as age increases over the mean level. The rate of return to age, the proxy variable for tenure, was found to increase between the relative low and high education worker sub-samples, refuting the strong screening hypothesis.

In summary, although Italy is characterised by a different education and labour market structure in comparison to the UK, there again appears to be no support for the strong screening hypothesis, tentative support for the weak screening hypothesis and strong support for the human capital model of education.

Appendix 7.1:

Summary of Variables derived from Bank of Italy Survey on Consumption by Italian Families 1989

Table 7.12: Description of Variables Derived from Bank of Italy SCIF 1989

Variable Name	Description
Age	Respondent's age in years
Married	0 = Respondent is not married, 1 = married or living as married
Single	0 = not single, 1 = single
Divorced/widowed	0 = not divorced or widowed, 1 = divorced or widowed
No formal Education	0 = other education, 1 = respondent has no formal education
Primary Certificate	0 = other education, 1 = primary school certificate
Intermediate Cert.	0 = other education, 1 = intermediate school certificate
High School Cert.	0 = other education, 1 = high school diploma (equivalent to UK 'A' levels)
Degree	0 = other education, 1 = university graduate (equivalent to UK degree)
Months worked	Months worked by respondent in 1989
Weekly Hours	Average hours worked per week in 1989
Blue Collar	0 = other occupational class 1 = blue collar worker, apprentice, domestic or similar job
Clerical	0 = other occupational class 1 = employed in a clerical, teaching or similar job
Middle Level Occupation	0 = other occupational class 1 = employed in a middle management job or with similar status
High Level Occupation	0 = other occupational class 1 = employed as a company director, president, top management, magistrate/judge, lecturer or job with similar status.
S.E. Professional	0 = other occupational class 1 = respondent is a self-employed professional
S.E. Entrepreneur	0 = other occupational class 1 = respondent is a self-employed entrepreneur
S.E. Other	0 = other occupational class 1 = respondent is a self-employed in another occupation (includes those working as self-employed assistants within companies)
North West	0 = Living in the North West 1 = Living elsewhere Areas included as North West Italy are: Piemonte, Valle d' Aosta, Lombardia, Liguria, Toscana
North East	0 = Living in the North East 1 = Living elsewhere Areas included as North East Italy are: Trentino - Alto Adige, Friuli - Venezia Giulia, Emilia Romagna
Central	0 = Living in Central Region 1 = Living elsewhere Areas included as Central are: Umbria, Marche, Lazio, Abruzzi, Molise
South	0 = Living in Southern Italy 1 = Living elsewhere Areas included as South are: Campania, Puglia, Basilicata, Calabria
Island	0 = Living in Sicily or Sardinia, 1 = Living elsewhere
Family Income	Family net disposable income in 1989 (Italian Lire)
***n* additional worker(s)**	The respondent's household contains *n* other person(s) who contribute to household income by full or part-time work.

Appendix 7.2:

The Influence of Additional Workers in the SCIF Respondent's Household

The results of estimating earnings functions for those SCIF respondents who have no additional workers living in their houses and contributing to the family income figure for 1989 are shown in Table 7.13. In comparison to Table 7.7 we can see that, in general, the estimated coefficients on age, age squared and the education variables (the variables we are most concerned with in this thesis) are not significantly affected in terms of magnitude and significance by the exclusion of those household heads who live in multiple worker households.

Table 7.13: Estimated Earnings Equations for Italian Male Full-timers with no Other Workers in Household in 1989 by Worker Type

Worker Type:	Employees (N = 897)		Self - employed (N = 350)	
Variable Name	Estimated Coefficient	T-Ratio	Estimated Coefficient	T-Ratio
Age	0.029	3.099*	0.051	2.764*
Age^2	-0.259E-3	-2.380*	-0.435E-3	-2.197*
Married	0.141	3.284*	0.096	1.091
Divorced/widowed	0.012	0.152	-0.079	-0.489
No Certification	0.076	0.989	0.018	0.125
Intermediate Certification	0.072	2.217*	0.017	0.231
High School Certificate	0.199	5.045*	0.212	2.529*
Degree	0.349	6.234*	0.443	3.596*
Clerical Employee	0.106	3.414*	--	--
Middle level Employee	0.307	7.056*	--	--
High Level Employee	0.560	8.161*	--	--
Self Emp. Professional	--	--	0.162	1.943**
Self Emp. Entrepreneur	--	--	0.106	1.656**
North West	0.180	5.049*	0.331	4.050*
North East	0.149	3.599*	0.139	1.668**
Central	0.114	3.548*	0.183	1.903**
Island	-0.012	-0.363	-0.056	-0.071
Constant	1.327	6.844*	1.005	2.416*
Adjusted R^2	0.334		0.190	
Variance of Estimate	0.117		0.263	
Mean ln w	2.466		2.706	

Notes: * Significant at 5% level or better, ** at 10% level, '--' denotes where a variable is not defined for that sub-sample.

The only major change is that no certification in comparison to primary certification no longer has a significant positive effect on the earnings of male employees. In Section 7.7.2, it appeared intuitively incorrect in the context of both the screening and human capital models to expect that no certification would have a positive earnings effect in comparison to a higher level of education (primary education), and this can now be attributed to the effect of additional workers in the household subsidising the earnings of unqualified household heads.

The decision to increase sample size and include dummy variables representing additional workers, following the argument that we should use all the available data to avoid incidental truncation problems, is made on the basis that the earnings equation, as shown in Table 7.13, is relatively robust.

The second argument is concerned with degrees of freedom; in a number of the regional and sectoral analyses the number of observations exhibiting positive dummy variable values for certain variables would have been seriously depleted if multiple worker households were omitted.

Chapter 8
Conclusion

The aim of this Thesis was to investigate the role which education played in the formation of full-time wage rates for workers in the UK over the period 1985-1991 and workers in Italy in 1989. The positive correlation between education and earnings in these two countries is not disputed, but what has been tested is the process in which higher levels of education generally lead to higher levels of earnings. The traditional model of the earnings-education relationship, human capital theory, posits that individuals invest in education to improve their productivity and therefore future income since firms are assumed to pay wages equal to individual productivity. The alternative model of the earnings-education relationship, the screening hypothesis, posits that education serves as an indicator of the general productive ability of an individual which may not be influenced by that education. In the 'strong' version of the screening hypothesis the education which is used as a signal does not improve productivity, whereas in the 'weak' version of the screening hypothesis the education does have a positive effect on productivity.

In Chapter 2 the theoretical foundations of the screening hypothesis were reviewed. The overall conclusion from Chapter 2 was that the efficiency of screening equilibria in the labour market depends upon the assumptions made about the production process, the number of types of labour, the nature of signalling costs and the ability of firms to use alternative screening devices and compete in wage setting. It was also posited that screening theory does not contradict later theories of wage determination; rather it acts as complementary model for labour markets characterised by asymmetric information.

Chapter 3 presented a survey of the previous empirical studies of the screening hypothesis. The overall conclusion from these studies was that there is little evidence in support of the strong screening hypothesis, some support for the weak screening hypothesis and overwhelming support for human capital theory. However, since tests tended to be put into the context of the human capital versus screening debate, it was found that there were few tests of the weak version of the screening hypothesis and tests of the role of credentials as screening devices. A lack of empirical evidence was also apparent for most EU member states, including the UK and, moreover, Italy.

In Chapter 4 traditional human capital functions were estimated for male and female full-timers who responded to the BSA Survey 1985-1991. The average percentage effect upon wage rates from each year of education was estimated as approximately 5-6% with the inclusion of additional explanatory variables controlling for union membership, recent unemployment, marital status, occupation, racial origin and geographical region. This figure is significantly lower than the estimated rate of return from the simple Mincerian function which was approximately 11%, and the rates of return estimated for previous UK studies; 10% [from Psacharopoulos & Layard (1979)] and 16% [from Harmon & Walker (1995)].

The inclusion of the additional explanatory variables reduced the superiority of the quartic Murphy & Welch (1990) function over the Mincerian function in explaining the variation in wage rates. Estimation of the Psacharopoulos & Layard (1979) function gave results showing significant interaction between years in the labour force and years of education. However, significant shifts in the marginal rate of return to years of education (MRE) were found in the three human capital models.

The shifts in the MRE were found to occur in years which would normally involve educational certification, and it was proposed that controlling for highest certification level in the wage rate functions could control for the MRE variations. Estimates of wage rate functions including dummy variables representing the highest certificate held, instead of years of education as a measure of education level, were found to explain the variation in wage rates more accurately because they allowed for the effect of years of schooling plus certificates upon wage rates. The object of Chapter 5 and Chapter 6 was to test the possible screening role that education may have had in the determination of full-time wage rates in the UK over the sample period.

In Chapter 5 separate wage rate functions were estimated for self-employed workers and employees in the BSA Survey sample. Significant differences were found between these sub-samples in the effects on wage rates of years of education, highest certification levels and private education.

The estimated average rate of return to years of education was higher for employees in comparison to the self-employed. All the certificate dummy variables were found to significantly increase wage rates of employees, whereas only degree level, trade and business, apprenticeships and O-level certification were found to significantly effect the wage rates earned by the self-employed. The effect of private schooling was positive and significant for employees but not for the self-employed. These results can be taken as evidence in support of the weak but not the strong screening hypothesis in relation to the market for male full-time workers in the UK, since under the strong screening hypothesis we would expect no significant education effects for the self-employed..

Unqualified and qualified employees were found to have significantly different estimated wage rate functions, and years of education were found to have no influence on the wage rates of unqualified workers. This may be because certificates rather than years of education act as a screening device and that years of education do not improve productivity. Alternatively, it may be that increased years of education have such a strong negative signalling effect upon the wage rates of the unqualified, since they are not accompanied by increased certification, that it outweighs any positive effect from improved productivity.

The negative effect of recent unemployment was found not to differ significantly between worker types, and the hypothesis that recent unemployment incidence had a screening role was rejected. The effect of years in the labour force was found to be significantly different between work types. This may be due to the wage-tenure structure inherent in employee pay schemes, but also may be due to experience having a screening role in the labour market. No evidence was found of a bias in the estimated rate of return to education by including professional workers in the regressions, and so unlike previous studies, professionals were not omitted from the sub-samples used to test the screening hypothesis.

In Chapter 6 a number of alternative methodologies were used to test the strong and weak versions of screening hypothesis in relation to the BSA Survey data. The results of testing Katz & Ziderman's (1980) weak screening model were found to give no support to this model based on an analysis of education levels by occupation level and worker type. However, the self-employed tend to be concentrated in certain occupations in the BSA Survey data and this may bias results.

The P-test methodology of making sectoral comparisons of mid- to early-career earnings ratios and wage rate functions was applied to the BSA Survey data. The methodologies of Tucker (1986) were also used. Using these methodologies, we can say that there generally appears to be little evidence in Chapter 6 in support of either version of the screening hypothesis, but that there is support for the human capital theory.

Combining the results of Chapters 4-6 we reach the overall conclusion that there is little evidence in support of the existence of strong screening in the UK, but that there is some support for the weak screening hypothesis and human capital theory. I would tend towards the view expressed by Dolton (1985) in relation to the role of education in the UK, in that there is reasonable evidence to support a model which incorporates both the signalling and human capital roles of education, but no evidence to support the strong version of the screening hypothesis.

Chapter 7 tested the role of education in the Italian labour market. Comparisons between earnings determination in the North-Centre and South of Italy, showed that there was little variation in the effect of education upon earnings, even though the two areas have different levels of economic development. Comparisons between the UK and Italy in 1989 showed that the average rate of return to years of education was approximately twice as high in the UK compared to Italy. It was also shown that the effects of gender and worker type are significantly different in the two countries. This implies that EU labour market policies aimed at convergence in wage rates and productivity should also address the issue of the differences in opportunities for female workers, the self-employed and the efficiency and equity of educational systems in providing skills and increased earnings for workers in member states. However, we must note that the earnings equations of the two countries differed in the dependant and independent variables included, and so these results are at best approximate representations of the true differentials between these two EU member states.

Chapter 7 applied the worker type comparative methodology from Chapter 5 and sectoral, education and tenure grouping, methodologies of Chapter 6 to data for Italy 1989. The higher returns to high school and university level certification estimated for the self-employed in comparison to employees is contrary to the screening hypothesis and therefore, although the other two education categories were shown to have no effect on the earnings of the self-employed, there is little support for the idea that education has a signalling role in the Italian labour market from these results.

Applying the P-test methodology of Chapter 6 to the Italian data gave some support to the weak, but not the strong, version of the screening hypothesis. Intermediate and high-school level certification appeared to hold no human capital or informational value in the services sector. However, degree level certification increased earnings by approximately 42% and 17% for public administration and service sector employees respectively. This result lends support to the weak screening hypothesis since there appeared to be a lower average rate of return to higher education in the less screened sector in comparison to the more screened sector. Using Tucker's (1986) methodologies on the Italian data provided some evidence in favour of the weak screening hypothesis, but refuted the strong screening hypothesis.

As with the UK data, there is some evidence to support a model which incorporates both the signalling and human capital roles of education in the Italian labour market, but no evidence to support the strong screening hypothesis.

If weak screening exists in the labour markets of the UK and Italy, as is suggested by the results of this Thesis, there are important policy implications. The weak screening model gives the result that workers are paid wages equal to their marginal productivity, which is equivalent to the human capital model; in this case self-funding policy is not justified if all courses are improving national productivity (and acting as signals).

However, some educational courses in the two countries may be acting mainly as screening devices and have little effect on individual and therefore national productivity, whereas other courses may be acting mainly as ways of improving individual and national productivity, and other courses have equal roles. Because of this the introduction of self-funding for higher education (and indeed post-compulsory education of all types) may distort both the distribution of income and the growth of national output.

If self-funding has blanket coverage then some individuals may abstain from investing in those courses which do impart useful skills (and also act as job market signals). In the case of weak screening the required policy would appear to be to impose self-funding only on those courses that act mainly as job market signals of *a priori* information, to impose joint funding (i.e. central and self-finance schemes) for those courses which both improve and signal productivity equally, and to centrally fund those courses which are solely or mainly human capital in nature, from national resources.

As previously mentioned there is no control variable or proxy variable for individual productive ability throughout the analyses contained within this thesis, this was due to data limitations; no such variables were available in the BSA sample or SCIF sample. Therefore, the first caveat to be applied to the results contained in this thesis is to note that an implicit assumption is being made; the individuals in the two groups used in each comparative methodology are on average assumed to have insignificantly different levels of ability. For example, if the employee subsample used in Chapter 5 have a higher average level of productive ability than the self-employed then this may be one reason why they earn more, rather than the differential being due to returns to their higher levels of education.

Taubman (1976a,b) found that not controlling for genetics and family background in such regressions may cause a over-estimation of coefficients of up to two thirds. However, Griliches (1977) showed that the assumed positive omitted-ability bias in estimation of earnings coefficients in earnings regressions may actually be insignificant or reversed.

Indeed, Weiss (1995) contends that in screening models firms cannot directly observe the productivity enhancing attributes of a worker that are commonly omitted from earnings regressions. Firms use education as an indirect estimator of the unobserved ability. The estimated coefficient on education is fully capturing the effects of the firms' estimation process and would not be affected by the inclusion of additional explanatory variables that the firm cannot directly observe. Indeed, due to similar data limitations as experienced in this thesis, a majority of the articles reviewed in Chapter 3 use simple Mincerian earnings functions to estimate the education-earnings relationship and have no control for individual demographic, regional or ability related variables.

The second caveat applies to the P-tests and is simply a re-statement of Ziderman's (1990) critique detailed in Section 6.2.7. Ziderman (1990) posits that the methodology of identifying whether educational effects are eroded with age is based upon an incorrect interpretation of the screening model. In the P-test literature the model tested is one in which firms pay irrationally higher starting salaries to the more educated workers in the absence of alternative information. The distinction drawn between the weak and strong hypotheses is based upon whether firms continue to pay irrational wages after the worker has been monitored on the job.

This theoretical framework is in conflict with the previous theoretical literature in which firms will only continue to use education as a screen if it can be used to correctly predict the productivity of workers at the point of hiring. Ziderman (1990) suggests that the erosion of returns to educational variables with age is an effect of older applicants rather than existing workers with higher tenure. He suggests that the observed erosion of returns with age is due to the accumulation of information from labour force participation which can be used as an alternative screen for productive ability.

A further limitation of this thesis is that it does not follow those methodologies which appear to be best designed for the analyses of the role of education; due to the lack of useful detail within both the BSA Survey and SCIF data sets. This author would suggest that three methodologies stand out as candidates for future research when suitable data becomes available; both because of their lucid analyses and their lack of application by previous economists.

These methodologies are as follows: Oosterbeek & Groot's (1994) methodology of the decomposition of actual years of schooling into effective, repeated, skipped, inefficient routing and dropout years. Wiles (1974) proposed methodology of comparing the earnings of workers in occupations related to their educational qualifications to those of other workers with the same qualifications, but who are working in areas not directly related to their education. A modification of Albrecht's (1981) methodology of analysing the hiring process of the employer using a probit model to test the screening hypothesis.

In Albrecht's analysis in which applicants are characterised by their education and the amount of information the hiring firm has about them, the firm is assumed to depend more heavily on education as a signal when screening applicants about which it has no alternative information, and the dependant variable is zero or one depending on whether the applicant is hired. I would suggest that the dependant should be zero or one depending on whether the applicant is asked for an interview i.e. if the applicant passes through the initial educational screening process, since much 'noise' is introduced by variations in interview performance and additional information arising from the interview.

Garen (1984) and Harmon & Walker (1995) tackle the endogeniety of schooling using two-stage selection models. Schooling is treated as a choice variable and selectivity corrected rates of return are estimated. The findings suggest that is important to control for selectivity and support the comparative advantage hypothesis of Willis & Rosen (1979). This methodology was not incorporated into the analyses in this thesis and in future research I hope to clarify the issue of educational choice between worker types using such a model.

Further research in this field should apply to different models as well as different methdologies. The intuitively appealing credentialist theory appears to have seldom been analysed empirically. In Thurow's (1975) job-queue model workers improve their education simply to maintain their relative position in the queue for jobs; a heirachy in which those at the front of the queue have the opportunity to gain jobs which have higher salaries than those that could be gained in a position further down the queue. Similar analyses can be found in the field of psychology; for example see Berg (1971) and Dore (1976). Such credentialist models, where qualifications and union, staff association or professional group membership is an uncompetitve and non-productive barrier to entry in the labour market, need to be thoroughly tested in an economic framework.

Second is the case alluded to in Section 2.5.3 and above, where in a weak screening environment there may be qualifications that have different strengths as signals and productivity enhancers. Following evidence of weak screening, future research should focus on the extent to which specific courses of centrally funded higher and non-compulsory education are job market signals and the extent to which they improve worker productivity; to allow better management and targetting of educational funding.

A third area that requires further research is the extent to which on-the-job training or day release courses, which may be funded by the firm (in the case of firm-specific skills) or indirectly by the worker (in the case of general skills), could replace higher education as a more efficient provider of human capital in some industries, and negate the necessity for other, possibly less efficient, screening processes.

Finally, in an international context, the differing roles of qualifications in the different domestic markets of member states of the EU (i.e. which qualifications are mainly used as screening devices, and which ones are considered mainly as productivity augmenting in a weak screening environment) implies that there may be discriminatory behaviour patterns inherent in hiring and wage setting processes that EU directives have not yet addressed. Further research is necessary to understand and evaluate the role of education in the EU labour market as a whole.

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