Wages determination, wage subsidies and training

by

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Abstract

In the economics literature, there has been a resurgent interest in measures of subjective well-being. This literature finds mixed results for the relationship between job satisfaction and earnings. We argue that this is due to the fact that earnings in a job satisfaction regression are endogenous. We estimate a job satisfaction equation that includes exogenous variation in earnings. We find that earnings have a consistently significant, but small positive effect on job satisfaction, and that relative earnings also matter

Despite over fifty years of research into the returns to education around the world, there has been no unified effort to analyse why the returns differ so significantly both over time and across countries. We specify two models where the returns to education are affected both directly and indirectly by changes in technology over time. Both models show that a large proportion of the variation in the returns to education can be explained by changes and differences in technology.

Through the Working Tax Credit and Child Tax Credit, the UK government currently subsidises the wages of around 6.3 million low-paid workers. The long-run implications of the tax credits for these workers have only been evaluated in terms of their effects on labour supply. We estimate the impact of the tax credits on wage growth and the take-up of training. We find no significant differences in the average wage growth of individuals receiving and not receiving the tax credits. We find that training is affected, with those individuals close to coming off welfare much more likely to take up training than individuals who face the prospect of staying on welfare for a long time.

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Finally, I would like to thank my family and friends for their constant support, especially my parents who have always given me their support and encouragement in all my work. I would also like to say a special thanks to my brother John and his wife Anthea, for their kindness, generosity and unwavering support throughout the research.

Declaration

I declare that this thesis represents all my own work and research, and that it has not been submitted for a research degree at any other University.

Some of the papers in this thesis represent the result of collaborative work with other researchers. Chapter 2, on Job Satisfaction and Earnings, is developed from joint work with Dr. Arnaud Chevalier at the Department of Economics, University of Kent. The version and results represented in this paper are all my own research on the topic. An earlier version of some of this work was published as a Discussion Paper at the London School of Economics, Center for Economic Performance, DP 531, May 2002.

The idea for Chapter 3, on cross-country patterns in the returns to education, came about through discussions with Dr. Colm Harmon and Dr. Kevin Denny at the Department of Economics, University College Dublin, while I worked as a researcher there. However, the paper and results presented here represents all my own research and work. A very early version of the paper has been published as a Discussion Paper at the London School of Economics, Center for Economic Performance, DP 3199, July 2002.

Finally the last two Chapters on tax credits, wage growth and training are my own work. Some of the analysis in the thesis has been included in a collaborative research paper with Professor Ian Walker (Department of Economics, University of Warwick) written for the Inland Revenue as part of their Working Paper Series. (Working Paper No. 3, May 2004).

1. Introduction

Wages are important in labour markets, and it is important to have estimates of the effect of individual characteristics on wages. It has been suggested that job satisfaction plays an important role in wage determination, yet estimates of the effect have been blighted by simultaneity between the job equation and the earnings equation. In the second chapter of this thesis, we estimate the determinants of job satisfaction. While you cannot identify the effect of job satisfaction on earnings without an instrument for job satisfaction, you can infer the correlation between unobservable determinants of wages and job satisfaction by comparing OLS and IV estimates of job satisfaction equations. If estimates of the job satisfaction equation by OLS are similar to those by IV, then that suggests that the strength of the causation is weak. We find this in Chapter 2, where we analyse the determinants of job satisfaction in a sample third level UK graduates. This justifies the omission of job satisfaction form the subsequent work where we analyse the determinants of wages. While we do find wages to be a consistently *significant* determinant of job satisfaction, the size of the effect is small.

In Chapter 3 we look at the relationship between earnings and education. Competitive labour markets are often thought of as a virtue, in that a competitive market is assumed to be a more efficient one. However, there is some theoretical and empirical evidence to show multiple equilibria can arise in competitive labour markets (Manning, 1992). Two such equilibria are low-wage low-skills and high-wage high-skills. For a given time period, we would expect the classification of different countries into such equilibria to be correlated with the returns to education in the economy. Consistent with the literature on changes in the wage structure over time (Autor *et al.* 2003), we test the hypothesis that differences in the return to education are correlated with differences and changes in technology. We characterise production in an economy using a production function where technology endowed inputs are complementary to skills. We find that the greater the degree of capital skill complementarity in production, the greater the return to education.

The implications of the results in Chapter 3 are that human capital accumulation is important in order to achieve the more desirable high-skills high-wage equilibrium. One of the criticisms of the tax credit wage subsidy programmes in the UK was that they would undermine the incentives of workers to avail of the rising returns to education (through technological change), and accumulate more human capital. In the final two chapters of the thesis we test this hypothesis for a group of workers who received the Family Credit (FC) or the Working Families Tax Credit (WFTC) as an in-work benefit.

We first consider whether the observed effects of human capital accumulation, i.e. wage growth, are correlated with receiving the tax credit. The results of the analysis we present would seem to suggest that at worst, individuals receiving the tax credit experienced wage growth that was no different on average than individuals not receiving the tax credit. We also find some evidence that the tax credit was associated with a wage growth *premium* for some recipients – thus reflecting the fact that the wage subsidy also had a positive effect on the net incentives of some individuals.

In Chapter 5 we analyse the take up of training by FC/WFTC recipients and non-recipients. Surprisingly, given the lack of any significant difference in observed wage growth from Chapter 4, we find that the take up of training by FC/WFTC recipients was significantly lower than similar non-recipients. This result is difficult to reconcile with the results from Chapter 4 on relative wage growth.

The inconsistency in the two sets of results could be a due to two factors: firstly, problems with the estimation methods employed; and secondly, the type of training we observe in the survey may not actually contribute much to wage growth in any case (see Blundell *et al.* 1999). In the conclusions section to the thesis, we consider which of these factors is likely to be more important and consider how we might deal with them in any future work.;

The key contribution of the papers in this thesis to the economics literature are

- We use exogenous variation in earnings to show the strength of the correlation between earnings and job satisfaction. The results show that the simultaneity bias between earnings and job satisfaction is likely to be small, and therefore earnings equations that omit job satisfaction as an explanatory variable are unlikely to be severely biased
- We show that the differences in the returns to education across countries and time can be explained by observed differences in the technology employed in production. Thus countries that wish to encourage investments in human capital by increasing the returns to skills should prioritise investments in technology.
- A commonly held belief regarding in welfare programmes that use wage subsidies is that they tend to lead to dead end jobs with little or no wage growth prospects. We show that for the UK tax credit programmes this is not the case. Indeed we provide some evidence to show that recipients may actually experience a wage growth premium.
- The training effects of the tax credit programmes are, however, less positive. We find tax credit recipients are less likely to do work-related training, and we attribute this to the disincentive associated with the taper off welfare.

2. Estimates of the Effect of Earnings on Job Satisfaction

This paper looks at the determinants of the job satisfaction of a group of third level graduates working in the UK. The key question we wish to answer is, what is the relationship between job satisfaction and earnings? In recent years there has been a resurgence of work into the usefulness of measures of subjective well being, and in particular self-reported job satisfaction, in economics. The initial work by economists in this area, in the late 1970s, was by Hamermesh (1977), Freeman (1978) and Borjas (1979). More recently, papers by Akerlof *et al.* (1988), Clark and Oswald (1996), Clark *et al.* (1996), Clark (1997), Groot and Van den Brink (1999), Shields and Ward (2001), Hamermesh (2001) and Lévy-Garboua and Montmarquette (2004), have all shown the usefulness of job satisfaction measures for economists.

The motivation for much of economic research into job satisfaction work comes from the fact that it has been shown to be a good predictor of real economic outcomes. Certain types of labour market behaviour, such as quitting, absenteeism and striking are all strongly correlated with job satisfaction. Additionally, job satisfaction is the most important criteria for the career choice of graduates (Chevalier, 2003). Hence economists have become interested in the individual determinants of job satisfaction.

Economists have long been sceptical of the use of measures of self-reported job satisfaction (and other measures of subjective well being) in economic research for two reasons. Firstly, without a rigorous understanding of what these variables actually mean, that is how they relate to both observed behaviour and the standard utility maximisation framework, the use of such variables in economic analysis can be misleading; see the discussion Lévy-Garboua and Montmarquette (2004). Secondly, and following on from the first point, without knowing whether or not asking someone about their job satisfaction elicits a meaningful answer or not, has profound consequences for the use of job satisfaction in empirical analysis, either as dependent variable or as an explanatory variable; see Bertrand and Mullainathan (2001).

This paper looks at the reported job satisfaction of two cohorts of graduates from a sample of UK universities. The data, described in more detail below, is unique in that it is both backward looking, and to a certain extent, forward-looking. Information on graduates' employment history at three points in time (the present and five/ten years in the past) is provided and we also have data on their beliefs regarding their past and future financial situation. These features of our dataset allow us to answer some interesting questions about the relationship between expectations (past, present and future) and job satisfaction[1]. The empirical framework utilises the *experienced preference* hypothesis developed in Lévy-Garboua and Montmarquette (2004). The framework, assumes that job satisfaction is an expression of an individual's experienced preference. In other words, asking a graduate about their job satisfaction is equivalent to asking them whether or not, given their expectations regarding the pecuniary and non-pecuniary aspects of the job, and their experienced outcomes, they would chose the same job again.

The modelling framework derived from the experienced preference hypothesis is appealing for three reasons. Firstly, the predictions of the model are consistent with some of the stylised facts in the economics literature on job satisfaction, and well being more generally; such as the fact that job satisfaction is U-shaped in age (Clark and Oswald, 1996) or that raising the income of all does not increase the happiness of all (Easterlin, 2001). Secondly, the framework does not represent a significant departure

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1 See also Eastlerlin (2001) on the relationship between past and future expectations and satisfaction. Easterlin argues that despite the positive expectations about the future, job satisfaction remains mostly constant over a lifetime, due to the fact that aspirations shift upwards as income increases.

from the conventional theory of choice and utility maximisation. And thirdly, the empirical specification of the framework that we estimate nests several of the more simple models already estimated in the literature. This means that we can use simple diagnostic tests in order to chose the best, or most parsimonious, model.

The rest of this paper is organised as follows: section 2 summarises the previous economics literature on job satisfaction; section 3 presents the modelling framework; section 4 describes the data set on UK university graduates; section 5 presents the results from the estimation; and section 6 concludes.

2.2. Job satisfaction as an economic variable

Research by economists into job satisfaction can be broadly divided into two strands of work. Firstly, there are those papers that look at the relationship between job satisfaction and observed behaviour, such as quits, job search and strikes. Secondly, there is a significant amount of research that looks at the determinants of job satisfaction itself. Before summarising the main conclusions from each of these strands of the literature, we present a brief discussion of the possible pitfalls of using job satisfaction, and subjective data more generally, in empirical analysis.

2.2.1. Measurement issues with subjective data

The paper by Bertrand and Mullainathan (2001) outlines the possible pitfalls associated with using subjective, or 'attitude' data, including job satisfaction, in empirical research. Bertrand and Mullainathan adopt a measurement error perspective, assuming that reported job satisfaction equals actual job satisfaction plus some error term. There are several reasons as to why the latent variable (actual job satisfaction) may be different from its expression (self-reported job satisfaction). For example, the wording of the question, the range of the scale of possible answers, or even the ordering of the question in the survey as a whole may affect the answer provided. However, from a job satisfaction perspective, perhaps the most significant issue is *cognitive dissonance* – that is, respondents, when asked about their job satisfaction, may report (and even feel) attitudes that are merely consistent with their past behaviour. For example, individuals who are paid very little for a tedious task may report high job satisfaction, relative to similar individuals who are paid lots to do the same task, otherwise, how can they be doing the task the first place, other than the fact that they like it.

Regardless of the source of the measurement error in job satisfaction, Bertrand and Mullainathan show that the implications for empirical analysis differ depending on whether job satisfaction is used as an explanatory or dependent variable. When job satisfaction is used as an explanatory variable, the implications of the measurement error are similar to those of any other dependent variable measured with error: if the measurement error problems are not dominant, then subjective variables can be useful as control variables, however care must be taken when interpreting the results.

The paper is more pessimistic regarding the implications of the measurement error when job satisfaction is used as a dependent variable. To use one of the examples from their paper – suppose we observe that people with higher earnings are more satisfied with their job, this could merely be a result of the fact that earning affects the way in which job satisfaction is *reported*. Any estimated correlation between earnings and job satisfaction will therefore be spurious. In this case, saying that earnings help predict job satisfaction is meaningless, if, in fact, all they are predicting are the error in the measure of job satisfaction. The usual approaches to dealing with measurement error, such as instrumental variables (IV), are not straightforward to implement in this case, as what is required is an instrument that affects earnings but not the *reporting* or measurement of job satisfaction[2].

Although the measurement error framework presented in Bertrand and Mullainathan is convincing in theory, there are at least three reasons as to why their pessimism regarding the use of subjective data is unwarranted. Firstly, the empirical evidence they present to support their arguments, particularly on job satisfaction, is by no means conclusive. For example, they argue that changes attitudinal questions do not predict changes in the outcome of interest (earnings). This is true, but only for the attidunal questions they look at (and not for job satisfaction). The attitudinal questions they consider typically require a yes or no answer – it is no surprise, therefore, that changes in these variables are poor predictions of changes in the continuous variable earnings. As Dominitz and Manski (1997) point out, attitudinal questions of this kind will rarely elicit a meaningful response, as they can express little of the richness of uncertainty, or even perception, that underlies the decision or the unobserved latent variable. Secondly, the paper by Clark *et al.* (1998) has used panel data and first differences in job satisfaction to test whether the white noise error in the measurement of job satisfaction means that it cannot be used in empirical work. They find no evidence that indicates that this is the case. And thirdly, many cross-sectional and panel studies (see below) have found job satisfaction to be a consistently useful predictor of absenteeism, quitting and productivity. The very fact that this relationship exists provides significant justification for looking at the determinants of self-reported job satisfaction.

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2 The problem becomes further complicated when one considers that both earnings and true job satisfaction are likely to be jointly determined in any case. Section 5 has a further discussion of this problem

2.2.2. Job satisfaction as an explanatory variable

There is a significant sociological and psychological literature on the relationship between job satisfaction and a whole range of behaviour. Job satisfaction in empirical economic research has mainly been used to look at the determinants of quit behaviour and worker turnover. Locke (1976) and Steel and Ovalle (1984) provide an extensive review of the sociological and psychological literature in this area. Among other things, they report that the survey evidence almost always reveals a strong negative correlation between job satisfaction and worker turnover. In the economics literature, Freeman (1978) has also looked at this issue. Using data on a sample of US workers Freeman found job satisfaction to be a significant determinant of labour market mobility, partly because it reflects aspects of the work environment that are not fully captured by other observable variables. Freeman finds that the impact of job satisfaction on quits is greater than that of earnings for older workers in particular. Akerlof *et al.* (1988) also look at the relationship between quits and job satisfaction for a sample of US workers. They find similar results to Freeman (1978), concluding that the decision to quit depends on the sum of pecuniary and non-pecuniary rewards, and job satisfaction is a monotonic, discrete sum function of this sum. More recently, Kristensen and Westergård-Nielsen (2004) have found a significant negative correlation between quitting and job satisfaction for a sample of Danish workers.

One of the weaknesses of the work by Freeman (1978) and Akerlof *et al.* (1988) is that they do not fully control for other labour market and non-labour market opportunities outside of the current job. The paper by Shields and Ward (2001) does exactly this and finds that job satisfaction remains a strong predictor of quit behaviour. Shields and Ward look at a sample of nurses working in the National Health Service (NHS), and include a range of controls, such as education and number of children, to proxy for opportunities outside of the current job. There are several other studies that have looked at the job satisfaction of workers within an industry or sector, including: the airline industry (Cappelli, 1988), academics (Ward and Sloane, 2000) and lawyers (Laband and Lentz, 1998).

The papers discussed above all use cross-sectional data to estimate the relationship between quitting and job satisfaction. If the error terms of the job satisfaction and quitting models are correlated (unobserved individual heterogeneity), then the robustness of the findings in these studies is open to question. Clark *et al* (1998) address this problem using panel data on job satisfaction and quits for a sample of German workers. They find the significant negative correlation between job satisfaction and quitting, identified in the cross-sectional studies, is robust to concerns about individual heterogeneity. In the analysis below, we attempt to control for the endogeneity of earnings in the job satisfaction equation by instrumenting earnings in the job satisfaction equation.

2.2.3. The determinants of job satisfaction

The second strand of the economics literature on job satisfaction takes it as a given that job satisfaction is a parameter of interest to economists, and estimates job satisfaction equations in order to find out what determines an individual's job satisfaction. The literature has typically found earnings to be an important determinant of job satisfaction, either directly (through individuals' own earnings) or indirectly (through relative or comparison earnings). Other significant factors are gender: women are more satisfied with their jobs than men (Hamermesh 1978, 2001); age: job satisfaction is U-shaped in age (Oswald and Clark, 1996); firm size: workers in smaller firms are more satisfied (Gardner, 2000) and (Idson, 1990); education: the less educated are more satisfied (Oswald and Clark, 1996; Groot and Maasen Van Den Brink, 1999). The results we present below are largely consistent with those found in the previous literature.

Battu *et al.* (1999) use the same survey of graduates used in this paper to look at the relationship between job satisfaction and job match. The quality of job match is measured by analysing respondent's answers to questions asking them whether their third level qualification was a requirement for the job they currently hold. Their findings suggest that mismatch affects earnings, and not job satisfaction per se[3].

Lévy-Garboua and Montmarquette (LGM, 2004) motivate the job satisfaction equations they estimate using a model of job satisfaction as *experienced preference*. That is, the job satisfaction reported in questionnaires is merely the respondent's judgement of whether he would wish to repeat his past career decisions. The main hypothesis they test is that job satisfaction is correlated with the earnings gaps experienced in the past and present. In the LGM modelling framework, satisfaction judgements are equivalent to utility comparisons under different *experienced* and *expected* scenarios. In this sense, their *experienced preference* framework can be thought of as being fairly similar to the Tversky and Kahneman (1991) model of loss aversion and regret.

In this paper, we estimate the determinants of job satisfaction on a sample of third level graduates, and directly test several of the predictions of the LGM model. We focus on testing the LGM model as we believe the model represents one of the few attempts by economists to incorporate job satisfaction equations into a utility maximising framework. As such, it is important to test the model on real data. From an estimation perspective, the advantages to using the LGM model were already outlined in the introduction.

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3 The measure of 'mismatch' used by Battu *et al.* is questionable, because it shows that as workers gain experience, they are less likely to say that their qualification was a requirement for the job. According the Battu definition of 'mismatch', this implies that quality of the match is decreasing in experience, which is contrary to standard human capital theory (Farber, 1999).

2.3. A model of job satisfaction as experienced preference

For ease of presentation of the theoretical model, we present the model for two outcomes 1: "satisfied", 0: "not satisfied". The actual data we use has six possible responses ranging from 1 "very dissatisfied" to 6 "very satisfied". As LGM point out, the model is easily generalised to several job satisfaction responses. An individual will state their judgement of their job satisfaction as:

$$J = 1 \ \textit{if}\ U(z) > U(z_1^{*}) \tag{2}$$

$$J = 0 \ \textit{if}\ U(z) \leq U(z^{*}) \tag{3}$$

where U is the individual's utility function, and z^{*} is an individual's expectations, or, as LGM put it, the "mentally experienced alternative". The latent variable underlying reported job satisfaction J is

$$J^{*}(z, z^{*}) \equiv U(z) - U(z^{*}) \tag{4}$$

Inserting (4) into equations (2) and (3) we get

$$J = 1 \ \textit{if}\ J^{*}(z, z^{*}) > 0 \tag{5}$$

$$J = 0 \ \textit{if}\ J^{*}(z, z^{*}) \leq 0 \tag{6}$$

Assuming that an individual's utility from work consists of a pecuniary element Y, and a non-pecuniary element u, and utility from work is maximised over the working life, then he will express a level of satisfaction with a job at a given point in time t if he perceives that the present job has greater value than any jobs that he might have chosen in the past and that he still may take in the future.

$$J_t = 1 \ \textit{if}\ Y_t + u_t > Y_t^{*} + u_t^{*} \tag{7}$$

$$J_t = 0 \ \textit{if}\ Y_t + u_t \leq Y_t^{*} + u_t^{*} \tag{8}$$

Pecuniary realisations and expectations, Y_t and Y_t^*, consist of both a backward and forward-looking element

$$Y_t = \sum_{t=1}^{t} \frac{w_t}{\left(1+r^t\right)} + \sum_{n=1}^{T} \frac{w_{t+n}}{\left(1+r\right)^n} = B_t + F_t \tag{9}$$

We can write a similar equation for pecuniary aspirations (or the "mentally experienced alternative") substituting expected earnings w_t^* for experienced earnings w_t. Period 1 represents the beginning of the working life (or it could be interpreted as the beginning of a new job) and period T retirement. The backward-looking component of equation (9) B_t, which is known with certainty, is the discounted sum of all past and current earnings, and the forward-looking part F_t is the expected present value of the job (or outside opportunities) in the future. As we only observe job satisfaction at one point in time, we assume that the non-pecuniary realisations and comparisons are proxied for by individual fixed effects, and we write $u_t = u$. As in Shields and Ward (2001), we use the individual characteristics in the job satisfaction equation to control for non-pecuniary outside opportunities. Substituting the equation (9) back into the equations (7) and (8), and setting $u_t = u$, we get

$$J_t = 1 \textit{ if } B_t - B_t^* + F_t - F_t^* + u - u^* > 0 \tag{10}$$

$$J_t = 0 \textit{ if } B_t - B_t^* + F_t - F_t^* + u - u^* \leq 0 \tag{11}$$

The LGM model is relatively simple in theory, however, without an unusually long panel, it is not straightforward to test empirically. One of the more significant issues is determining when exactly work *starts* – that is, when the discounting begins. Using the sample of UK university graduates in this paper gets around this problem to a certain extent. This is because we observe career choice and earnings immediately after graduating, as well as job tenure on the current job and spells of employment or further study[4]. Another issue relates to the forward-looking element of equations (10) and (11), F_t and F_t^*. The test of the model predictions in LGM (2004) assumes that the present value of expected future earnings gaps are contained in the error term of the regression, which may result in biased estimates of the model parameters. The sample of graduates does not contain precise information on either F_t or F_t^*, however it does have information on graduates' beliefs about their future financial situation, which we use as proxies for $F_t - F_t^*$. We outline the approach in the empirical section below.

2.3.1. The LGM model and stylised facts from the literature

As was noted in the introduction, one of the appealing characteristics of the LGM model is that it is consistent with many of the stylised facts in the economics literature on job satisfaction. Firstly, the negative correlation between job satisfaction and quitting is consistent with the LGM model. Holding the non-pecuniary comparisons of the job constants, we can see that the forward-looking component in equations (10) and (11), $F_t - F_t^*$, is the key determinant of whether or not to stay in the job. As the value of $F_t - F_t^*$ increases, so does the level of reported job satisfaction, while the probability of leaving the job declines. Secondly, Easterlin (2001) has observed that raising the incomes of all does not necessarily increase the happiness of all. This again is consistent with equations (10) and (11), as raising the incomes of all would hold all earnings gaps constant. Thirdly, many studies find that job satisfaction is either increasing or U-shaped in age; see, among others, Hamermesh (1977, 2001), Clark and

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4 According to the LGM model, we could also assume that work 'begins' when the graduate started the current job, or started working with the current firm. This is not a practical approach given the current data set, as we would have to identify earnings with the period when the graduate starting working (in the current job or firm), which is not possible with this data. We include several controls in the estimation that gets around these problems, such as frequency/length of unemployment spells, spells of further study, and current job tenure.

Oswald (1996), and Clark *et al.* (1996, 1998). In the context of the LGM model, this implies that J_t in equations (10) and (11) is rising with experience. If individuals have rational expectations, then they learn to make fewer 'mistakes', and the backward-looking component $B_t - B_t^*$ becomes increasingly positive, and the forward-looking component $F_t - F_t^*$ goes to zero[5 6].

2.4. Data and Job Satisfaction Measures

The data set we use for our analysis is taken from a sample of over 15,000 graduates of third level institutions in the United Kingdom. The Higher Education Funding Council for England (HEFCE) commissioned the survey in the winter of 1996. Its primary aim was to study the employment patterns of people with degrees (undergraduate and postgraduate) and diplomas at different points during their careers. Battu *et al.* (1999) and Chevalier (2003) have used this data set to analyse the extent of over-education among UK graduates, and Belfield *et al.* (1997) have used it to trace the career choices and patterns of third level graduates in the UK.

Two cohorts of graduates were contacted by postal survey; the first cohort gained qualifications in 1985 and the second in 1990, with approximately half the questionnaires being sent to each group. However, in practice, the older cohort were more difficult to contact, leading to an over representation of the younger cohort. This leads one to question the validity of the survey - however Belfield *et al.* (1996) have used nationally representative samples, such as the Labour Force Survey, to look at the issue

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5 Making fewer 'mistakes' could mean that individuals either adjust their expectations/aspirations according to their experience or continue searching until they find a job that matches their expectations/aspirations.

6 LGM also argue that the *experienced choice* framework is consistent with the observation that people are, in general, satisfied with their jobs (see Sousa-Poza and Sousa-Poza, 2000). Again, they appeal to the rational expectations explanation, "[U]nder certainty and stable preferences, a rational person would always be satisfied with a deliberate decision made in the past. It is merely the occurrence of surprises in the outcomes and/or possibilities which makes the posterior preference deviate from the prior." (LGM 2004, page 139).

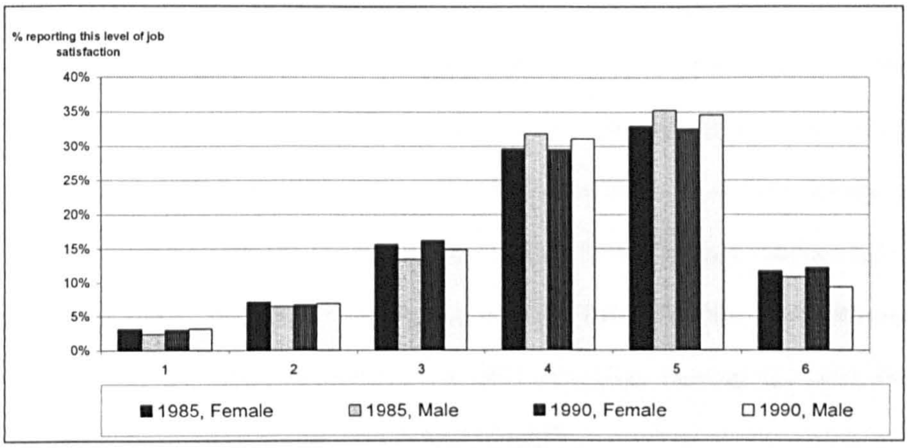
of representability and provide sufficient evidence to show that the survey is indeed representative. The survey asks graduates a variety of questions about their jobs at dated intervals that correspond to one, six and, for the 1985 cohort, eleven years after graduation. The job satisfaction measure is categorical and can take any integer value in the interval [1,6], with 1 labelled "very dissatisfied" and 6 "very satisfied". Job satisfaction is reported for the current job in 1996.

Figure 2.1 shows the distribution of reported job satisfaction for each of the cohorts and separately for men and women. The figure shows the distribution for recipients of degrees (undergraduate or postgraduate, excluding the Open University); **Figure 2.2** shows the same distribution for graduates who studied for either a sub degree qualification ('diplomas') or who gained their qualification from the Open University (OU)[7]. The figures show that, consistent with observations in previous studies (Easterlin, 2001; Sousa-Poza and Sousa-Poza, 2000) majority of people are fairly satisfied with their jobs – about three quarters of the graduates report job satisfaction greater than 3, and around a quarter of graduates are not so happy in their jobs. Female graduates report higher levels of job satisfaction, across both cohorts. **Figure 2.2** shows that the gender effect is stronger for recipients of diplomas and OU graduates, with relatively large number of these female graduates claiming to be 'very satisfied' with their jobs – this could be because graduates who study for a vocational qualification have better job match. Overall, we find no significant geographical pattern in the reported job satisfaction of the graduates in the sample, either at the government office region (12 regions) or HEFCE regions (21) listed in the survey. We did find a weak negative correlation between job satisfaction and living in a

7 The full sample is 15,530 third level graduates. We drop graduates who are not working in 1996, or who do not report their job satisfaction. Furthermore, we only report the job satisfaction of those graduates who say that working (employee or self-employed) is their main activity in 1996. This leaves us with a total working sample of 12,846.

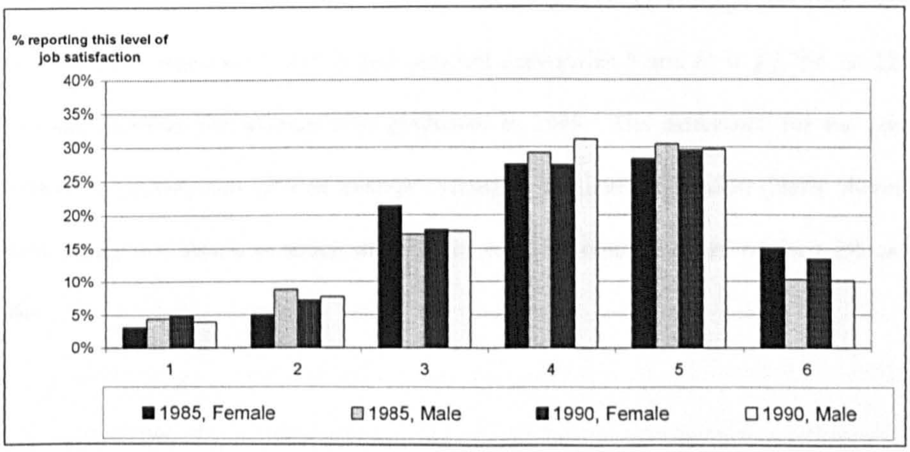
metropolitan area (other than London) for graduates with diplomas. However, the difference becomes insignificant when we include controls for occupation, industry and earnings.

Figure 2.1 Reported job satisfaction by cohort and gender - degree recipients (undergraduate & postgraduate)



Source: *The Careers of Highly Qualified Workers*, HEFCE 1996

Figure 2.2 Reported job satisfaction by cohort and gender – diplomas and Open University



Source: *The Careers of Highly Qualified Workers*, HEFCE 1996

The key question in this paper is want to answer in this paper is what is the relationship between job satisfaction and earnings? **Table 2.1** and **Table 2.2** provide evidence that shows that there is a significant positive correlation between earnings and job satisfaction. **Table 2.1** shows the average earnings for each category of job satisfaction for 1985 graduates and **Table 2.2** shows the same statistics for 1990 graduates. An interesting conclusion from both tables is that although there does not seem to be a significant difference between each of the cohorts, there is a significant difference between men and women in the effect of earnings on job satisfaction. The tables show that, proportionately, the difference in earnings levels across reported job satisfaction is quite similar for both cohorts. For example, for the older cohort of men (**Table 2.1**) the difference in average earnings between those who are either very dissatisfied (category 1) or dissatisfied (2) and those who are satisfied (5) or very satisfied (6) is around £7,790 per annum. This represents around 25% of average earnings (£31,100) for this cohort. For the younger cohort of men (**Table 2.2**) the same difference is around, £6,122, which represents about 26% of average earnings (£23,660) for the younger cohort, similar to the older cohort of men[8].

The differences for the female sample are much smaller, not only in levels, but also proportionately. For the older cohort, the difference in average earnings between dissatisfied (categories 1 and 2) and satisfied (categories 5 and 6) is £2,764, or 12% of average earnings for women who graduated in 1985. The difference for the younger cohort is £2,344, also 12% of average earnings. Similarly, Chevalier (2003) shows that women do not attach as much importance to the financial reward of their job as men do.

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[8] Full summary statistics are provided in tables in the appendix. The average age of the older cohort with a degree is 34 (men and women). The average age of the younger cohort with a degree is around 30. For those with a diploma, the average age is 42 for the older cohort, and 38 for the younger cohort.

Table 2.1 **Average annual earnings by reported job satisfaction, 1985 graduates**

	Men			Women		
Job satisfaction	**E(annual earnings)**	***N***	**Std. Err.**	**E(annual earnings)**	***N***	**Std. Err.**
Very dissatisfied	£24,050	70	*1515*	£22,328	64	*1459*
2	£26,480	176	*824*	£20,627	130	*941*
3	£28,547	349	*659*	£21,737	342	*531*
4	£30,346	781	*483*	£23,017	576	*479*
5	£33,158	861	*473*	£24,510	644	*477*
Very satisfied	£34,969	262	*1020*	£22,454	240	*843*

Notes: We drop graduates who are not working in 1996, or who do not report their job satisfaction. Furthermore, we report the job satisfaction of those graduates where working (employee or self-employed) is their *main activity* in 1996. ***Source:*** The Careers of Highly Qualified Workers, HEFCE 1996

Table 2.2 **Average annual earnings by reported job satisfaction, 1990 graduates**

	Men			Women		
Job satisfaction	**E(annual earnings)**	***N***	**Std. Err.**	**E(annual earnings)**	***N***	**Std. Err.**
Very dissatisfied	£17,424	125	*878*	£16,066	137	*882*
2	£20,006	268	*498*	£18,707	263	*543*
3	£22,511	598	*381*	£18,519	654	*306*
4	£23,446	1207	*290*	£19,394	1157	*228*
5	£25,199	1282	*306*	£20,411	1269	*235*
Very satisfied	£25,683	363	*703*	£19,448	478	*420*

Notes: See notes for **Table 2.1**

The LGM model of job satisfaction as experienced preference also implies that that there will be a positive correlation between earnings growth and job satisfaction. Holding expectations/aspirations constant (and non-pecuniary aspects of the job), we would expect to observe job satisfaction increasing with earnings growth.

Table 2.3 and **Table 2.4** show average growth in earnings over the 1991 – 1996 period for each cohort and for men and women separately[9]. Both tables show that earnings growth is important for job satisfaction. Furthermore, contrary to the summary statistics presented in **Table 2.1** and **Table 2.2**, there is a difference between both cohorts. Looking at

9 Ideally, we would want to estimate average growth in real wages. However, although weekly and annual earnings are reported for 1986, 1991 and 1996, weekly hours are only reported for the current main job in 1996. In order to at least partially control for changes in earnings associated with changes in hours, we restrict the sample to those graduates who were working full time in 1991 *and* 1996.

Table 2.3, there appears to be a U-shaped relationship between job satisfaction and earnings growth for women in the older cohort, however, the standard errors are large and the differences are not significant.

In the younger cohort men and women look a lot more similar. The relatively higher earnings growth across job satisfaction categories in this cohort is probably only a reflection of the different position that younger and older cohorts occupy in the age-earnings profile. Another interesting result is the difference in the standard errors, within each job satisfaction category, between the older and younger cohort. Comparing

Table 2.3 and **Table 2.4**, we see that almost without exception, the standard errors for the younger cohort are consistently larger than those for the older cohort – despite the fact that we have more observations of the younger cohort. This result is consistent with one of the main predictions of the model of job satisfaction as *experienced preference*, namely that as people get older, they make fewer 'mistakes' and their job satisfaction becomes more consistent with their expectations of earnings (current, past and future)[10].

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10 It could also be possible, that dissatisfied graduates revise their expectations in order to justify past and current choices, as in Bertrand and Mullainathan (2001). However, we do not believe that young graduates will not have (or take) the opportunity to improve their job match in order to increase their satisfaction.

Table 2.3 **Average growth real in annual earnings 1991-1996 by reported job satisfaction, 1985 graduates**

	Men			Women		
Job satisfaction	***E*[Earnings growth, 1991-1996]**	***N***	**Std. Err.**	***E*[Earnings growth, 1991-1996]**	***N***	**Std. Err.**
Very dissatisfied	19.34%	56	*5.59%*	28.97%	47	*6.37%*
2	26.36%	154	*2.65%*	29.02%	86	*4.15%*
3	31.09%	311	*2.02%*	25.59%	242	*2.36%*
4	37.77%	699	*1.67%*	31.04%	414	*1.84%*
5	48.72%	766	*2.26%*	37.08%	445	*2.41%*
Very satisfied	48.36%	230	*3.61%*	35.21%	155	*4.25%*

Notes: We drop graduates who are not working in 1996 and 1991, or who do not report their job satisfaction. Furthermore, we report the job satisfaction of those graduates where working (employee or self-employed) is their main activity in 1996. All earnings are in £1991 and indexed using the RPI, the sample for earnings growth is restricted to full-time workers in 1991 *and* 1996. ***Source:*** The Careers of Highly Qualified Workers, HEFCE 1996

Table 2.4 **Average growth in real annual earnings 1991-1996 by reported job satisfaction, 1990 graduates**

	Men			Women		
Job satisfaction	***E*[Earnings growth, 1991-1996]**	***N***	**Std. Err.**	***E*[Earnings growth, 1991-1996]**	***N***	**Std. Err.**
Very dissatisfied	37.52%	68	*6.71%*	32.25%	75	*5.52%*
2	36.76%	196	*3.91%*	44.34%	162	*4.20%*
3	45.41%	433	*3.12%*	45.68%	414	*3.51%*
4	57.98%	889	*2.25%*	54.01%	736	*2.54%*
5	68.91%	948	*2.38%*	61.27%	777	*2.76%*
Very satisfied	67.10%	262	*5.42%*	62.45%	290	*5.09%*

Notes: See notes for **Table 2.3**

2.5. Estimating the determinants of job satisfaction

The aim of analysis in this section is determine the empirical model that best explains reported job satisfaction. Of particular interest is the channel through which earnings affect job satisfaction. Three empirical models of the job satisfaction equation are estimated: (i) the *basic model*, which includes no controls for comparison earnings and is purely static; (ii) the *current earnings comparison model*, which is the LGM model with no forward or backward looking elements; and (iii) a *lifetime earnings comparison model*, which is model (ii) with forward and backward looking elements.

2.5.1. Estimates of the basic model

The *basic model*, which follows the early work by Freeman (1978), involves estimating a linear regression where own earnings have a direct impact on job satisfaction

$$j_t = \alpha + X_t\beta_1 + y_t\theta_1 + \varepsilon_t \tag{12}$$

The matrix X_t controls for individual characteristics, such as age, job tenure and occupation, y_t is a measure of annual earnings and ε_t is a random disturbance term with the usual properties. The latent variable underlying the LGM model is additive in earnings comparisons, therefore, following LGM, earnings enter the job satisfaction equation in levels, not logs. Several econometric problems arise in the estimation of (12). The literature review has already discussed problems relating to measurement error in self-reported job satisfaction, however, here we will concentrate on other types of endogeneity related to earnings. The endogeneity may arise due to reasons relating to unobserved heterogeneity, which (potentially) could affect both job satisfaction and earnings; or from the fact the earnings and job satisfaction are a simultaneous system of equations. In order to take account of the endogeneity of earnings we instrument earnings in the job satisfaction equation. We discuss the approach below.

The pecuniary determinants of job satisfaction

Earnings are instrumented using the occupation (8 categories) of the head of the household at aged 14 and region of work (21 regions) in 1996. In using parental occupation aged 14 as an instrument we are making use of results in the literature that show a strong positive intergenerational correlation in earnings (Dearden *et al.*, 1997, Solon, 1999 for a review). The results from estimating the reduced form earnings equation are shown in the appendix. We estimate an earnings equation for each cohort of graduates by gender. The results show that, after controlling for a range of other characteristics, parental occupation is not a significant determinant of earnings for the older cohort of women. Additionally, we use region of work in 1996 as a further exclusion restriction. As in Shields and Ward (2001), we confirm that region does not affect job satisfaction, after controlling for income – as compensating differentials would suggest. We confirmed that the two sets of instruments are valid, since job satisfaction regressions based on a single set of exclusion variables, give the same results for the coefficient on pay. Thus, we believe that the instruments capture the exogenous components of pay.

The full set of results from estimating equation (12) is shown in **Table A2.11** at the end of the paper. A separate ordered probit of job satisfaction is estimated for each cohort of men and women. **Table 2.5**, shown below, reports the coefficients on earnings only from the ordered probit, the results for all other variables are shown in **Table A2.11**. **Table 2.5** also shows the results from including the exogenous estimate of earnings from the earnings equation in the job satisfaction equation instead of reported earnings The IV-specification is estimated using limited information methods, that is, by a two-step procedure. Additionally, we bootstrap the estimation (1000 replications) in order to obtain efficient standard errors.

The results show that earnings do affect job satisfaction directly, both in the non-instrumented equation and instrumented equations. Surprisingly, this is one of the few results in the literature that *consistently* finds such a significant effect of own earnings on job satisfaction, although it should be noted that this is our basic estimate of the job satisfaction equation and we have yet to include controls for relative earnings effects. The marginal effects that correspond to the coefficients on earnings in **Table 2.5** are shown in **Table 2.6**. The table shows the increase in the probability of an individual reporting job satisfaction of 5 or 6 ('satisfied') when earnings are increased by £5,000. The third row in **Table 2.6** shows the sample probability of being satisfied with the job. Although this is one of the few results in the literature to show a significant positive correlation between own earnings, the effect seems relatively small[11]. For example, if we calculate a simple average elasticity on the basis of the marginal effect, in **Table 2.6** we see that for an average increase in earnings of 20% (£5,000 on top of £24,829), the probability of being satisfied only increases by around 7.5% (3.3% on top of 43.1%). In the next section we will interested to see whether the effect of relative earnings is any larger.

Table 2.5 Coefficient on earnings in the basic job satisfaction equation

Cohort	Female 1985		Male 1985		Female 1990		Male 1990	
Earnings not instrumented	0.0057		0.0088		0.0072		0.0111	
	(1.83)+		(4.09)**		(2.38)*		(4.83)**	
Earnings instrumented		0.014		0.0128		0.0243		0.0159
		(2.31)*		(2.97)**		(3.50)**		(3.00)**
Observations	1462		1999		2466		2586	
Log likelihood	-2229.28		-2936.04		-3790.40		-3832.94	
Chi2	99.08		155.92		97.88		125.76	

Notes: Absolute value of z statistics in parentheses. (+) significant at 10%; (*)significant at 5%; (**) significant at 1%. The standard error for instrumented earnings is obtained by bootstrapping the estimation with 1000 replications. The regression also includes controls for a range of other characteristics, both work related and non-work related (see Table A2.11)

Source: The Careers of Highly Qualified Workers, HEFCE 1996.

11 Ferrer-I-Carmonell and Frijters (2004) find similar small, but significant, coefficients for the effect of earnings happiness.

Table 2.6 Marginal effect of earnings on job satisfaction

	Effect on probability of being satisfied [5,6] from increasing annual earnings by £5,000			
Cohort	**Female 1985**	**Male 1985**	**Female 1990**	**Male 1990**
Earnings not instrumented	1.08%	1.81%	1.44%	2.21%
Earnings instrumented	2.77%	2.54%	4.80%	3.11%
Sample probability of being satisfied [5,6]	43.92%	44.72%	44.18%	43.13%
Sample mean annual earnings	£23,433	£31,324	£19,902	£24,659

Notes: The marginal effects in the table are calculated from the regression results in Table A2.11. All marginal effects are calculated at the mean value of earnings, shown in the final row of the table.

Source: The Careers of Highly Qualified Workers, HEFCE 1996.

The negative bias we see on the earnings parameter could be indicative of a compensating differential story[12]. That is, the effect of earnings on job satisfaction would be biased downwards if people were paid more to take on more dangerous or risky jobs. In this case, we would see well-paid people reporting low levels of job satisfaction. Introducing independent variation in earnings, by instrumenting, should remove the bias. The ideal way to test the compensating differentials hypothesis would be to estimate the entire system of equations by instrumenting job satisfaction in an earnings equation. If the bias on job satisfaction in the earnings equation was positive, then we could say with more certainty that this is a compensating differentials story. However, full identification of the system of equations that determine job satisfaction and earnings is beyond the scope of the current paper. An interesting avenue for future work would be to use job satisfaction to fully quantify compensating differentials for different types of individuals and jobs.

12 Alternatively, the negative bias could also reflect the fact there is measurement error in the earnings variable, attenuating the coefficient to zero.

Non-pecuniary determinants of job satisfaction

Apart from earnings, there are several other characteristics that affect job satisfaction, and, regardless of the specification of earnings in the job satisfaction equation, these factors remain significant throughout the analysis that follows.

We find that for the older cohort of graduates, being married or living with a partner is correlated with higher levels of reported job satisfaction. To the extent that job satisfaction is positively correlated with overall feelings of well-being, this result is consistent with the economics literature on happiness (see Oswald, 1997 and Blanchflower and Oswald, 2004). There is also some weak evidence that having children is correlated with higher levels of job satisfaction for women, although it is only significant for the younger cohort. Several studies have also found a negative correlation between job satisfaction and bad health outcomes (Clark and Oswald, 1996). The only health related question in the graduate survey asks graduates whether or not they have a work-limiting disability. Disability is negatively correlated with job satisfaction; however, it is only significant for the younger cohort of women (at the 10% level). When we exclude earnings from the job satisfaction equation, the disability is significantly negatively correlated with job satisfaction for all cohorts and genders, implying that most of the disability effect on job satisfaction is picked up by the relatively lower earnings associated with these individuals.

The survey also asks the graduates whether the initial qualification gained in 1985 or 1990 was specified as a job requirement for their current job. Graduates who answer 'yes' to this question also report significantly higher levels of job satisfaction. As Battu *at al.* (1999) point out, this could be interpreted as a job match effect, where those graduates who answer yes also have a better job match, which is positively correlated with job satisfaction. The impact of this proxy for job match differs significantly by cohort. For the older cohort, the marginal effect on the probability on being satisfied (category 5 or 6) of this variable (going from 'No' to 'Yes') is 4% for men and 3.6% for women. For the younger cohort, the marginal effect is significantly larger, 8.6% for men and 8.8% for women[13]. This implies that the effect of job match on job satisfaction, *as measured by whether the initial qualification is a requirement for the job*, could be declining in age[14].

Another result that is entirely consistent with the previous job satisfaction literature is that the self-employed are significantly more satisfied with their jobs; see Hundley (2001) and Blanchflower *et al.* (2004)[15]. The marginal effect of being self employed on reporting job satisfaction of 5 or 6 ranges from around 9% to 13%.

The coefficient on hours of work is difficult to interpret, not only because it fluctuates from negative (women, 1985 and 1990) to positive (men, 1985), but also because the assumption that hours of work are (weakly) exogenous is unlikely to hold. If you are dissatisfied with your job, then you are probably also likely to work (or at least *prefer* to work) fewer hours, which implies that true effect of hours in the job satisfaction is unlikely to be identified in the estimated job satisfaction equation. As with earnings, it would be ideal to instrument hours in the job satisfaction equation, however, it is not obvious what instrument could be used in the reduced form labour supply equation, and we do not attempt to do it in this paper We therefore do not wish to over-emphasise the result for hours.

13 'Marginal' effects of categorical variables refer to the effect on the probability of reporting a certain job satisfaction level from moving from not having the characteristic to having the characteristic.

14 As a graduate gains more experience in their chosen career, the initial qualification may no longer be an explicit requirement - so there is measurement error in this variable for the older cohort. The presence of measurement error may also go some way towards explaining the lower coefficient we observe.

15 Hundley (2001) summarises the reasons as to why we might expect to observe a positive correlation between job satisfaction and self employment, these include: autonomy and variety in the workplace, fuller utilisation of skills (i.e. the self-employed are less likely to consider themselves overeducated), more flexible work schedules, and, outside options are likely to be more restricted for the self-employed and therefore they value their current job more highly.

Workers in larger firms tend to report lower levels of job satisfaction, particularly in the younger cohort of graduates. The effects are fairly similar once you move beyond a firm size of 25 employees; that is, the effects are more-or-less the same regardless of whether a graduate is in a firm or 100 or 500 employees. Again, this is a common finding in job satisfaction studies; see Gardner (2001), Clark and Oswald (1996) and Idson (1990). The reasons cited for the negative correlation between firm size and job satisfaction are similar to those cited by psychologists for the positive correlation between self-employment and job satisfaction, such as autonomy, variety, responsibility in the workplace, etc.

The regression model also included several other variables in order to more fully control for characteristics of the job not directly related to earnings. These include controls for profit sharing in the firm (insignificant), membership of a company health scheme (positive and significant for younger men only), and membership of company pension scheme (varying from positive to negative and significant to insignificant). The lack of any consistent pattern across cohorts in the effect of these variables on job satisfaction makes it hard to draw any firm conclusions regarding their relative importance. Clearly, several of the variables are correlated with other controls already included in the model, for example, we know that bigger firms are also more likely to offer company pensions, health programmes and profit sharing schemes. In fact, when we regress job satisfaction on controls for pension scheme membership, company car, health scheme membership and profit share in the firm, with *no other controls*, we find that all of these variables are significantly positively correlated with job satisfaction.

2.5.2. Current earnings comparison model

The current earnings comparison model is the model that is estimated in much of the recent job satisfaction literature, including Oswald and Clark (1996) and Clark (1997).

The model is equivalent to the LGM model without any forward or backward looking components. The specification is a modification of the basic job satisfaction equation in (12) and includes a control for comparison or expected earnings y_t^*,

$$j_t = \alpha + X_t\beta_1 + y_t\theta_1 + y_t^*\theta_2 + \varepsilon_t \tag{13}$$

Equation (13) is the specification estimated in Clark and Oswald (1996), among others. Assuming that either y_t, or some combination of factors that directly determine y_t, are used to estimate y_t^*, then there are some potential collinearity problems in the estimation of (13). As an alternative to (13), we write $\xi_t = y_t - y_t^*$, and rewrite (13) as,

$$j_t = \alpha + X_t\beta_1 + \xi_t\delta_1 + \varepsilon_t' \qquad (14),$$

thereby imposing the restriction $\delta_1 = \theta_1 = -\theta_2$. In an extended version of the model in equation (14) we also relax the equality assumption.

Measuring expected/comparison earnings

The key to credibly testing the predictions of the LGM model in the setup of equation (13) or (14) is to find the right measure of expected/comparison earnings, and hence the 'earnings gap'. However, without asking graduates directly about their income expectations, this is no simple task. The survey does ask graduates about their relative financial position both in the past and the future; these questions are used in the estimation in section to proxy for future earnings. However, the survey does not contain any questions that ask graduates about their *level* of expected earnings, thereby allowing us to directly calculate $y_t - y_t^* = \xi_t$.

In order to get around some of the debate surrounding inference of expectations based on realisations – which is summarised in detail in Dominitz and Manski (1997) – we estimate equation (14) for several definitions of expected earnings, y_t^e, and test to see which measure of expected earnings best explains the data. The first estimate of expected earnings, $y_t^e \equiv y_t^{e1}$, is the fitted value from an earnings equation calculated in the current period. The residual from this regression then enters the job satisfaction equation as our estimation of the experience 'earnings gap'. This is the approach followed in almost all the literature that looks at the relationship between comparison income and job satisfaction, including LGM (2004), Clark and Oswald (1996) and Clark (1997). The assumption here is that graduates calculate expected earnings making full use of all the information available to them, as an econometrician would. The merits and pitfalls associated with using earnings regressions to estimate expected earnings are discussed in several papers by Manski; see Dominitz and Manski (1997) and Manski (1993a and 1993b).

The second estimate of expected earnings, $y_t^e \equiv y_t^{e2}$, assumes workers form expectations about earnings *growth* and not necessarily earnings *levels*. The summary statistics presented in **Table 2.3** and **Table 2.4** showed there was a positive correlation between earnings growth over the 1991 – 1996 period and job satisfaction. Rather than estimate an equation that tries to explain earnings growth over this period, we simply estimate the average earnings growth by cohort, gender, current qualifications and subject studied for the initial degree in 1985/1990. The implicit assumption here is that graduates do not make comparisons with a narrowly defined group of individuals (as in the regression), but rather compare themselves with other graduates who have broadly similar earnings related characteristics. The level of comparison/ expected earnings in this case are simply the earnings that the graduate would have had in 1996, *had they experienced real earnings growth over the 1991-1996 period that was in line with the average for other graduates with their characteristics.*

The third and final estimate of expected earnings, $y_t^e \equiv y_t^{e3}$, embodies some of the forward-looking elements of the LGM model of job satisfaction. Rather than consider the earnings growth that graduates might have experienced in the past five years, we consider the earnings growth that they *could* expect in the next five years. This forward-looking comparison of earnings is similar to the extensive psychological literature on *upward comparisons* (Collins, 199). However, in this case, rather than making comparisons with graduates who are better than them, we test to see whether graduates compare themselves with other similar graduates who have more work experience. In order to do this we make use of the cohort nature of the sample, 1990 graduates comparing their 1996 earnings with the 1996 earnings of similar graduates from the 1985 cohort.

Results: earnings comparison model

The discussion of the results in this section will focus on the effect of comparison earnings on job satisfaction only. The previous section on the basic model discussed in detail how other non-earnings variables affect job satisfaction. Furthermore, we do not re-present the full results for each of the samples, as the coefficients on these are variables are unchanged when we estimate the earnings comparison model. We use the results in this section to test two of the central predictions of the LGM model: (i) that the effect of the earnings gap on job satisfaction declines as people get older; (ii) the effect of expected/comparison earnings on job satisfaction is offset by the effect of the earnings gap on job satisfaction.

Table 2.7 below presents the results from the estimating the job satisfaction equation, for each of the measures of comparison earnings. The first column, Model (1), shows the results from estimating an ordered probit that includes the residual from the earnings equation as the measure of the earnings gap. The residual from the earnings equation are correlated with job satisfaction – but for men only. The residual is insignificant for both cohorts of women. Furthermore, for all cohorts, including the residual from the earnings equation is no better at explaining the job satisfaction than simply including own earnings in the job satisfaction equation. If we compare the log likelihoods in **Table 2.7** and **Table 2.5**, we can see that Model (1) has no more explanatory power than the basic model of job satisfaction. This is also true of Model (3), which uses potential earnings in five years time as a measure of comparison earnings. Of the three models presented in **Table 2.7**, Model (2) is the only one that consistently performs better than the basic model of job satisfaction without any earnings comparisons. The measure of comparison earnings used to estimate the earnings gap in Model (2) is the earnings that a graduate might have expected in 1996 had he experienced earnings growth in line with graduates who have characteristics similar to their own. This measure of earning is the average earnings growth by gender, cohort and subject studied of the previous 5-years[16]. Although Model (2) does have greater explanatory power than the basic model of job satisfaction, the evidence is not all that convincing. The difference between the log likelihoods is small, and it is unlikely that a test that does not rely on sample size (as the LR-test does) would reject one model in favour of the other.

The prediction of the LGM model, that the effect of the earnings on job satisfaction declines as people get older, is not supported by the results in **Table 2.7** – this contradicts the results presented in LGM (2004). The coefficient on the earnings gap for the younger cohort only exceeds the coefficient for the older cohort for men in Model (1), and a Wald test confirms that the coefficients are not actually significantly different from one another. Apart from indicating that the LGM model of job

16 Alternatively, we could estimate this using a wage growth equation. We have tried both approaches and find that the results are practically identical. She standard errors in tables presented are bootstrapped replications (1000).

satisfaction may not be a true model of behaviour, the predicted age effect may not be supported by our results for three other reasons. Firstly, we only look at one period, and ignore any earnings gaps in the past and future. Later on, we extend the earnings comparison model to include forward and backward looking elements. Secondly, if non-pecuniary characteristics that determine job satisfaction are different for both cohorts (as we might expect them to be, and as the results in **Table A2.11** confirm) and are not fully controlled for in the estimation, then this could bias the coefficients on the earnings gap downwards. Thirdly, the average age gap between each of the cohorts is only around 5 years. This difference in ages may not be large enough to observe differences in the impact of the earnings gap – LGM compare 30-year olds with 40 year-olds.

Another prediction of the LGM model is that it is the earnings *gap* that matters in job satisfaction judgments, and expected/comparison earnings alone do not significantly affect job satisfaction (as argued in Clark and Oswald, 1996). That is, in equation (11) the effect of comparison earnings on job satisfaction is offset by the discounted sum of the experienced earnings gaps. We test this hypothesis by estimating job satisfaction equations that not only include the earnings gaps as in **Table 2.7** but also control for expected/comparison earning. That is, we estimate the following job satisfaction equation for each measure of expected earnings:

$$j_t = \alpha + X_t\beta_1 + y_t^{*}\theta_2 + \xi_t\delta_1 + \varepsilon_t' \qquad (14),$$

The results are reported in **Table 2.8**, and, as before, we report the results for each of the three definitions of expected/comparison earnings. In Model (1), we find that the level of expected/comparison earnings on job satisfaction is *not* offset by the earnings gap, at least within the current period. In fact, for Model (1), where expected/comparison earnings are estimated by an earnings regression, expected earnings are consistently positive and significant. It is quite likely that the inclusion of expected earnings and the residual from the earnings regression introduces some collinearity problems. The results for Model (2) and Model (3) are consistent with the predictions of the LGM model. We find that expected/comparison earnings are insignificant in three of the samples, the one exception is the sample of 1990 male graduates.

To summarise the results in this section - the results of the earnings comparison model that looks at earnings gaps in the current period are reasonably supportive of the predictions of the LGM model. The specifications that include the earnings gap in the job satisfaction equation do have greater explanatory power than the basic model of job satisfaction, however, the increased explanatory power is not very large. In the next section, we will test whether adding experienced earnings gaps in the past improves the explanatory power of the models.

Table 2.7 Earnings comparison model, no controls for current comparison earnings

Sample	**Female, 1985**			**Male, 1985**			**Female, 1990**			**Male, 1990**		
Model	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)
$\xi_t^1 = y_t^e - y_t^{e1}$	0.0014			0.0069			0.003			0.0093		
	(0.4)			(2.77)**			(0.85)			(3.44)**		
$\xi_t^2 = y_t^e - y_t^{e2}$		0.0067			0.015			0.0122			0.0113	
		(1.68)+			(4.96)**			(3.04)**			(4.01)**	
$\xi_t^3 = y_t^e - y_t^{e3}$			NA			NA			0.0066			0.0086
									(2.06)*			(3.73)**
Observations	1462	1462	NA	1999	1999	NA	2466	2466	2466	2586	2586	2586
Log likelihood	-2230.89	-2228.49	NA	-2937.46	-2929.88	NA	-3793.23	-3786.77	-3787.72	-3836.65	-3832.87	-3839.18
Chi squared	95.85	99.90	NA	153.07	168.23	NA	92.22	105.14	98.98	118.34	119.90	117.14

Notes: The coefficients in the table are the results of ordered probits of job satisfaction on the difference between own earnings and comparison/expected earnings and controls for workplace and personal characteristics (see Table A2.11). The sample of graduates for each gender-cohort is restricted to graduates who said that work was their main activity in 1996. Model (3) is not estimated for 1985 graduates, as comparison earnings for this model are the earnings that 1990 graduates can expect in 5 years time, i.e. the average earnings of 1985 graduates in 1996. Absolute values of z-statistics are in parentheses. (+) significant at 10% level, (**) 5% level, (*) 1% level. The standard errors on each of the measures of the earnings gap are obtained by bootstrapping the estimation with 1000 replications. ***Source:*** The Careers of Highly Qualified Workers, HEFCE 1996.

Table 2.8 Earnings comparison models, controlling for current comparison earnings

Cohort	**Female, 1985**			**Male, 1985**			**Female, 1990**			**Male, 1990**		
Model	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)
y_t^{e1}	0.0184			0.0130			0.0258			0.0171		
	(2.86)*			(2.97)*			(3.21)			(3.00)*		
$\xi_t^1 = y_t^e - y_t^{e1}$	0.0028			0.0077			0.0040			0.0099		
	(0.84)			(3.06)*			(1.11)			(3.66)*		
y_t^{e2}		0.0039			0.0020			0.0001			0.0087	
		(0.95)			(0.68)			(0.039)			(2.38)**	
$\xi_t^2 = y_t^e - y_t^{e2}$		0.0075			0.0152			0.0123			0.0127	
		(1.88)+			(5.02)*			(2.85)*			(4.40)*	
y_t^{e3}			NA			NA			0.0055			0.0152
									(0.59)			(2.9)*
$\xi_t^3 = y_t^e - y_t^{e3}$			NA			NA			0.0072			0.0107
									(2.06)			(4.4)*
Observations	1462	1462	1462	1999	1999	1999	2466	2466	2466	2586	2586	2586
Log likelihood	-2225.19	-2229.03	NA	-2935.99	-2929.63	NA	-3784.66	-3786.77	-3787.52	-3832.63	-3832.41	-3824.68
Chi squared	107.27	99.59	NA	156.02	168.74	NA	109.36	105.15	99.39	126.38	126.83	126.13

Notes: The coefficients in the table are the results of ordered probits of job satisfaction on the difference between own earnings and comparison/expected earnings, and comparison earnings themselves, as well as controls for workplace and personal characteristics. The sample of graduates for each gender-cohort is restricted to graduates who said that work was their main activity in 1996. Model (3) is not estimated for 1985 graduates, as comparison earnings for this model are the earnings that 1990 graduates can expect in 5 years time, i.e. the average earnings of 1985 graduates in 1996. Absolute values of z-statistics are in parentheses. (+) significant at 10% level, (**) 5% level, (*) 1% level. The standard errors on each of the measures of the earnings gap, and expected earnings are obtained by bootstrapping the estimation with 1000 replications. ***Source:*** The Careers of Highly Qualified Workers, HEFCE 1996.

2.5.3. The LGM model with backward- and forward-looking comparisons

The third specification of the job satisfaction equation that we estimate is our full empirical specification of the LGM model, with both forward and backward looking components. The job satisfaction equation we estimate is as follows

$$\begin{aligned} j_t &= \alpha + X_t\beta_1 + \xi_t\delta_1 + \xi_{t-5}\delta_2 + \xi_{t-10}\delta_3 \\ &+ \psi_{t+1}\delta_4 + \psi_{t+5}\delta_5 + \varepsilon_t \end{aligned} \tag{15}$$

The variables ξ_t, ξ_{t-5} and ξ_{t-10} correspond to the earnings gap in 1996, 1991 and 1986 respectively. For graduates who are not working in 1986 (including the 1990 cohort), the ξ_{t-10} term falls out of the regression. For the older cohort, we assume that the working life 'begins' in 1986, and, for the younger cohort 1991 (the year of graduation). The estimates of the model in LGM (2004) only consider 2 periods and include no controls for forward-looking expectations of the earnings gap. Indeed, LGM assume that expected future income gaps are contained in the error term of the regression. We include explicit controls for expected future income in the ordered probit, and, as such, the estimation in this section represents a more comprehensive test of the LGM model. The variables ψ_{t+1} and ψ_{t+5} in (15) use the answers to the questions in the survey that ask graduates about their future financial expectations. The precise wording of the question is "*Looking ahead, how do you think you will be financially a year from now/five years from now?*". There are four possible answers to this question: *better off than now*, *worse off than now*, *about the same*, and *don't know*.

The coefficients on the answers to the future expectations questions need to be interpreted with some caution (to put it mildly). There are several reasons for this, not least of which is that they do not directly measure expectations of the future earnings gap. Firstly, the comparison earnings the questions refer to are own earnings in the current period, not expected/comparison earnings as we defined them above (by any definition in **Table 2.7** or **Table 2.8**). Another potential problem with using the answers to these attitudinal questions is the fact that the answers they elicit from respondents may not accurately reflect the full range of uncertainty that people perceive when it comes to estimating both their own actual earnings in the future, as well as their expected/comparison earnings[17]. Bearing all these caveats in mind, we believe that in the absence of any other direct proxies for expectations of the future earnings gap, the answers to this question should be included in the estimation – however, we would refrain from placing any causal interpretation on the coefficients. Furthermore, we also believe that including the answers to the questions is preferable to the approach in LGM (2004), which is to assume that the random disturbance term in their model also reflects the present value of earnings gaps in the future. In practice, both questions about future financial expectations are, unsurprisingly, correlated. However, the correlation coefficient is not so large as to lead to estimation problems when both variables are included in the estimated job satisfaction equation. The correlation coefficients are 0.38 (female, 1985 cohort), 0.43 (male, 1985 cohort), 0.38 (female, 1990 cohort) and 0.41 (male 1990 cohort). The qualitative findings presented below are not affected by the exclusion of one or other of the forward looking variables, and a comparison of the log likelihoods indicates that the model has more explanatory power when both variables are included.

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17 A further problem may also be that the question does not actual refer to the individual's earnings, but their general 'financial situation'. However, we believe that the fact that the earnings are *the* major component of an individual's financial situation mitigates this problem somewhat. If we compare the answers to the question asking them about their financial situation *five years ago* with the information we have on 1991-1995 earnings growth, we find that those individuals who say they were better off five years ago also experienced practically zero earnings growth in real terms, and also have a much bigger standard deviation. Similarly, graduates who say they are financially better off now experienced positive earnings growth on average and have a much smaller standard deviation.

Results: full LGM model

The full set of results from estimating the LGM model in (15) are shown in the appendix . We show the results from estimating an ordered probit of job satisfaction where the earnings gap is measured in two periods only, the current period (1996) and five years back., and **Table A2.13** shows the results from estimating a three period model, including estimates of the earnings gap for 1986. This specification is estimated for the 1985 cohort only. The measure of comparison earnings we use in the specifications in this section is the earnings that a graduate might have expected, had he had earnings growth over the previous five years in line with similar individuals from his cohort - where 'similar' individuals are assumed to be the same gender, and have studied for the same qualification and subject. This is the same measure of comparison earnings used to construct the wage gap in Model (2) (**Table 2.7** and **Table 2.8**). We use this measure of comparison earnings to construct the earnings gap because it the measure that produced results that were most consistent with our priors from the LGM model. We assume that graduates only start their 'current careers' when they graduate; therefore, wage growth in the first period of work (1991 for the younger cohort, 1986 for the older cohort) is assumed to equal zero. The measure of comparison earnings in each of these periods for each cohort is just the mean earnings by gender, qualification studied for (i.e. diploma, degree or diploma) and subject. The distribution of each of these characteristics is shown in the tables of summary statistics at the end of the paper.

In this section we focus on interpreting the coefficients on the earnings gap, as well as the coefficients on future financial expectations. For convenience, therefore, we reproduce the results for each of these variables in the tables below. As in the previous estimation, the standard errors for the coefficients on the estimated earnings gap are obtained by bootstrapping the estimation (1000 replications).

The first key result from estimating our empirical specification of the full LGM experience preference model is that adding in the controls for wage gaps in the past and future financial expectations significantly improves the model. Comparing the log likelihoods for all four samples (**Table 2.7** compared with **Table 2.9**) we can see the estimated likelihood increases significantly under the full model. For women in the 1985 (1990) cohort, the likelihood increases from –2225 to –2200 (-3786 to –3732); and for men in the 1985 (1990) cohort, the likelihood increases from –2929 to –2841 (-3832 to –3745).

The second key result is that for three of the four cohorts, the earnings gaps in the past are largely insignificant in judgements of current job satisfaction (**Table 2.9**). The one exception is in the younger cohort of men, where the earnings gap in 1990 is significantly positive. However for this cohort, the effect of the *current* earnings gaps continues to dominate, almost twice as large as the gaps experienced in the past (although the difference is not significant). With the exception of the younger cohort of women, these results are actually consistent with the LGM model. The model predicts that as workers get older, the effect of earnings gaps in the past declines. We find the same result when we look at the three period model for the older cohort only, wage gaps in the current period weight more heavily on job satisfaction than wage gaps in the past.

Another key predictions of the LGM model is that the coefficient on the earnings gap decreases as workers get older – because expected earnings become more in line with realised earnings as workers get older. When we compare the coefficient on the earnings gap (current or past) across cohorts, we find that for women, the coefficients are not significantly different from one another. For men in the 1990 cohort, however, we do find that the earnings gap in 1991 is positively correlated with job satisfaction, whereas the same variable is insignificant for men in the 1985 cohort. LGM (2004) actually find little support for this hypothesis in their data. However, they argue that the estimated effect of the current earnings gap on job satisfaction is likely to be biased downwards. The bias arises because that the future earnings gap, which is an omitted variable in their analysis, is likely to be positively correlated with both the current earnings gap and current job satisfaction. Therefore, the fact that the size of the coefficients on the earnings gap across the female cohorts are not significantly different from one another should not be interpreted as a significant reason to reject the LGM model of job satisfaction as experienced preference[18]. Indeed, the significant difference we *do* observe for men is consistent with predictions of the experienced preference model.

The fourth key result we find in the full specification is that future financial expectations are significantly positively correlated with job satisfaction – individuals who expect to be better off in the future are also more satisfied. In fact, the significant increases in the maximised log likelihood that we remarked on above are largely driven by the inclusion of these variables in the ordered probit. Looking at the coefficients, the one consistent result is that graduates in all four groups share a strong dislike of *uncertainty*. The negative correlation between job satisfaction and those graduates who say they 'Don't know' whether they will be better off or worse off in the future is very strong, and in the older cohort, the effect is about the same as that observed for the group who say that they expect to *worse off* in the next year (the 'Don't know' group

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18 It could also be argued that the inclusion of the variables controlling for future financial expectations helps to remove some of the bias discussed above. However, a comparison of the coefficients on the current earnings gap in **Table 2.9** with the coefficients on the earnings gap for Model (2) in **Table 2.7** actually shows that the inclusion of the answers to the questions about future financial expectations does little to change the coefficients on the current earnings gap. Another reason why we might not observe a difference in the coefficients for our sample is because the difference in the average age of the individuals in each cohort is not large enough for there to be any significant difference in expectations formation.

represents between about 10% and 20% of graduates – see the summary statistics in at the end of the paper).

Interestingly, the results also seem to imply that, for the younger cohort in particular, the expected financial situation in the near future weighs more heavily on job satisfaction that the expected situation in the more distant future. This result stands even when we estimate all the separate ordered probits that do not include the answers to both questions at the same time . Overall, it would seem that the coefficients on the answers to the questions about future financial expectation are consistent with the LGM model – that is, if you expect to be better off in the future than you are now, then you are more satisfied. However, given the reservations that we expressed earlier about what the answers to these questions *actually* mean (in the context of the variables in the LGM experienced preference model), we stop short of saying that the results provide *definitive* evidence that the model of job satisfaction as experienced preference is supported by the data on the job satisfaction of UK third level graduates.

Table 2.9 Coefficients on the earnings gaps from estimating the LGM model of job satisfaction as experienced preference (equation 15), 2-period model

Ordered probit: dependent variable job satisfaction [1,6]	Cohort			
	Female, 1985	**Male, 1985**	**Female, 1990**	**Male, 1990**
Estimated earnings gap (t=1991)	0.0047	-0.0003	0.0004	0.0071
	(1.11)	(0.09)	(0.08)	(1.96)*
Estimated earnings gap (t=1996)	0.0061	0.0115	0.0099	0.0114
	(1.54)	(3.80)**	(2.39)*	(3.85)**
"Looking ahead, how do you think you will be financially a year from a year from now?".				
Better off than now				
Worse off than now	-0.3801	-0.7274	-0.5850	-0.8239
	(3.37)**	(6.59)**	(6.46)**	(8.26)**
About the same	-0.1440	-0.2518	-0.2836	-0.1929
	(2.10)*	(4.46)**	(5.82)**	(3.92)**
Don't know	-0.3986	-0.7428	-0.4042	-0.4430
	(2.18)*	(4.61)**	(3.01)**	(2.76)**
"Looking ahead, how do you think you will be financially a year from five years from now?".				
Better off than now				
Worse off than now	-0.4151	-0.6478	-0.3088	-0.4184
	(4.20)**	(6.45)**	(3.94)**	(4.33)**
About the same	-0.1002	-0.0643	-0.1215	-0.1688
	(1.25)	(0.90)	(1.91)+	(2.13)*
Don't know	-0.2741	-0.2550	-0.1585	-0.3743
	(3.33)**	(3.09)**	(2.37)*	(5.18)**
Observations	1462	1999	2466	2586
Log likelihood	-2200.67	-2842.43	-3732.64	-3745.49
Chi2	156.29	343.14	213.40	300.67
Pseudo-R2	0.03	0.06	0.03	0.04

Absolute value of z statistics in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 2.10 Coefficients on the earnings gaps from estimating the LGM model of job satisfaction as experienced preference (equation (15)) – 3-period model

Ordered probit: dependent variable job satisfaction [1,6]	Cohort	
	Female, 1985	Male, 1985
Estimated earnings gap (t=1986)	0.0070	0.0017
	(0.97)	(0.29)
Estimated earnings gap (t=1991)	0.0029	-0.0013
	(0.49)	(0.34)
Estimated earnings gap (t=1996)	0.0058	0.0097
	(1.26)	(2.99)**
"Looking ahead, how do you think you will be financially a year from a year from now?".		
Better off than now		
Worse off than now	-0.4729	-0.7516
	(3.77)**	(6.29)**
About the same	-0.1372	-0.2899
	(1.78)+	(4.74)**
Don't know	-0.4149	-0.8217
	(2.14)*	(4.63)**
"Looking ahead, how do you think you will be financially a year from five years from now?".		
Better off than now		
Worse off than now	-0.4403	-0.5793
	(4.11)**	(5.40)**
About the same	-0.0929	-0.0187
	(1.03)	(0.24)
Don't know	-0.2522	-0.2183
	(2.72)**	(2.44)*
Observations	1168	1711
Log likelihood	-1768.80	-2431.06
Chi2	140.32	278.91
Pseudo-R2	0.04	0.05

Absolute value of z statistics in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

2.6. Conclusion

This paper makes two important contributions to the economics literature on the economics of job satisfaction. Firstly, the empirical evidence presented in the paper indicates that earnings have a significant positive effect on individuals' self reported job satisfaction. We show that when the endogeneity of earnings in the job satisfaction equation is controlled for, the effect of own earnings increases significantly. For some groups, the marginal effect of earnings on job satisfaction more than doubled when we included an IV estimate of own earnings in the job satisfaction regression. The fact that earnings are endogenous in the job satisfaction equation may go some way towards explaining why the previous studies in this area provide mixed results for the relationship between the two variables. One fruitful avenue for future research in this area might be to try and determine exactly why the endogeneity problem should lead to a *negative* bias (apart from the fact that earnings may be measured with error).

Even though this is one of few the results in the literature to show such a persistent significant positive correlation between own earnings and job satisfaction, the effects we found were relatively small. This implies that there is a range of factors over and above earnings, both individual and job-related characteristics, which also determine self-reported job satisfaction. We include several such characteristics in the job satisfaction equations we estimate and the results we find are almost entirely consistent with those found elsewhere in the literature.

The second contribution of this paper to the literature is that it provides formal tests of the model of job satisfaction as experienced preference as developed in Lévy-Garboua and Montmarquette (2004). The experienced preference interpretation of self-reported job satisfaction is appealing in that it is consistent with standard economic theories of utility maximising behaviour as well as reference dependent behaviour. Furthermore, the predictions of the model are intuitive and consistent with the observed patterns of job satisfaction across individuals with different characteristics. The evidence we presented is supportive of the model of job satisfaction as experienced preference, although the results are by no means definitive. The empirical tests of the experienced preference framework would be significantly improved if we able to include reliable data on expectations of future earnings and earnings gaps. It is not at all obvious how this could be achieved - however, if the experience preference framework is to be seriously as an *economic* model of job satisfaction, and then we would see this as the key weakness that needs to be addressed in any future empirical work.

Appendix – Summary statistics, and results from the probit estimation

Table A2.11 Full results from estimating the basic model (equation (12))

Order probit dependent variable: Job satisfaction [1,6]	Female, 1985		Male, 1985		Female, 1990		Male 1990	
	Non-IV	*IV*	*Non-IV*	*IV*	*Non-IV*	*IV*	*Non-IV*	*IV*
Earnings 1996 ('000)	0.0057		0.0088		0.0072		0.0111	
	(1.83)+		(4.09)**		(2.38)*		(4.83)**	
Earnings 1996 ('000) – *instrumented*		0.014		0.0128		0.0243		0.0159
		(2.31)		(2.97)		(3.50)		(3.00)
1985/1990 qualification: Sub degree	*Omitted*		*Omitted*		*Omitted*		*Omitted*	
1985/1990 qualification: 1st Degree	-0.1837		0.1662		0.0376		0.0527	
	(1.29)		(1.57)		(0.52)		(0.84)	
1985/1990 qualification: Postgraduate	-0.2188		0.1518		0.0378		0.0763	
	(1.37)		(1.18)		(0.43)		(0.87)	
1985/1990 qualification: Open University	-0.0558		0.0967		-0.0226		0.0261	
	(0.36)		(0.80)		(0.24)		(0.31)	
Married/Partner	0.1283		0.2028		-0.0150		-0.0539	
	(1.93)+		(3.28)**		(0.33)		(1.15)	
Number of children	0.0570		-0.0103		0.0855		0.0336	
	(1.52)		(0.41)		(2.38)*		(1.21)	
Work limiting disability	-0.1320		-0.0458		-0.2251		-0.1212	
	(0.88)		(0.36)		(1.88)+		(1.03)	
First class degree, or distinction	0.1257		0.1176		0.1698		0.0956	
	(1.07)		(1.21)		(2.15)*		(1.29)	
Currently have a PhD	0.1982		-0.0046		0.0834		-0.1715	
	(1.16)		(0.04)		(0.51)		(1.23)	
Currently have a masters	-0.0692		-0.0720		0.0653		-0.0536	
	(0.91)		(1.11)		(0.98)		(0.85)	
Currently have a prof. qual.	0.0108		-0.1873		-0.0218		0.0001	
	(0.18)		(3.61)**		(0.45)		(0.00)	
Qualification from 1985/1990 is a job requirement (current job)	0.1198		0.0864		0.2125		0.2157	
	(1.95)+		(1.72)+		(4.46)**		(4.88)**	
Self employed	0.3434		0.2353		0.2174		0.2078	
	(2.73)**		(2.50)*		(1.98)*		(2.18)*	
Hours of work	-0.0071		0.0074		-0.0048		0.0013	
	(2.68)**		(2.92)**		(2.35)*		(0.65)	
Job tenure>4 years	0.0341		0.1475		-0.0164		-0.0399	
	(0.38)		(1.75)+		(0.27)		(0.65)	
Firm size: <=25 employees	*Omitted*		*Omitted*		*Omitted*		*Omitted*	

Order probit dependent variable: Job satisfaction [1,6]	Female, 1985		Male, 1985		Female, 1990		Male 1990	
	Non-IV	*IV*	*Non-IV*	*IV*	*Non-IV*	*IV*	*Non-IV*	*IV*
Firm size: 25 - 99 employees	-0.0039		-0.1404		-0.0935		-0.1984	
	(0.04)		(1.58)		(1.41)		(2.49)*	
Firm size: 100 - 499 employees	-0.1235		-0.2085		-0.1887		-0.1374	
	(1.26)		(2.38)*		(2.67)**		(1.75)+	
Firm size: 500+ employees	-0.0081		-0.0982		-0.1584		-0.1346	
	(0.09)		(1.18)		(2.45)*		(1.83)+	
Member of company pension scheme	-0.2315		-0.0042		0.1292		-0.0366	
	(3.06)**		(0.06)		(2.39)*		(0.67)	
Company health scheme	-0.0431		0.0170		0.0523		0.1189	
	(0.49)		(0.27)		(0.76)		(2.26)*	
Company car scheme	0.2645		0.0032		0.1004		0.0460	
	(2.85)**		(0.05)		(1.27)		(0.81)	
Company profit share scheme	-0.0123		-0.0358		-0.0543		0.0510	
	(0.14)		(0.58)		(0.75)		(0.98)	
Member of trade union	0.0362		-0.0981		-0.1101		-0.1405	
	(0.53)		(1.55)		(2.13)*		(2.58)**	
Work in the public sector	-0.1335		-0.1311		0.0231		0.1040	
	(1.66)+		(1.92)+		(0.38)		(1.83)+	
Continuous unempl spell >=12 months in last 5/10 years	0.0693		-0.2281		-0.0441		0.0565	
	(0.52)		(1.99)*		(0.37)		(0.52)	
Months employed since first qualification	0.0022		0.0018		0.0046		0.0005	
	(1.52)		(1.14)		(3.43)**		(0.40)	
Squared	-0.0000		-0.0000		-0.0000		-0.0000	
	(0.84)		(1.04)		(3.27)**		(0.37)	
Observations	1462		1999		2466		2586	
Log likelihood	-2229.28		-2936.04		-3790.40		-3832.94	
Chi2	99.08		155.92		97.88		125.76	
Pseudo-R2	0.02		0.03		0.01		0.02	

Absolute value of z statistics in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

Table A2.12 Full results from estimating the LGM model of job satisfaction as experience preference (equation (15)) – 2-period model

Ordered probit: dependent variable job satisfaction [1,6]	Cohort			
	Female, 1985	**Male, 1985**	**Female, 1990**	**Male, 1990**
Estimated earnings gap (t=1991)	0.0047	-0.0003	0.0004	0.0071
	(1.11)	(0.09)	(0.08)	(1.96)*
Estimated earnings gap (t=1996)	0.0061	0.0115	0.0099	0.0114
	(1.54)	(3.80)**	(2.39)*	(3.85)**
"Looking ahead, how do you think you will be financially a year from a year from now?".				
Better off than now				
Worse off than now	-0.3801	-0.7274	-0.5850	-0.8239
	(3.37)**	(6.59)**	(6.46)**	(8.26)**
About the same	-0.1440	-0.2518	-0.2836	-0.1929
	(2.10)*	(4.46)**	(5.82)**	(3.92)**
Don't know	-0.3986	-0.7428	-0.4042	-0.4430
	(2.18)*	(4.61)**	(3.01)**	(2.76)**
"Looking ahead, how do you think you will be financially a year from five years from now?".				
Better off than now				
Worse off than now	-0.4151	-0.6478	-0.3088	-0.4184
	(4.20)**	(6.45)**	(3.94)**	(4.33)**
About the same	-0.1002	-0.0643	-0.1215	-0.1688
	(1.25)	(0.90)	(1.91)+	(2.13)*
Don't know	-0.2741	-0.2550	-0.1585	-0.3743
	(3.33)**	(3.09)**	(2.37)*	(5.18)**
1985/1990 qualification: Sub degree	*Omitted*	*Omitted*	*Omitted*	*Omitted*
1985/1990 qualification: 1st Degree	-0.1661	0.1736	0.0384	0.0297
	(1.16)	(1.64)	(0.54)	(0.47)
1985/1990 qualification: Postgraduate	-0.1738	0.2013	0.0710	0.1466
	(1.08)	(1.56)	(0.81)	(1.67)+
1985/1990 qualification: Open University	0.0305	0.2705	0.0528	0.1892
	(0.19)	(2.20)*	(0.56)	(2.19)*
Married/Partner	0.1413	0.2193	0.0090	-0.0513
	(2.11)*	(3.52)**	(0.19)	(1.09)
Number of children	0.0373	-0.0099	0.1005	0.0373
	(0.98)	(0.39)	(2.77)**	(1.34)
Work limiting disability	-0.1050	0.0653	-0.1469	-0.1199
	(0.70)	(0.51)	(1.22)	(1.02)
First class degree, or distinction	0.1542	0.1698	0.1761	0.0967

Ordered probit: dependent variable job satisfaction [1,6]	Cohort			
	Female, 1985	**Male, 1985**	**Female, 1990**	**Male, 1990**
	(1.30)	(1.74)+	(2.23)*	(1.30)
Currently have a PhD	0.1820	-0.0205	0.0713	-0.1533
	(1.06)	(0.18)	(0.43)	(1.09)
Currently have a masters	-0.0470	-0.0554	0.0843	-0.0235
	(0.62)	(0.85)	(1.27)	(0.37)
	Female, 1985	**Male, 1985**	**Female, 1990**	**Male, 1990**
Currently have a prof. qual.	0.0354	-0.1491	-0.0051	0.0276
	(0.60)	(2.89)**	(0.11)	(0.58)
Qualification from 1985/1990 is a job requirement (currently)	0.1119	0.0667	0.1629	0.1715
	(1.82)+	(1.32)	(3.40)**	(3.84)**
Self employed	0.3863	0.3070	0.2670	0.2404
	(3.05)**	(3.25)**	(2.42)*	(2.52)*
Hours of work	-0.0075	0.0072	-0.0045	0.0001
	(2.80)**	(2.83)**	(2.22)*	(0.07)
Job tenure>4 years	0.0195	0.1403	-0.0308	-0.0781
	(0.22)	(1.66)+	(0.51)	(1.26)
Firm size: <=25 employees	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Firm size: 25 - 99 employees	0.0021	-0.1406	-0.1219	-0.2060
	(0.02)	(1.57)	(1.84)+	(2.58)**
Firm size: 100 - 499 employees	-0.1156	-0.1907	-0.1958	-0.1266
	(1.17)	(2.16)*	(2.76)**	(1.61)
Firm size: 500+ employees	0.0082	-0.1221	-0.1791	-0.1574
	(0.09)	(1.46)	(2.76)**	(2.14)*
Member of company pension scheme	-0.2420	0.0046	0.1107	-0.0295
	(3.19)**	(0.07)	(2.04)*	(0.54)
Member of company health scheme	-0.0434	-0.0051	-0.0005	0.0938
	(0.49)	(0.08)	(0.01)	(1.78)+
Member of company car scheme	0.2225	-0.0349	0.0788	0.0314
	(2.39)*	(0.54)	(0.99)	(0.55)
Company profit share scheme	-0.0305	-0.0808	-0.0689	0.0381
	(0.33)	(1.29)	(0.96)	(0.73)
Member of trade union	0.0709	-0.0630	-0.0752	-0.0790
	(1.03)	(0.98)	(1.44)	(1.44)
Work in the public sector	-0.0939	-0.0846	0.0690	0.1479
	(1.16)	(1.23)	(1.12)	(2.58)**
Continuous unempl spell >=12 months in last 5/10 years	0.1153	-0.1364	-0.0575	0.1009
	(0.86)	(1.18)	(0.48)	(0.92)
Months employed since first qualification	0.0029	0.0027	0.0049	0.0007
	(2.02)*	(1.64)	(3.69)**	(0.50)
Months employed squared	-0.0000	-0.0000	-0.0000	-0.0000
	(1.33)	(1.65)+	(3.57)**	(0.52)
Observations	1462	1999	2466	2586
Log likelihood	-2200.67	-2842.43	-3732.64	-3745.49

Ordered probit: dependent variable job satisfaction [1,6]	**Cohort**			
	Female, 1985	**Male, 1985**	**Female, 1990**	**Male, 1990**
Chi2	156.29	343.14	213.40	300.67
Pseudo-R2	0.03	0.06	0.03	0.04
Absolute value of z statistics in parentheses				
+ significant at 10%; * significant at 5%; ** significant at 1%				

Table A2.13 Full results from estimating the LGM model of job satisfaction as experience preference (equation (15)) – 3-period model

Ordered probit: dependent variable job satisfaction [1,6]	Cohort	
	Female, 1985	Male, 1985
Estimated earnings gap (t=1986)	0.0070	0.0017
	(0.97)	(0.29)
Estimated earnings gap (t=1991)	0.0029	-0.0013
	(0.49)	(0.34)
Estimated earnings gap (t=1996)	0.0058	0.0097
	(1.26)	(2.99)**
"Looking ahead, how do you think you will be financially a year from a year from now?'.		
Better off than now		
Worse off than now	-0.4729	-0.7516
	(3.77)**	(6.29)**
About the same	-0.1372	-0.2899
	(1.78)+	(4.74)**
Don't know	-0.4149	-0.8217
	(2.14)*	(4.63)**
"Looking ahead, how do you think you will be financially a year from five years from now?'.		
Better off than now		
Worse off than now	-0.4403	-0.5793
	(4.11)**	(5.40)**
About the same	-0.0929	-0.0187
	(1.03)	(0.24)
Don't know	-0.2522	-0.2183
	(2.72)**	(2.44)*
1985/1990 qualification: Sub degree		
1985/1990 qualification: 1st Degree	-0.1084	0.2407
	(0.73)	(2.19)*
1985/1990 qualification: Postgraduate	-0.1240	0.2604
	(0.73)	(1.92)+
1985/1990 qualification: Open University	0.0936	0.2862
	(0.56)	(2.23)*
Married/Partner	0.1121	0.2432
	(1.50)	(3.54)**
Number of children	0.0290	-0.0005
	(0.68)	(0.02)
Work limiting disability	-0.0919	0.0378
	(0.56)	(0.28)
First class degree, or distinction	0.1209	0.1216
	(0.88)	(1.12)
Currently have a PhD	0.1350	-0.1139
	(0.62)	(0.78)

Ordered probit: dependent variable job satisfaction [1,6]	Cohort	
	Female, 1985	Male, 1985
Currently have a masters	-0.0369	-0.0185
	(0.41)	(0.26)
Currently have a masters	-0.0369	-0.0185
	(0.41)	(0.26)
Currently have a prof. qual.	0.0751	-0.1649
	(1.15)	(2.94)**
Qualification from 1985/1990 is a job requirement (current job)	0.1061	0.0454
	(1.56)	(0.83)
Self employed	0.4076	0.3075
	(2.83)**	(2.97)**
Hours of work	-0.0085	0.0068
	(2.81)**	(2.49)*
Job tenure>4 years	0.0124	0.0898
	(0.12)	(0.95)
Firm size: <=25 employees	*Omitted*	*Omitted*
Firm size: 25 - 99 employees	-0.0700	-0.0495
	(0.70)	(0.51)
Firm size: 100 - 499 employees	-0.1409	-0.1140
	(1.28)	(1.18)
Firm size: 500+ employees	-0.0033	-0.0402
	(0.03)	(0.44)
Member of company pension scheme	-0.2891	-0.0962
	(3.30)**	(1.32)
Member of company health scheme	0.0320	-0.0179
	(0.33)	(0.27)
Member of company car scheme	0.2160	-0.0380
	(2.07)*	(0.55)
Member of company profit share scheme	-0.0543	-0.0606
	(0.53)	(0.91)
Member of trade union	0.0954	-0.0655
	(1.25)	(0.94)
Work in the public sector	-0.0865	-0.0886
	(0.95)	(1.17)
Continuous unempl spell >=12 months in last 5/10 years	0.1013	-0.0216
	(0.47)	(0.14)
Months employed since first qualification	0.0032	0.0032
	(1.84)+	(1.66)+
Months employed squared	-0.0000	-0.0000
	(1.33)	(1.66)+
Observations	1168	1711
Log likelihood	-1768.80	-2431.06
Chi2	140.32	278.91
Pseudo-R2	0.04	0.05

Absolute value of z statistics in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

Table A2.14 Summary Statistics, Female Graduates 1985

	Female, 1985 graduates					
	Degree (UG, PG)			Sub degree, OU		
Personal characteristics	**Average**	**Std. Err.**	**Obs**	**Average**	**Std. Err.**	**Obs**
Age	34.66	0.16	1167	45.65	0.46	285
Married	57.53%	1.44%	1175	66.90%	2.78%	287
Partner	14.47%	1.03%	1175	9.41%	1.73%	287
Separated	4.94%	0.63%	1175	9.41%	1.73%	287
Single	22.89%	1.23%	1175	14.29%	2.07%	287
Number of children	1.54	3.20%	413	1.53	8.52%	73
Current qualifications						
PhD	3.32%	0.52%	1175	0.70%	0.49%	287
Masters	19.23%	1.15%	1175	11.50%	1.89%	287
Degree	91.57%	0.81%	1175	81.53%	2.29%	287
Professional	31.57%	1.36%	1175	41.46%	2.91%	287
PGCE	18.04%	1.12%	1175	10.45%	1.81%	287
PGDIP	15.74%	1.06%	1175	14.29%	2.07%	287
Other qual	17.87%	1.12%	1175	41.81%	2.92%	287
1990/1990 qualification						
Length initial study (years)	3.20	0.03	1169	4.50	0.09	284
Was 1990 qual. requirement in job specification (1996)?	69.28%	1.35%	1175	36.93%	2.85%	287
Was 1990 qual. requirement in job specification (1991)?	68.62%	1.36%	1163	33.80%	2.81%	284
Was 1990 qual. requirement in job specification (1986)?	33.60%	2.11%	500	35.77%	4.34%	123
Would do the same course again	44.62%	1.45%	1172	52.96%	2.95%	287
Would do slightly different course	29.52%	1.33%	1172	34.84%	2.82%	287
Would do very different course	25.09%	1.27%	1172	11.15%	1.86%	287
Would not do a degree	0.43%	0.19%	1172	0.35%	0.35%	287
Would not do a diploma	0.34%	0.17%	1172	0.70%	0.49%	287
Employment history	122.94	1.58	1175	123.75	2.76	287
Months employed since graduating (1990)						
Continuous spell of unempl.t for >=12 months	4.43%	0.60%	1175	5.57%	1.36%	287
Earnings 1991	£17,041.28	£208.77	1175	£16,114.98	£470.77	287
Earnings 1986	£8,756.55	£160.61	916	£11,533.73	£404.98	252
Did not work between leaving school & 3rd level	73.25%	1.29%	1170	13.29%	2.01%	286
Worked for less than a year	10.17%	0.88%	1170	1.40%	0.70%	286
Worked for 1-2 years	4.70%	0.62%	1170	4.20%	1.19%	286
Worked for >2 years	11.88%	0.95%	1170	81.12%	2.32%	286

	Female, 1985 graduates					
	Degree (UG, PG)			Sub degree, OU		
Current Job						
Earnings 1996	24108.09	333.87	1175	20668.99	594.82	287
Weekly hours of work 1996	39.35	0.35	1175	39.00	0.77	287
Job satisfaction	4.16	0.04	1175	4.20	0.07	287
Member of a trade union	43.83%	1.45%	1175	57.14%	2.93%	287
Work in the public sector	52.60%	1.46%	1175	72.82%	2.63%	287
Less than 3 months	3.57%	0.54%	1175	2.09%	0.85%	287
3-12 months	6.98%	0.74%	1175	3.83%	1.14%	287
1-2 years	12.77%	0.97%	1175	8.36%	1.64%	287
3-4 years	11.32%	0.92%	1175	7.67%	1.57%	287
>4 years	65.02%	1.39%	1175	77.35%	2.47%	287
Are you a member of profit sharing scheme at work?	17.62%	1.11%	1175	7.67%	1.57%	287
Are you a member of a company car scheme at work?	16.17%	1.07%	1175	8.01%	1.61%	287
Are you a member of the work pension scheme?	74.47%	1.27%	1175	78.40%	2.43%	287
Are you a member of the company health scheme?	21.02%	1.19%	1175	10.80%	1.84%	287
Future financial expectations - 1 year ahead						
Better off	35.73%	1.40%	1170	24.56%	2.55%	285
Worse off	8.80%	0.83%	1170	9.82%	1.77%	285
About the same	52.48%	1.46%	1170	63.16%	2.86%	285
Don't know	2.99%	0.50%	1170	2.46%	0.92%	285
Future financial expectations - 5 years ahead						
Better off	53.62%	1.46%	1173	30.28%	2.73%	284
Worse off	9.80%	0.87%	1173	19.37%	2.35%	284
About the same	18.24%	1.13%	1173	30.99%	2.75%	284
Don't know	18.33%	1.13%	1173	19.37%	2.35%	284

Source: The Careers of Highly Qualified Workers, HEFCE 1996

Table A2.15 Summary Statistics, Male Graduates 1985

	Male, 1985 graduates					
	Degree (UG, PG)			Sub degree, OU		
Personal characteristics	**Average**	**Std. Err.**	**Obs**	**Average**	**Std. Err.**	**Obs**
Age	34.60	0.12	1614	44.57	0.44	380
Married	64.83%	1.19%	1618	74.80%	2.23%	381
Partner	11.37%	0.79%	1618	7.87%	1.38%	381
Separated	2.72%	0.40%	1618	4.46%	1.06%	381
Single	20.52%	1.00%	1618	12.60%	1.70%	381
Number of children	1.78	2.67%	770	1.85	6.67%	158
Current qualifications						
PhD	5.93%	0.59%	1618	1.57%	0.64%	381
Masters	21.94%	1.03%	1618	14.44%	1.80%	381
Degree	91.16%	0.71%	1618	72.70%	2.29%	381
Professional	32.01%	1.16%	1618	28.87%	2.32%	381
PGCE	8.90%	0.71%	1618	8.66%	1.44%	381
PGDIP	12.73%	0.83%	1618	11.55%	1.64%	381
Other qual	10.07%	0.75%	1618	54.33%	2.56%	381
1990/1990 qualification						
Length initial study (years)	3.10	0.02	1610	4.31	0.08	377
Was 1990 qual. requirement in job specification (1996)?	64.59%	1.19%	1618	38.58%	2.50%	381
Was 1990 qual. requirement in job specification (1991)?	67.31%	1.17%	1600	35.36%	2.46%	379
Was 1990 qual. requirement in job specification (1986)?	37.06%	1.72%	788	38.51%	3.85%	161
Would do the same course again	42.35%	1.23%	1615	44.97%	2.56%	378
Would do slightly different course	32.32%	1.16%	1615	39.95%	2.52%	378
Would do very different course	23.90%	1.06%	1615	11.90%	1.67%	378
Would not do a degree	1.24%	0.28%	1615	1.59%	0.64%	378
Would not do a diploma	0.19%	0.11%	1615	1.59%	0.64%	378
Employment history	123.76	0.92	1618	132.35	3.14	381
Months employed since graduating (1990)						
Continuous spell of unempl.t for >=12 months	5.19%	0.55%	1618	2.62%	0.82%	381
Earnings 1991	£20,218.79	£213.32	1618	£20,885.83	£499.20	381
Earnings 1986	£9,786.56	£143.07	1347	£15,027.47	£452.02	364
Did not work between leaving school & 3rd level	66.46%	1.18%	1604	16.36%	1.90%	379
Worked for less than a year	15.15%	0.90%	1604	4.75%	1.09%	379
Worked for 1-2 years	4.74%	0.53%	1604	4.75%	1.09%	379

	Male, 1985 graduates					
	Degree (UG, PG)			Sub degree, OU		
Worked for >2 years	13.65%	0.86%	1604	74.14%	2.25%	379
Current Job						
Earnings 1996	32303.1	341.92	1618	27166.6	599.92	381
Weekly hours of work 1996	45.59	0.25	1618	44.43	0.54	381
Job satisfaction	4.24	0.03	1618	4.02	0.07	381
Member of a trade union	25.90%	1.09%	1618	45.14%	2.55%	381
Work in the public sector	30.84%	1.15%	1618	45.67%	2.56%	381
Less than 3 months	3.34%	0.45%	1618	1.57%	0.64%	381
3-12 months	7.54%	0.66%	1618	3.41%	0.93%	381
1-2 years	13.91%	0.86%	1618	5.25%	1.14%	381
3-4 years	9.83%	0.74%	1618	5.25%	1.14%	381
>4 years	64.96%	1.19%	1618	83.46%	1.91%	381
Are you a member of profit sharing scheme at work?	29.98%	1.14%	1618	20.73%	2.08%	381
Are you a member of a company car scheme at work?	30.53%	1.15%	1618	19.95%	2.05%	381
Are you a member of the work pension scheme?	75.65%	1.07%	1618	81.89%	1.98%	381
Are you a member of the company health scheme?	36.59%	1.20%	1618	24.93%	2.22%	381
Future financial expectations - 1 year ahead						
Better off	46.12%	1.24%	1611	32.98%	2.42%	379
Worse off	6.33%	0.61%	1611	8.97%	1.47%	379
About the same	44.63%	1.24%	1611	56.20%	2.55%	379
Don't know	2.92%	0.42%	1611	1.85%	0.69%	379
Future financial expectations - 5 years ahead						
Better off	67.78%	1.16%	1614	44.41%	2.57%	376
Worse off	6.07%	0.59%	1614	19.41%	2.04%	376
About the same	15.24%	0.89%	1614	19.95%	2.06%	376
Don't know	10.90%	0.78%	1614	16.22%	1.90%	376

Source: The Careers of Highly Qualified Workers, HEFCE 1996

Table A2.16 Summary Statistics, Female Graduates 1990

	Female, 1990 graduates					
	Degree (UG, PG)			Subdegree, OU		
Personal characteristics	**Average**	**Std. Err.**	**Obs**	**Average**	**Std. Err.**	**Obs**
Age	31.38	0.16	1931	40.19	0.45	519
Married	41.42%	1.12%	1941	55.43%	2.17%	525
Partner	23.49%	0.96%	1941	14.86%	1.55%	525
Separated	3.86%	0.44%	1941	10.86%	1.36%	525
Single	30.96%	1.05%	1941	18.67%	1.70%	525
Number of children	1.44	3.73%	308	1.52	6.04%	129
Current qualifications						
PhD	2.01%	0.32%	1941	0.76%	0.38%	525
Masters	14.68%	0.80%	1941	5.71%	1.01%	525
Degree	90.57%	0.66%	1941	53.33%	2.18%	525
Professional	26.69%	1.00%	1941	39.81%	2.14%	525
PGCE	13.96%	0.79%	1941	5.71%	1.01%	525
PGDIP	16.33%	0.84%	1941	11.62%	1.40%	525
Other qual	20.20%	0.91%	1941	49.33%	2.18%	525
1990/1990 qualification						
Length initial study (years)	3.19	0.02	1929	3.69	0.08	521
Was 1990 qual. requirement in job specification (1996)?	70.48%	1.04%	1941	41.52%	2.15%	525
Was 1990 qual. requirement in job specification (1991)?	64.18%	1.10%	1904	34.50%	2.09%	516
Was 1990 qual. requirement in job specification (1986)?	37.88%	1.66%	858	38.53%	3.30%	218
Would do the same course again	49.46%	1.14%	1933	56.32%	2.17%	522
Would do slightly different course	30.68%	1.05%	1933	31.03%	2.03%	522
Would do very different course	18.83%	0.89%	1933	9.96%	1.31%	522
Would not do a degree	0.62%	0.18%	1933	0.57%	0.33%	522
Would not do a diploma	0.41%	0.15%	1933	2.11%	0.63%	522
Employment history	88.40	2.69	1941	100.72	6.14	525
Months employed since graduating (1990)						
Continuous spell of unempl.t for >=12 months	2.99%	0.39%	1941	4.19%	0.88%	525
Earnings 1991	£12,393.61	£127.95	1941	£12,707.62	£281.38	525
Earnings 1986	£9,783.49	£338.06	418	£9,916.93	£333.09	319
Did not work between leaving school & 3rd level	62.38%	1.10%	1930	19.35%	1.73%	522
Worked for less than a year	11.09%	0.71%	1930	4.02%	0.86%	522
Worked for 1-2 years	5.54%	0.52%	1930	6.32%	1.07%	522
Worked for >2 years	20.98%	0.93%	1930	70.31%	2.00%	522

	Female, 1990 graduates					
	Degree (UG, PG)			Subdegree, OU		
Current Job						
Earnings 1996	20436.6	190.98	1941	17922.8	329.81	525
Weekly hours of work 1996	41.76	0.25	1941	38.18	0.54	525
Job satisfaction	4.21	0.03	1941	4.09	0.05	525
Member of a trade union	43.59%	1.13%	1941	47.81%	2.18%	525
Work in the public sector	57.39%	1.12%	1941	63.81%	2.10%	525
Less than 3 months	4.74%	0.48%	1941	3.05%	0.75%	525
3-12 months	10.92%	0.71%	1941	5.33%	0.98%	525
1-2 years	21.48%	0.93%	1941	12.95%	1.47%	525
3-4 years	15.51%	0.82%	1941	9.71%	1.29%	525
>4 years	46.57%	1.13%	1941	68.38%	2.03%	525
Are you a member of profit sharing scheme at work?	15.46%	0.82%	1941	11.62%	1.40%	525
Are you a member of a company car scheme at work?	9.22%	0.66%	1941	8.19%	1.20%	525
Are you a member of the work pension scheme?	73.00%	1.01%	1941	72.76%	1.94%	525
Are you a member of the company health scheme?	15.71%	0.83%	1941	12.95%	1.47%	525
Future financial expectations - 1 year ahead						
Better off	45.05%	1.13%	1929	35.69%	2.09%	524
Worse off	6.48%	0.56%	1929	8.59%	1.23%	524
About the same	45.52%	1.13%	1929	52.10%	2.18%	524
Don't know	2.95%	0.39%	1929	3.63%	0.82%	524
Future financial expectations - 5 years ahead						
Better off	61.79%	1.11%	1934	52.68%	2.19%	522
Worse off	8.48%	0.63%	1934	12.84%	1.47%	522
About the same	15.15%	0.82%	1934	18.58%	1.70%	522
Don't know	14.58%	0.80%	1934	15.90%	1.60%	522

Source: The Careers of Highly Qualified Workers, HEFCE 1996

Table A2.17 Summary Statistics, Male Graduates 1990

	Male, 1990 graduates					
	Degree (UG, PG)			Subdegree, OU		
Personal characteristics	Average	Std. Err.	Obs	Average	Std. Err.	Obs
Age	30.90	0.14	1878	38.17	0.37	695
Married	42.60%	1.14%	1885	63.48%	1.82%	701
Partner	19.10%	0.91%	1885	12.55%	1.25%	701
Separated	1.86%	0.31%	1885	4.14%	0.75%	701
Single	36.07%	1.11%	1885	19.69%	1.50%	701
Number of children	1.58	3.40%	413	1.76	4.75%	257
Current qualifications						
PhD	2.76%	0.38%	1885	1.28%	0.43%	701
Masters	19.42%	0.91%	1885	5.71%	0.88%	701
Degree	91.30%	0.65%	1885	52.92%	1.89%	701
Professional	27.37%	1.03%	1885	25.39%	1.65%	701
PGCE	5.99%	0.55%	1885	4.42%	0.78%	701
PGDIP	11.46%	0.73%	1885	8.70%	1.07%	701
Other qual	17.82%	0.88%	1885	69.19%	1.75%	701
1990/1990 qualification						
Length initial study (years)	3.27	0.02	1880	3.81	0.07	700
Was 1990 qual. requirement in job specification (1996)?	66.10%	1.09%	1885	42.94%	1.87%	701
Was 1990 qual. requirement in job specification (1991)?	66.29%	1.10%	1842	36.68%	1.84%	687
Was 1990 qual. requirement in job specification (1986)?	46.99%	1.67%	896	34.87%	2.56%	347
Would do the same course again	47.82%	1.15%	1878	46.78%	1.89%	699
Would do slightly different course	31.52%	1.07%	1878	36.62%	1.82%	699
Would do very different course	19.49%	0.91%	1878	12.73%	1.26%	699
Would not do a degree	0.96%	0.22%	1878	0.86%	0.35%	699
Would not do a diploma	0.21%	0.11%	1878	3.00%	0.65%	699
Employment history	93.43	2.91	1885	94.23	4.71	701
Months employed since graduating (1990)						
Continuous spell of unempl.t for >=12 months	3.77%	0.44%	1885	3.57%	0.70%	701
Earnings 1991	£13,863.93	£138.41	1885	£17,168.33	£339.14	701
Earnings 1986	£10,840.57	£299.76	530	£13,458.96	£331.44	536
Did not work between leaving school & 3rd	56.34%	1.14%	1878	14.57%	1.33%	700

	Male, 1990 graduates					
	Degree (UG, PG)			Subdegree, OU		
level						
Worked for less than a year	13.90%	0.80%	1878	7.86%	1.02%	700
Worked for 1-2 years	7.14%	0.59%	1878	7.14%	0.97%	700
Worked for >2 years	22.63%	0.97%	1878	70.43%	1.73%	700
Current Job						
Earnings 1996	24807.9	241.61	1885	24257.4	417.89	701
Weekly hours of work 1996	45.41	0.25	1885	44.38	0.39	701
Job satisfaction	4.21	0.03	1885	4.08	0.05	701
Member of a trade union	25.09%	1.00%	1885	38.52%	1.84%	701
Work in the public sector	31.46%	1.07%	1885	31.95%	1.76%	701
Less than 3 months	4.99%	0.50%	1885	3.28%	0.67%	701
3-12 months	11.35%	0.73%	1885	8.27%	1.04%	701
1-2 years	18.36%	0.89%	1885	11.70%	1.21%	701
3-4 years	14.48%	0.81%	1885	9.56%	1.11%	701
>4 years	50.40%	1.15%	1885	66.90%	1.78%	701
Are you a member of profit sharing scheme at work?	28.54%	1.04%	1885	25.25%	1.64%	701
Are you a member of a company car scheme at work?	20.16%	0.92%	1885	18.83%	1.48%	701
Are you a member of the work pension scheme?	73.47%	1.02%	1885	72.47%	1.69%	701
Are you a member of the company health scheme?	30.13%	1.06%	1885	25.53%	1.65%	701
Future financial expectations - 1 year ahead						
Better off	58.99%	1.14%	1875	42.20%	1.87%	699
Worse off	5.28%	0.52%	1875	7.44%	0.99%	699
About the same	34.08%	1.09%	1875	47.78%	1.89%	699
Don't know	1.65%	0.29%	1875	2.58%	0.60%	699
Future financial expectations - 5 years ahead						
Better off	78.12%	0.95%	1878	61.14%	1.84%	700
Worse off	4.47%	0.48%	1878	10.86%	1.18%	700
About the same	7.67%	0.61%	1878	12.71%	1.26%	700
Don't know	9.74%	0.68%	1878	15.29%	1.36%	700

Source: The Careers of Highly Qualified Workers, HEFCE 1996

Table A2.18 Reduced form earnings equation

Earnings equation (OLS)	Female, 1985	Male, 1985	Female, 1990	Male, 1990
Occupation of main wage-earner aged 14				
Manager & administrator				
Professional & assoc. professional	-0.3720	-0.1023	0.1208	-0.0487
	(0.50)	(0.14)	(0.28)	(0.09)
Clerical	-1.7581	-1.7904	-0.8703	-0.2065
	(1.30)	(1.46)	(1.36)	(0.23)
Manufacturing	-1.2185	0.0777	-0.0642	-0.9127
	(1.44)	(0.09)	(0.13)	(1.65)+
Personal & protective	-1.0877	-2.4620	0.9278	0.7953
	(0.82)	(2.08)*	(1.02)	(0.78)
Sales	-1.1694	0.3558	0.1404	-0.4676
	(0.93)	(0.30)	(0.21)	(0.54)
Plant & machine operatives	-0.7523	-0.8547	0.2656	-1.9321
	(0.74)	(1.65)+	(0.43)	(3.07)**
Qualification in 1985, 1990				
Diploma				
First degree	2.7095	4.0449	2.7444	2.0561
	(1.93)+	(3.10)**	(4.50)**	(2.98)**
Postrgraduate degree	0.5977	1.4750	2.4033	2.6038
	(0.38)	(0.96)	(3.35)**	(3.11)**
Open university	0.4211	0.6440	1.6846	4.3806
	(0.28)	(0.43)	(2.18)*	(4.67)**
First class degree or distinction	1.9363	3.4892	1.6773	3.0154
	(1.55)	(3.39)**	(3.05)**	(4.26)**
Subject studied (1985/1990 qualification)				
Medicine, dentistry, pharmacy, etc				
Biological sciences	-2.0785	-12.0484	-3.5052	-6.3220
	(1.63)	(6.60)**	(4.75)**	(4.75)**
Agriculture & related	-2.9775	-12.3487	-3.2923	-8.7668
	(1.80)+	(4.41)**	(3.01)**	(4.73)**
Physical Sciences	-0.9168	-10.7399	-1.7328	-4.6863
	(0.71)	(6.30)**	(2.30)*	(4.04)**
Mathematical Sciences	1.0175	-7.4934	0.2968	-1.9160
	(0.69)	(4.42)**	(0.33)	(1.58)
Engineering & Technology	1.7494	-8.3972	0.2229	-3.0668
	(0.67)	(5.10)**	(0.25)	(2.78)**
Architecture & town planning	2.0725	-17.6406	-4.3386	-7.3742
	(0.40)	(9.00)**	(2.91)**	(6.52)**
Social, Economic & Political	0.0763	-7.7189	-1.9678	-3.4113
	(0.06)	(4.50)**	(2.86)**	(2.78)**
Business & administrative	-2.4118	-8.2190	-0.6835	-2.5954
	(2.01)*	(4.55)**	(0.99)	(2.23)*
Languages	-0.7926	-11.4592	-2.9660	-7.0135
	(0.61)	(5.02)**	(3.68)**	(4.35)**

Earnings equation (OLS)	Female, 1985	Male, 1985	Female, 1990	Male, 1990
Humanities	-3.5250	-14.0166	-3.2972	-7.4145
	(2.66)**	(7.61)**	(4.38)**	(5.44)**
Education	-0.3171	-12.2040	0.1725	-3.0917
	(0.25)	(6.96)**	(0.25)	(2.25)*
Current qualifications (1996)				
PhD	2.1544	-0.5848	3.0170	0.9535
	(1.50)	(0.54)	(2.18)*	(0.63)
Masters	0.9384	1.8704	1.7574	1.1933
	(1.12)	(2.61)**	(3.12)**	(1.98)*
Degree	-0.2147	0.5315	0.1582	0.2302
	(0.24)	(0.59)	(0.29)	(0.35)
Professional qualification	2.7641	3.8094	2.5566	3.0200
	(4.55)**	(6.28)**	(6.89)**	(6.47)**
Months employed since 1985/90	0.0426	0.1085	0.0303	0.0258
	(2.70)**	(5.06)**	(2.94)**	(1.91)+
Months employed squared	-0.0001	-0.0001	-0.0000	-0.0000
	(3.16)**	(4.89)**	(2.83)**	(1.85)+
Current job characteristics				
Job tenure <=1 year				
Job tenure 1-2 years	1.0619	0.1198	-0.6085	-0.5372
	(0.91)	(0.10)	(1.13)	(0.80)
Job tenure 3-4 years	1.0915	0.2528	-0.0241	0.4044
	(0.92)	(0.19)	(0.04)	(0.52)
Job tenure > 4 years	1.8055	-0.0576	1.1123	-0.1760
	(2.04)*	(0.06)	(2.23)*	(0.30)
Employees in firm <25				
Employees in firm 25 - 99	2.0852	3.6747	1.0851	1.7518
	(2.34)*	(3.82)**	(2.35)*	(2.28)*
Employees in firm 100 - 499	2.7778	4.6463	1.8571	2.4048
	(3.04)**	(4.87)**	(3.90)**	(3.32)**
Employees in firm >=500	4.2317	5.8537	2.9200	4.2580
	(4.99)**	(6.35)**	(6.43)**	(5.85)**
Self employed	3.3016	6.9484	2.0289	5.9687
	(1.97)*	(5.41)**	(1.58)	(4.88)**
Occupation				
Manager & administrator				
Professional & assoc. professional	-2.0464	-1.9559	-1.5611	-2.5181
	(2.68)**	(3.09)**	(3.35)**	(4.72)**
Clerical	-11.2691	-13.1328	-7.5174	-10.2298
	(11.45)**	(8.05)**	(12.41)**	(9.84)**
Manufacturing	-5.5600	-9.0321	-5.2144	-6.5317
	(2.04)*	(2.88)**	(5.48)**	(6.45)**
Personal & protective	-9.5793	-5.8520	-4.7055	-5.7408
	(6.93)**	(2.93)**	(4.14)**	(4.90)**
Sales	-5.2140	1.2710	-1.6681	-0.4263

Earnings equation (OLS)	Female, 1985	Male, 1985	Female, 1990	Male, 1990
	(3.54)**	(0.60)	(1.07)	(0.32)
Plant & machine operatives	-10.4051	-11.0648	2.5446	-6.3395
	(2.83)**	(6.68)**	(0.61)	(3.11)**
Personal characteristics				
Married or partnered	0.2086	1.5968	-0.0130	2.0778
	(0.34)	(2.37)*	(0.04)	(5.12)**
Number of children	-1.6656	1.2136	-1.2136	0.9053
	(4.55)**	(4.43)**	(4.64)**	(3.70)**
Region of work				
Tyne & Wear Metropolitan Districts				
Rest of Northern Region	0.2558	4.3381	0.2757	1.8451
	(0.15)	(1.91)+	(0.28)	(1.56)
South Yorkshire Metropolitan Districts	-0.8249	4.6726	0.9534	0.9421
	(0.38)	(1.66)+	(0.68)	(0.71)
West Yorkshire Metropolitan Districts	1.4025	2.1023	0.5735	1.4140
	(0.77)	(0.89)	(0.59)	(1.33)
Rest of Yorkshire & Humberside region	-0.2929	1.6607	-1.2366	4.1014
	(0.14)	(0.72)	(1.05)	(2.55)*
East Midlands region	1.0073	2.7314	0.6022	0.9600
	(0.58)	(1.25)	(0.62)	(0.98)
East Anglia	0.5764	6.3588	3.6181	3.4373
	(0.30)	(2.54)*	(2.21)*	(2.54)*
Outer London	5.3060	8.1318	2.2422	4.0205
	(2.85)**	(3.62)**	(2.28)*	(3.56)**
Inner London	11.2833	14.4243	6.1836	8.3161
	(6.38)**	(6.88)**	(6.35)**	(7.62)**
South East	2.9646	6.7955	1.6428	3.9730
	(1.89)+	(3.46)**	(1.96)+	(4.59)**
South West	0.5396	2.2249	-0.4262	0.8423
	(0.30)	(1.07)	(0.48)	(0.90)
West Midlands Metropolitan dsitricts	2.5224	4.2135	0.5548	2.2009
	(1.46)	(1.96)*	(0.61)	(2.00)*
Rest of West Midlands	1.2245	4.4816	0.6207	1.4224
	(0.67)	(1.97)*	(0.62)	(1.39)
Greater Manchester Metropolitan districts	0.5158	3.6092	0.1149	2.5498
	(0.26)	(1.68)+	(0.12)	(1.97)*
Merseyside Metropolitan districts	1.2637	6.9307	0.2295	4.6876
	(0.51)	(2.45)*	(0.14)	(2.32)*
Rest of North West region	0.5453	3.6991	-0.3653	1.1868
	(0.29)	(1.69)+	(0.38)	(1.10)
Wales	0.5770	0.7413	1.1314	-0.0854
	(0.30)	(0.34)	(0.86)	(0.07)
Central belt	2.5717	2.8855	0.7372	3.0233
	(1.41)	(1.30)	(0.64)	(2.45)*
Rest of Scotland	3.9888	3.9290	0.6954	4.3010
	(1.70)+	(1.71)+	(0.61)	(3.40)**
Northern Ireland	0.2003	0.2783	-2.3531	0.6198

Earnings equation (OLS)	Female, 1985	Male, 1985	Female, 1990	Male, 1990
	(0.12)	(0.13)	(2.22)*	(0.43)
Outside UK	4.2816	15.2421	2.6185	11.1824
	(1.63)	(6.30)**	(1.65)+	(7.37)**
Constant	13.2418	12.4716	14.2166	17.6168
	(4.42)**	(3.24)**	(10.05)**	(9.44)**
Observations	1462	1999	2466	2586
R-squared	0.26	0.33	0.24	0.27
F-test	9.26	18.77	13.83	15.44

Robust t statistics in parentheses, (**) significant at 1% level, (*) significant at 5% level, (+) significant at the 10% level.

3. Cross Country Evidence on the Returns to Education: Patterns and Explanations

There are few if any models in labour economics that explicitly try to predict how the returns to schooling might vary with the characteristics of an economy. In this paper we analyse the determinants of the private returns to education for a sample of forty-five countries over a number of years. The measure of the private return to education used is the coefficient on schooling from a standard Mincerian regression framework. We consider two candidates as possible explanations for differences in the return that we observe between countries and over time. The first explanation relates the return to investing in education to the level of technology bias in the economy. The second explanation tests whether the complementarity between skills and capital equipment in production is associated with a higher return to education. Both explanations are closely related, in that one possible definition of capital equipment is, that it is capital used in production that has a strong technology component, such as computers for example.

The first part of this paper presents the estimates of the return to education that we use in the empirical analysis. We are particularly interested in whether the stylised facts from the data set we construct are consistent with those noted elsewhere in the literature, such as Psacharopoulos (1994, 2002), Trostel (2002) and Ashenfelter *et al.* (1999). The second part of the paper relates the private return to education to more commonly used measures of the skill premium found in the literature on changes in the wage structure over time. It is standard practice in this literature to define the level of labour skill on the basis of workers' education. For example, in much of the US literature that looks at the changes in the wage structure since the 1960s skilled labour is defined as requiring college completion or better (at least 16 years of schooling in the US); see Krusell *et al.* (2000) and Freeman and Katz (1995).

As in Acemoglu (2003), by implicitly identifying this measure of the skill premium with the Mincerian return to education we are able to draw on models that explain patterns of skill premia over time and across countries. With regard to explaining the observed cross-country differences in the return to education, we test two hypotheses. Firstly, in those countries where there is a greater *technology bias* in production, the return to education will also be higher (Acemoglu, 2003). Secondly, and related to the first hypothesis, countries with greater stocks of capital equipment, such as computers, will also have a higher return to education. The second hypothesis draws on the models developed initially by Griliches (1969), and subsequently the models of capital-skill complementarity developed in Krusell *et al.*, (2000) and Flug and Hercowitz (2000), among others. We are also interested in the effects of trade and globalisation on the return to education. The technology-bias and capital-skill complementarity models make some predictions about the effect of trade on the return to education. These trade effects differ from more traditional models of trade and the wage structure, such as those in Findlay and Kierkowski (1983) or Katz and Murphy (1992), in that trade does not directly affect the wage structure by changing the relative price of skill-intensive and labour-intensive goods.

The rest of the paper is outlined as follows: section 2 presents the data set we use in our analysis. Section 3 presents the stylised facts and compares them with those noted elsewhere in the literature. Section 4 presents the models that we use to explain the observed patterns in the return to education, and tests the theoretical predictions of these models using the sample of returns to education collected for this paper. Section 5 summarises and concludes.

3.2. Data

In this section we describe the data used in the empirical analysis in Section 3 and Section 4. We first present the data we use as a dependent variable - the private return to education – and then describe the data we use as explanatory variables, i.e. stocks of education, capital equipment, etc.

3.2.1. The private return to education

The variable of interest in this paper is the private return to education as estimated by Mincer's empirical approximation of the human capital theoretical framework developed by Becker; Mincer (1974). Mincer showed that if the cost of attending school for an additional year was only the opportunity cost of the students' time, and if the proportional increase in earnings was constant over the lifetime, then the log earnings could be shown to be linearly related to an individual's years of schooling. In this paper we use the slope of this relationship as our measure of the private return to schooling. The measure of private return to education is obtained via least squares estimates of the following equation:

$$\log w_i = X_i \beta + rS_i + \delta \exp_i + \gamma \exp_i^2 + u_i \qquad (1)$$

where $\log w_i$ is the log of earnings for individual i, and S_i is a measure of their schooling, $\exp_i$ is a measure of experience and u_i is a disturbance term[19].

The return to education is measured by the parameter r in equation (1). The coefficient on schooling is essentially the average individual discount rate for the population. This arises directly out of the Mincer model where schooling decisions are made by equating the net present values of the earnings streams of two different

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[19] The inclusion of the quadratic in work experience was originally to allow for returns to on-the-job training or other factors that accrue with work experience. See Harmon *et al* (2000) for a detailed review.

schooling choices. From the perspective of the current paper, where we wish to compare the returns to education across countries with different educational systems, this is a useful feature of Mincer's model, as it implies that it is time spent in school and not qualifications obtained that is the key determinant of earnings. Ease of estimation, due extensive improvements in data collection and computing power, has resulted in hundreds of estimates of the return to education for a large number of countries; see, for example, Psacharopoulos (1994, 2002) and Trostel *et al.* (2002).

Critics of the Mincerian approach argue that some caution must be taken in interpreting the education slope in equation (1) as a private return to education; see the review paper by Card (2001). Perhaps the most widely known criticism is the fact that unobserved measures of ability and other characteristics are likely to be correlated with education. This problem of omitted variable bias has resulted in a large number of instrumental variable estimates of the return to education, which in turn has led to further debate over instrument validity; Kling (2001). There are other problems with the Mincerian approach such as measurement error (from both the left and the right) and selection biases due to the fact that we only observe wages for those individuals in employment. Some researchers have also dismissed the idea of an educational production function, thereby removing the causal link in Mincer's approach, and instead claim that education is merely a signal of innate ability.

There is no definitive answer to the questions surrounding the Mincerian approach. However the bulk of the evidence would seem to suggest that education is not merely a proxy for unobserved ability[20]. While recognising that there are potential problems with OLS estimates of a Mincer earnings equation, it remains the only model that provides

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20 The two main survey papers of the Mincer model, Griliches (1977) and Card (2001), both provide evidence in support of the estimatable form in equation (1). Griliches found that after controlling for the positive ability bias and negative measurement error bias in the Mincer approach, the net bias was zero.

us with a significant number of estimates of the return to education for a large number of years and countries. Psacharopoulos (1994) notes that in drawing cross-country comparisons of the returns to schooling there is a trade-off between quantity and quality - while wanting to obtain as many estimates of the return so as to make the analysis interesting, we also want to ensure that the quality of the estimates is such that the analysis is credible.

In order to provide some cross-checks on the quality of the estimates of the return to education that we use for the multivariate modelling, we compare our estimates with the estimates collected in two other independent sources. The first set of estimates of the return to education is taken from Psacharopoulos (1994) and consists largely of estimates for developing countries. The estimates are for a single year only, and there are 57 countries in the sample. The second set of estimates is from the meta-analysis paper by Ashefelter *et al.* (1999). The estimates of the return to education in this study are from over 80 different sources, and for 16 developed countries. The Ashenfelter sample includes estimates of the return regardless of the estimation method used. As we noted, above, for the purposes of the current paper, we have also constructed our own sample of estimates consisting of 387 observations of the return to education for 45 different countries. The returns are available for a variety of different years for each country. A particularly useful feature of the data set constructed for the current paper is that we include separate estimates for men and women.

In the empirical section that tests the models outlined in the introduction, we use the set of estimates collected for the current study. There are two reasons for this. The first reason is that it contains estimates of the returns for both men and women, and we wish to explore some reasons for the significant differences we observe between them. The second reason is that in constructing our own sample of estimates we are better able to monitor data quality, a particularly important concern, given that we plan to use the estimates of the return as dependent variables in a regression. We specify three criteria in order for an estimate of the return to education to be included our own data set.

Firstly, estimates of the return to education must be the coefficients on schooling from a Mincer log earnings equation. The main reason for this is that we want to be able to attribute observed differences in the return to characteristics of a given economy, not to the estimation strategy itself. Including instrumental variable or selection corrected estimates of the return would introduce further dimension to the analysis of cross-country variations.

Secondly, estimates must be obtained using the similar specifications. The specification is equivalent to that of equation (1) above, where the dependent variable is the log of net earnings. We do include estimates for some countries that also include controls for union membership or marital status in the regression. We do not believe that this raises serious problems for our analysis. As has been remarked elsewhere, Deardon (1998), estimates of the return to education obtained from a log earnings equation are remarkably robust to the inclusion of further controls on the right hand side.

Thirdly, the estimates must be obtained using internationally recognised and used data sets: the reason for this is that it gives some indication as to the reliability of the estimates, whether they were obtained using robust data sources and whether the data set was representative of the population at a point in time in a country. For some countries, the less developed ones in particular, the number of observations used to obtain the estimate of the return to schooling is small. In such cases we use sample size as weights in the OLS regression. That said, the estimates we have of the return to education in many of the developing countries in the sample compare favourably with those published elsewhere; see Psacharopoulos (1994, 2002).

Using the sample we construct for the current paper, **Table 3.1** reports the average returns for men and women, in ascending order for men, for each of the countries in the sample. The final two columns of the table show the years for which we observe the return to education, as well as the data sources. The returns are not observed for every year of the time interval reported in Table 1. We use three sources to obtain estimates of the returns to education for the 45 countries in our own sample of the cross-country returns to education.

The first source is the *International Social Survey Programme* (ISSP) data set. This is the same data set used by Trostel *et al* (2002) in their analysis of the cross-country differences in the return to education. The Trostel *et al.* paper is concerned with estimating the economic returns to schooling for a sample of 28 countries, and they provide few explanations as to the patterns they observe. In this paper we take the work a step further by estimating the return to education by year over the period 1985-1995. The ISSP data set has the unique advantage of having used a common questionnaire in each of the countries, therefore removing one possible source of error when using the data to compare the returns to education across countries. The estimates are calculated for a sample of employed men and women aged 21-59 years in the year of interview.

The second source is the volume edited by Harmon *et al.* (2001), which has drawn together the results of research in fifteen European countries. The estimates are the results of a research program entitled "Public Funding and Private Returns to Education" (PURE). The major advantage of using the PURE estimates is that all the countries in the research network adopted a common estimation framework similar to that of equation (1). Comparisons of the estimates in the PURE sample with those in the ISSP sample, along with those obtained by Trostel *et al.* (2002), shows very similar trends and stylised facts.

The PURE sample and ISSP data accounts for 30 of the 45 countries in the sample. Estimates of the returns to education for a further fifteen, largely developing, countries were obtained using the *World Values Survey* (WVS, 1990 and 1997). The WVS contains micro data from household surveys that were conducted in approximately 40 countries between 1990 and 1997. Krueger and Lindahl (2000) have used the WVS, which was designed to be comparable across countries, to calculate average schooling levels internationally. The WVS was a face-to-face survey in each country that asks individuals the following question: "*At what age did you complete your formal education either at school or at an institution of higher education (Please exclude apprenticeships)?*" The main purpose of the WVS was to compare political values and social norms across different societies, however questions about income and schooling were also included. The coding of the schooling and income variables in the WVS vary by both country and year, for example, in some countries, the coding of the income variable is restricted to a few categorical data points. We therefore restrict our sample to fifteen countries that have consistent coding for both schooling and income variables[21]. We have compared the estimates of the return to education for the countries in the WVS, and find they are very similar to the estimates for the same countries in Psacharopoulos (1994, 2002).

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21 The data appendix in Krueger and Lindahl (2000) goes into far greater detail about this issue. They use the full sample of countries in the WVS; therefore the problems relating to the coding of questions prove to be a more significant problem for their work.

Table 3.1 Cross-country evidence on the returns to schooling

Ranking (men)	Country	Male Return	St. Error	Female Return	St. Error	Year(s)	Source
45	Venezuela	0.0109	0.0028	0.0075	0.0029	1995	C
44	Croatia	0.0140	0.0049	0.0311	0.0103	1995	C
43	Ukraine	0.0222	0.0043	0.0287	0.0041	1995	C
42	Estonia	0.0230	0.0043	0.0122	0.0035	1995	C
41	Belarus	0.0298	0.0078	0.0387	0.0068	1990, 1995	C
40	Lithuania	0.0308	0.0075	0.0309	0.0108	1995	C
39	Latvia	0.0363	0.0140	0.0482	0.0110	1995	A
38	Canada	0.0367	0.0070	0.0498	0.0090	1995	A
37	Georgia	0.0390	0.0074	0.0518	0.0079	1995	C
36	Bulgaria	0.0416	0.0133	0.0624	0.0143	1992-1993	A
35	Czech Republic	0.0420	0.0099	0.0516	0.0106	1994-1995	A
34	New Zealand	0.0449	0.0112	0.0367	0.0135	1991-1995	A
33	Italy	0.0455	0.0014	0.0561	0.0027	1977-1995	A, B
32	Norway	0.0490	0.0030	0.0554	0.0037	1980-1995	A, B
31	Slovakia	0.0496	0.0120	0.0482	0.0090	1995	A
30	Sweden	0.0498	0.0026	0.0463	0.0075	1970-1996	A, B
29	Russian Federation	0.0514	0.0113	0.0625	0.0119	1991-1995	A
28	Denmark	0.0523	0.0020	0.0325	0.0020	1981-1995	B
27	India	0.0537	0.0110	0.0751	0.0139	1990	C
26	Argentina	0.0554	0.0088	0.0679	0.0091	1990, 1995	C
25	Greece	0.0567	0.0027	0.0757	0.0047	1974-1994	B
24	Nigeria	0.0580	0.0118	0.0428	0.0112	1990, 1995	C
23	United Kingdom	0.0589	0.0037	0.0977	0.0051	1978-1995	A, B
22	Netherlands	0.0592	0.0027	0.0572	0.0045	1985-1996	A, B
21	Turkey	0.0608	0.0071	0.0698	0.0094	1995	C
20	Australia	0.0631	0.0091	0.0858	0.0185	1986-1990	A
19	Belgium	0.0697	0.0080	0.0600	0.0078	1990	C
18	Spain	0.0706	0.0047	0.0783	0.0033	1995	A, B
17	Israel	0.0750	0.0109	0.0836	0.0117	1993-1994	A
16	France	0.0759	0.0011	0.0734	0.0019	1970-1993	B
15	Germany	0.0799	0.0030	0.1004	0.0056	1984-1997	A, B
14	Poland	0.0800	0.0110	0.1127	0.0113	1991-1995	A
13	Switzerland	0.0887	0.0025	0.0821	0.0039	1992-1998	A, B
12	Chile	0.0899	0.0117	0.0926	0.0096	1990, 1995	C
11	Finland	0.0903	0.0040	0.0855	0.0043	1984-1995	B
10	Austria	0.0914	0.0043	0.0982	0.0029	1981-1997	A, B
9	Hungary	0.0929	0.0154	0.0875	0.0126	1990, 1995	A
8	Slovenia	0.0930	0.0125	0.1127	0.0127	1993	A
7	United States	0.0977	0.0158	0.1199	0.0190	1985-1995	A
6	Japan	0.0998	0.0121	0.1201	0.0272	1993-1995	A
5	Ireland	0.1010	0.0073	0.1300	0.0090	1987-1995	A
4	Mexico	0.1015	0.0144	0.0991	0.0157	1990,1995	C
3	Portugal	0.1056	0.0009	0.1085	0.0011	1982-1995	B
2	Philippines	0.1194	0.0210	0.2086	0.0450	1992	A
1	Brazil	0.1773	0.0239	0.1735	0.0284	1990	C
	Average (1995)	*0.0679*	*0.0060*	*0.0774*	*0.0076*	*1995*	

Notes: Sources (A) ISSP; (B) PURE, (C) *World Values Survey.*

3.2.2. Explanatory Variables

This section briefly presents the explanatory variables used in the multivariate analysis in section that follows. We first describe schooling data we use (stock measures), and then describe the other characteristics of the (macro) economy that we use as explanatory variables.

Aggregate Schooling Data

The main data-source for international schooling data is the Barro and Lee (1997) data set, which was further updated in Barro and Lee (2000). Barro and Lee measure average years of schooling and average levels of schooling attainment in the population using survey and census based data as reported by the United Nations Educational, Scientific and Cultural Organisations (UNESCO)[22]. For missing observations Barro and Lee impute the mean years of schooling in the population using historical enrolment data and a perpetual inventory method. This method updates average schooling attainment and average years of schooling using census based estimates for an anchor year and enrolment and graduation data for subsequent years.

A possible problem with the measure of schooling we use is that international measures of average schooling are likely to be measured with some degree of error. The errors are to some extent unavoidable as the enrolment rates, as measured by UNESCO, are of a low quality in many developing countries in particular. The paper by Krueger and Lindahl (2000) describes the problems associated with the measurement error in great detail. The appendix to this chapter also has an in-depth discussion of the implications of such measurement error for our analysis. Here, we summarise the key results . We

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22 See the UNESCO Institute for Statistics (http://www.uis.unesco.org/ev_en.php?ID=2867_201&ID2=DO_TOPIC).

find that OLS estimates of the effect of average schooling on the return to education could be *downward* biased by between 12% and 35% when we use the Barro-Lee data. However, if we use differenced schooling data, as in Krueger and Lindahl (2000), the problem is much more severe, with coefficient estimates likely to be biased downward by up to 50%.

The Macroeconomy

The bulk of the macroeconomic variables come from the World Bank *World Development Indicators* (WDI, 2003). The other main data source is the Penn World Tables (Summers *et al.* 1995), which we use to construct measures of the capital stock for a sub-sample of countries in the data set. In the section below, where we formally test the predictions of the capital skill complementarity model, we go into greater on the measures of the capital stock we construct.

3.3. Stylised Facts

3.3.1. Gender Differences

Table 3.1 presents estimates of the rate of return to education collected from the data sources described in the previous section. The results (sorted in order of magnitude for men) show significant variation in the returns to education across countries. Brazil and the Philippines stand out in terms of the male returns to education. However, the results are very similar to the only comparable source, Psacharopoulos (1994). He finds returns to education in Brazil of about 15% (1989), and in the Philippines of about 9% (1988).

In a number of countries the education premium is considerably higher for women than it is for men. The returns are, on average, 1% higher for women than for men. Both the magnitude and direction of the gender differential are consistent with the previous evidence in Psacharopoulos (1994) and Trostel *et al.* (2002). Part of this difference in the education premium may be driven by the fact that estimates of the return to education for women may be contaminated by upwards selection bias; see Card (2001). However, recent studies of the effect of selection bias on the estimates of the female return to education conclude that OLS estimates are robust to controls for selectivity; see the Harmon *et al.* (2002). Other studies compare the OLS results with those from a median regression and also find no significant selection biases.

It is possible to explain at least part of the gender difference in the education premium by appealing to the literature on the gender pay gap. One of the observations in this literature is that the female-male wage gap is decreasing in skills or education; see Blau and Kahn (1997, 2003). Given that the slope of the earnings-education profile is equivalent to the return to education, then this implies that over a certain range of the schooling distribution the wage profile of women should be steeper than that of men, with the difference in slopes declining both as education increases and as the wage gap falls. Such an empirical relationship should also be observable in our data set on the returns to education. In particular, we can propose the following two hypotheses:

Hypothesis 1: *There is a negative correlation between the female-male difference in the return to education and the average years of schooling of women;* and

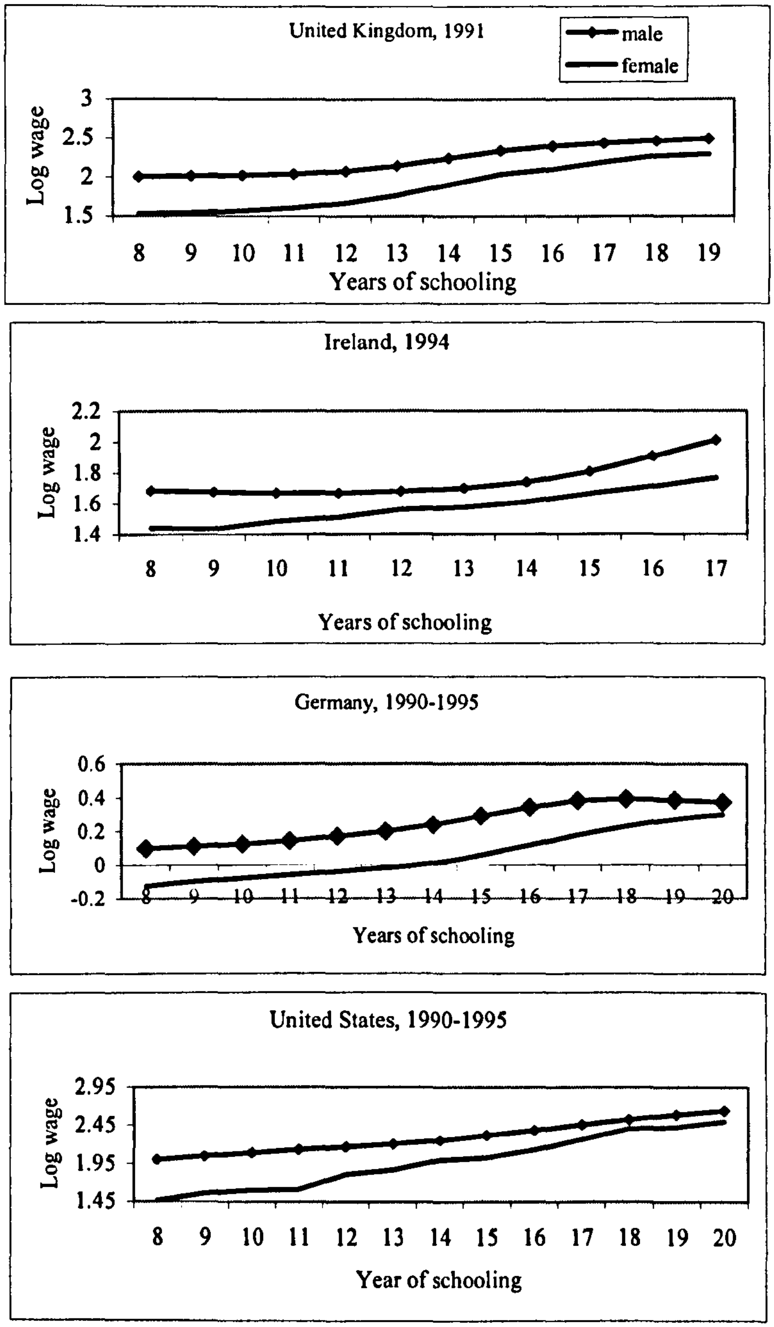
Hypothesis 2: *There is a negative correlation between the female-male difference in the return and the female-male wage gap.*

We first test the empirical observation, as suggested by Blau and Kahn (1997, 2003), that the female-male wage gap is decreasing in education for a sub-sample of countries in our dataset. We look at four countries, the United States, the United Kingdom, Germany and Ireland. **Figure 3.1** shows the non-parametric regression lines from a regression of log wages on schooling for four of the each of the four countries.

The female-male wage gap is clearly decreasing in education, the one exception is Ireland, where the gap narrows and then widens again after 14 years of schooling, although the precision of the estimates after this point is questionable due to a large drop in the number of observations of women in Ireland with more than 14 years of education (at least in 1994, the year of the household data set we use).

Table 3.2 shows the results of testing *Hypothesis 1* and *Hypothesis 2* in a simple bivariate regression, the dependent variable in each regression is the difference in the female-male return to education. The first three columns test *Hypothesis 2* that the difference in the return is declining in the female-male wage gap. In the first column the explanatory variable is the average wage of women in manufacturing as a percentage of the average male wage in manufacturing (WDI, 2003). Columns two and three use the ratio of wages in agriculture and non-agricultural activities respectively. All three regressions are supportive of *Hypothesis 2*, showing a clear negative correlation between the wage gap and gender differences in the return to education.

Figure 3.1 Log wages by schooling: USA, UK, Germany and Ireland



Notes: Each of the curves is the fitted value from a non-parametric regression of log wages on years of schooling. For the UK we use micro-data on from the *General Household Survey* (1991); for Ireland the *International Adult Literacy Survey* (1994), for USA and Germany the *International Social Survey Program* (1995).

Table 3.2 The gender pay gap and the female-male difference in the return to schooling

Dependent variable in each regression is the female-male difference in the return to schooling for each country and year	(I)	(II)	(III)	(IV)	(V)	(VI)
Female wage in manufacturing as a percentage of male wage[(a)]	-0.079 (1.936)**					
Female wages in agriculture as a percentage of male wages[(a)]		-0.059 (1.803)+				
Female wages in non- agricultural activity as a percentage of male wages[(a)]			-0.127 (2.932)**			
Average schooling years in the population aged ≥ 15 years[(b)]				-0.003 (1.989)*		
Average schooling years in the population aged ≥ 25 years[(b)]					-0.003 (2.078)*	
Labour force participation of women (%)[(a)]						-0.054 (2.542)**
N	102	88	98	185	182	189
Mean of explanatory variable	0.737	0.870	0.812	8.451	8.223	0.611
Standard Error of explanatory variable	0.103	0.092	0.130	2.063	2.130	0.117

Notes: All regressions include controls for country fixed effects. The absolute values of the *t-statistics* are shown in parentheses. (+) significant at the 10% level; (*) significant at the 5% level; (**) significant at the 1% level. ***Data sources***: (a) World Development indicators (World Bank). (b) Barro and Lee (2000).

The sample size for the first three regressions is somewhat smaller than we might have expected. At most we would expect approximately 190 observations (the dependent variable is the difference in the female-male return, so the sample is halved), however, data on the wage gap (WDI) is only available for about 100 of these year country observations.

Columns IV and V test *Hypothesis 1* by regressing the difference in the wage premium on the average number of schooling years of ***women*** in the population (Barro and Lee, 1997, 2000). The first regression considers the population aged 15 years or older, and the second the population aged 25 or older. The results from both regressions are strongly supportive of *Hypothesis 1;* the female-male difference in the return to education is lower in those countries where women have higher average years of schooling.

As an alternative way to test *Hypothesis 1* we also consider how the female-male difference in the return to education varies with the labour force participation of women. Educational attainment is a reliable predictor of labour force participation, due to the fact that it increases wage offers more quickly than the reservation wage. Therefore, we would expect those countries with higher female labour force participation also to have higher average schooling levels for these women, *ceteris paribus*. Our prior is that there should be a negative correlation between the labour force participation of women and the female-male difference in the education premium. The last column of **Table 3.2** confirms our priors; there is indeed a strong negative correlation between labour force participation and the female-male difference in the return to education.

3.3.2. Time trends in the return to education

In this section we consider how the returns to education have varied over time. This is particularly relevant to theories such as increased globalisation or technological change as a cause of changing returns to skills. In this section we also use the data on returns to schooling from Psacharopoulos (1994) and Ashenfelter *et al.* (1999). The paper by Psacharopoulos (1994) builds on a series of studies that collected estimates of schooling returns from around the world. Here, we take the estimates of the Mincer model in Psacharopoulos' 1994 paper and examine the trends in the data. The information from each study (there are 57 usable data points) is relatively sparse: the Mincer coefficient, average level of schooling, the year of the data and the country on which it is based.

The data set from Ashenfelter *et al.* (1999) contains over 1,000 observations on the return to education from over 80 studies. This information in this data is richer than that in Psacharopoulos (1994) in that we have details on the sample size and the estimation method used to generate the different estimates. Moreover, unlike the Psacharopoulos estimates, we have multiple estimates for many the countries, for example there are 47 separate estimates for the USA (consisting of 13 years of estimates between 1970 and 1998, 26 OLS estimates, 13 IV estimates, and 8 estimates from samples of twins). This allows us to do some simple meta analysis taking into account the fact the series we are modelling is a set of estimated parameters. The countries included in the Ashenfelter sample are also different from those in the Psacharopoulos sample. Whereas the latter contains a number of developing countries, all of the countries in the Ashenfelter sample are western economies[23].

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[23] The countries included in the Psacharopoulos sample are: Argentina, Australia, Bolivia, Botswana, Brazil, Canada, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Cyprus, Dominican Republic, Ecuador, El Salvador, Ethiopia, France, Germany, Ghana, Greece, Guatemala, Honduras, Hong Kong, Hungary, India, Indonesia, Israel, Italy, Jamaica, Japan, Kenya, Kuwait, Malaysia, Mexico, Morocco, Netherlands, Nicaragua,

In **Table 3.3** we present the results from three regressions where the dependent variable is the estimated rate of return from the Psacharopoulos study. The first specification explains the rate of return with year and the year squared. The results indicate that the rate of return follows a quadratic trend falling initially and then rising. The only data on the economy available to us for this data is the average years of schooling completed. The second specification includes average schooling years as a regressor and it can be seen that this has the immediate effect of making the time trend statistically insignificant. The most obvious interpretation of the negative coefficient on schooling is a supply side one: a higher level of human capital depresses the return. In the section below, where we test the prediction of the technology-bias model, we refine this model to account for endogenous technological development.

Table 3.3 Time variation in the returns to schooling

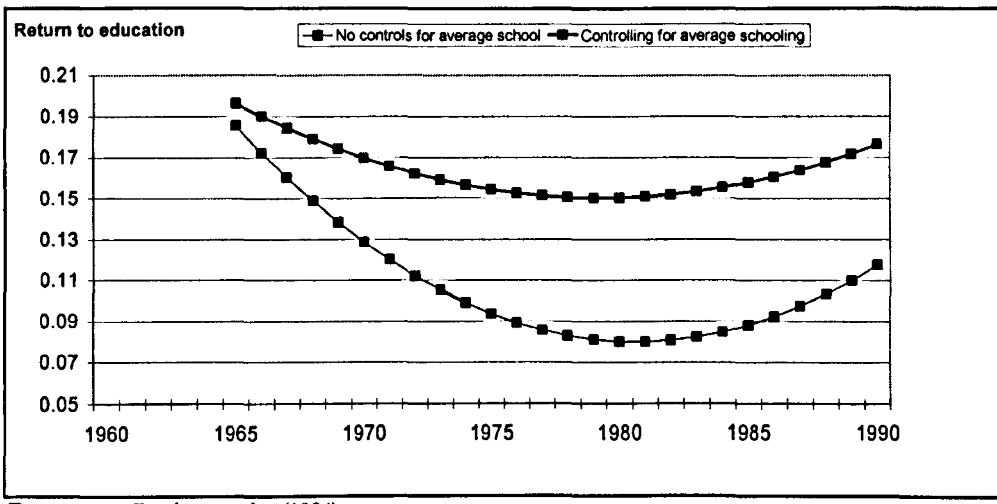
	Model (1)	Model (2)	Model (3)
Year	-0.0697	-0.0359	0.0209
	(2.44)*	(1.24)	(0.73)
Year squared	0.0004	0.0002	-0.0001
	(2.43)*	(1.27)	(0.77)
Schooling		-0.0074	-0.0041
		(3.27)**	(2.15)*
OECD countries (17)			
South & Central America (19)			0.0597
			(3.95)**
Africa (7)			0.0499
			(2.01)*
Asia (14)			0.0117
			(1.15)
Constant	2.8894	1.5736	-0.6877
	(2.53)*	(1.37)	(0.60)
Observations	57	57	57
R-squared	0.08	0.27	0.41

Notes: The 57 data points are taken from Psacharopoulos (1994). The countries included in the Psacharopoulos sample are listed in footnote 5. Absolute value of t-statistics are parentheses. (+) significant at the 10% level (*) significant at 5% (**) 1 % level

Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, Singapore, South Korea, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Tunisia, United Kingdom, United States, Uruguay, and Venezuela

The third specification includes dummy variables for the continent of the country. The results show that the quadratic trend from the first specification is no longer present given these controls. **Figure 3.2** graphs the trend in the estimated returns based on the first and second specifications reported above.

Figure 3.2 Return to Schooling 1965-1993: Psacharopoulos data (1994)



Data source: Psacharopoulos (1994).

The estimates of the return to education based on the Psacharopoulos data are available only up to 1990. A richer, and more up-to-date, data set is that used by Ashenfelter *at al.* (1999). We use this data to check on the robustness of the results from the Psacharopoulos data. The first column of **Table 3.4** replicates the simple quadratic trend estimated in **Table 3.3** and finds essentially the same pattern: the rate of return falling until the beginning of the 1980's and rising thereafter.

A useful feature of this data set is that we have details of the estimation of the parameters from the original studies, including, the number of observations, method of estimation and the standard error of the estimate. This allows us to do a simple meta-analysis of the data. The motivation for the meta-analysis is that the data we are analysing is neither based on population statistics or a simple random draw but is derived from a set of independent econometric estimates. We therefore wish to take into account the uncertainty associated with these estimates. The simplest way to do this is use weighted least squares with the weight being the reciprocal of the standard error of the estimated return from the original study. The results of this exercise are shown in column 2, and they prove to be fairly close to the unweighted.

In the third specification we include a set of dummies to control for the use of different estimation methods since there is a view in the literature that particular techniques tend to give rise to higher or lower estimates. As noted in the Ashenfelter *et al.* paper, there is a tendency for there to be trends in the use of particular econometric techniques, with say Instrumental Variables and Heckman type sample selection correction becoming more common. Consequently, we want to ensure that trends in the return do not represent trends in econometric practice. However, as column 3 shows, controls for estimation methods have little impact on the estimated trend in the rate of return. In column 4 we include country dummies. There are 16 different countries in the data and, unlike the Psacharopoulos data; they are all relatively advanced western economies. The broad picture remains the same - the returns follow a quadratic trend falling until the early 1980's and rising thereafter.

Figure 3.3 plots the trends in the rate of return for the US, Scandinavia and Europe (excluding Denmark, Finland, Sweden and Norway). We include a separate trend line for Scandinavian countries, as there is some weak evidence that the returns in Scandinavia are lower. The lines are drawn using the coefficients from a regression of the schooling return on year, year squared, and controls for the estimation method. While the US rate of return starts off lower and falls at a similar rate it starts to rise earlier and does so at a faster rate than in Europe so that by the end of the period (1997) the rate of return to a years schooling is about 2 percentage points higher.

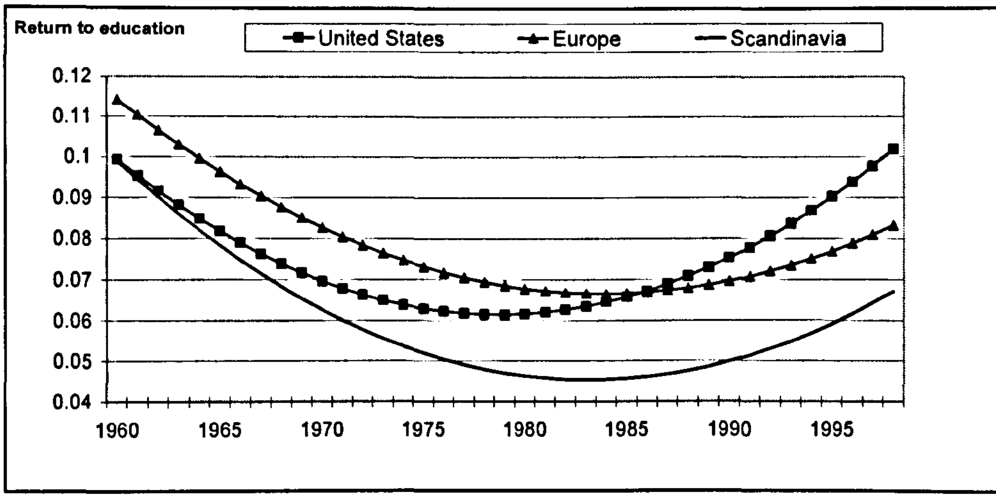
Table 3.4 Time variation in the return to schooling: Meta-analysis

Specification	(1)	(2)	(3)	(4)	(5)
Year	-0.0144	-0.0142	-0.0137	-0.0196	-0.0194
	(5.86)**	(7.39)**	(7.27)**	(12.83)**	(13.02)**
Year squared	0.0001	0.0001	0.0001	0.0001	0.0001
	(5.96)**	(7.49)**	(7.37)**	(12.81)**	(12.99)**
OLS	*Omitted*	*Omitted*	Omitted	*Omitted*	*Omitted*
Instrumental Variables			0.0209		0.0228
			(5.07)**		(7.43)**
Twins Studies			0.0042		0.0138
			(0.21)		(0.92)
Selection corrected (Heckman)			-0.0075		-0.0036
			(2.21)*		(1.41)
Fixed Effects, random effects models			0.0328		0.0175
			(3.41)**		(2.41)*
Austria	*Omitted*	*Omitted*	*Omitted*	*Omitted*	*Omitted*
Denmark				-0.0340	-0.0342
				(8.39)**	(8.68)**
Finland				0.0020	0.0018
				(0.49)	(0.46)
France				-0.0103	-0.0122
				(2.92)**	(3.54)**
United Kingdom				0.0131	0.0094
				(3.46)**	(2.53)*
Germany				0.0008	-0.0001
				(0.22)	(0.04)
Greece				-0.0231	-0.0233
				(5.22)**	(5.43)**
Ireland				0.0188	0.0184
				(2.87)**	(2.90)**

Specification	(1)	(2)	(3)	(4)	(5)
Italy				-0.0266	-0.0281
				(7.53)**	(8.17)**
Netherlands				-0.0256	-0.0263
				(5.75)**	(6.10)**
Norway				-0.0207	-0.0215
				(3.97)**	(4.24)**
Portugal				0.0047	0.0044
				(1.46)	(1.39)
Switzerland				-0.0013	-0.0009
				(0.33)	(0.24)
Sweden				-0.0318	-0.0321
				(8.92)**	(9.26)**
Spain				-0.0087	-0.0086
				(2.34)*	(2.37)*
United States				-0.0067	-0.0079
				(1.72)+	(2.08)*
Constant	0.6587	0.6535	0.6325	0.8982	0.8887
	(6.43)**	(8.11)**	(8.00)**	(13.98)**	(14.22)**
Observations	1010	969	969	969	969
R-squared	0.04	0.06	0.10	0.50	0.53
Summary statistics					
Average return to schooling – All countries	0.0707				
Standard error	*0.0009*				
Average return to schooling – United States	0.0810				
Standard error	*0.0049*				
Average return to schooling – Europe (excl. Scandinavia)	0.0749				
Standard error	*0.0011*				
Average return to schooling – Scandinavia	0.0563				
Standard error	*0.0012*				

Notes: Absolute value of t statistics in parentheses. (+) significant at 10% level; (*) significant at 5%; (**) significant at 1% Specifications (1) Basic regression. (2) Weighted regression – weights given by the standard error of the estimate of the returns to schooling. (3) As (2) but additional estimation method fixed effects controls included. (4) As (2) but additional country fixed effects included. t-statistics are in parentheses.

Figure 3.3 Time variation in returns: 1960 – 1998



***Data source*:** Ashenfelter *et al* (1999).

Two explanations that have been frequently proposed for the U-shape in the returns over time are trade union membership and changes in productivity. Trade unions may affect the rate of return to education by compressing the wage structure. A long time series of trade union membership across countries is difficult to construct, as the data is not easily available. Instead we use the data on strike behaviour, which can be considered a proxy for not only union membership but also the how active a trade union is. The data, from the International Labour Organisation (ILO)[24], counts the total number of workers striking in a given country and year. The results from a regression of the return to education on the proportion of workers striking in a country in a given year are shown in **Table 3.5.** The correlation between the proportion of the workers striking and the return to education is negative, as we might expect given the wage compression argument outlined above - however, the relationship is not particularly strong. Furthermore, once we include controls for country fixed effects the

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24 Various years, see (http://www.ilo.org/public/english/bureau/stat/child/actrep/yearbook.htm). The ILO does provide data on trade union membership, however this is available only from 1990 onwards.

t-statistic on the strike variable falls significantly. There is not a huge amount of variation in the strike variable over time within countries, hence the inclusion of the country fixed effects tends to render the strike variable insignificant. The results in the table, however indicative they might by, are supportive of the hypothesis that the presence of a stronger union compresses the wage structure in such a way that lowers the return to education.

As we mentioned above, another possible explanation for changes in the returns to education over time (as well as differences in the return across countries) is changes in productivity over time. In **Figure 3.4** we plot the returns to education for a sub-sample of countries against an index of multi-factor productivity. The return to education is for men only, and the index of multi-factor productivity is taken from the OECD productivity database (May, 2004)[25]. The relationship is plotted for a subsample of countries for which we have a reasonably long time series of returns to education, as well as measures of MFP. The figure shows that, for almost all of the countries, there is a strong positive correlation between the return to education and productivity growth. The major exception is Germany, which seems to exhibit a negative correlation between productivity growth and the return to education. The cross plots in **Figure 3.4** ignore the possibility that the supply of skills may have been increasing while productivity was increasing – this could have offset any corresponding increase in the return to education. Indeed, the average years of schooling in the population (aged 15+) in (West) Germany increased by 7.3% (from 9.64 years to 10.34 years) over the period for which **Figure 3.4** is drawn (1984 – 1997), over roughly the same time period in Denmark (1981 – 1995), where we observe a strong positive relationship in **Figure**

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25 Details of how the productivity index is calculated can be found at http://www.oecd.org/topicstatsportal/0,2647,en_2825_30453906_1_1_1_1_1,00.html#30455278 - basically MFP is measured as difference between output and input change for all factors in the economy.

3.4, the same increase was only 3.2% (9.25 years of schooling on average to 9.65 years, all data from Barro and Lee, 1997 and 2000).

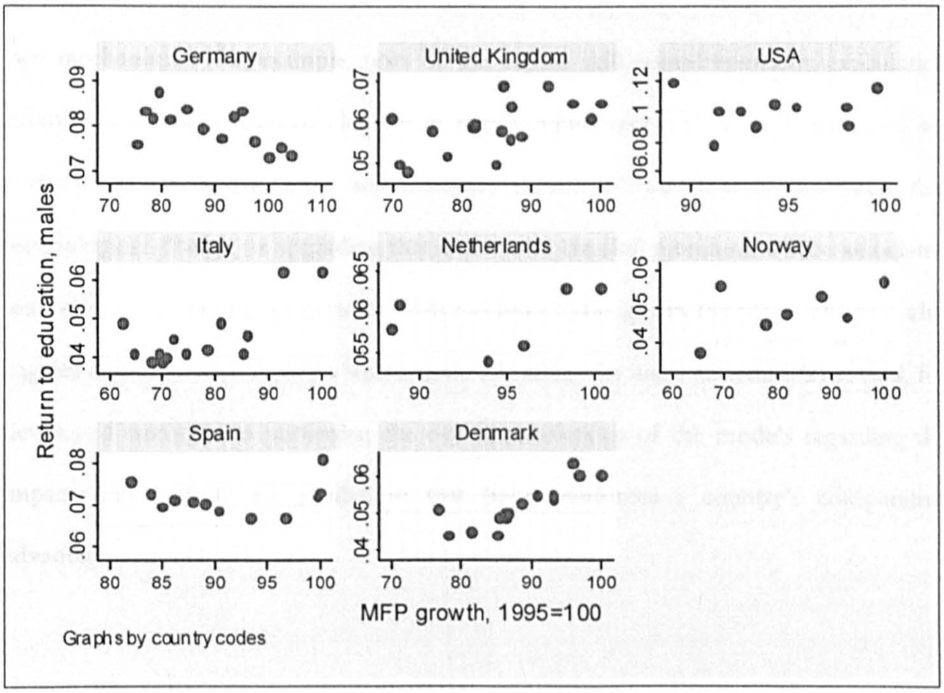
The key conclusions from the analysis of data in this section are as follows. Firstly, across countries, we consistently observe a higher return to education for women than men. The difference is decreasing in the average schooling of women in the population and labour force participation. Secondly, the return to education tends to follow a U-shape over time, declining slowing up to the early 1980s and rising thereafter. We tested two possible explanations for this observed U-shape. The first was unionisation, which we found to explain little of the U-shape in the returns, although our proxy for unionisation is probably not that great. The second explanation we considered was changes in productivity over time. Cross-plots of indices of multi-factor productivity revealed a very strong positive correlation with the return to education. The data supports the hypothesis that much of the increase we have seen in the return to education since the early 1980s is due to skill-bias technological change which has fed through into productivity growth. This leads us nicely onto the next two sections. We will now try to explain the major differences in the return to education *between* countries by using models that relate the return *directly* to differences in technologies between countries as well as to differences in the type of capital employed in production.

Table 3.5 Relationship between Union Activity and return to education

Sample	Sample constructed for this paper		Ashenfelter *et al.* (1999)	
Dependent variable is the return to education	(1)	(2)	(3)	(4)
Striking workers (% total labour force)	-0.1035	-0.0662	-0.1080	-0.0751
	(3.51)**	(1.54)	(3.51)**	(1.41)
Constant	0.0766	0.0800	0.0713	0.0803
	(37.27)**	(7.74)**	(43.38)**	(28.60)**
Country fixed effects		Yes		Yes
Estimation methods fixed effects			Yes	Yes
Observations	273	273	515	515
R-squared	0.02	0.75	0.02	0.50
Average proportion of workers striking	0.02480		0.0260	
Standard error	*0.0024*		*0.0019*	
E(beta)	0.07405		0.0685	
Average return to education	*0.0017*		*0.0014*	

Notes: Absolute value of *t statistics* in parentheses. (+) significant at 10% level; (*) significant at 5%; (**) significant at 1% Specifications (2) and (4) include controls for county fixed effects.

Figure 3.4 The return to education and changes in multi-factor productivity



Notes: The data on Multi-factor productivity growth is taken from the OECD Productivity Database (May 2004). The MFP measure is indexed to 1995=100, and is calculated using constant prices. The measures of the return to education are taken from the database constructed for the current paper.

3.4. Explaining the observed differences in the return to education

In this section we test the predictions of two models that provide a framework for analysing the cross-country patterns that we observe in the returns to education. As in Acemoglu (2003) we identify the wage-premium or skill-premium, often used in studies that seek to explain changes in the wage-structure, with estimates of the return to education or schooling.

Recent studies that have tried to explain changes in relative wages, in the US in particular, have concentrated on two alternative but not mutually exclusive transmission mechanisms: skill-bias technological change (see Acemoglu (2003) and the Katz *et al.* (1995) volume) and capital-skill complementarity (Krusell *at al.* (2000) and Flug and

Hercowitz (2000)). In the theoretical work the two mechanisms have often been treated in isolation. Empirically, however, it is not easy to separately identify the effect of the two mechanisms. For example, tests of the capital skill complementarity explanation often look at the effects of changes in capital equipment on the skill premium; see Autor *et al.* (2003) and Levy and Murnane (1996). However, it is also likely that technological change, or upgrading that impacts on the skill premium, will be associated with changes in capital equipment. Both models of changes in the wage structure also suggest different ways through which trade can affect the wage structure. That said, for developed countries in particular, the overall predictions of the models regarding the impact trade effects are similar, in that trade reinforces a country's comparative advantage.

3.4.1. Technological Change and the return to education: technology leaders and followers

The paper by Acemoglu (2003) is relevant for the current paper, not least because Acemoglu identifies the skill- or wage-premium, used in the vast literature on determinants of changes in the wage structure, with the return to education. The Acemoglu paper develops a simple theoretical model to analyse how skill premia differ both over time and across countries. The relative simplicity of the model is appealing as it means that equations can be easily transformed into estimatable forms.

Skill premia are modelled as a function of technology and relative quantity effects. An increase in the supply of skills over time induces a technological improvement that ultimately leads to an *increase* in the demand for skills. The key point in the model is that the skill bias of technology is itself an endogenous function of the relative supply of skilled workers in the economy.

One of the major differences between Acemoglu's work and more traditional models of changes in the wages structure is in the effects of trade opening on relative wages. The effect of trade on the relative demand for labour, and therefore on the skill premium, usually operates through the effect it has on relative prices. In the technology bias model, however, trade affects the skill premium by changing the level of skill bias in the economy.

The simplest case is one where the world is divided into technology leaders and technology followers. Technology leaders invent all the technology used in production in the world. Technology followers can only import technologies from technology leaders. Assume there is one technology leader (the 'leader'), and a group of less developed countries (LDCs) that are technology followers ('followers'). The demand for skilled labour amongst the followers is a *constant technology demand*, as the technology used in these countries will not be developed within the countries themselves. The leader develops its own technologies; therefore the demand for skilled labour will be an *endogenous technology demand*, which may be increasing in the relative supply of skills. The endogenous and constant technology demand curves are illustrated in **Figure 3.5** below. The downward sloping constant technology demand curve is consistent with the negative correlation that we observed between the return to education and average schooling years in the economy in the Psacharopoulos data (see **Table 3.3**).

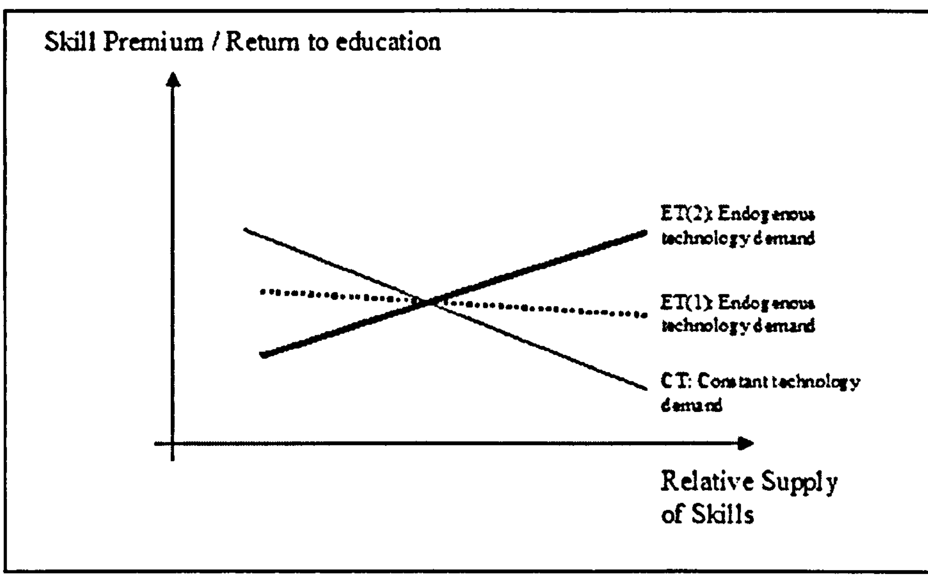
Define the return to education in country c as r_c, and assume that we only observe individuals with years of schooling equal to h or l, i.e. *high* (skilled) or *low* (unskilled), the model posits the return as a function of technology and product prices

$$r^c \equiv \frac{w_h^c}{w_l^c} = f\left(p^c, T^c\right) \tag{2}$$

where r^c is the return to education (read 'skill premium') in country c, $\left(w_h^c / w_l^c\right)$ is the ratio of high skilled workers' wages to low skilled wages, p^c is the relative price of skill intensive goods (all other prices are normalised to one), and T^c indicates the level of *technology bias* in country c.

Holding technology constant, $T^c = T_k^c$, the function $f\left(p^c, T^c\right)$ has the following property: $f'\left(p^c\right)\big|_{T^c = T_k^c} > 0$, i.e. across countries with the same technology, we would expect the skill premia to be increasing in the relative price of skill intensive goods.

Figure 3.5 The demand for skills in the technology bias model



Notes: This figure is reproduced from Acemoglu (2003)

Assuming that the relative price of skill-intensive goods is inversely related to the relative supply of skilled labour, we can re-write equation (2) as

$$r^c \equiv \frac{w_h^{\;c}}{w_l^{\;c}} = g\left(\frac{H^c}{L^c}, T^c\right) \tag{3}$$

where (H_c/L_c) is the supply of skilled labour to unskilled labour in country c. Holding technology constant, the function $g\left(\frac{H^c}{L^c}, T^c\right)$ has the following property: $g'\left(\frac{H^c}{L^c}\right)\Bigg|_{T^c=T_k^c} < 0$. This is illustrated by the constant technology demand curve facing technology followers in **Figure 3.5.**

In the simple specification above, the level of technology is taken as a given because these countries do not develop their own technologies. However, the technology leader can respond to changes in the relative supply of skilled labour with innovations, and the development of more skill-bias technology. There are two opposing factors that influence the direction of technological change, both relating to the expected flow of profits that comes from developing new technology. The first is a simple a *price effect,* where technologies that produce more expensive goods will be updated more quickly. Assuming that goods using scarce factors have higher prices, then innovation will be directed at the scarce factor, i.e. the lower the relative supply of skills, the more innovation there will be in technology leader's economy.

The second factor that influences the direction of technological change is a quantity or *market size effect.* In the model, the market for the technology is just the workers that use it, the more workers there are who will use the technology the greater the flow of profits from a given innovation. This encourages innovation for the more abundant factor. It is worth noting here that Acemoglu initially only considers the impact of the market size effect in the leader's country alone. This is because it is assumed initially that intellectual property rights are not enforced in the technology follower countries, i.e. no patents, royalties, etc are paid. The overall predictions of the model are unchanged when intellectual property rights are included.

If we assume that the market size effect dominates the price effect, which seems reasonable at least among technology leaders, then this implies the following: in countries that that develop their own technologies, we will observe a *positive correlation* between the relative supply of skills and the return to education[26]. As a test of the predictions of the model of skill-biased technological change, we estimate the following regression *for technology followers* with a given level of technological know how, $T^c = T_k$

$$r^c = \alpha + \beta\left(\frac{H^c}{L^c}\right) + \varepsilon \tag{4}$$

where ε is a white noise error term with the usual properties. According to the technology bias model, for technology followers the coefficient β should be less than zero. We can estimate a similar equation for technology leaders, i.e. countries that use technology developed locally. The expectation is that the coefficient on the relative supply of skilled labour would be greater than β above, and perhaps positive, corresponding to the endogenous technology demand curves in **Figure 3.5.**

The key to being able to properly test the predictions of the technology bias model is to accurately define the countries that are technology leaders and those that are technology followers. The usual approach is to assume that LDCs are technology followers, whereas more developed countries are the technology leaders. Given the

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26 As Acemoglu points out, the assumed dominance of the market size effect relies on there being a positive elasticity of substitution between skill-intensive outputs and labour-intensive outputs. Interestingly, the same condition is also imposed in the capital skill complementarity model of Krusell below.

heterogeneous sample of countries for which we have data on the returns to education, we provide some evidence (**Table 3.6**) in support of our categorisation of countries into technology leaders and technology followers. **Table 3.6** presents several indicators of each country's potential to develop new technologies in response to a rising relative supply of skilled labour. The indicators are royalty and licence fees payments received/paid (as a proportion of GDP), expenditure on research and development (R & D) as a percentage of GDP, and patent applications filed[27]. The figures in the table are the averages over the 1995 – 1996 period. Technology leaders clearly stand out as those countries the receive a relatively large amount of royalty payments, spend a significant amount on R & D, and where we see a relatively large number of patents being filed each year.

27 All of the data in **Table 3.6** is taken from the WDI (2003). Variables are defined by the World Bank as follows: **(a)** Royalty and license fees are payments and receipts between residents for the authorized use of intangible, non-produced, non-financial assets and proprietary rights (such as patents, copyrights, trademarks, industrial processes, and franchises) and for the use, through licensing agreements, of produced originals of prototypes (such as films and manuscripts). **(b)** Expenditures for research and development are current and capital expenditures (both public and private) on creative, systematic activity that increases the stock of knowledge. Included are fundamental and applied research and experimental development work leading to new devices, products, or processes. **(c)** Patent applications are applications filed with a national patent office for exclusive rights for an invention--a product or process that provides a new way of doing something or offers a new technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years.

Table 3.6 Technology leaders and technology followers: WDI data 1995-1996

	Royalties received (% GDP) [a]	Royalties paid (%GDP) [a]	R & D (%GDP) [b]	Patent applications (per 1 million pop.) [c]	Leader/Follower
Netherlands	0.58%	0.72%	2.01%	315	Leader
United Kingdom	0.55%	0.50%	1.90%	433	Leader
United States	0.42%	0.10%	2.55%	417	Leader
Sweden	0.36%	0.39%	4.03%	800	Leader
Belgium	0.23%	0.43%	1.81%	139	Leader
Ireland	0.17%	4.38%	1.32%	255	Leader
Israel	0.15%	0.18%	2.96%	239	Leader
Germany	0.13%	0.24%	2.26%	665	Leader
Japan	0.13%	0.19%	2.77%	2705	Leader
France	0.12%	0.16%	2.30%	287	Leader
Canada	0.10%	0.32%	1.68%	108	Leader
Hungary	0.09%	0.22%	0.65%	82	Follower
Norway	0.07%	0.22%	1.66%	354	Follower
Slovak Republic	0.07%	0.41%	1.03%	37	Follower
Austria	0.07%	0.26%	1.60%	310	Follower
Australia	0.06%	0.26%	1.65%	509	Follower
Czech Republic	0.05%	0.14%	1.03%	61	Follower
Finland	0.05%	0.33%	2.54%	566	Follower
Mexico	0.04%	0.14%	0.31%	4	Follower
Italy	0.04%	0.10%	1.01%	154	Follower
Spain	0.03%	0.23%	0.83%	68	Follower
Slovenia	0.03%	0.13%	1.44%	151	Follower
Estonia	0.03%	0.05%	0.57%	10	Follower
Russia	0.02%	0.01%	0.90%	123	Follower
New Zealand	0.02%	0.33%	1.08%	381	Follower
Portugal	0.02%	0.25%	0.75%	11	Follower
Croatia	0.01%	0.21%	0.45%	57	Follower
Poland	0.01%	0.07%	0.71%	63	Follower
Chile	0.01%	0.12%	0.58%	13	Follower
Brazil	0.01%	0.09%	0.77%	17	Follower
Argentina	0.00%	0.15%	0.42%	18	Follower
Philippines	0.00%	0.12%	1.71%	2	Follower
India	0.00%	0.03%	2.46%	2	Follower
Latvia	0.00%	0.01%	0.46%	79	Follower
Bulgaria	0.00%	0.00%	0.52%	41	Follower
Greece	0.00%	0.05%	0.59%	42	Follower
Nigeria	0.00%	0.00%	0.00%		Follower
Turkey	0.00%	0.03%	0.45%	6	Follower
Lithuania	0.00%	0.04%	0.52%	28	Follower
Switzerland			2.73%	382	Follower
Denmark			1.85%	449	Follower
Belarus			0.00%	65	Follower
Ukraine			1.07%	71	Follower
Georgia			0.33%	54	Follower

Notes: All data is taken from the World Bank WDI (2003). (a), (b), (c) a full list of variable definitions are provided in the footnote above. Blank cells indicate no data for a particular country.

Table 3.7 (technology leaders) **Table 3.8** (technology followers) show the results from estimating equation (4). The dependent variable in each regression is the return to schooling[28]; each specification includes a different control for the relative supply of skills. In specification (1) the definition of the relative supply of skilled labour is the average years of schooling in the population aged 25 or older. The skills variable in specification (2) is the same, only this time it is for the population aged 15 or older. Specifications (3), (4), (5) and (6) all use measures of attainment to control for the relative supply of skills. Define $TERT^c$ is the proportion of the population who have third level (or equivalent) qualifications, and SEC^c as the proportion with second level (or equivalent) qualifications. The definition of the relative supply of skills, $\left(\frac{H_c}{L_c}\right)$, in specifications (3) and (4) is as follows:

$$\left(\frac{H_c}{L_c}\right) = \frac{SEC^c + TERT^c}{1 - SEC^c - TERT^c}. \qquad (5).$$

In specification (3) both $TERT^c$ and SEC^c are measured as a proportion of the population aged 25 plus - in specification (4) as a proportion of the population aged 15 plus. The definition of the relative supply of skills in specifications (5) and (6), with a similar distinction by age threshold, is:

$$\left(\frac{H_c}{L_c}\right) = \frac{TERT^c}{1 - TERT^c}. \qquad (6).$$

For technology leaders, we find a positive relationship between the relative supply of skills and the return to schooling, consistent with the idea of an upward sloping

28 Estimates of the return for women and men for the same country and year are treated as separate dependent variables. The explanatory variables (average schooling and labour force participation) are also gender specific. The ratio of the proportion of the population with second and/or third level education to the proportion without is not gender specific.

endogenous technology demand curve. For technology followers, we find the opposite result - a negative relationship, which is also consistent with a downward sloping exogenous technology demand curve. Both results hold regardless of the measure of the relative supply of skills that we use. All the specifications include a control for labour force participation of men and women in order to control for gender differences in the return to education. Despite the fact that the predictions of the technology bias model are supported by the data, a considerable amount of variation in the data remains unexplained. For technology leaders the R-squared in **Table 3.7** does not exceed 0.34 (specification 1), and for technology followers the highest R-squared is 0.12 (specification 4). The question is, therefore, what other factors are causing the cross-country differences we observe in the return to education? In the technology bias model, the other key determinant of the skill premium is the flow of trade. In the technology bias model trade induces changes in the level of skill bias of the economy, thereby altering the slope of the endogenous (exogenous) technology demand curves in the technology leader (follower) countries. As was the case for the model without trade, there are two opposing trade-effects on the direction of innovation, the *price effect* and the *market size effect*.

Table 3.7 Skilled biased technological change and the returns to education – *Technology leaders*

Dependent variable: return to schooling	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Average schooling (25 plus)	0.0081					
	(5.62)*					
Average schooling (15 plus)		0.0071				
		(4.38)*				
Secondary and post-secondary (25 plus)			0.0118			
			(4.79)*			
Post-secondary (25 plus)				0.0309		
				(3.85)*		
Secondary and post-secondary (15 plus)					0.0118	
					(3.15)*	

Post-secondary (15 plus)						0.0322
						(2.98)*
Labour force participation	-0.1042	-0.0943	-0.0918	-0.0959	-0.0891	-0.0927
	(7.14)*	(6.30)*	(6.29)*	(6.09)*	(5.98)*	(5.88)*
Year	0.1149	0.0728	0.1374	0.1467	0.1531	0.1551
	(0.71)	(0.46)	(0.89)	(0.93)	(0.98)	(0.98)
Year squared	-0.00003	-0.00002	-0.00003	-0.00004	-0.00004	-0.00004
	(0.72)	(0.46)	(0.89)	(0.93)	(0.97)	(0.98)
Constant	-113.7	-71.8	-136.3	-145.5	-152.8	-153.1
	(0.71)	(0.46)	(0.89)	(0.93)	(0.98)	(0.98)
R-squared	0.34	0.30	0.30	0.28	0.26	0.27
Observations	142	142	142	142	142	142
Averages of variables						
E(return to schooling)	0.0814	0.0814	0.0814	0.0814	0.0814	0.0814
Standard error	*0.0022*	*0.0022*	*0.0022*	*0.0022*	*0.0022*	*0.0022*
E(relative supply of skills)	9.3393	9.4645	0.8376	0.2802	0.7489	0.2581
Standard error	*0.1243*	*0.1179*	*0.0614*	*0.0227*	*0.0497*	*0.0201*

Notes: Absolute values of t-statistics in parentheses. (+) significant at the 10% level; (**) significant at 5%; (*) significant at 1%. The dependent variable is a coefficient from an earnings equation; therefore all estimates are bootstrapped (500 replications) in order to obtain standard errors. The data on the relative supply of skills is taken from Barro and Lee (1997, 2000).

Table 3.8 Skilled biased technological change and the returns to education – *Technology followers*

OLS: Dependent variable return to schooling	(1)	(2)	(3)	(4)	(5)	(6)
Average schooling (25 plus)	-0.0022					
	(2.11)					
Average schooling (15 plus)		-0.0031				
		(2.43)				
Secondary and post-secondary (25 plus)			-0.0025			
			(2.33)			
Post-secondary (25 plus)				-0.0618		
				(4.60)		
Secondary and post-secondary (15 plus)					-0.0142	
					(3.74)	
Post-secondary (15 plus)						-0.0579
						(4.37)
Labour force participation	-0.0183	-0.0173	-0.0246	-0.0153	-0.0187	-0.0199
	(1.28)	(1.24)	(1.80)	(1.13)	(1.38)	(1.49)
Year	0.2645	0.2857	0.2773	0.3158	0.3079	0.2819
	(1.16)	(1.25)	(1.20)	(1.38)	(1.33)	(1.23)
Year squared	-0.00007	-0.00007	-0.00007	-0.00008	-0.00008	-0.00007
	(1.15)	(1.24)	(1.20)	(1.37)	(1.32)	(1.22)
Constant	-263.8856	-285.0677	-276.3453	-314.9832	-307.0408	-281.3074
	(1.16)	(1.25)	(1.20)	(1.38)	(1.33)	(1.23)
R-squared	0.07	0.09	0.05	0.12	0.08	0.10
Observations	245	245	245	245	245	245
Averages of variables						
E(return to schooling)	0.0681	0.0681	0.0681	0.0681	0.0681	0.0681
Standard error	*0.0019*	*0.0019*	*0.0019*	*0.0019*	*0.0019*	*0.0019*
E(control for relative supply of skills)	8.1246	8.1766	0.7848	0.1666	0.5400	0.1496
Standard error	*0.1539*	*0.1417*	*0.0695*	*0.0088*	*0.0276*	*0.0080*

Notes: Absolute values of t-statistics in parentheses. (+) significant at the 10% level; (**) significant at 5%; (*) significant at 1%. The dependent variable is a coefficient from an earnings equation; therefore all estimates are bootstrapped (500 replications) in order to obtain standard errors. The data on the relative supply of skills is taken from Barro and Lee (1997, 2000). The Barro-Lee data is reported at 5-year intervals from 1960, we use measure for the year that is closest to that for which we have an estimate of the return to education.

For technology leaders, who we assume trade primarily with technology followers, the price effect leads to further innovation. This is because the relative price of skill intensive goods rises as labour-intensive goods are imported from the technology followers' countries, as in standard trade models. The price effect on its own should therefore lead to a more positively sloped endogenous technology demand curve.

The extent of the market size effect due to the opening-up of trade depends on whether intellectual property rights are enforced or not. If trade does not affect the diffusion of technology from leaders to followers, then the market size is unchanged. Similarly if the enforcement of property rights is unaffected by trade opening, then the market size effect is also unchanged. However, if trade opening leads to the opening up of new markets for technology or leads to a greater enforcement of intellectual property rights then the market size effect changes. The extreme case is one where the opening up of trade coincides with the full enforcement of intellectual property rights. The pre-trade market for technology and innovation is just the relative supply of skilled labour in the leader's country, $\left(H^c/L^c\right)$. However, with the opening-up of trade, the market for skill-bias technology is now the world relative supply of skills, $\left(H^w/L^w\right)$. If $\left(H^w/L^w\right)<\left(H^c/L^c\right)$ then the market size effect will induce the creation and development of more labour-intensive ***not*** skill intensive technologies, leading to a relatively flatter endogenous technology demand curve.

Ultimately, it is an empirical question as to how trade will change the market for a given technology, although the presumption in the Acemoglu paper is that, for technology leaders, the price effect will dominate, meaning a steeper endogenous technology demand curve[29].

The effect of trade opening on technology followers is similar to that for technology leaders – it all depends on the technology or skills inherent in the goods they import/export. An added effect for the technology followers is that the exogenous technology demand curve (which is downward sloping) could become more positively sloped as the skill-biased technology developed in the technology leader's country filters down to technology followers. If, however, the market size effect dominates, then increased trade may induce labour-biased technological change that lowers the skill premia for technology followers.

Table 3.9 shows the results from estimating a regression of the return to education on the same controls used in **Table 3.7** and some trade variables in specification. The table shows the results for technology leaders only; the results for technology followers are shown in **Table 3.10.** The control for the relative supply of skills is the average number of years of schooling in the country for the population aged 25 or older (specification (1) from **Table 3.7**). The regression includes a control for agricultural imports as a proportion of total merchandise imports[30]. This is used as a proxy for the extent to which each technology leader trades in *labour intensive* goods. As discussed above, greater trade in labour intensive good should, through the price effect in the technology-bias model, be correlated with a higher return to education or skills. This is exactly what the regression shows. We also estimated regressions with different controls for trade in labour intensive goods, such as imports of ore, metals and other

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29 There is a significant trade literature on the relationship between trade, innovation, imitation and knowledge spill overs; see for example, Feenstra and Hanson (1995). In future work it would be useful to incorporate more of the insights from this literature into the model presented here.

30 A full description of the variables use, as defined in the WDI, is shown in the notes to **Table 3.9.**

primary products. These other variables were also positively correlated with the return to education, though the correlation was not always significant.

The regression results in **Table 3.9** also show the coefficients on the variables we use as proxies for the market size effect (on innovation). The first specification includes exports of financial services and other similar products; the second specification includes exports of high technology products; both variables are from the WDI (2003). The hypothesis underlying the market size effect is that the more skill intensive exports a technology leader has, and assuming intellectual property rights are enforced, the greater the market for innovation or the development of skill intensive technologies, and therefore the greater the return to education. The results in **Table 3.9** are consistent with the market size hypothesis; exports of skill intensive products are positively correlated with the return to education in our sample of technology leaders.

The results in **Table 3.10** show the relationship between the trade variables and the returns to education amongst the group of technology followers. In order to control for the supply of skills we include the relative supply of workers with third level education in the population[31]. The two specifications in **Table 3.10** include different controls for the imports of what we classify as skill intensive goods: computer related products and financial services products[32]. According to the market size hypothesis, the greater the market for a given technology (i.e. the workers who use the technology) the greater the return to skills. Thus we would expect to observe a positive correlation between imports of these variables and the return to education amongst technology followers – this is exactly what we observe in **Table 3.10,** both the coefficients are significant and positive. In general the results in **Table 3.10** are consistent with the

[31] We use the relative supply of workers with third level education to control for the relative supply of skills because the previous regression results showed that the variable that produced the highest R2 in the regression.

[32] The precise definitions are given at the bottom of **Table 3.10**.

predicted effects of trade from the technology bias model. We now go on to consider an alternative model that can explain the differences we observe in the return to education – the capital skill complementarity model.

Table 3.9 Impact of trade in the technology-bias model, technology leaders

OLS: Dependent variable return to schooling	(1)	(2)
Average schooling (25 plus)	0.0097	0.0069
	(4.89)*	(3.65)*
Labour force participation rate	-0.1075	-0.1033
	(7.13)*	(5.90)*
Agricultural imports (% imports) (a)	1.0282	0.9414
	(3.94)*	(2.93)*
Financial services exports (% exports) (b)	0.0675	
	(2.41)**	
High-technology exports (% exports) (c)		0.11481
		(4.19)*
Constant	0.0227	0.0433
	(4.09)**	(2.00)**
R-squared	0.59	0.49
Observations	110	80
Averages of variables in the regression		
Return to schooling (25 plus)	0.0805	0.0826
Standard error	*0.0024*	*0.0028*
Average schooling (25 plus)	9.6551	9.7655
Standard error	*0.1365*	*0.1458*
Labour force participation rate	0.7401	0.7358
Standard error	*0.0116*	*0.0141*
Agricultural imports (% imports) (a)	2.6163	2.4281
Standard error	*0.0823*	*0.0997*
Financial services exports (% exports) (b)	6.2388	
Standard error	*0.5580*	
High-technology exports (c)		0.2151
Standard error		*0.0104*

Notes: The dependent variable in the regression is the coefficient on schooling from an earnings regression; the results in the table are bootstrapped (500 replications) in order to obtain the standard errors. Absolute value of *t-statistics* in parentheses. (+) significant at the 10% level (**) significant at the 5% level; (*) significant at the 1% level. ***Variable definitions (WDI, 2003)***: **(a)** Agricultural raw materials imports (% of merchandise imports): Agricultural raw materials comprise SITC section 2 (crude materials except fuels) excluding divisions 22, 27 (crude fertilizers and minerals excluding coal, petroleum, and precious stones), and 28 (metalliferous ores and scrap). **(b)** Insurance and financial services (% of commercial service exports): Insurance and financial services cover freight insurance on goods exported and other direct insurance such as life insurance; financial intermediation services such as commissions, foreign exchange transactions, and brokerage services; and auxiliary services such as financial market operational and regulatory services. **(c)** High-technology exports (% of manufactured exports): High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery.

Table 3.10 **Impact of trade in the technology-bias model, technology followers**

OLS: DEPENDENT VARIABLE RETURN TO SCHOOLING	(1)	(2)
Relative supply 3rd level graduates	-0.0859	-0.0892
	(4.96)*	(4.77)*
Labour force participation rate	-0.0193	-0.0154
	(1.43)	(1.00)
Agricultural imports (% imports) [(a)]	-0.5066	-0.5831
	(2.37)**	(2.62)**
Computer imports (% imports) [(b)]	0.0368	
	(2.32)**	
Financial services imports (% imports) [(b)]		0.1535
		(2.47)**
Constant	0.1057	0.1114
	(9.24)*	(9.17)*
R-squared	0.24	0.24
Observations	217	205
Averages of variables in the regression		
Beta	0.0691	0.0700
Standard error	*0.0020*	*0.0021*
Rel supply	0.1691	0.1668
Standard error	*0.0093*	*0.0098*
Lfps	0.7290	0.7257
Standard error	*0.0106*	*0.0109*
Ag imports	0.0342	0.0344
Standard error	*0.0011*	*0.0011*
Comp imports	0.3089	
Standard error	*0.0074*	
FS imports		0.0544
Standard error		*0.0028*

Notes: The dependent variable in the regression is the coefficient on schooling from an earnings regression; the results in the table are bootstrapped (500 replications) in order to obtain the standard errors. Absolute value of *t-statistics* in parentheses. (+) significant at the 10% level (**) significant at the 5% level; (*) significant at the 1% level.

***Variable definitions** (WDI, 2003)*: **(a)**, **(c)** see notes from **Table 3.9.** **(b)** Computer, communications and other services (% of commercial service imports): Computer, communications and other services (% of commercial service imports) include such activities as international telecommunications, and postal and courier services; computer data; news-related service transactions between residents and nonresidents; construction services; royalties and license fees; miscellaneous business, professional, and technical services; and personal, cultural, and recreational services.

3.4.2. Capital skill complementarity and the return to education

The relationship between the capital stock and the demand for skills has been investigated in a variety of papers. Using the broadest possible definition of capital, several authors have estimated the correlation between changes in the overall capital stock and the demand for skills; Goldin and Katz (1996), Flug and Hercowitz (2000). Other studies have used a narrower definition of capital, examining the relationship between changes in capital equipment and the demand for skills; see, for example, Krusell *et al.* (2000). The papers by Levy and Murnane (1996) and Autor *et al.* (2003) look at particular types of capital equipment – computers. They find computers have increased the demand for skilled labour, and in particular college-trained labour.

The estimating equations presented below are motivated by an aggregate production function with four inputs, capital structures, capital equipment, skilled labour and unskilled labour. In the model, capital equipment and skilled labour are complements. The estimating model builds on the work in in Krusell *et al.* (2000), which itself is a modification of the earlier work by Griliches (1969). The aggregate production function is given by

$$y = AG(k_s, k_e, u, s) \tag{5}$$

where y is output, A is neutral technological change, k_s is the stock of capital infrastructure and k_e is the stock of capital equipment, u is the unskilled labour input and s is the skilled labour input. The main characteristic of the production function is that equipment and skilled labour are complements, whereas equipment and unskilled labour are substitutes. Hence, countries that invest a lot in their capital equipment stock should also generate a higher relative demand for skilled labour. The production function is assumed to be Cobb-Douglas over capital structures and a CES function of the three other inputs:

$$y = k_s^{\alpha}\left(k_e, u, s\right)^{1-\alpha} \tag{6}$$

The second function in (6), $\left(k_e, u, s\right)$, enters the production function as a constant elasticity of substation (CES) aggregation of capital equipment (k_e), unskilled labour (u) and skilled labour (s):

$$\left(k_e, u, s\right) = \Psi_1\left(u, \Psi_2\left(k_e, s\right)\right) = [\omega u^{\sigma} + (1-\omega)\left(\lambda k_e^{\rho} + (1-\lambda)s^{\rho}\right)^{\frac{\sigma}{\rho}}]^{\frac{1}{\sigma}} \tag{7}$$

where the variables Ψ_1 and Ψ_2 represent the CES aggregators, and $(\rho, \sigma) < 1$. The nesting $\Psi_1\left(u, \Psi_2\left(k_e, s\right)\right)$ in (7) makes more sense than the alternative nesting $\Psi_1\left(s, \Psi_2\left(k_e, u\right)\right)$. However, both formulations impose restrictions on the implied elasticities. The form used in (7) assumes that the elasticity of substitution from unskilled labour to capital equipment is the same as that from unskilled labour to skilled labour. For the alternative formulation $\Psi_1\left(s, \Psi_2\left(k_e, u\right)\right)$ the elasticity of substitution between skilled labour and capital equipment is the same as that between skilled labour and unskilled labour, which is inconsistent with the data and therefore a less credible assumption. Combining equations (6) and (7) we can write the production function as

$$y = k_s^{\alpha}\left(\left[\omega u^{\sigma} + (1-\omega)\left(\lambda k_e^{\rho} + (1-\lambda)s^{\rho}\right)^{\frac{\sigma}{\rho}}\right]\right)^{\frac{1-\alpha}{\sigma}} \tag{8}$$

Capital skill complementarity requires the elasticity of substitution between capital equipment and unskilled labour to be greater than that between capital equipment and skilled labour. The elasticity of substitution between equipment and unskilled labour is

$1/(1-\sigma)$, and the elasticity between equipment and skilled labour is $1/(1-\rho)$. Therefore, we say there is capital skill complementarity when $\sigma > \rho$.

Assuming workers are paid their marginal products, then taking the ratio of the marginal product of skilled labour to unskilled labour gives us the skill premium, as in the technology bias model from the previous section. Once again, we assume that the skill premium in the model is equivalent to our estimate of the return to education. Therefore the comparative statics from (8), which tell us how the skill premium changes according the factors used in production, also apply to the return to education.

The marginal product of skilled and unskilled labour can be obtained by taking the first differential of equation (8). The ratio of these marginal products is the skill premium:

$$r = \frac{dy/ds}{dy/du} = \frac{(1-\mu)(1-\lambda)}{\mu}\left[\frac{\lambda k_e^{\ \rho}}{s^{\rho}} + (1-\lambda)\right]^{\frac{\sigma-\rho}{\rho}}\left(\frac{u}{s}\right)^{1-\sigma} \tag{9}$$

The testable predictions of this simple model, in the context of our sample of cross-country returns to education, are given by log linearising equation (9):

$$\ln r \cong \mathrm{H} + (1-\sigma)\ln\left(\frac{u}{s}\right) + (\sigma-\rho)\ln\left(\frac{k_e}{s}\right) \tag{10}$$

where $\mathrm{H} = \ln\left(\frac{(1-\mu)(1-\lambda)}{\mu}\right)$. Ignoring the constant, the first component of equation (10) is a simple *relative quantity effect* (Krusell *et al.*, 2000). Given that the CES parameter $\sigma < 1$, then countries with a greater supply of skilled labour relative to unskilled labour will have a lower return to education[33]. The second component of equation (10) is the capital-skill complementarity effect. Capital-skill complementarity requires $\sigma > \rho$,

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[33] In the model in Krusell *et al* (2000), the stock of skilled and unskilled labour is measured in efficiency units. Their estimatable form, therefore includes a *relative efficiency effect also*. They show that assuming a positive elasticity of substitution between skilled and unskilled labour, then an increase in the relative efficiency of skilled labour will also lead to an increase in the skill premium.

therefore if capital equipment and skilled labour are complements, then the return to education should be larger for those countries with a greater stock of capital equipment relative to skilled labour.

The most consistent source of data on capital stocks for a variety of countries and years is available from the Penn World Tables (PWT Mark 5.6a, Summers *et al.,* 1995). This data is only available for *9* of the countries in our sample and provides data on capital stocks up to 1992. The methods used to calculate capital stocks are outlined in the PWT codebook. Briefly, the authors have benchmark estimates of the capital stocks in each country at various points in time; they fill in the missing years by using investment data and making assumptions about the depreciation rates of different types of capital. The measure of capital equipment we use is total non-residential capital stock minus non-residential construction capital and other types of construction capital. The reduced sample consists of 132 year-country observations of returns to education, the stock of skills and the stock of capital equipment. **Table 3.11** shows the average value of the capital stocks for each of the countries in the sample. The capital stock is measured in 1985 US dollars and the figures in **Table 3.11** are averaged for each year we observe the return to education.

Figure 3.6 plots the relationship between the return to schooling and the ratio of the stock of capital equipment to the stock of skilled workers (post-secondary education, aged 25 or older) in the sample[34]. The cross plot shows a clear positive correlation between the two variables, as predicted by the model. **Table 3.12** presents the estimates from an OLS regression of equation (10). In order to avoid problems with

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[34] In the context of the capital-skill complementarity model, we have experimented with defining skilled labour as having secondary education or better, however, we found that the definition used in the text (post-secondary) better explains the observed returns to education.

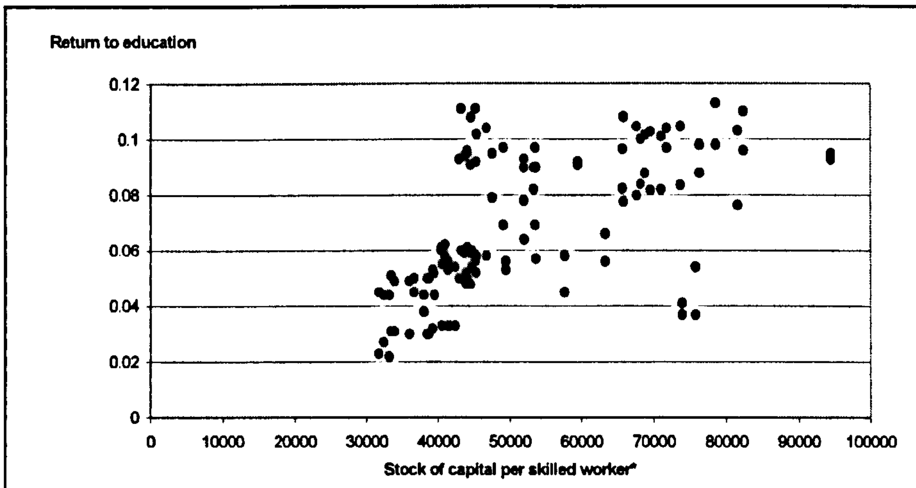
collinearity, we define the relative stock of unskilled labour, $\left(\frac{u}{s}\right)$, as the average schooling in the population aged 25 or older. The definition of the ratio of the stock of capital equipment to skilled labour is as per **Figure 3.6**. The results from estimating equation (10) are exactly as the capital skill complementarity model suggest. The return to education is decreasing in the supply of skilled relative to unskilled labour, but increasing as the stock of capital equipment increases relative to the stock of skilled labour. The estimates are consistent with the theory that capital equipment and skilled labour are complements: $\sigma > \rho$. The estimated substitution elasticity between unskilled labour and skilled labour is 1.86, a similar elasticity to that found in Krusell *et al.* (2000) and other papers referenced therein. The estimated elasticity between skilled labour and capital equipment is 0.72, which is again consistent with the results from other studies. The regression results presented in **Table 3.12** include a dummy variable for the USA, as a graphical analysis of the distribution of capital per worker showed that it was clearly an outlier. The relatively low stock of capital equipment per worker in the US is difficult to explain, and it probably reflects the fact that the PWT data is not of a very high quality for some countries. The analysis in the Krusell paper does not use PWT measures of the stock of capital equipment per worker, *and* they also adjust the capital stock for changes and differences in quality – which we do not do here. This may be one of the reasons for the fact that the US is an outlier. That said, when we re-estimate equation (10) excluding the US, the results are practically unchanged. To summarise, we believe that the US-effect is probably a reflection of poor data rather than the fact that the model does not apply equally to the US returns to education

Table 3.11 Stocks of capital equipment

	Capital equipment per skilled worker	Total stock of capital equipment (£million)	Years oberved
Germany	£72,606	£429,100	1985 - 1992
United Kingdom	£48,851	£238,200	1978 - 1992
USA	£21,556	£1,397,000	1985 - 1992
Austria	£92,667	£30,320	1983 - 1991
Netherlands	£51,780	£75,560	1986 - 1992
Norway	£60,835	£22,490	1980 - 1991
Sweden	£47,370	£44,130	1981 - 1991
Denmark	£37,002	£23,860	1981 - 1992
Finland	£54,814	£26,500	1984 - 1991

Notes: The data on capital stocks is taken from the Penn World Tables (Summers *et al.*, 1995). Capital equipment is defined as total non-residential capital stock minus non-residential construction capital and other types of construction capital. Skilled workers are workers who have acquired at least some post-secondary education or related training (Barro and Lee, 2000).

Figure 3.6 The relationship between the return to schooling and the ratio of capital equipment to skilled labour



Notes: (*) The data on capital stocks is taken from the Penn World Tables (Summers *et al.*, 1995). Capital equipment is defined as total non-residential capital stock minus non-residential construction capital and other types of construction capital. Skilled workers are workers who have acquired at least some post-secondary education or related training (Barro and Lee, 2000). The USA is omitted from this figure because it is an outlier in the figure; the regression includes a dummy variable for the USA.

Table 3.12 Estimates of the parameters from the capital skill complementarity model

OLS regression: dependent variable is the log of the return to schooling	**Coefficients from the capital-skill complementarity model**
Log (average schooling in population aged 25 plus) [(a)]	0.5378
	(2.45)**
Log (Stock of Capital equipment [(b)]/Stock of workers with post-secondary education [(b)])	0.8529
	(7.59)*
Dummy variable for USA	1.4596
	(4.70)*
Constant	-10.8039
	(7.16)*
R-squared	0.50
Observations	132
Elasticities between labour and capital equipment	
$1/(1-\sigma)$, unskilled	1.86
$1/(1-\rho)$, skilled	0.72

Notes: The dependent variable in the regression is the coefficient on schooling from an earnings regression; the results in the table are bootstrapped (500 replications) in order to obtain the standard errors. Absolute value of *t-statistics* in parentheses. (**) significant at the 5% level; (*) significant at the 1% level. (a) The data on the stock of skills and average schooling is taken from Barro and Lee (2000). Skilled workers are workers who have acquired at least some post-secondary education or related training. (b) The data on capital stocks is taken from the Penn World Tables (Summers *et al.*, 1995). Capital equipment is defined as total non-residential capital stock minus non-residential construction capital and other types of construction capital. We include a dummy variable for the USA in the sample because the graphical analysis of the relationship between the stock of capital equipment, skills and the return to education showed that it was a clear outlier. One reason for this could be data. The Krusell *et al.* (2000) paper uses data from Gordon (1990), which is a quality-adjusted, sector specific measure of the stock of capital equipment.

As was the case for the technology bias model, the opening-up of international trade also has implications for the effects of capital-skill complementarity. Flug and Hercowitz (2000) and Feenstra and Hanson (1997) both recognise the fact that international trade is likely to be one of the main sources of new capital equipment, particularly in developing countries where the initial stock of capital equipment is low. We do not report the results here, but we also find that for less developed countries in our sample, imports of capital equipment are indeed a significant source of capital equipment for less developed countries. We have also looked at the correlation between

R & D expenditure and the stock of capital equipment in a country, and find that countries that invest a lot in R & D also have higher stocks of capital equipment.

To conclude this section, we find that the capital-skill complementarity explanation of cross-country patterns in the return to education is not rejected in our sample of 9 countries. The estimated substitution elasticities are consistent with capital equipment and skilled labour being complements. The results are also close to other results that have been found in several other studies, and for the US in particular.

3.5. Conclusion

We set out to do two things with this paper. Firstly, we wanted to document the cross-country and cross-time differences in the return to education. We showed that the return to education has changed over time, following a U-shape that reached a trough in the 1980s, and has been increasing since then. We also showed that the increase in the return was strongly correlated with changes in productivity over time.

In the multivariate analysis we estimated two models that both relate the return to education to changes in technology – one directly, via technology bias in the demand for skills, and the other indirectly, through changes in capital equipment stocks. Both models explain a significant proportion of the differences we observe in the return across countries.

One of the implications of the results we present is that developing countries that wish to increase the stock of skills in the economy could do a lot worse than by opening up their trade with countries that are technology leaders. Not only will the increased imports of capital equipment raise the return to education (and therefore the demand for schooling) through capital skill complementarity but it will also increase the return to education through the market size effect as predicted by the technology bias model –

the snag is, of course, what happens to the level of exports of *labour intensive* products as they trade more with the world's technology leaders.

Appendix: Measurement error in schooling attainment

Measurements of the stock of human capital in the economy play a key role in the empirical estimation in this chapter. It is therefore important to consider the reliability of the measures of the average schooling and stock of human capital that we use. This section extends the work in Krueger and Lindahl (2000), which looked at the measurement error in the Barro Lee (1993) estimates of schooling attainment.

Barro and Lee (1997, 2000) impute measures of schooling attainment and average schooling using the perpetual inventory method and historical information on the stocks and flows of enrolments. The use of historical information means that any errors in the variables are likely to be correlated over time. Suppose for a given country we observe average measures of schooling S_1 and S_2 for two periods. Average schooling in each period is measured with error equal to e_t. If the measurement error is uncorrelated over time, $E(e_1, e_2) = 0$, then the proportion of the variation in S_1 due to the measurement error is given by

$$R_1 = \left(\frac{\text{cov}(S_1, S_2)}{\text{var}(S_1)} \right).$$

R_1 is often referred to as the reliability ratio for S_1, and it has a corresponding probability limit equal to $\frac{\text{var}(S^*)}{(\text{var}(S^*) + \text{var}(e_1))}$, where S^* is the true measure of average schooling in the country. If we assume constant variances then the change in the reliability ratio, $R_{\Delta S_1}$, will be lower than the cross sectional reliability if the serial correlation of the true variable is higher than the serial correlation of the measurement errors. This becomes clear when we write the full expression for the reliability ratio

$$R_{\Delta S_1} = \left(\frac{\operatorname{var}(S^*)}{\operatorname{var}(S^*) + \operatorname{var}(e)(1 - r_e)/(1 - \rho_{s^*})} \right),$$

where r_e is the serial correlation of the error terms and ρ_{s^*} the serial correlation of the true average schooling in the population. The expression for $R_{\Delta S_1}$ above is not easily estimated and Krueger and Lindahl (2000) have proposed a more practical version, which is the one we use here

$$R_{\Delta S_1} = \left(\frac{\operatorname{cov}(\Delta S_1, \Delta S_2)}{\operatorname{var}(\Delta S_1)} \right)$$

Estimating the reliability ratios

In order to provide some benchmark for the quality of the data we use on average schooling and attainment in the population (Barro and Lee, 2000), we look at the reliability of three possible measures of average schooling in the population. The first source is, of course, the Barro and Lee (2000) (Barro-Lee) data. The second measure we have of average schooling in the population is derived from Kyriacou (1991). Kyriacou regressed point estimates of average schooling in the 1970s on enrolment rates for primary, secondary and post-secondary schooling. Coefficient estimates from this model were then used to predict average schooling for 1985 and 1965. Both the Barro-Lee data and the Kyriacou-type estimates of average schooling are based on the same enrolment rates (UNESCO). The measurement error in the estimates is therefore likely to be positively correlated. Therefore, following Krueger and Lindahl (2000), we would propose that the reliability ratios for these two measures are an upper bound on the true reliability of the data. It would informative, therefore, to look at estimates of average schooling that do not use these enrolment rates. Our third estimate of average schooling in the population uses the Kyriacou approach with 1980 as the starting year, and extrapolating to average schooling for 1985, 1990 and 1995. The dataset we use to do this is the world values survey for 1990 and 1995. The sample of countries varies both by source and time-period.

Table A2 presents the reliability ratios for the measures of schooling, the first panel compares the Barro-Lee estimates with the Kyriacou-type estimates, and the second panel compares the Barro-Lee estimates with the WVS. The reliability ratios are calculated by regressing one measure of schooling on the other, the notes at the foot of each table provide further explanations. The reliability ratios in panel A are encouraging, ranging from about 0.609 to 0.889 for both the Barro-Lee and Kyriacou-type data. However, when we consider differences, the results are somewhat worse. The signal in the Kyriacou-type data falls dramatically to 0.096, a very similar result to that in Krueger and Lindahl. The results for the reliability of changes in the Barro-Lee data are not nearly as bad, 0.498, though the fall is still quite large. Using the results discussed in the previous section we can put some interpretation on this result. If we used changes in the average years of schooling in an OLS framework to try and explain international differences in the return to schooling, then the results would be biased downwards by 50% or 90% depending on whether we were using Barro-Lee or Kyriacou-type measures of average schooling. Panel B of Table A2 presents the reliability ratios of the WVS and Barro-Lee data. We noted above that the positive correlation in the errors of both the Barro-Lee and Kyriacou data was likely to bias the estimates of the reliability ratios upwards. We can use the estimates of the reliability ratio obtained using the WVS to test this. However, looking at the first column of Table A2, panel B, it would seem that this is not such a serious problem. For 1990 the reliability ratio of the Barro-Lee estimates of average schooling are actually higher (though within a standard deviation) than when we used the Kyriacou type data. For 1995, the estimates are lower when we use the WVS to calculate the reliability of the

Barro-Lee data, implying that the previous estimate could indeed be an upper bound estimate of the true reliability ratio.

Table A3.13 **Correlation matrix for Barro-Lee and Kyriacou-type measures of average schooling (Panal A)**

	S_{85}^{BL}	S_{90}^{BL}	S_{95}^{BL}	S_{85}^{K}	S_{90}^{K}	S_{95}^{K}	ΔS_{85-95}^{BL}	ΔS_{85-95}^{K}
S_{85}^{BL}	--							
	--							
S_{90}^{BL}	0.969							
	(68)							
S_{95}^{BL}	0.960	0.983						
	(68)	(76)						
S_{85}^{K}	0.764	0.761	0.727					
	(59)	(59)	(59)					
S_{90}^{K}	0.747	0.739	0.738	0.967				
	(65)	(73)	(69)	(59)				
S_{95}^{K}	0.722	0.725	0.732	0.824	0.892			
	(63)	(69)	(69)	(57)	(67)			
ΔS_{85-95}^{BL}	-0.407	-0.217	-0.132	-0.305	-0.228	-0.166	--	0.195
	(68)	(68)	(68)	(65)	(65)	(65)	--	(57)
ΔS_{85-95}^{K}	0.154	0.177	0.232	0.063	0.196	0.618	0.195	--
	(57)	(57)	(57)	(57)	(57)	(57)	(57)	--

Notes: The numbers in the table are for average schooling in the population aged 15 or over. Superscripts refer to data sources K, Kyriacou; BL, Barro-Lee. Subscripts refer to years. The figures were also calculated for the population aged 25 or over and the results were practically the same.

Panel A1 (cont.) **[Covariance matrix for Barro-Lee and Kyriacou-type measures of average schooling**

	S_{85}^{BL}	S_{90}^{BL}	S_{95}^{BL}	S_{85}^{K}	S_{90}^{K}	S_{95}^{K}	ΔS_{85-95}^{BL}	ΔS_{85-95}^{K}
S_{85}^{BL}	--							
	--							
S_{90}^{BL}	5.14							
	(68)							
S_{95}^{BL}	4.87	4.61						
	(68)	(76)						
S_{85}^{K}	3.36	3.28	4.14					
	(59)	(59)	(59)					
S_{90}^{K}	3.83	3.43	3.43	3.85				
	(65)	(73)	(69)	(59)				
S_{95}^{K}	2.98	3.91	3.76	3.76	4.83			
	(63)	(69)	(69)	(57)	(67)			
ΔS_{85-95}^{BL}	-0.631	-0.325	-0.194	-0.191	-0.335	-0.282	--	0.179
	(68)	(68)	(68)	(65)	(65)	(65)	--	(57)
ΔS_{85-95}^{K}	0.467	0.522	0.646	0.1626	0.543	2.03	0.179	--
	(57)	(57)	(57)	(57)	(57)	(57)	(57)	--

Notes: See notes for Panel A

Reliability of three different measures of average schooling (1985 – 1990)

A.	Reliability of Barro-Lee data (1985-1995)	Reliability of Kyriacou-type data (1985-1990)*
1985	0.656	0.889
	0.073	*0.099*
	(59)	(59)
1990	0.720	0.759
	0.078	*0.082*
	(73)	(73)
1995	0.879	0.609
	0.100	*0.069*
	(69)	(69)
Changes		
1985-1995	0.498	0.096
	0.200	*0.065*
	(57)	(57)
B.	**Reliability of Barro-Lee data (1990 – 1995)**	**Reliability of *World Values Survey Data* (1990 – 1995)**
1990	0.853	0.919
	0.091	*0.098*
	(26)	(26)
1995	0.617	0.762
	0.053	*0.220*
	(38)	(38)

Notes: The numbers are for average schooling in the population aged 15 or over. The figures were also calculated for the population aged 25 or over and the results were practically the same. *The Kyraicou-type estimators of average schooling are based on measures of average schooling and gross enrolment by levels for 1980. Gross enrolment data was taken from the *World Development indicators* provided by the World Bank. Gross (as opposed to Net) data refers to the number of individuals *actually* enrolled in school as a ratio of those who you would expect to be enrolled in school, given the population of a given age and the characteristics of the schooling system.

The estimated reliability ratios are the slope coefficients from a bivariate regression of one measure of average schooling on another (the statistical motivation for the analysis is given in Appendix 1). For example, the 0.656 coefficient in the first column of the first row is the result of a regression of the Kyriacou-type measure of average schooling on Barro-Lee measures of average schooling. The 0.889 coefficient in the next column is the result of the reverse regression. Similar calculations were carried out for the *World Values Survey* and the Barro-Lee data in panel B. Samples sizes are in parentheses and standard errors are in italics.

4. The impact of income support programmes in the United Kingdom on wage growth

This paper attempts to uncover the effects of a welfare-to-work programme, which acts as a wage subsidy, on wage growth by exploiting an expansion to this welfare programme in the UK. The conventional wisdom is that such programmes trap recipients into low wage, low quality work – this comes from the simple argument that the poverty trap, which a wage subsidy for low income workers induces, reduces the benefits to on-the-job training or job search and so reduces wage growth. In fact, it is also possible that a wage subsidy will also reduce the costs of general training because we would normally expect workers to pay for their own general training in the form of lower gross wages. So a wage subsidy is a way of sharing these costs with the taxpayer. Wage growth can also come about through on-the-job search, the incentives for which are also affected by the wage subsidy. This is because the taper *off* welfare induces a higher marginal tax rate for individuals on the programme. Thus, the net effect on wage progression depends on whether it reduces costs by more or less than the benefits.

Tax credit programmes form the core of the UK government's policy to *'make work pay'*, the primary aim being to provide support for low-wage families with children who are working[35]. The goal of the system of tax credits is to improve the work incentives of people with low attachment to the labour force, and to encourage them to move into employment. Therefore, understanding the effect of programmes such as FC/WFTC on wage growth is clearly an important question.

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35 Since this paper was first written the Government has extended the tax credit programme to individuals without children, and the overall system of tax credits has been renamed the 'Working Tax Credit' (WTC).

Economic assessments of tax credit programmes in the UK have focused on the labour supply effects, see Blundell *et al.* (2000) and Blundell and Walker (2001), or the incentives to take up the wage subsidy, see Brewer *et al.* (2003a, 2003b). This is the first paper to consider how such wage subsidy programmes in the UK affect an individual's wage growth[36]. The paper uses Labour Force Survey panel data to look at wage levels and growth before and after Working Families' Tax Credit (WFTC) replaced Family Credit (FC) in the UK. We exploit the shape of the FC/WFTC budget constraint, as well as the nature of the reform in order to estimate the effect of tax credits on wage growth. FC/WFTC had a structure that theoretically provided negative incentives for investments that promote wage growth for some (people receiving the maximum amount of the credit) and positive incentives for others (people close to the point where they come off the credit). The data we use in this paper, the UK Labour Force Survey, for 1997-2003, bridges the FC and WFTC periods. We discuss the differences between each of the programmes in the following sections.

The rest of the paper is outlined as follows: section 2 gives the background to the income support programmes in the United Kingdom, and also presents the relevant literature; section 3 presents the data use in the analysis, the quarterly rolling panel from the UK Labour Force Surveys (LFS); section 4 summarises the wage growth of welfare recipients according to certain characteristics including the relevance of job mobility. Finally, in Section 5 we present results of the multivariate analysis, which exploits the "natural experiment" that the FC to WFTC reform provides. Section 6 concludes with some observations for future research.

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36 There are a small number of studies that have looked at the impact of such programs in the US; see Burtless (1998), Card *et al.* (2001), Connolly and Gottschalk (2001) and Connolly *et al.* (2002). Almost all of these papers use welfare experiments, with treatment and control groups, to estimate the impact of the programmes on wage growth. As far as we are aware, the current paper is the only one to use welfare reform to identify the effect of a wage subsidy on wage growth.

4.2. Background on welfare-to-work programs in the United Kingdom

Tax credits form a core part of the UK government's overall welfare strategy to "make work pay", but their proximate aim was to provide earnings supplementation for working low-wage families with children and so reduce child poverty[37]. In the UK, there has been a system of wage subsidies in place for working families since the early 1970s, and, in the US, the Earned Income Tax Credit introduced in 1975 plays a similar role. The Family Income Supplement (FIS) was introduced as a means-tested benefit in the UK in 1971. In 1988, the hours and earnings thresholds for eligibility for the FIS were relaxed and the programme was renamed Family Credit (FC). In October 1999, Family Credit was restructured and renamed the Working Families Tax Credit (WFTC). In April 2003, tax credits were extended to families without children, and the programme was re-branded as the Working Tax Credit (WTC) and the Child Tax Credit (CTC). Given that a lengthy time series of information on the WTC and CTC is not yet available, we focus in this paper on FC and WFTC. However, we believe that the evidence we present on the wage growth effects of WFTC also applies to WTC, as the means testing, and hence the incentive effects, of each of the programmes is very similar.

4.2.1. The Structure of Family Credit and the Working Families' Tax Credit

In order to be eligible for FC or WFTC a family with dependent children needed to have one adult working a minimum of 16 hours per week[38]. A family was eligible for a maximum amount depending on the number of dependent children in the family, plus a small bonus if at least one of the parents was working full-time (greater than or equal

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37 Blundell (2001) has in depth discussion of how in-work welfare programs fit in the government's so called 'iron triangle' of welfare reform, that is, the three goals of: raising the living standards of those on low incomes; encouraging work and self-sufficiency; and keeping fiscal costs down.

38 A dependent child is one who is under 16 years of age, or under 19 if in full-time education up to A-level or equivalent standard.

to 30 hours per week). Under FC the maximum amount was payable if the family's net income was lower than a threshold amount, which was £80.65 per week prior to the changeover to WFTC in October 1999. The taper for net income in excess of the threshold amount was 70 pence for every £1 in excess of threshold income. The value of the credit also depended on household savings: savings over £3,000 would reduce the award, while savings over £8,000 rendered the family ineligible for any tax credit.

FC was payable at a flat rate for six months, regardless of changes in the family's circumstances in the intervening period. This fixing of the payment period for FC was set so as to avoid prohibitive administrative and compliance costs. FC was also paid to mothers (if requested) even if eligibility was in respect of the father's earned income[39]. Using data from the Labour Force Survey, we find an average (real) payment over the January 1997 - October 1999 period of about £56 and the average of the last quarter was close to £63. We estimate the take-up rate for FC for the same period to be 54%[40].

Starting in October 1999, FC was replaced with WFTC. The reformed program was substantially more generous. In August 2001 there were 1,269 thousand families receiving WFTC, compared with 784 thousand families receiving FC in August 1999. As well as this, the average reward had increased to £82 per week by August 2001[41].

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39 The structure of FC and WFTC created some perverse incentives. For example, there is clearly an incentive for an individual to get a relatively low-paying job in order to get FC/WFTC, and then in the intervening 6 months get a much better job while continuing to receive the wage subsidy. We attempt to control for this in the analysis by separating out those individuals who change jobs and those who remain in the same job.

40 The take-up rate is defined as the proportion of families who are eligible and who take up the tax credit. Eligibility is calculated using the tax benefit model described below. This is lower than the published take-up rates of 69%. However, it is consistent with other estimates of the take-up rate obtained using the Labour Force Survey; see Brewer, *et al.* (2003b). The Brewer paper considers several explanations for the difference in estimated take-up rates, the most obvious being that fact that they are measures of take-up in different time periods.

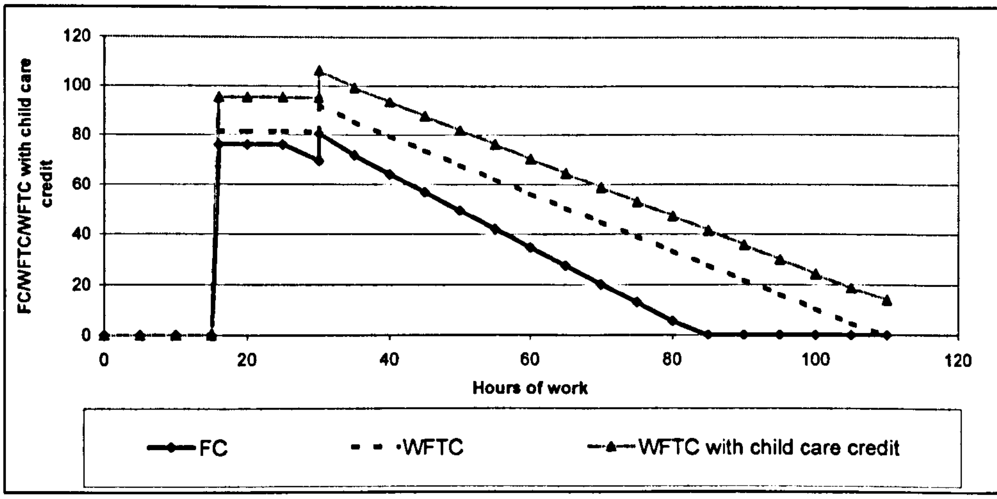
41 Statistics are taken from the Inland Revenue Quarterly Statistics on the WFTC and FC, August 2001 and November 1999. The difference in the number of families on FC and WFTC is not, of course, entirely due to the reform of the welfare system, some of the changes are due to the trend increase in take-up. However, if we compare the number of people on FC in August 1997 (the same two-year time frame as August 1999 and August 2001), there were still only 758 thousand families on FC.

The increased generosity of the WFTC came about due to four major changes relative to the FC system:

1. An increased credit for children of between £ 19.85 and £ 25.95 per week;
2. An increase in the earnings threshold for eligibility from £80.65 per week to £90 per week;
3. A reduction in the taper off welfare from 70% to 55%;
4. The introduction of a child-care credit of 70% of actual child-care costs up to a maximum of £150 per week (for two children, £100 for one child) week that replaced FC's partial childcare disregard.

The largest cash gains as a result of the move from FC to WFTC went to those people who were at the end of the taper on FC. This is shown in **Figure 4.1.** The figure shows the average weekly amount of the credit received by a working single mother with one dependent child aged between five and ten, and earning a wage of £3.15 per hour. As a result of the reform, individuals who were receiving the maximum credit saw a significant increase in the level of their payment. A number of individuals also move from being on the taper to being on the maximum. However, as noted above, the largest cash gains went to those individuals who were just at the end of the taper off FC, but for whom the WFTC reform created an entitlement to in-work benefits. When we compare the wage growth of individuals on WFTC, below, we will pay particularly close attention to this group of individuals. With regard to the child-care credit, in August 2001 it was estimated that approximately 12% of all recipient families had a childcare tax credit included in their reward, the average amount of which was £ 37.50 per week (Inland Revenue, WFTC quarterly report, August 2001).

Figure 4.1 FC and WFTC weekly award, June 2000



Notes: The weekly award is calculated for a single mother with one child and a gross wage of £3.15 per hour. The raw data is taken from the LFS June 2000.

4.2.2. Comparisons with other in-work benefit programs

Several countries have relied on tax credits and/or employment/wage subsidies in their welfare to work programs. In this section we discuss programs in the US (the Earned Income Tax Credit) and Canada (the Self Sufficiency Project). The majority of work on welfare receipt and wage growth has used data from programs in these countries. The study by Gradus and Jusling (2001) reviews schemes that have been proposed and that are already operating in several European countries.

The Earned Income Tax Credit (EITC) was introduced in the US in 1975 and is one of the oldest income support programs in the world. As with the move from FC to WFTC, the EITC was reformed in several tax acts throughout the 1980s and 1990s that vastly increased the scope of the program. Individuals are assessed for EITC eligibility on the basis of the taxpayer's income and the number of qualifying children. However, unlike the UK system of in-work benefits, the EITC has both a phase-in schedule (40% in 1996) and a phase out schedule (21% in 1996). This leads to a far smoother budget constraint than the one we observe for FC or WFTC. Also unlike the UK system, the

EITC is based on an individual taxpayer's income, and not the family income. Most of the work on the labour market impact of the EITC has concentrated on the labour supply effects; see Blundell (2000) and references therein. This is largely because the several reforms of the program throughout the 1980s and 1990s make it an ideal candidate for a natural experiment.

The Canadian Self-Sufficiency Project (SSP) was a federally funded experiment designed to determine the effectiveness of using earnings supplements to reduce the long-term dependence of welfare recipients on the state. The program is discussed and analysed in Card *et al.* (2001) and Connolly *et al.* (2001). Both of these papers consider the wage growth effects of the welfare program, and we discuss their results in the literature section below.

From an economic evaluation perspective, the SSP is a well-designed experiment, in that treatment and control groups are easily observed. However, certain parts of the design differ greatly from programs operating in the UK. These design issues lead to differences in the incentive structure of the three programs that make direct comparisons between the programs difficult. The SSP, which began in the mid-1990s, was available to single parents with 12 months of welfare history and who could find a job that averaged 30 hours per week over a one-month period. Individuals who did not satisfy the eligibility requirements did not, however, lose all welfare assistance, as, unlike FC/WFTC, program participation did not alter the income assistance level.

Supplement payments for individuals eligible for the SSP were based on earnings and were equal 50% of the difference between the participant's monthly earnings and a target earnings level in that period. The target earnings level, like the earnings threshold in FC/WFTC, was set so as to provide adequate income support while also creating positive incentives for work; see Connolly *et al.* (2001) for a full explanation of how target earnings were estimated for each individual in the treatment group. The rule for supplement payments implies an implicit taper of 50% against any increase in earnings, which could either result from an increase in hours, or searching for a job with a higher wage.

The major difference between SSP and the UK programs relates to the time frame during which the individuals could receive the credit. From the time of eligibility each participant has 12 months to take up the assistance. From that point they can only claim the benefit for a maximum of 36 consecutive months. This creates a significant incentive for respondents to obtain higher wages by working harder or searching for better-paid jobs, otherwise they face a significant fall in earnings at the end of 36-months. This differs greatly from the FC/WFTC programs, where an individual can receive the credit almost indefinitely[42].

4.2.3. General literature on wage growth

Why do wages rise over a career? Over the past few decades a significant body of economics literature has emerged that attempts to answer this question. In this section we summarise the results of this research and consider how an individual's welfare status will inform any priors we have about their wage growth. Broadly speaking, we can attribute wage growth to four sources: the accumulation of labour market experience, the accumulation of job tenure (seniority), movements up the wage distribution through job mobility, and the accumulation of human capital. However, the lack of adequate data to analyse such complex economic behaviour has lead to a considerable debate over the relative importance of each factors.

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42 An individual can come of FC/WFTC if their children are no longer counted as dependent children. The average duration on FC/WFTC ranges from 19 months (couples) to 22 months (lone mothers).

The standard neoclassical explanation for the fact that wages rise with tenure is that individuals receive firm specific training that is productive and thus their marginal product and wage rises over time. Since the firm's spending on training declines as workers age, the gap between the wage and the value of the marginal product declines. Several papers have attempted to estimate the size of the real rate of return to tenure. For the US, the estimates of the return to tenure range from about 0.6% per year (Abraham and Farber, 1987) to 2.5% per year (Williams, 1991; Brown, 1989; Topel, 1991). The average returns to experience have been estimated at around 2% per year (Williams, 1991).

The estimates vary considerably depending on whether or not the authors confront a number of econometric problems that arise when estimating wage change equations. The two main issues are discussed in detail in Altonji and Williams (1998). Firstly, permanent differences across individuals in wage rates are likely to be correlated with heterogeneity in mobility. Secondly, endogenous mobility decisions induce spurious correlations between labour market experience, job tenure and job match quality. Overcoming these problems using cross-sectional data is almost impossible, and the usual approach is to use panel data. Zangelidis (2002) uses panel data to look at the wage growth of a group of UK workers over time. He finds that the unobserved individual characteristics and job-match effects are correlated with both employer tenure and labour market experience, which leads to estimates of both these slope effects that are biased upwards. After eliminating the bias, through both instrumentation and differencing, the author finds an average return to *ten* years of tenure of just 7%.

Wage growth due to job mobility is closely related to the literature on job matching. The wage growth premium due to mobility can also be attributed to improvements in the match between a worker's skills and the requirements of a job. Gottschalk (2001) compares the wage gains of US workers who are consistently working for the same employer and those who change employers. In order to deal with the endogeneity that arises when individuals stay in jobs that are better matches, Gottschalk assumes a linear approximation of matching process – so the (log) wage increases linearly with tenure in the job. Gottschalk finds that mean wage growth between jobs is large in comparison to wage growth while working for the same employer. He notes that the results vary considerably by education, skills, and gender - male workers who are less educated having the largest wage growth premium.

4.2.4. Literature on the labour market effects of wage subsidy programs

Economic assessments of welfare programmes have tended to focus on the work incentive effects that operate via the programmes' impact on net incomes. Studies on the impact of the EITC in the US (see, for example, Eissa and Leibman, 1996) and FC/WFTC in the UK (see, for example, Blundell *et al* (2000) and Brewer *et al* (2003a)) have suggested that such policies are effective at encouraging individuals to work. However, exactly how effective FC/WFTC at increasing labour supply has been the subject of some debate. The evaluation of FC/WFTC suggests that the incentive effects on the labour supply of single parents (lone mothers) is counter balanced by the disincentive effects on the labour supply of couples (married women).

The studies that evaluate the labour market effects of in-work welfare programmes have paid little attention to the *quality* of the jobs that are obtained. Indeed, the effect that such policies might have on the structure of gross wages faced by individuals in the economy has been largely ignored[43]. This is despite the fact that one of the frequent

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[43] As noted, above, the exceptions are the papers by Card *et al.* (2001) and Connolly *et al.* (2001, 2002a). However, as we show, below, both these papers take very different approaches to analysing the wage effects of the Canadian SSP.

criticisms of wage-subsidy programmes is that they subsidise bad, poorly paid jobs with little or no prospects. In this paper we aim to fill the gap in the literature by considering how the incentive effects of a wage subsidy program would impact on the wages, and the growth in wages, of a given individual.

Blundell and Walker (2001) mentioned a variety of reasons as to why income support programmes might affect the wage levels, and their rate of growth, of programme participants. As outlined above, welfare transfers in in-work welfare programmes are typically means-tested, that is, they explicitly serve to subsidise low wage work. To the extent that low skilled labour is inelastically supplied, we would expect any increase in the supply of unskilled workers arising from the programme to be accompanied by a decrease in gross wage rates faced by *all* unskilled workers and the size of this decrease would depend on the elasticity of labour demand. The fear that the demand side of the market will capture some part of a subsidy to the supply-side has often been expressed but we can find no studies that have tried to estimate this effect.

The tax incidence literature gives mixed messages – work by Gruber (1997) exploited a natural experiment in Chile where a payroll tax was imposed on some firms but not others. The study showed that gross wages were unchanged; while work by Bingley and Lanot (2002) exploited differential local tax changes across Denmark and showed that around half of the change in tax induced change in net wages were compensated for by offsetting changes in gross wages[44]. In the UK it was partly because of a fear that the increased generosity of WFTC (compared to FC), and the change in its administration that would explicitly inform employers which workers were on WFTC, that resulted in the WFTC reform (October 1999) being introduced *after* the minimum wage (April 1999) was in place. It was hoped that the minimum wage would reduce the

44 See also Leigh (2003) for the incidence of EITC in the USA.

possibility of firms being able to appropriate some of the benefits of the subsidy to reduce their gross wage bill. The presence of the minimum wage further complicates the analysis we carry out below. When making comparisons of wage levels and wage growth we attempt to filter out individuals who are affected by the minimum wage, although, ultimately, we find it makes little difference to the overall results.

Welfare recipients could also, and independently, experience lower rates of wage growth if their returns to wage enhancing investments are reduced from being on welfare. The lower return is due to the fact that WFTC was means tested. For example, take an individual on WFTC who faced an average marginal income tax rate of 22% and paying national insurance at 10%. If this person was receiving the maximum amount of WFTC for which they were eligible, then their implicit tax rate is no different from someone who was not on WFTC, i.e. 32%. However, if this person was on the WFTC taper, then they lost 55 pence of every pound of WFTC for *net* earnings above the threshold. This means that they then faced an implicit tax rate of 69% (= 0.32 + 0.55*(1.00-0.32)). The taper off family credit was 70 pence of every pound of FC above the net earnings threshold, therefore the effective marginal tax rate for individuals on FC was 80% (= 0.32 + 0.70*(1.00-0.32)).

The existing empirical literature focuses on the impact of net constraints on short run (labour supply) behaviour – only Card *et al* (2001) and Gottschalk and Connolly (2001, 2002a) have considered the long run implications for wage growth. While we are used to thinking that low skilled workers enjoy little or no wage growth, recent evidence from the US suggests otherwise. Gladden and Taber (2000 and 2002) have shown that low skilled workers have a return to experience that is at least comparable with that of skilled workers. This implies that the common belief, by policy makers and economists, that low skilled workers are locked into dead end jobs in which wages stagnate, is not actually supported by US data. However, the models that are used to explain the wage profiles of (low skilled) workers tend to rely on the assumption of competitive labour markets, and in particular that workers are always paid their (gross) marginal products – i.e. the implicit assumptions underlying any empirical wage equation.

There are several reasons why the wages of workers may depart from their marginal products. For example, the productivity of workers may not be apparent when they are hired and there may be reasons for having delayed compensation that pays workers more than their marginal products once they have acquired significant human capital that is, at least partly, job-specific.

A second source of market imperfection comes from the credit market where it has been noted elsewhere, in the context of higher education, that it is difficult to borrow against human capital. Thus, low skilled individuals may be deterred from accepting jobs, which feature *general* training, even though that training might have a relatively large rate of return, because the starting wages are below their reservation wages. The papers by Card *et al.* and Connolly and Gottschalk do not consider the case where individuals can engage in human capital investment on-the-job. Some of the early research on training suggests that employees pay for their own general training in the form of lower wages and share the costs of firm specific training. Yet, according to the evidence in Booth and Bryan (2003) from the BHPS, most work-related training is viewed by its recipients as general, the majority is informal, the longest formal training courses are for induction purposes, and the vast majority of formal training takes place either at the workplace or at the employer's training centre. Training may not be just firm specific, but also industry specific. Acemoglu and Pischke (1998), find that a significant amount of training is indeed industry specific rather than firm specific, and that this would also feature some sharing of the costs.

The training literature does therefore suggest that workers contribute to the costs of any training in the form of lower wages than would otherwise be the case. Furthermore, given credit market constrains, the role of FC/WFTC might have been to encourage low skilled workers to accept offers of jobs with very low starting wages and enable them to enjoy the resulting wage growth associated with the accompanying on-the-job training[45]. Therefore, the decision by FC/WFTC participants to train, and hence the subsequent wage growth, would depend on a present value calculation.

How this calculation would be affected by a wage subsidy depends on the nature of the subsidy. Suppose the subsidy were means-tested and one were close to the end of the taper so that eligibility is almost exhausted. Then we might expect the future returns to training to be largely unaffected by the subsidy, since it is about to expire. However, the subsidy would affect the net costs of training since the training would lower the wage and this would be partly offset by the subsidy. If the subsidy were not means tested at all and if it were linear (i.e. the subsidy rate was independent of income) then the subsidy would reduce the benefits and costs by the same amount and we would not expect an effect on training and hence on wage growth of recipients compared to non-recipients.

The FC/WFTC subsidy is complicated by the maximum. As shown in **Figure 4.1**, there is a range of income were individuals receive a maximum subsidy and so the marginal subsidy is zero, while for earnings above this point the marginal subsidy is positive. This is the case where the programme reduces the benefits and does not

45 The theoretical arguments are not, however, quite this simple in a world where labour supply is itself a choice variable. Suppose WFTC encouraged individuals to work longer hours when their wages had grown sufficiently that they were no longer entitled, then this would increase the utilisation rate of human capital and thereby increase the return to it.

reduce the costs and so we would expect less training to occur and smaller wage growth. In contrast, for higher earning individuals being close to the end of the taper generates the opposite incentive effects – FC/WFTC then reduces costs but might have little effect on benefits and we would expect more training and higher wage growth for recipients. In the empirical section, we use a model of the UK tax benefit system to estimate the two kink-points in the weekly FC/WFTC budget constraint. The first kink is the gross earnings at which individuals, given their family characteristics and other household income, go from being on the maximum to being on the taper. The second kink is the gross earnings at which individuals run off the taper and become ineligible for FC/WFTC – we call this second kink point the FC/WFTC runoff point.

Unlike EITC, FC/WFTC was means tested against household income and so many secondary workers whose partners are in work might have been expected to be closer to the point where eligibility would be about to expire than to the maximum entitlement[46]. Thus, we would expect positive wage growth effects to be more likely for individuals with working partners present (two-earner couples) than for single parents.

A final complication was the implicit time limited nature of FC/WFTC. Eligibility depended on having a dependent child so that as children age the household came closer to the point where the adverse impact of the programme on future benefits of training fell to zero and the effect was therefore positive. With this in mind, in the empirical section we use age of the youngest child in the household to instrument FC/WFTC take-up which we assume is endogenous in the wage growth equation.

46 Administrative data shows that, in November 2002, the average award for two earner couples was approximately £59 compared to £86 for single earner households.

As noted, above, both the Card *et al.* and Connolly and Gottschalk papers consider the implications of a simple wage subsidy for job search. The paper by Card *et al.* argues that one of the features of the Canadian SSP was that it selected individuals with relatively *flatter* wage profiles[47]. The means tested structure of FC/WFTC makes its implications for job search slightly different. In particular, given that job search is also an investment decision, similar considerations will apply to job search as to training. If costs and benefits are similarly affected by the subsidy then there will be no impact. The costs of on-the-job search might be the forgone leisure while searching whose value, at the margin, is determined by the net wage and so is affected by the subsidy.

Following on from the discussion of the literature on wage-growth and welfare receipt, we address some of the testable hypotheses (drawn from Card *et al.* (2001) and Connolly and Gottschalk (2002a) and from considerations of training) about the relative wage-growth of FC/WFTC recipients and non-recipients. The argument in Card *et al* would suggest lower within-job wage growth amongst FC/WFTC recipients, and Connolly and Gottschalk suggest lower job-to-job growth for the same group[48]. Our own arguments are less pessimistic and suggest positive effects on wage growth associated with those whose eligibility is either small and short-lived, because earnings are close to the point where entitlement falls to zero, or because eligibility is expected to be short-lived due to the youngest child approaching independence. This could be due to job search considerations or training arising from the nonlinear form of the means tested wage subsidy.

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47 The theory that FC/WFTC may have *selected* individuals who, ex ante, had flatter wage profiles is addressed in Chapter 4.

48 In fact, Connolly *et al.* (2002a) find no significant difference in the job-to-job wage growth for the treatment and control groups. Also, Card *et al.* find that recipients of the wage subsidy had wage growth in line with that of similar individuals over the period.

In the next section we present the data and tabulate some of the evidence to address each of the above ideas. The sections that follow then introduce more complicated multivariate analysis that allows us to formally test the hypotheses.

4.3. Data

The analysis in this paper is based upon the five-quarter rolling panel of the United Kingdom Quarterly Labour Force Survey (LFS). The LFS is a continuous, household survey, which provides a range of data on labour market statistics, as well as related topics such as training, qualifications, income and disability[49]. The survey has a panel design where each sampled address is interviewed for five waves. Interviews take place at three-month intervals with the fifth interview taking place a year after the first. During each quarter, interviews take place at about 59,000 addresses with about 138,000 respondents, representing a response rate of around 80%. In any one quarter there are five different cohorts, each from a different wave of the panel, that is, approximately 11,800 addresses in each quarter can be attributed to wave one, two, three, four or five.

Prior to Spring 1997, the LFS only asked respondents about their earnings in the first wave of the panel. After this point individuals were also asked their wages in the fifth wave. This allows us to observe wage *growth* over a twelve-month period and using data from spring 1997 to Winter 2002 we construct a data set that contains information on twenty cohorts of individuals. Dropping the self-employed and those with missing data for crucial variables we are left with a total of 51,074 in the male sample – consisting of 39,908 married or cohabiting of which 21,512 have dependent children, and 11,166

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49 The quarterly LFS is based on seasonal quarters, that is, Spring (March – May), Summer (June – August), Autumn (September – November) and Winter (December – February). A full description of the data set, along with sampling and survey techniques can be found at http://www.statistics.gov.uk/STATBASE/Source.asp?vlnk=358&More=Y.

single men. We drop the small number of single-father families, which is too small for analysis. The female sample consists of 54,968 observations – 40,475 are couples (married and cohabiting) of which 19,934 have dependent children, and 14,493 are single-women households (4,852 with dependent children, that is lone mothers). The numbers in the table are for a balanced panel, that is, we drop those individuals who we do not observe in both wave one and wave five. The details of how the sample is constructed are given in the appendix to this chapter [50].

The fact that the LFS provides us with five-quarters of data on a panel of individuals means that we are able to measure job tenure, job changes (both quits and layoffs) as well as wage growth. This is important, as it is well known in the literature that job tenure information in other datasets have been particularly unreliable; see Altonji and Williams (1998). In the LFS, further questions on whether or not individuals change jobs between waves allow us to remove those individuals who we believe are reporting inaccurate job tenure data[51].

The main features of the wage growth data are presented in the figures below. The figures show cross plots of wage levels and wage growth for men and women based on two different definitions of wages. Wage growth can be defined with reference to hourly pay, which is recorded in the data for a subset of individuals who report earnings ('reported hourly pay'), or as average hourly earnings derived from usual weekly earnings and weekly hours of work ('earnings per hour worked'). The figures below graph the wage data for these two alternative definitions for the three main groups of

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50 The LFS is a household survey; we would therefore expect the number of couples in the female sample (40,475) to be equal to the number of couples in the male sample (39,908). However, the discrepancy arises here because the panel is balanced separately for both men and women, that is we keep *individuals* who are in the survey in both waves 1 and 5, employees in both waves and who report hourly earnings in both waves.

51 In the few cases where it is obvious that an individual has misreported their job tenure, we drop the observations.

interest – married fathers, married mothers and lone mothers[52]. While the average hourly wage formed by dividing earnings by hours of work has larger variance than the hourly pay they are clearly closely correlated[53]. Measurement error in hours of work may help explain why the ratio has higher variance than the direct hourly pay measure. **Figure 4.3**, **Figure 4.5** and **Figure 4.7** each show the scatter of changes in the average earnings per hour worked against changes in the direct measure of average hourly pay for each of the three groups, married/cohabiting dads, married cohabiting mothers, and single mums we look at. Once again, we find that the variance in earnings per hour worked is clearly higher, however the strong correlation between the two variables remains[54]. Overtime hours will also contribute to a difference in the two measures – this is because for those individuals who do not report *actual* hours in the week worked, we use the proxy variable 'usual hours worked', which may not correspond exactly to the earnings in that week.

Given that there are no strong economic reasons for choosing one variable over the other, and the fact that the variables are closely correlated, hereafter we use the data on directly recorded hourly pay – although we would note that the substantive findings in the paper are not affected by this choice. It should be borne in mind, however, that both variables clearly measure different things – hourly pay may be a better indicator of household welfare (since its changes are independent of changes in recorded hours of

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52 We have dropped the lone parents who are men because they are such a small sample.

53 Simple regressions, for samples where they are both recorded, of one against the other have a slope of 0.83 (*standard error*, 0.002) and an intercept of 0.36 (*standard error*, 0.005) with an R-squared of 0.76 for the fathers, and a slope of 0.82 (*standard error*, 0.002) and an intercept of 0.31 (*standard error*, 0.003) with an R-squared of 0.77 for the mothers. For more detailed comparisons see Skinner *et al.* (2002).

54 Although we note that the variance in the average level (and growth) of earnings per hour worked is usually higher, for none of the three groups above is the estimate significantly different from the average value given by the hourly pay variable.

work), while average earnings per hours worked changes because both hours and earnings change.

4.3.1. Data used to construct the tax benefit model

In the next section we analyse the evidence on the average wage growth of individuals on FC/WFTC. We begin with a comparison of the summary statistics for different groups of individuals, and then introduce more structural multivariate analysis to see whether the results are robust. A key component of this analysis involves estimating the weekly FC/WFTC, thus allowing us to estimate eligibility and take up rates, as well as the maximum-taper kink point and the FC/WFTC run-off point[55], that is, the level of earnings required to take an individual off FC/WFTC. Furthermore, in order to make use of the 'natural experiment' that the FC-WFTC reform induces, we need to estimate FC *and* WFTC eligibility pre- and post-reform. In order to estimate the FC/WFTC weekly amount, which is based on *net household income*, we have written a tax benefit model. The model estimates the net earnings and benefits for the respondent, and where appropriate, the spouse. We first estimate the income tax payable, followed by national insurance, unemployment benefit, and finally FC or WFTC. The program uses tax parameters - rates, thresholds, etc - from the Inland Revenue for each financial year in the sample (1997 – 2002).

[55] From Winter 1992 – Winter 1999, the LFS asked respondents directly about the amount of Family Credit received. We use this data to crosscheck the output of our tax benefit model.

Figure 4.2 **Reported hourly pay against earnings per hour worked: Married/cohabiting fathers in the LFS 1997 - 2003**

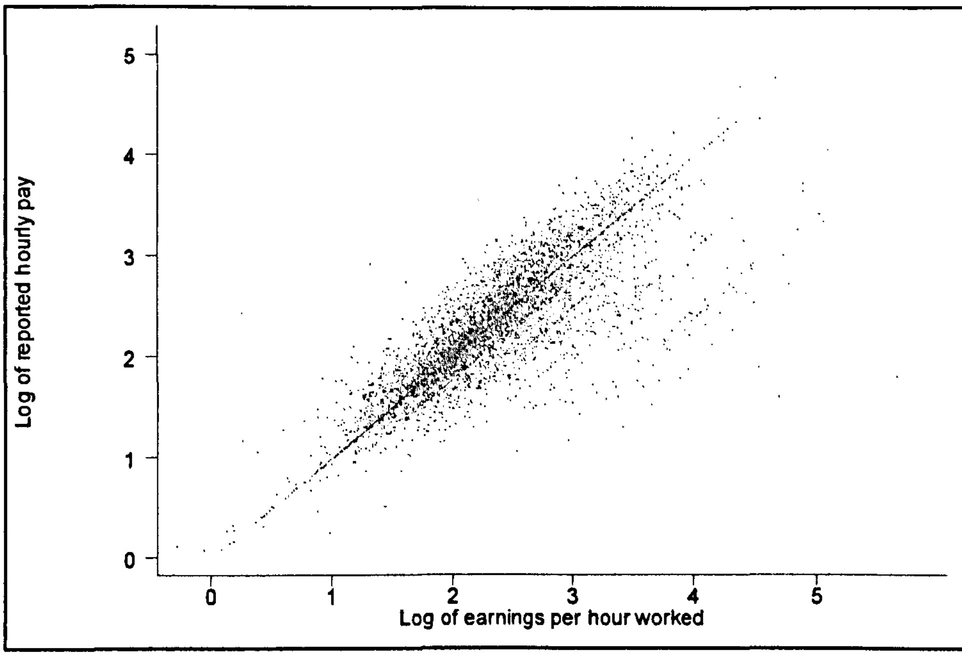
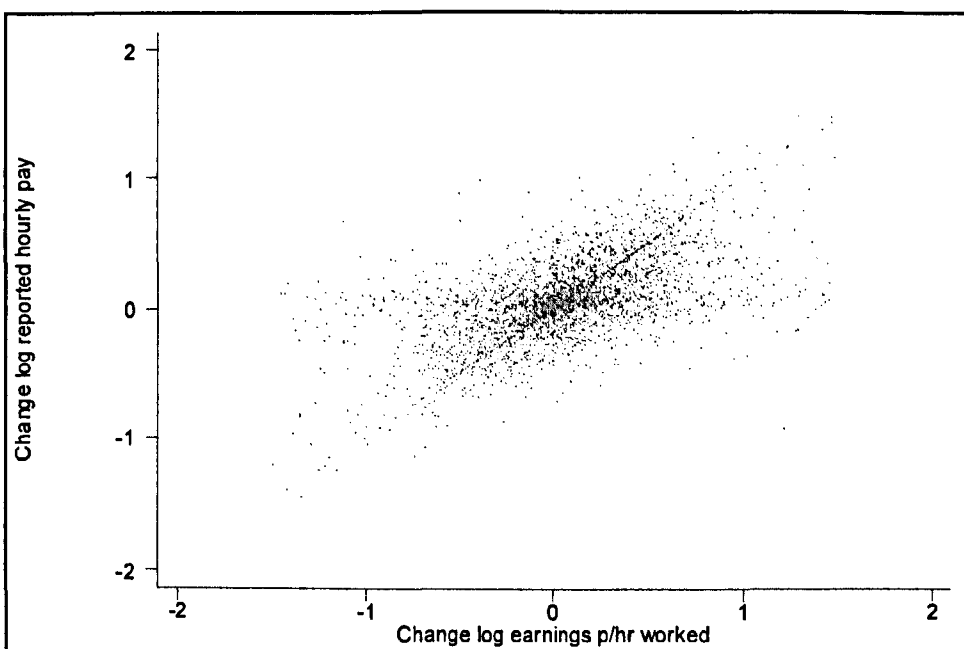


Figure 4.3 **Average annual change in earnings per hour worked against annual change in reported hourly pay: Married/cohabiting fathers in the LFS 1997 – 2003**



Notes: The growth in earnings is measured over a 12-month period. All earnings (growth and levels) are real, and have been deflated to January 2000 prices using the monthly RPI.

Figure 4.4 **Reported hourly pay against earnings per hour worked: Married/cohabiting mothers in the LFS 1997 - 2003**

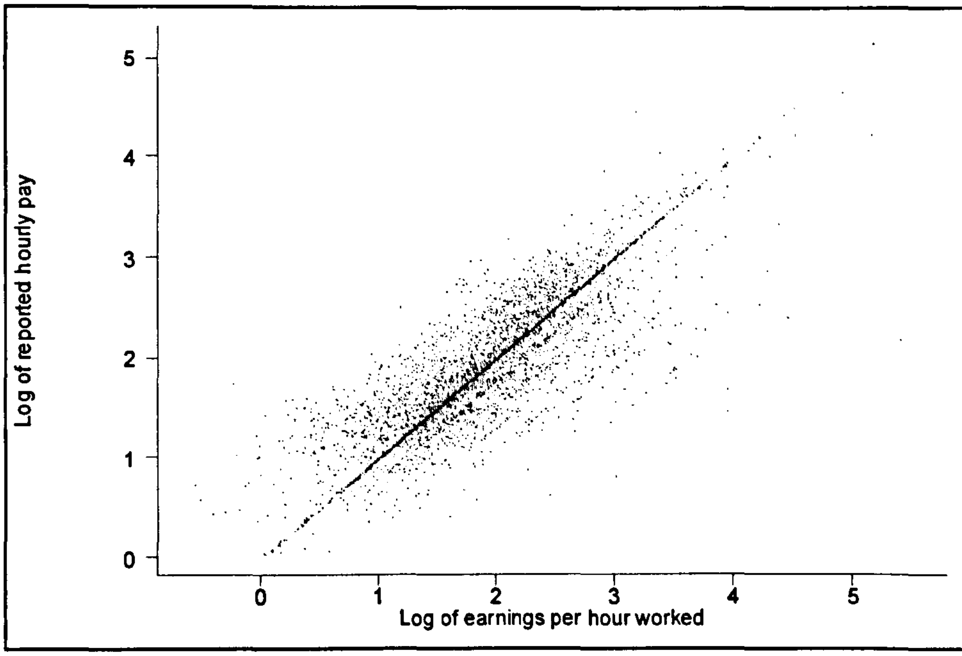
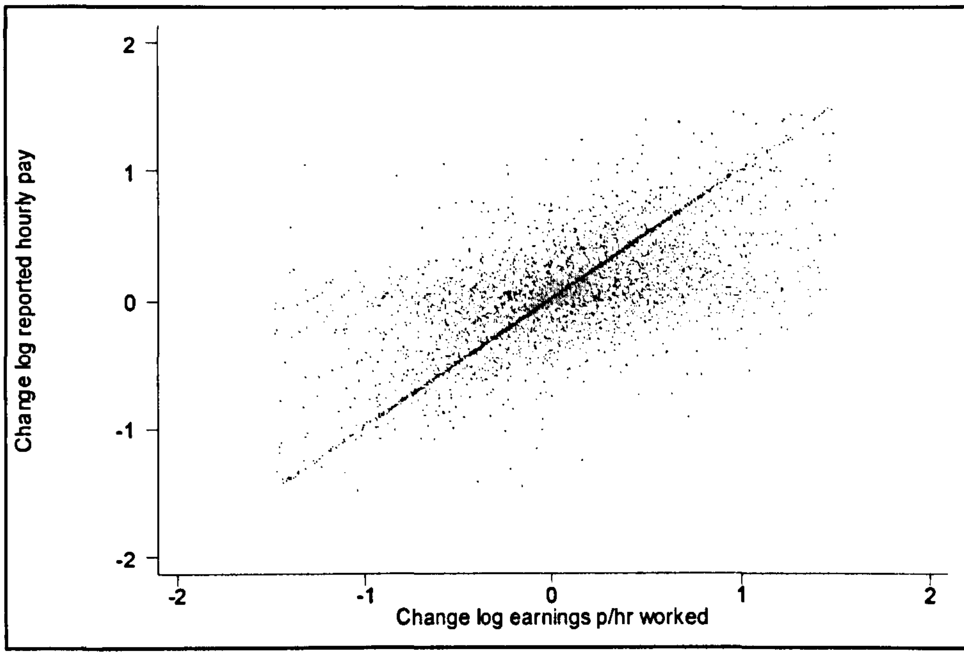


Figure 4.5 **Average annual change in earnings per hour worked against annual change in reported hourly pay: Married/cohabiting mothers in the LFS 1997 – 2003**



Notes: See notes for Figure 4.3

Figure 4.6 **Reported hourly pay against earnings per hour worked: Single mothers in the LFS 1997 - 2003**

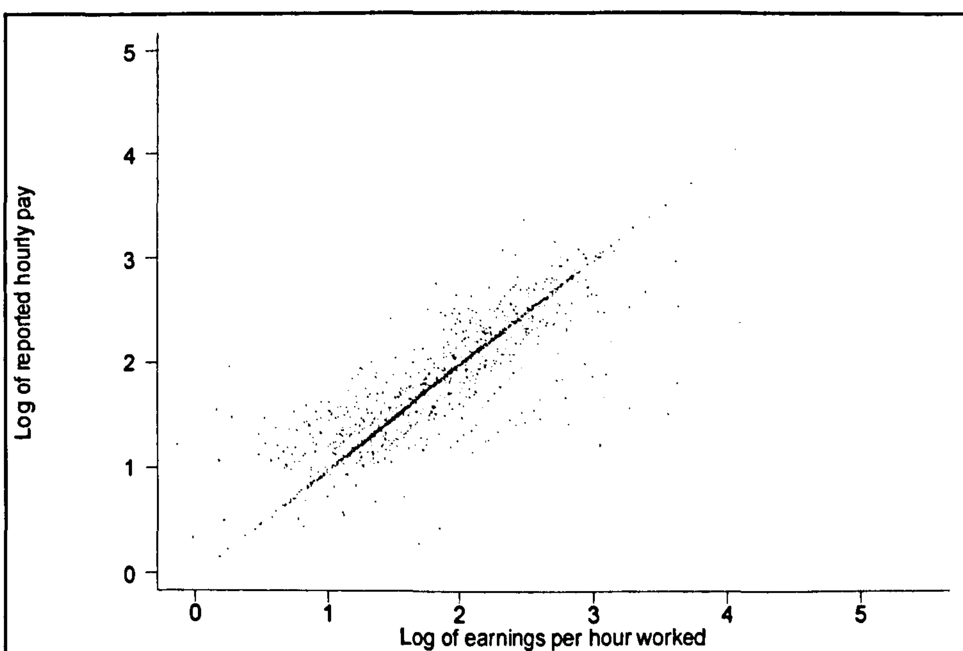
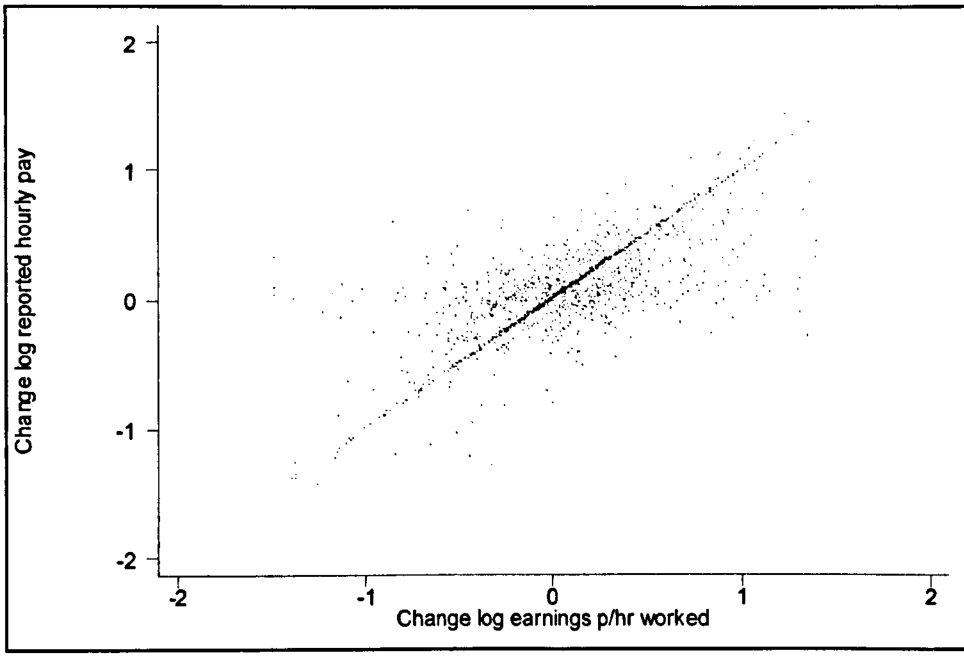


Figure 4.7 Average annual change in earnings per hour worked against annual change in reported hourly pay: Single mothers in the LFS 1997 – 2003



Notes: See notes for Figures 4.3

4.4. Results for the LFS

The LFS is a panel which re-interviews individuals and families every 13 weeks. We are able to track FC/WFTC status over each of the five waves of the survey. **Table 4.1** shows the breakdown of the data by FC/WFTC status. Around 18% of the households with children in the data were single mothers. Lone mothers are much more stable recipients with more than a third (34%) of lone mothers receiving the credit throughout waves 1 to 5, this represents a 'staying-on' rate over the 12-month period of 74.2% (1,565/(1,565+544)). The staying on rate for married mothers and married fathers is lower at 33.1% and 49.5% respectively.

Table 4.1 FC/WFTC receipt for married couples and lone mothers

	Married dads		Married mothers		Lone mothers	
	Frequency	%	Frequency	%	Frequency	%
Always on	868	4.1%	432	2.2%	1,565	34.0%
Never on	18,674	87.2%	17,588	89.2%	1,961	42.7%
Off-on	1,000	4.7%	826	4.2%	527	11.5%
On-off	884	4.1%	873	4.4%	544	11.8%
Staying-on rate		49.5%		33.1%		74.2%
	21,426		19,719		4,597	

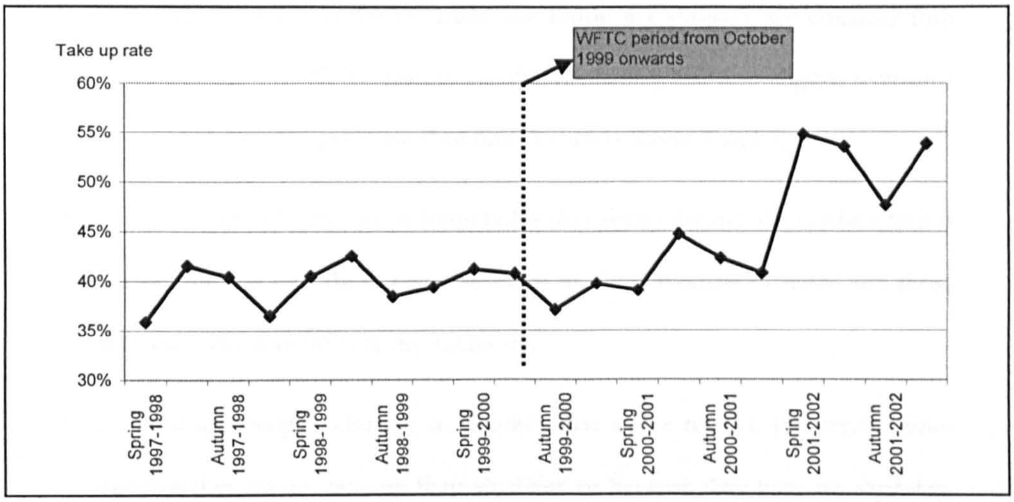
Notes: Data from the LFS 1997 – 2003. The totals in the table do not correspond exactly to those in the previous table for three reasons: firstly, because not all individuals answer the questions about receipt of FC/WFTC benefits; secondly, we drop individuals who make more than one transition over the 12 month period, i.e. on-off-on, or off-on-off, etc, as such observations are more likely to be recording errors than actual transitions; and thirdly, a number of households (76) record receipt of FC/WFTC but the household dataset shows no dependent children in the household, we therefore drop these observations.

It is important to remember that the sample is a balanced panel of men and women, who are working *and* report hourly earnings in *both* waves 1 and 5 (this is despite the fact that receipt for a married mother could be due to the partner working). This explains all of the observed differences in sample size between married fathers and mothers. The appendix shows the sample size and proportions when we do not condition on working and reporting hourly earnings in waves 1 and 5 – the table shows that the proportions for married fathers and married mothers in these samples are almost identical, as we would expect.

The FC/WFTC take-up rate is shown in **Figure 4.8**. The take-up rate is estimated using the tax benefit model described in above. The take-up rate is defined as the number receiving and entitled divided by the number entitled. Brewer *et* al (2003a, 2003b) have noted that the LFS will typically under-record take-up relative to both the

Family Resources Survey (FRS) and the sample used by the Inland Revenue in the quarterly statistics publications. This is partly because the LFS has no information on assets and so overstates the numbers entitled. However Brewer *et al.* have made some comparisons with the FRS, and their results suggest that the under-recording of take-up is not a significant source of error. In fact, the main reason why our estimates of take-up depart from official statistics is because we cannot include pipeline cases (who have claimed but not yet received) and we drop a number of non-entitled (according to our tax-benefit model) recipients. The fact that the tax benefit model classifies some families as 'not entitled', when the LFS record them as being receiving tax credits due to several factors. It is partly due to the reasons outlined above, i.e. pipeline cases and missing information on assets, and partly because of the way in which the Inland Revenue evaluated eligibility for FC/WFTC. As we noted in section 2, eligibility for FC/WFTC was evaluated every six months. The period during which families are observed in the LFS will not always coincide with the period when they were judged eligible or ineligible for FC/WFTC. This will give rise to some of the discrepancies we observe in the data. The dotted line in **Figure 4.8** marks the advent of WFTC and there was a large increase in take-up in LFS shortly after the reform.

Figure 4.8 Take-up rate FC/WFTC 1997 – 2003



Notes: LFS (1997 – 2003). The take up rate is estimated using the tax benefit model described in section 3, and is defined as the proportion of eligible households who take up the tax credit.

4.4.1. Wage Growth by FC/WFTC History

Table 4.2 shows the mean percentage changes in the real wage between wave 1 and wave 5 broken down by FC/WFTC status. As noted, above, we use the hourly wage that is the directly observed hourly pay variable, similar findings apply for our constructed average hourly earnings.

The FC/WFTC history variable describes each individual's FC/WFTC status for all waves. Using the rules for eligibility for FC/WFTC, based on incomes and the number of dependent children in a household, we are able to calculate the maximum amount for which a household is eligible[56]. The introduction of WFTC was phased in from October 1999, so between October 1999 and Spring 2000 it is not possible to identify whether these individuals in the LFS are in receipt of FC or WFTC. Here we assume all such individuals post cohort 11 are on FC in wave 1 and we have checked that he

56 Unfortunately the LFS does not include questions regarding the amount of savings or childcare expenditure in a household. We assume that savings (and childcare) are equal to zero when calculating the maximum amount for which a household is eligible.

results in this section are not sensitive to whether we calculate the maximum entitlement using FC rules or WFTC rules. As **Table 4.1** showed, we consider four possible states for the FC/WFTC history variable (excluding the non-eligible recipients and those whose status changes more than once between waves 1 and 5):

- *Always on* - people who are in households that always receive the credit which is further divided into those receiving close to the maximum or more and those receiving less than 90% of the maximum;
- *Never-on* are people who are in families that never receive the credit either because they do not take-up their eligibility or because they have no eligibility. This group of individuals is further divided in to *eligible but never take-up*, and *ineligible*[57];
- *Off/on* are people who are in families that make a single off/on transition between waves 1 and 5; and
- *On/off* are people who make a single on/off transition between waves 1 and 5.

The mean wage growth presented for each of the groups in **Table 4.2** shows several interesting results, some of which are consistent with our priors the previous discussion, and others which are not. Firstly, the group that move from being on either FC or WFTC to not being on it generally experience relatively higher wage growth across almost all groups pre- and post-reform. This is not surprising, given that this is a group that ceases to be eligible *because* of their relatively higher wage growth. This is clearly the group of individuals who are close to the run-off point in wave 1. Therefore, in line with the discussion, above, on the cost and benefits of training or job search, we

57 The LFS only records household income for wave 1 and wave 5, hence we are only able to estimate eligibility and take-up for these two waves. In **Table 4.2**, where we sub-divide the *never-on* group into eligible and ineligible we use the estimate of eligibility in Wave 1. The implicit assumption is that eligibility in wave 1 is a reasonable proxy for eligibility in the other waves of the survey.

might expect this group of individuals to take up more (general) training (and hence get higher wages) –because the costs (wage-sacrifice) are subsidised, but they get more of the benefit stream because their entitlement is already close to the run-off point. We test this hypothesis formally below, estimating the probability of this group taking up (general) training, controlling for how close to run off point each individual is as well as the age of youngest dependent child in the household.

In contrast to the group that move from off FC/WFTC, the individuals that move on to FC/WFTC tend to have lower wage growth. We do not read too much into this result as, apart from the fact that the standard errors are relatively large (for the pre-reform group in particular), clearly part of the reason they fall into eligibility for FC/WFTC is *because* they have lower wage growth.

The non-entitled groups are, of course, higher wage workers and they typically exhibit modest levels of wage growth, while the non-take-up groups are lower wage workers and these typically exhibit higher wage growth perhaps because they are younger, have lower tenure, lower education, etc. Alternatively, this latter group may fail to take-up because they expect to be entitled for a short period either because of their anticipated high wage growth or because their wage levels are not amongst the lowest of recipients and they are close to the point where their entitlement to FC/WFTC would, in any case, be exhausted. They may also be entitled for a relatively shorter period if their children are closer to becoming independent than the entitled group who do take up the credit. A comparison of the mean age of the youngest dependent child in the family for the two groups confirms that this is indeed the case – that is, some of the eligible, non-take-up group will not bother with the credit because their children are close to becoming independent and it is therefore not worth the effort. In the sample of single mothers, pre-reform, the mean age of the youngest dependent child in families who are eligible but do not take-up is 10.54 (standard error 0.3190), compared with a mean age for eligible families who do take up of 8.98 (standard error 0.2280). In the WFTC period, the same averages are 11.48 (0.2411) and 9.16 (0.1482). When we compare the difference in mean ages for married mothers and married fathers, we observe the same significant difference, although it is not as large – the full set of mean comparisons are shown in **Table A4.16** in the appendix.

Table 4.2 also shows the mean real wage growth for individuals on FC/WFTC for all five waves of the survey. The table shows the wage growth for individuals who were on the maximum (greater than or equal to 90% of the maximum) and those receiving less than the maximum (less than 90% of the maximum). This categorisation represents our crude attempt to capture the different incentives faced by the two groups of FC/WFTC recipients – that is, individuals on the maximum face a period of no 'tax' on their wage growth, and then, once they come on to the taper, a relatively longer period when their wage growth is taxed. In terms of their effect on the incentives to take part in wage enhancing activities (such as training and job search), these two forces are opposing, so it is difficult to predict whether we will observe relatively higher or lower wage growth for individuals on the maximum. The figures in **Table 4.2** show that individuals on the max have higher mean wage growth, in both the FC and WFTC periods, relative to individuals on the taper. This would seem to imply that the net incentives for individuals on the max to take part in wage enhancing activities are positive. However, we also know that the group on the maximum FC/WFTC are the lowest wage group and we would expect them to be low tenure, low experience and hence high wage growth. We would also expect the eligible but no take-up group to be low wage workers, and hence have relatively higher wage growth, and the figures in the table confirm this also. Interestingly, in the FC period, the no take up group have higher mean wage growth than individuals on the maximum –

perhaps indicating that the prospect of the taper has some effect – but for women in the WFTC period, this pattern is reversed.

It is also instructive to compare across periods. In terms of the different incentives facing (potential) FC/WFTC recipients, one of the significant changes due to the reform was the reduction in the taper from 70% for FC, to 55% for WFTC. This reduces the 'tax' on wage growth, and hence we would expect some increase in the wage growth for people on the maximum. For married/cohabiting men and women, the differences in the wage growth for the two groups are not very different, and certainly not significantly different. For single mothers, however, there is a significant increase in the wage growth for women on the maximum, and the wage growth now significantly exceeds that of single mothers on the taper.

We noted, above, that individuals on the maximum, while gaining the full benefit of the wage subsidy, also, for a period at least, do not pay the associated 'tax' on wage growth because they are not on the taper. Thus, for a certain period the incentive effects of the wage subsidy are greater than zero. However, once they come off the maximum, individuals face a relatively long period on the taper. One reason for the higher observed wage growth observed for those on the maximum is that these individuals could have a high discount rate - that is, they place a greater emphasis on wage gains now, while they are not on the taper, and they are not so concerned about the fact that higher wage growth also brings them closer to the point where they move off the maximum and onto the taper. It makes sense, therefore, to test whether there is a correlation between wage growth and the distance between an individual's current earnings and the threshold earnings that moves them from being on the maximum to being on the taper.

Figure 4.9 and **Figure 4.10** plot the growth in wages against the ratio of current earnings to the threshold level of earnings required to move an individual from being on the maximum to being on the taper[58]. The threshold level of earnings is calculated using the eligibility rules for FC/WFTC and tax benefit model described in the data section. **Figure 4.9** is drawn for single mothers on FC and receiving the maximum amount; **Figure 4.10** is drawn for single mothers on WFTC receiving the maximum. The figures are drawn for single mothers only, as the comparison for married/coupled partners is complicated by the presence of the spouse or partner's earned income. **Figure 4.9** shows, as expected, that there is a strong negative correlation between the wage growth of individuals on the maximum and how 'close' they are to coming off the maximum and onto the FC taper. The slope of the line through the scatter in **Figure 4.9** is -0.3133 (standard error 0.0774). **Figure 4.10,** for WFTC recipients on the maximum, also shows a negative correlation, though it is weaker (-0.1126) and insignificant (standard error 0.1063). The weaker relationship for WFTC recipients on the maximum might be explained by the fact that some of these individuals only came onto the maximum *after* the reform, and would previously have been on the FC taper. Thus, we observe more bunching in **Figure 4.10** to the right of the figure, close to a ratio of 1, than we do in **Figure 4.9** – also, the taper under WFTC was significantly flatter than that on FC (55% versus 70%), which would also partly explain the weaker correlation.

We can also estimate the length of time it will take for a given individual to come off the maximum and onto the taper. **Table 4.3** shows the mean number of years for single mothers to come off the maximum onto the taper. The number of years (Y) is

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58 In order to avoid problems associated with reduced sample size, the data in **Figure 4.9** and **Figure 4.10,** and **Table 4.3** refers to individuals on FC/WFTC in at least wave 1. The sample is not split into *Always on*, *On-off*, *etc.*

estimated as $Y=\ln(T/E)/\ln(1+g)$, where T the threshold level of earnings at which an individual comes off the maximum onto the taper; E are current weekly earnings; and g is the current growth rate of earnings (we use annual growth in the real wage). The estimate variable Y is purely a static measure of the number of years it would take a given individual to come off the maximum, it assumes constant growth rates, no changes in FC/WFTC eligibility rules, and no change in family circumstances, i.e. number and age of dependent children. The estimated number of years is calculated for the FC and WFTC periods separately. The first row of the table (FC>0*MAX) shows the mean years for a single mother receiving the maximum FC amount to come off the maximum. The estimates imply that a single mother, receiving the maximum FC amount, with average earnings growth, could expect to remain on the maximum for about 3.5 years – it should be the same in both the FC and WFTC periods, and it is. This is not a particularly short time period, and it is therefore not surprising that we would observe individuals on the maximum with relatively higher wage growth – the higher wages remain 'untaxed' by the taper for about 3.5 years. The second row (WFTC>0*MAX) in **Table 4.3** shows the number of years that an individual receiving the maximum amount of credit can expect to remain on the maximum, given their current earnings growth. Given the increased generosity of WFTC, we might have expected the number of years to be greater than that for FC>0*MAX (row 1), however, this need not necessarily be the case, as the sample is different. WFTC>0*MAX contains individuals who would not have been in the FC>0*MAX sample. The final two rows of the table compare like-for-like individuals. The third row (FC>0*MAX & WFTC>0*MAX, FC (Y)) shows the mean number of years for single mothers receiving the maximum FC amount (and who were eligible for *both* the FC and WFTC maximum amounts). The fourth row (FC>0*MAX & WFTC>0*MAX, WFTC (Y)) shows the same figure for single mothers receiving the maximum WFTC amount. The table shows that the increased generosity of WFTC means an increase in years on the maximum of about 1 year, although, the variance in the mean is large and the difference is not significant.

Table 4.2 Wage (hourly pay) growth (% change) by FC and WFTC receipt status

	Married Men		Married Women		Lone Mothers	
FC Status	Mean	Std Err	Mean	Std Err	Mean	Std Err
Always on						
Receipt<0.90 of max	7.90%	*0.0219*	6.45%	*0.0415*	5.41%	*0.0176*
Receipt>0.90 of max	11.66%	*0.0354*	7.12%	*0.0395*	7.76%	*0.0158*
Never on						
Non-takeup	15.06%	*0.0147*	9.07%	*0.0094*	9.20%	*0.0144*
Not entitled	5.04%	*0.0037*	5.01%	*0.0050*	6.41%	*0.0122*
Off/on	-0.23%	*0.0285*	-4.48%	*0.0441*	3.65%	*0.0352*
On/off	5.78%	*0.0148*	6.01%	*0.0172*	12.98%	*0.0348*
WFTC Status						
Always on						
Receipt<0.90 of max	7.38%	*0.0110*	4.40%	*0.0464*	3.06%	*0.0132*
Receipt>0.90 of max	7.42%	*0.0222*	12.57%	*0.0335*	15.39%	*0.0165*
Never on						
Non-takeup	11.00%	*0.0078*	8.92%	*0.0068*	9.38%	*0.0138*
Not entitled	5.32%	*0.0028*	4.83%	*0.0036*	3.33%	*0.0110*
Off/on	3.24%	*0.0104*	3.83%	*0.0145*	7.77%	*0.0145*
On/off	9.88%	*0.0145*	7.99%	*0.0213*	7.91%	*0.0389*

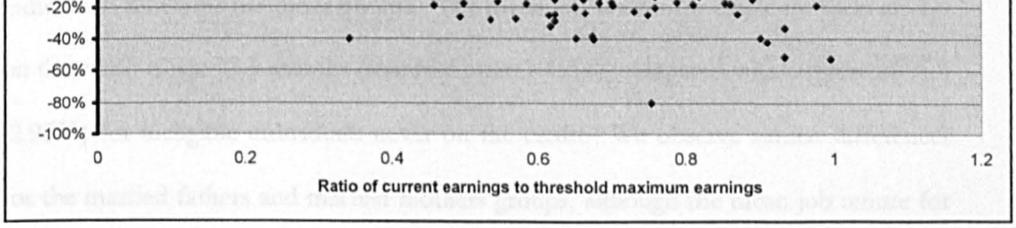
Notes: LFS (1997 – 2003). Wage here is defined as reported hourly pay. All growth is measured as real wage growth. Wages are deflated to January 2000 using the monthly RPI. Standard errors in italics.

Table 4.3 **Single mothers receiving the maximum FC/WFTC, time taken to come onto the taper, given current wage growth, children and earnings**

Single mothers	FC Period		WFTC Period	
Receipt	Years	Std Err	Years	Std Err
FC>0*MAX	3.44	*0.18*	3.69 [a]	*0.46*
WFTC>0*MAX	3.28 [a]	*0.16*	3.58	*0.50*
FC>0*MAX & WFTC>0*MAX, FC (Y)	3.44 [a]	*0.18*	3.30 [a]	*0.48*
FC>0*MAX & WFTC>0*MAX, WFTC (Y)	4.26 [a]	*0.22*	4.51 [a]	*0.60*

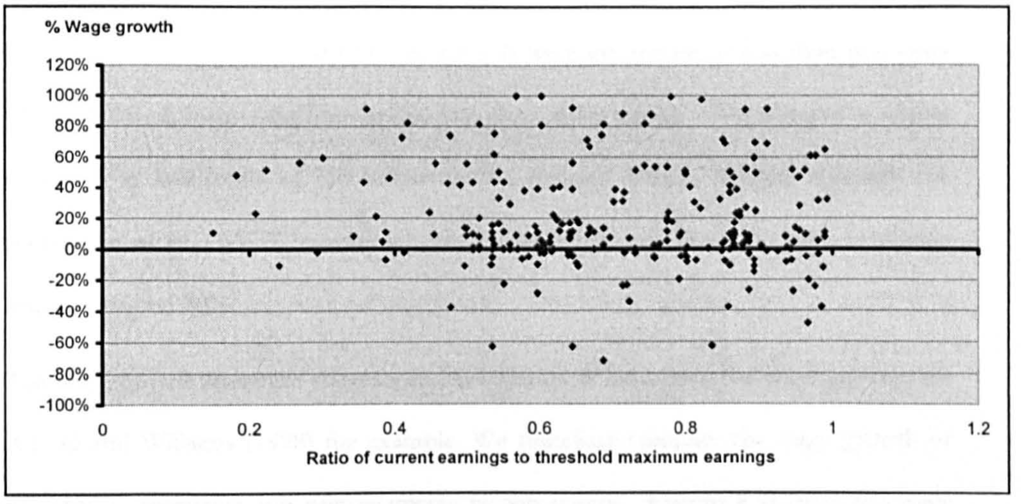
Notes: LFS, 1997 – 2003. The number of years (Y) required to come off the maximum is calculated as Y=ln(T/E)/ln(1+g), where T is the threshold level of weekly earnings to come off the maximum onto the taper, given the number of dependent children in the household; *E* is the current level of weekly earnings and *g* is the growth rate of earnings (proxied for using the current growth in real wages). The number of years calculated is purely static in that it does not control for changes in hours or age(s) and number of dependent kids. (a) Obviously we do not observe the amount of WFTC (FC) received by a single mother in the FC (WFTC) periods. These figures are calculated using the tax benefit model described in the data section.

Figure 4.9 **The relationship between real wage growth and the ratio of current earnings to the level of earnings that moves individuals on the maximum onto the taper – single mothers only, FC period**



Notes: LFS 1997 – 2003. Single mothers only, on FC in wave 1 of the survey. The slope of the regression line through the scatter plot is -0.3133 (standard error 0.0774).

Figure 4.10 **The relationship between real wage growth and the ratio of current earnings to the level of earnings that moves individuals on the maximum onto the taper – single mothers only, WFTC period**



Notes: LFS 1997 – 2003. Single mothers only, on WFTC in wave 1 of the survey. The slope of the regression line through the scatter plot is -0.1126 (standard error 0.1063).

4.4.2. Wage Growth by job tenure and FC/WFTC History

Individuals on FC/WFTC have significantly lower levels of average job tenure than almost any other group. The mean job tenure for each of the three samples by FC/WFTC history is shown in **Table 4.4**. The table also shows the mean job tenure for a 'snapshot' of individuals – whether or not they were receiving FC/WFTC in wave 1. The mean job tenure for individuals on FC/WFTC (either for all five waves, or those on FC/WFTC in wave 1) is, not surprisingly, significantly lower than that for individuals in any of the other groups. The mean job tenure for single mothers always on the credit is just 47.5 months (standard error 1.4554), compared with a figure of 95.4 (2.9833) for ineligible individuals never on the credit. We observe similar differences for the married fathers and married mothers groups, although the mean job tenure for each category of FC/WFTC history in the married father's sample is higher.

Figures A4.20-A4.22 in the appendix shows the distribution of job tenure for each of the samples. The figures show that for both the female samples, almost half of the women we observe on FC/WFTC (in wave 1) have job tenure of less than two years (about 60% of them have job tenure less than three years). We observe a similar bunching at low levels of job tenure in the married fathers sample, although the proportion of FC/WFTC recipients with job tenure of less than two years is slightly lower at around 40%.

The wage growth literature suggests that job tenure is important for wage growth; see Altonji and Williams (1998) for example. We therefore compare the wage growth of FC/WFTC recipients and non-recipients by job tenure. **Figure 4.11** plots the wage growth of married fathers by FC/WFTC history and job tenure. The next two plots show the same relationship for married mothers and single mothers respectively. The three figures are drawn for all individuals, regardless of whether they change jobs between waves. The next section compares job mobility for FC/WFTC recipients and non-recipients. Because the cell sizes decline rapidly for job tenure beyond four years - particularly for individuals on FC/WFTC - we group these individuals into one category. Furthermore, the sample sizes are too small to divide the sample into non-recipients who are eligible or ineligible, or recipients on the maximum and not on the maximum. The aim here is simply to see whether FC/WFTC recipients have wage growth that is in line with the wage growth of non-recipients with similar job tenure.

In terms of the patterns of wage growth across categories of job tenure, FC/WFTC recipients (always on) and non-recipients (never on) in all three samples follow a very similar pattern – wage growth is highest in the low tenure groups, and declines with tenure. The higher wage growth at lower levels of job tenure is consistent with the idea that (general) training takes place early on in the job (as in Booth and Bryan, 2003).

The fact that we observe a similar shape for the *always on* and *never on* groups, and assuming the shape is in part attributable to training, indicates that the take-up of training may not be affected by the wage subsidy. There is some weak evidence (for married fathers and single mothers) that the *level* of wage growth within a given category of job tenure is higher for individuals never on FC/WFTC, compared with individuals always on FC/WFTC. However, the difference is not significant in any of the samples. In the multivariate analysis, we will formally test this hypothesis.

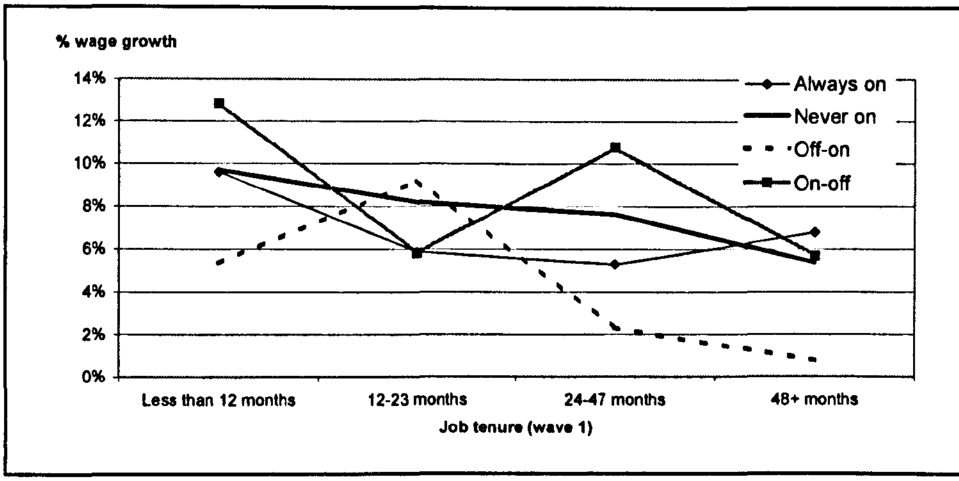
For couples – married/cohabiting men and women – it is probably not wise to draw any concrete conclusions about relative wage growth, as we do not control for total household income. However, we do observe significantly lower wage growth in the *off-on* group for both samples. This implies that low wage growth could be one of the key factors that result in a person taking up FC/WFTC.

Table 4.4 Mean job tenure (months) by FC/WFTC history

	Married dads		Married mums		Single mums	
FC/WFTC history	**Mean job tenure**	Std. Err	**Mean job tenure**	Std. Err	**Mean job tenure**	Std. Err
Always on	60.2	2.3900	45.1	2.4942	47.5	1.4554
Never on						
Eligible, no take-up	92.4	2.9930	72.5	1.0524	75.4	3.4260
Ineligible	125.6	0.7788	87.0	0.6840	95.4	2.9833
Off-on	82.8	2.9293	60.5	2.2209	61.0	4.0005
On-off	90.6	3.1472	67.1	2.3958	51.1	2.5751
Total	118.1	0.7014	81.0	0.5419	66.1	1.2367
On FC/WFTC, wave 1*	62.8	2.0071	48.9	1.9460	48.2	1.3243
Not on FC/WFTC, wave 1**	121.9	0.7289	82.4	0.5569	81.9	1.9431
Observations	**21,426**		**19,719**		**4,597**	

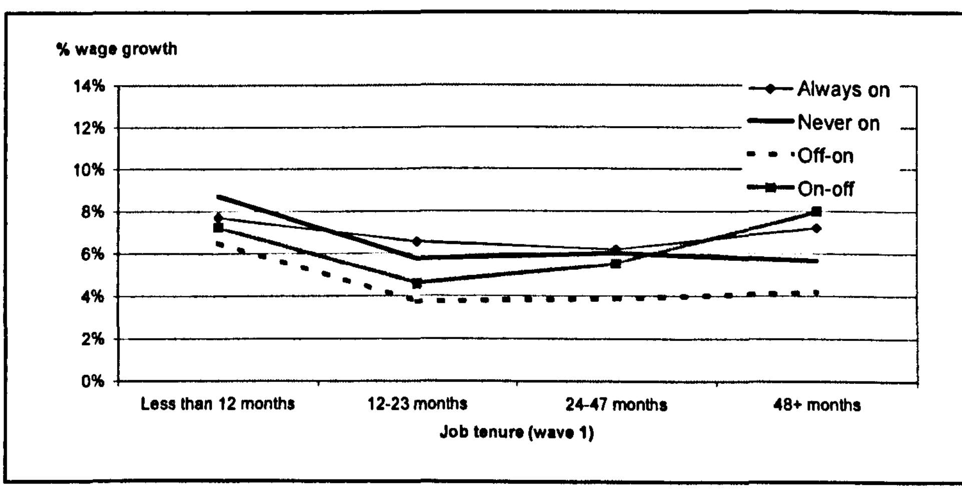
Notes: Job tenure is for wave 1 of the LFS 1997–2003. Standard errors in italics. (*) The on *FC/WFTC in wave 1* group is made up of the two groups *Always on* and *On-off*. (**) The *Not on FC/WFTC, wave 1* is made up of the two groups *Never on* and *Off-on*.

Figure 4.11 Wage growth of married fathers by FC/WFTC history and job tenure



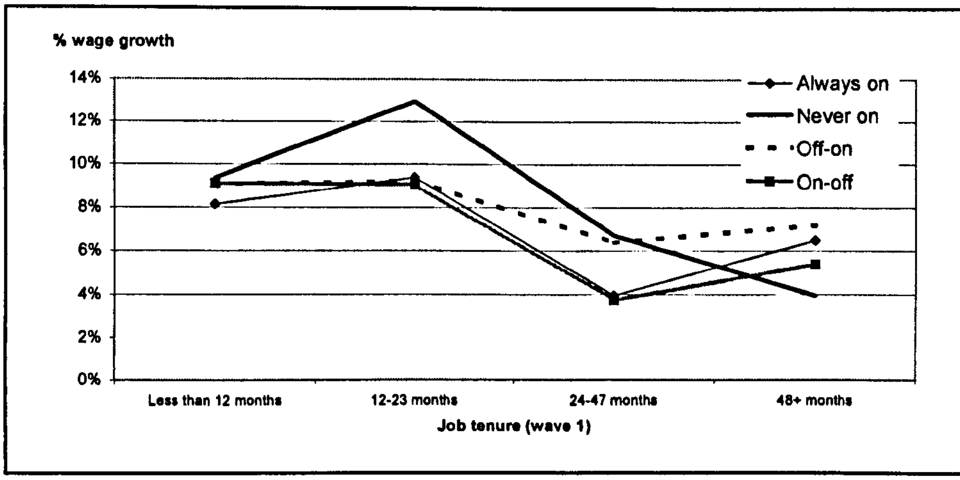
Notes: Wage growth is the percentage change in real wages over a 12-month period, LFS 1992 - 2003

Figure 4.12 Wage growth of married mothers by FC/WFTC history and job tenure



Notes: Wage growth is the percentage change in real wages over a 12-month period, LFS 1992 - 2003

Figure 4.13 Wage growth of single mothers by FC/WFTC history and job tenure



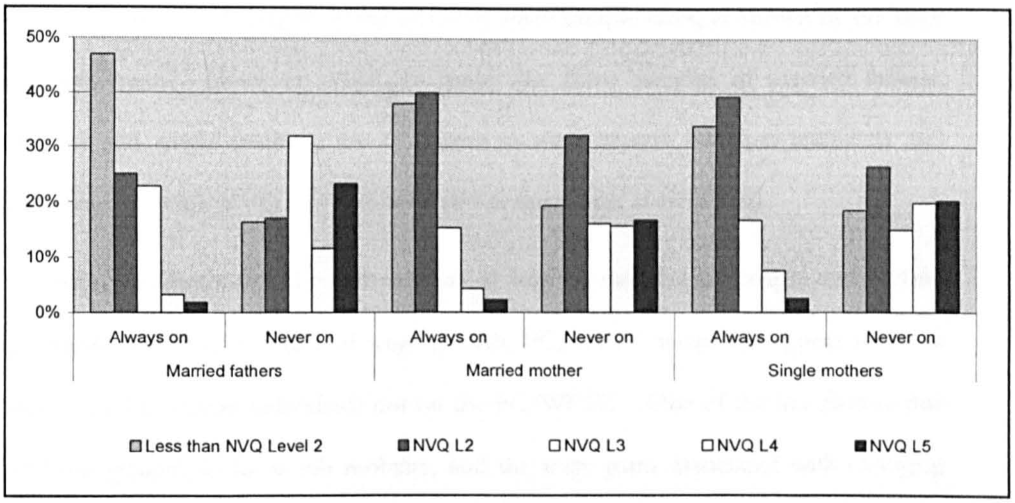
Notes: Wage growth is the percentage change in real wages over a 12-month period, LFS 1992 - 2003

4.4.3. Wage growth by qualifications and education

The LFS contains a considerable amount of information on respondents' qualifications and skills. Wage growth (and perhaps the take-up of training) may be affected by these qualifications. So, in **Figure 4.14** we break the sample by both highest qualification and FC/WFTC status. In order to make the figure easier to read, we show the proportions for the *always on* and *never on* groups only. The figure groups the highest qualification into National Vocational Qualification (NVQ) categories, which is the same grouping used by the DFES[59]

[59] The exact definitions what constitute each NVQ level can be found at http://www.skillsbase.dfes.gov.uk/Database/Database.asp?sect=5&page=4.

Figure 4.14 Breakdown of highest qualification by WFTC status



Notes: LFS 1997 – 2003.

The data clearly shows that FC/WFTC recipients have lower qualifications than those parents who are never in receipt of FC/WFTC. **Table 4.5** and **Table 4.6** show the change in the log real wage between waves 1 and 5 by highest qualification observed in wave 1 for the *always on* and *never on* groups. The sample used in **Table 4.5** (for both the *always on* and *never on* groups) contains all individuals, regardless of job tenure. In **Table 4.6,** we restrict the sample to people with job tenure (in wave 1) of two years or less. The motivation for this is so that we can make comparisons with individuals who we know are similar, not only in terms of qualifications, but also job tenure – which, as the previous section showed, is important for wage growth. The sample size for NVQ Level 4 and NVQ Level 5 qualifications decreases significantly when we restrict job tenure to two years are less; we therefore merge these two groups in **Table 4.6.**

The comparison of the wage gains shows that at the lower end of the qualifications spectrum FC/WFTC recipients typically have higher wage growth than non-recipients. This is true even when we compare 'more similar' individuals by job tenure in **Table 4.6**. As we would expect for people with lower job tenure, mean wage growth is higher for both recipients and non-recipients, but wage growth for recipients is still higher. The comparisons are dogged by the relatively small sample sizes, as shown by the large standard errors. However, when we group the three samples of married fathers, mothers and single mothers, the difference in wage growth between recipients and non-recipients with NVQ less than level two is significant at 10% level.

The main conclusion for the comparisons of wage growth by job tenure and highest qualification is that, in terms of wage growth, FC/WFTC recipients appear to do at least as well as similar individuals not on the FC/WFTC. One of the key factors that we have ignored so far is job mobility, and the wage gains associated with changing jobs. We now turn our attention to analysing wage growth by job stayers and job movers.

Table 4.5 Real wage growth for FC/WFTC recipients and non-recipients by highest qualification (wave 1)

	Married fathers		Married mother		Single mothers	
Qualifications	**Always on**	**Never on**	**Always on**	**Never on**	**Always on**	**Never on**
Less than NVQ Level 2	7.9%	4.2%	6.7%	4.2%	8.7%	3.7%
	(0.0181)	(0.0075)	(0.0302)	(0.0068	(0.0193)	(0.0187)
NVQ L2	4.9%	6.7%	10.6%	5.5%	8.0%	5.7%
	(0.0235)	(0.0066)	(0.0376)	(0.0055)	(0.0151)	(0.0135)
NVQ L3	6.8%	6.3%	9.1%	5.7%	4.5%	5.4%
	(0.0277)	(0.0048)	(0.0428)	(0.0075)	(0.0278)	(0.0226)
NVQ L4	9.6%	6.6%	-9.0%	6.5%	6.1%	6.8%
	(0.0513)	(0.0081)	(0.1488)	(0.0077)	(0.0368)	(0.0234)
NVQ L5	2.5%	8.0%	-1.2%	6.3%	8.1%	8.9%
	(0.1737)	(0.0058)	(0.0811)	(0.0081)	(0.0457)	(0.0186)

Notes: Standard deviations in parentheses. Observations are for a balanced panel of employees in both waves 1 and 5 of the LFS, 1997 - 2003. Wage growth is measured in real terms, indexed to January 2000 prices using the monthly RPI.

Table 4.6 **Real wage growth for FC/WFTC recipients and non- by highest qualification (wave 1), job tenure restricted to *two years* or less (wave 1) for all individuals**

	Married fathers		Married mothers		Single mothers	
	Always on	Never on	Always on	Never on	Always on	Never on
Less than NVQ Level 2	10.6%	5.4%	7.4%	5.5%	9.9%	4.8%
	0.0214	0.0182	0.0310	0.0120	0.0250	0.0248
NVQ L2	7.3%	6.5%	10.9%	8.1%	9.7%	10.8%
	0.0315	0.0164	0.0513	0.0109	0.0234	0.0208
NVQ L3	9.3%	10.1%	12.5%	7.8%	6.8%	2.5%
	0.0434	0.0104	0.0804	0.0157	0.0404	0.0552
Greater than NVQ Level 3 *	9.1%	11.5%	-8.4%	6.6%	8.7%	8.2%
	0.0572	0.0120	0.1089	0.0126	0.0429	0.0302

Notes: Standard deviations in parentheses. Observations are for a balanced panel of employees in both waves 1 and 5 of the LFS, 1997 - 2003. The sample is restricted to individuals with job tenure less than ore equal to two years. (*)NVQ Level 4 and Level 5 are grouped due to small sample sizes. Wage growth is measured in real terms, indexed to January 2000 prices using the monthly RPI.

4.4.4. Job changes and wage growth

The LFS allows us to identify two groups of workers: those who continue to work with the same employer over the five waves (12-month period): "job-stayers"; and those who change employers: "job-movers"[60]. Several papers have noted the importance of mobility in wage growth. The literature that relates migration decisions to investments in human capital provides some support for the hypothesis that labour mobility can also be seen as an investment in human capital (see Widerstedt (1998) and references therein). Gottschalk (2001) also finds that the relative wage gains for job-movers are considerably larger than those for job-stayers. The Connolly and Gottschalk model

60 The second group could be further divided into quits and layoffs, however, for FC/WFTC recipients in particular we have few observations of the latter. We therefore ignore this distinction here, furthermore, individuals' answers to questions about reasons for leaving their job may not be 100% truthful, making any distinction between quits and layoffs likely to be measured with some error.

predicts that individuals on the SSP programme would be less mobile (because they have fewer incentives to search for a more highly paid job). We can test a couple of basic hypotheses using the data from the LFS. Firstly: are individuals who are always on FC/WFTC more or less likely to leave their jobs? And secondly, are their wage changes comparable with FC/WFTC non-recipients who also leave their jobs?

Using the LFS we can determine whether an individual moved jobs using one of two variables. The first variable is the answers to a question in each wave that asks them whether or not they have left a paid job in the previous thirteen weeks[61]. The second job-change indicator variable is constructed from the job tenure data, if job tenure in wave 5 is less than 12 months and less than job tenure in wave 1 we take this as an indication that the respondent has changed jobs at some point over the last 12 months. Each of the two job change indicators should, of course, match - however, due to measurement error associated with misreporting[62], for a handful of individuals this is not always the case. These individuals are dropped from the sample.

The proportion of individuals who change jobs is shown in **Figure 4.15. Figure 4.16** shows the differences in wage growth across each of the groups. For each of the samples, FC/WFTC *always on* have substantially higher probability of moving jobs between wave 1 and 5 compared to *Never on*. In fact, for married fathers and mothers the *Always on* group are twice as likely to change jobs relative to the *Never on* group. While these figures are suggestive, unfortunately the cell sizes are too small to do a reliable breakdown by whether individuals are receiving the maximum or something

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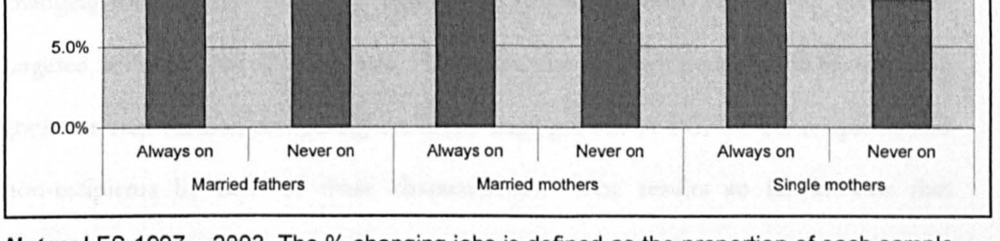
61 The question does not actually ask the respondent whether the job they left was their *main job*. However, given that very few of FC/WFTC recipients in the sample have a second job, we assume the answers to the question refer to having left their main job.

62 As noted in Altonji and Williams (1998) there is a tendency for individuals to report job tenure with error, particularly after changing jobs.

less[63]. This would be useful to see if FC/WFTC were acting as an on-the-job search subsidy – since effective on-the-job search might require some reduction in working hours and consequent reduction in income which would be smaller for those in the taper than for those on the maximum.

However, wage growth in **Figure 4.16** is higher for the *Always on* job movers relative to *Never on* job movers. As we noted above, the cell sizes are small, however, when we group the three samples the difference in wage growth for job movers is significant at the 5% level. Thus, at least part of the additional real wage growth experienced by FC/WFTC recipients that we observed compared to non-recipients in the previous section (**Table 4.5** and **Table 4.6**) might be attributable to them quitting more frequently to take higher paid jobs.

Figure 4.15 Job changes by FC/WFTC status



Notes: LFS 1997 – 2003. The % changing jobs is defined as the proportion of each sample who leave at least one paid jobs in the 12 months between wave 1 and wave 5 of the survey.

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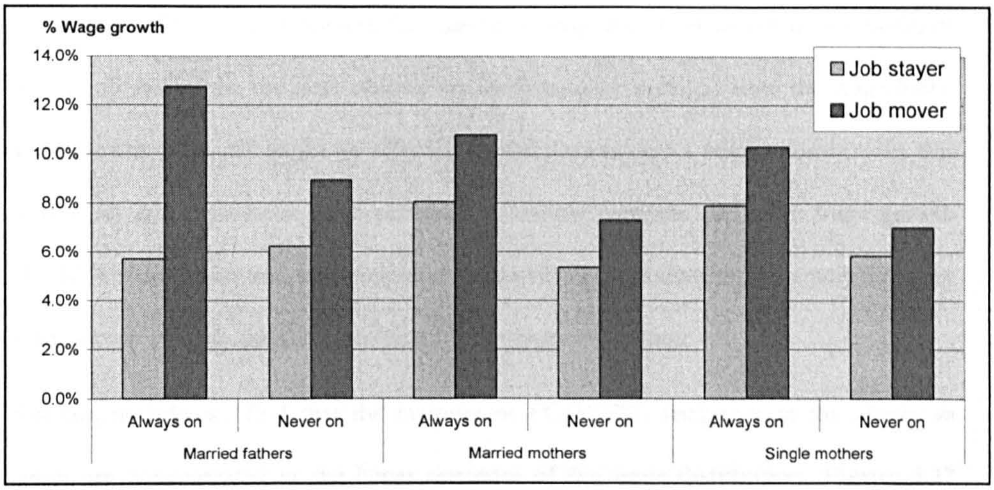
63 The cell sizes of individuals who change jobs between waves for each of the samples are: married fathers 139 (*Always on*), 1550 (*Never on*); married mothers 81 (*Always on*), 1747 (*Never on*); and single mothers 188 (*Always on*), 118 (*Never on*). A significant weakness of using the LFS panel to analyse job change is that people who leave jobs are also more likely to leave the survey.

Figure 4.16 Wage growth by FC/WFTC status



Notes: LFS 1997 – 2003. Wage growth is measured in real terms, indexed to January 2000 prices using the monthly RPI.

4.4.5. Starting wage, wage growth, and FC/WFTC status

The previous three sections have all presented evidence to show that FC/WFTC recipients have characteristics that are unlike those in the general population. That is, they typically have low job tenure, fewer qualifications, and are more mobile in terms of changing jobs. None of this is particularly surprising; after all, the tax credits are targeted at these types of individuals. However, the evidence presented in each section goes one step further, comparing the mean wage growth of FC/WFTC recipients and non-recipients by each of these characteristics. The results so far indicate that FC/WFTC certainly do not seem to fare any *worse* in terms of wage growth, and under some comparisons (by qualifications and job mobility) they seem to experience higher wage growth on average. In this section we present one final comparison of mean wage growth by FC/WFTC status – by quantile of the starting (wave 1) wage distribution.

There is a small literature that relates the importance of the initial wage to career wage growth; see for example, Gladden and Tabor (2002)[64]. Connolly and Gottschalk (2002) develop a model that incorporates the wage level-wage growth trade-off into a model of on-the-job search. In the next chapter we look in more detail at how the wage level-wage growth trade off might be affected by the presence of a wage subsidy. In this section, as in the previous three sections, we simply compare the mean wage growth FC/WFTC recipients and non-recipients with a similar characteristic – namely that they both occupy roughly the same position in the wage distribution.

Not surprisingly, we find that the majority of FC/WFTC recipients in the *Always on* group are concentrated in the lower quantiles of the wage distribution. **Figure 4.17** shows the proportion of individuals in the *Always on* and *Never on* groups in each quintile of the wage distribution in wave 1. The quintiles are calculated separately for each of the three samples, but across all individuals both on and off FC/WFTC. Over 77% of married fathers in the *Always on* group are in the bottom quintiles of the wage distribution (of married fathers). About half of married mothers in the *Always on* group are in the bottom quintile, compared with just over a quarter of single mothers in the *Always on* group.

Figure 4.18 shows the average change in the log hourly wage for each of the three samples by quintiles of the starting wage. The cell sizes for the upper quintiles are very small for the *Always on* group, and we do not report the mean wage growth for these quintiles. For married/couples men and women, the mean wage growth for FC/WFTC in the first and second quintiles is lower. This contradicts the results from the previous comparisons of mean wage growth, although the difference for married

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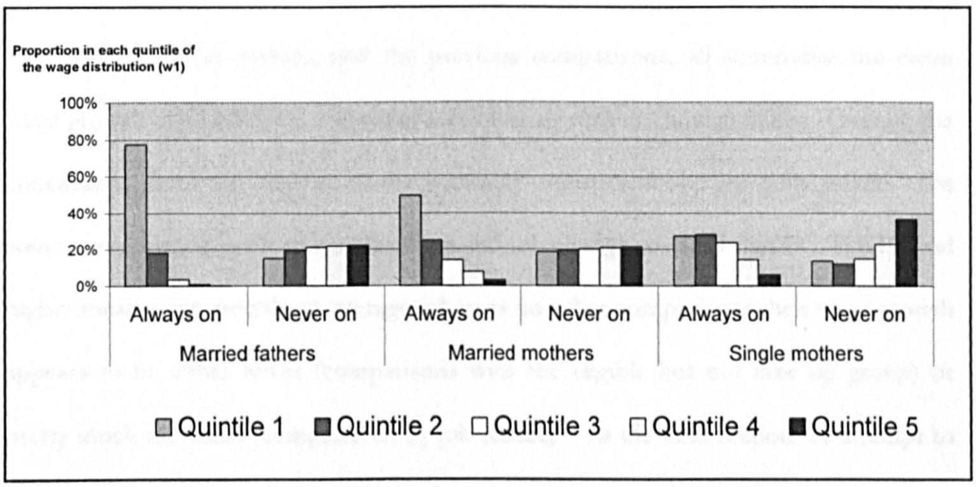
64 Gladden and Tabor consider the starting wage at the time of entering the labour market. They wish to use this as a proxy for the heterogeneous characteristics that potentially bias the slope coefficients in a log wage equation. That is, it is the permanent (unobserved) component of the wage equation.

mothers is only marginal and it is also insignificant[65]. For married fathers, however, the differences are large and significant – in the first quintile the difference in mean wage growth for the *Always on* and *Never on* groups is 10.8% (standard error 0.0167), the difference in the second quintile is 9.3% (0.0249). The pattern for single mothers is completely the opposite – single mothers in the *Always on* group at the bottom of the wage distribution have *higher* wage growth than their counter parts in the *Never on* group. The difference in the means is 6.1% (standard error 0.0311). Mean wage growth for single mothers in the *Always on* group in the second quintile is also higher (3.3%), but the difference is not significant.

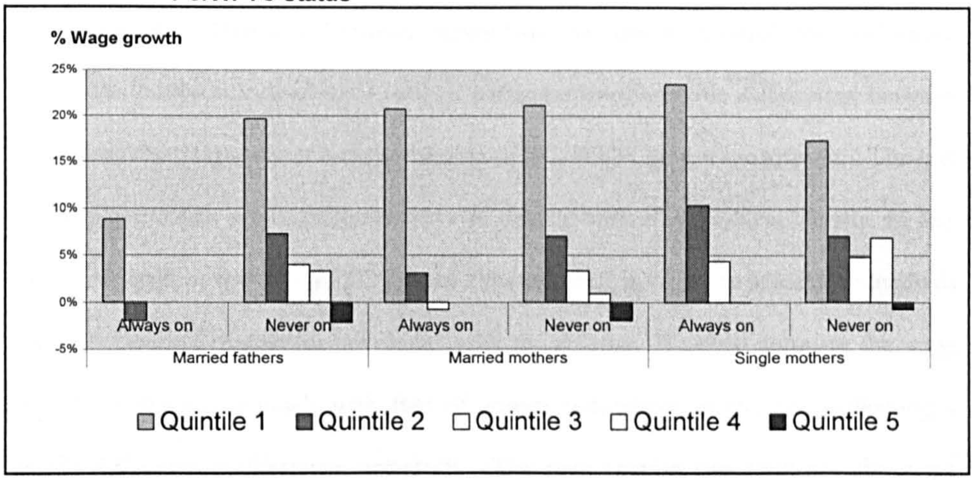
Figure 4.17 Position of FC/WFTC recipients in the wage distribution (wave 1)



Notes: LFS, 1997 – 2003. The quintiles of the wage distribution are estimated separately for each of the three samples

65 For married mothers, the difference in mean wage growth between the *Always on* and *Never on* group in the first quintile is 0.3% (standard error 0.0284), for the second quintile the difference is 4% (standard error 0.0326).

Figure 4.18 % Wage growth by quintile of the wage distribution (wave 1) and FC/WFTC status



Notes: LFS, 1997 – 2003. The quintiles of the wage distribution are estimated separately for each of the three samples. We do not report wage growth for quintiles where the cell size is too small.

The analysis in this section, and the previous comparisons, all summarise the mean wage growth of FC/WFTC recipients according to various characteristics. Overall, the conclusions from the analysis of the summary statistics above are quite mixed. On some comparisons, such as qualifications and job change, we find that FC/WFTC had higher mean wage growth on average; whereas on other comparisons their wage growth appears to be either lower (comparisons with the eligible but not take up group) or pretty much the same (comparisons by job tenure). In the next section we attempt to clear up some of this confusion by making 'cleaner' comparisons - first by comparing the mean wage growth of recipients and non-recipients according the natural experiment outlined above; and second by estimating multivariate models of wage growth, controlling for FC/WFTC receipt and a whole range of characteristics.

4.5. Wage growth and the FC/WFTC reform

Much of the analysis above has supported the idea that wage growth was affected by FC/WFTC status in ways that give credence to the idea that wage subsidies affect wage growth via incentives for on-the-job acquisition of human capital through training.

However a major concern with the results above is that, while we control for some of the observable differences between individuals, we fail to control for *unobservable* differences between individuals – and in particular unobservable differences between individuals that might affect *both* the take-up of FC/WFTC and wage growth. The rest of the paper looks a two different ways to dealing with this problem. Firstly, in this section we exploit the FC-WFTC reform ('the reform') in order to identify individuals that only become eligible for tax credits after the reform. We then compare the wage growth of these individuals with that of similar individuals in the past following a simple difference-in-difference approach. The next section parameterises the wage growth equation and estimates wage growth controlling for FC/WFTC status and also including selectivity correction terms. The correction terms are derived from a bivariate probit of FC/WFTC take-up in both waves, assuming correlation in the unobservables from both FC/WFTC take-up equations (wave 1 and wave 5) and the wage growth equation.

As noted, above, one approach to dealing with the problem of unobservables in FC/WFTC participation and wage growth is to exploit the WFTC reform. The WFTC reform extended the taper higher up the income distribution, so that individuals, who were originally paid too well to be entitled to FC, became entitled to WFTC after the reform (**Figure 4.1** showed that the change in the maximum was modest by comparison). Thus we can identify the pre-reform individuals who are not entitled to FC but would be entitled to WFTC had it been introduced. In principle, the group of newly entitled (post-reform) individuals is the same, on average, to those who were in this part of the wage distribution prior to the WFTC post-reform and hence were not subject to the effects of the taper. That is, the WFTC reform presents us with a natural experiment that allows us to compute a difference-in-differences estimate of the effects of the taper on wage growth.

Table 4.7 presents the raw data for these comparisons. All of the first six groups in the table are entitled both pre- and post-reform and are split into recipients and non-recipients and then further divided into level of receipt (on the maximum/not on the maximum). The seventh group are those who are floated onto tax credits by the reform. And there is a final group, not shown, which are those people who are not entitled and not receiving either pre- or post-reform. In each case, we have grouped the data across types of individual to try to get more precise estimates. FC and WFTC refer to levels of entitlement while R refers to receipt. Note that someone with FC>0 will necessarily have WFTC>0 because WFTC was more generous for all individuals.

Consider the non take-up groups first. The FC>0, R=0 group real wage growth was 9.8% and post WFTC this becomes 9.7% which suggests that the macroeconomic environment for low wage workers was not changing much over this period. This is reinforced by inspecting the 0<FC<0.9*max, R=0 subgroup - which is the part of the non-takeup group with not quite so low wages - here wage growth is also practically unchanged going from 8.8% to 8.7%, while the FC>0.9*max, R=0 subgroup, which is a very low wage group, saw wage growth rise from 13.2% to 14.8%.

Comparing those who are on the maximum and who take-up (FC>0.9*max, R>0) we see that wage growth rises from 12.8% to 18.0% (a difference of 5.2% which is statistically significant) perhaps reflecting the increase in the incentives for wage growth arising from the fall in the taper. As we noted, above, one reason for this might be that the maximum plateau got longer under WFTC so that, for given wage level and wage growth, recipients of the maximum could expect to remain on the maximum for longer – delaying the time when the wage gains would be subject to the taper (see **Table 4.3, Figure 4.9** and **Figure 4.10**).

The receiving group not on the maximum (denoted 0.9*max>FC>0, R>0) is the group that tells us about the effect of the fall in the taper from 70% to 55%. **Table 4.7** shows that wage growth falls slightly from 5.9% to 5.1%, though the difference is insignificant. The fall in wage growth could be due to the fact that the tapered region has got longer, so for given wage and wage growth WFTC recipients can expect to remain on the taper for longer than FC recipients. This delays the time when the wage gains become free of the taper.

Table 4.7 Wage growth under FC and WFTC

	FC period		WFTC period	
	Mean	Std Dev.	Mean	Std Dev.
FC/WFTC takeup group				
FC>0, R>0	0.081	*0.007*	0.094	*0.007*
FC>0.9*max, R>0	0.128	*0.014*	0.180	*0.017*
0<FC<0.9*max, R>0	0.059	*0.010*	0.051	*0.010*
FC/WFTC non-takeup group				
FC>0, R=0	0.098	*0.006*	0.097	*0.006*
FC>0.9*max, R=0	0.132	*0.013*	0.148	*0.016*
0<FC<0.9*max, R=0	0.088	*0.006*	0.087	*0.006*
Newly entitled group				
FC=0, WFTC>0	0.033	*0.023*	0.039	*0.016*

Notes: LFS 1997 – 2003.

The most informative group, however, is the FC=0, WFTC>0 group whose wages made them newly eligible to WFTC post reform but who were ineligible for FC pre-reform. Here wage growth rises from 3.3% to 3.9% perhaps reflecting the changes in incentives that have occurred (none of the newly entitled group would be entitled to the maximum). This wage growth change of just 0.6%, although still statistically insignificant, is larger than the extrapolation from the (slightly poorer) group who are on the taper both pre and post reform (0<FC<0.9*max, R>0). This might reflect the fact that the newly entitled are likely to be closer to the point at which they cease to be entitled to credit and so face a shorter period of time over which they have to pay the taper on their wage gains.

While **Table 4.7** presents the results of a natural experiment, it might still be desirable to examine the effects of the reform using multivariate methods. Although this natural experiment is unusual, since it allows us to compare individuals in the same parts of the wage distribution both pre and post reform, there may still have been changes that occurred over time that changed the composition of the FC>0, R>0 and FC=0, WFTC>0 groups. For example, the introduction of the National Minimum Wage, just 6 months ahead of the WFTC reform, may have inflated wage growth prior to the reform. Inspection of the data did not reveal any changes at that time or just before. Another change was the treatment of childcare costs, which became more generous under WFTC. Inspection of the data for mothers with pre-school aged children in the household, where formal childcare expenses are more of an issue does not reveal large differences relative to the group with older children. Moreover, inspection of the observable characteristics (age, job tenure, education, etc.) of these two groups before and after the reform does not show any significant changes in characteristics.

4.5.1. Econometric model of wage growth and FC/WFTC receipt

In this section we present the results of a multivariate analysis of wage growth, where the wage growth equation includes controls for FC/WFTC status over the five waves of the survey. The wage growth equation for individual i is specified as follows

$$\Delta w_i = \alpha + X_i'\beta + H_i'\gamma + \varepsilon_i \tag{1}$$

where X_i is a matrix of characteristics, such as job tenure, experience and qualifications; H_i specifies FC/WFTC history over the five waves, and ε_i is an error term. Ignoring the question of eligibility for now, the latent variable underlying the decision to take-up FC/WFTC is given by

$$F1_i^* = z_i'\delta + u_i \tag{2}$$

$$F5_i^* = M_i'\varpi + v_i \tag{3}$$

where $F1_i^*$ refers to wave 1 of the survey, and $F5_i^*$ refers to wave 5. The observed variables, either on FC/WFTC, $(F1_i, F5_i) = 1$, or not on FC/WFTC, $(F1_i, F5_i) = 0$, are defined as follows

$$F1_i = 1 \text{ if } F1_i^* > 0, \tag{4}$$

$$F1_i = 0 \text{ if } F1_i^* \leq 0, \tag{5}$$

$$F5_i = 1 \text{ if } F5_i^* > 0, \tag{6}$$

$$F5_i = 0 \text{ if } F5_i^* \leq 0. \tag{7}$$

Given that we drop observations of individuals who make more than one *on-off* or *off-on* transition, the four groups defined previously in the paper can defined according to $F1_i$ and $F5_i$:

$$\textit{Always on: } F1_i = 1 \text{ and } F5_i = 1, \tag{8}$$

$$\textit{Never on: } F1_i = 0 \text{ and } F5_i = 0, \tag{9}$$

$$\textit{Off-on: } F1_i = 0 \text{ and } F5_i = 1, \tag{10}$$

$$\textit{On-off: } F1_i = 1 \text{ and } F5_i = 0, \tag{11}$$

In order to obtain unbiased estimates of the parameters in the wage growth equation, we need to confront several endogeneity problems. Firstly, there is a double selection problem, relating to attrition from the survey and also the decision to participate in employment in both waves. Secondly, FC/WFTC status itself may be endogenous, as the unobserved characteristics that determine the four states above are also likely to be correlated with wage growth. We follow the usual approach to dealing with each of these problems, firstly estimating Heckman-type selection terms to account for the self selection into employment, then estimating a reduced form equation to obtain instrumented estimates of the probability of being *always on* FC/WFTC or *never on*. We explain each of these steps in turn.

4.5.2. Self-selection and attrition

As we mentioned above, there are actually two selection issues when it comes to using the LFS panel to analyse wage growth. The first issue relates to attrition from the survey itself. With regard to the relationship between attrition and *observable* characteristics, the ONS has gone to some lengths – including the inclusion of booster samples in the survey - to ensure that the sample in each wave of the survey remains representative of the population. In **Table A4.17** we provide some comparisons of the mean characteristics of individuals who remain in the survey for all five waves ('balanced') and individuals who leave before the fifth wave[66]. The table shows the means for the key characteristics that we have analysed throughout the paper, for the three groups of single mothers, married/couples mothers, and married/couples fathers. The final row in the table shows that the attrition in the survey – measure as the proportion of individuals in wave 1 not present in wave 5 – is not insignificant, 39% of the sample of singles mothers and about 27% from each of the sample of married/couples fathers and mothers. However, the characteristics of the individuals in each of the samples are, on average, very similar. There are a few characteristics on which the samples differ (though not for all three groups). Single mothers in the balanced panel, are more likely to be on FC/WFTC, at least in wave 1, 17.4% of the sample of individuals who leave before wave 5, and 21.4 % of the balanced panel. The individuals in the balanced panel also have higher mean job tenure (in wave 1), although, relative to the stock of job tenure in each group, the difference is small - ranging from 6 months for single mothers, to around 12 months for married fathers. Finally, we also observe that individuals in the balanced panel have, on average, fewer qualifications – a greater proportion of individuals in the balanced panel state that their highest qualification is an NVQ level 1 – although, as before, the differences are small.

Overall, comparisons of the observable characteristics of individuals in the balanced panel with those who leave the survey before wave 5 indicates that selection on observables in probably not a serious problem. A greater problem, due to the attrition, is selection (out of the survey) on *unobservables*, particularly if the unobservables are also

66 The table places no restrictions on working or reporting an hourly wage in one or both waves. For individuals not working, the work related characteristics are clearly not included in the calculation of the means

correlated with either wage growth or the FC/WFTC status. One way to address this problem is to estimate and include Heckman-type selection terms in the estimation of the structural form equations, as we do for self-selection into and out of employment. However, this is very difficult to do in practice, as some of the key variables affecting the decision to enter or leave the survey, such as changes in family circumstances, will not be observed because people do not remain in the survey. It might be possible to use values from previous waves for these variables - however, this raises the further problem of introducing spurious correlations into the analysis because of problems relating to recall bias; see Jiminez-Martin and Perrachi (2002) for an example from the Spanish Labour Force Survey. Given that modelling the selection decision leading to attrition is just very difficult to with this the data (or, indeed, any data), *and* that it probably poses more problems that it solves, we assume, conveniently, that the it does not bias the results of our estimated parameters below.

4.5.3. Self-selection into and out of employment

In order to construct a sample to analyse wage growth, we need to constrain the sample to those individuals who not only are in the survey in both waves, but also who are in employment in both waves. **Table 4.8,** below, shows the flows into and out of employment between wave 1 and wave 5 of the LFS. The table shows that in wave 1 a high proportion of married fathers are in employment, with no difference between the on FC/WFTC and not on FC/WFTC groups. However, by wave 5 of the survey, we can see that over 9% of employed fathers on FC/WFTC (wave 1) have left employment, compared with just 4% for fathers not on FC/WFTC. Married mothers have, of course, a much lower probability of being in employment in the first place – 70% for mothers not on FC/WFTC, 48% for mothers on FC/WFTC (whose receipt is obviously in respect of partner's earnings). The exit rate from employment for mothers on FC/WFTC is also higher than the not on group, 13% versus 6%, a similar to married fathers. Single mothers not receiving the credit have a relatively low probability of being in employment in wave 1, just 34%. Single mothers receiving the credit must all be employment in order to receive the credit[67], and interestingly we find the exit rate from employment for single mothers is about the same (8% or 9%), regardless of whether they are receiving the credit or not.

We estimate a bivariate probit in order to model the employment decision in both waves. The bivariate probit model has been used in many other studies where researchers are confronted by a double selection problem and the decisions they are trying to model are not independent; see, for example Heitmueller (2004) and Mohanty (2001). The model can be used to calculate selection correction terms – mills ratios – that are analogous to the commonly used Heckman selection terms.

The selection correction terms, outlined in equations (12) and (13) below, are slightly different from the typical Heckman selection terms (where the decisions are independent), in that they are modified using the correlation matrix of the unobservables from the latent variable models underlying the participation decision n both waves.

67 In the survey we observe small proportion a single mothers (4%) receiving the tax credit but reporting themselves as not employed. Apart from the obvious reporting error explanation, this situation could also arise because of the gap between evaluation periods for FC/WFTC eligibility (6 months). We drop these individuals from the sample.

Table 4.8 Participation by in employment by FC/WFTC status, waves 1 and 5

	Wave 1			Wave 5		
Married/couples fathers						
	Employed, wave 1			Employed, wave 5 Conditional on employed in wave 1		
FC/WFTC status	No	Yes	*Obs.*	No	Yes	*Obs.*
Not on FC/WFTC (W1)	13%	87%	*33,546*	4%	96%	*29,320*
On FC/WFTC (W1)	13%*	87%	*2,336*	9%	91%	*2,027*
Observations	*4,535*	*31,347*		*1,294*	*30,053*	
Married/couples mothers						
	Employed, wave 1			Employed, wave 5 Conditional on employed in wave 1		
FC/WFTC status	No	Yes	*Obs.*	No	Yes	***Obs***
Not on FC/WFTC (W1)	30%	70%	*38,018*	6%	94%	*26,742*
On FC/WFTC (W1)	52%*	48%	*2,594*	13%	87%	*1,243*
Observations	*12,627*	*27,985*		*1,829*	*26,156*	
Single mothers						
	Employed, wave 1			Employed, wave 5 Conditional on employed in wave 1		
FC/WFTC status	No	Yes	*Obs.*	No	Yes	*Obs.*
Not on FC/WFTC (W1)	66%	34%	*8,166*	8%	92%	*2,771*
On FC/WFTC (W1)	0%	100%	*2,241*	9%	91%	*2,241*
Observations	*5,395*	*5,012*		*441*	*4,571*	

Notes: LFS 1997 – 2003. (*) For married/coupled fathers and mothers, receipt of family could be in respect of the partner working above the threshold level of hours (16) – hence, unlike single mothers, the proportions in these cells need not be zero. All three samples are for individuals of working age, 16 – 64 (men) and 16 – 59 (women)

Write the latent variables underling the decision to participate in waves 1 and 5 as:

$$P1_i^* = \Omega_i^{'}\delta + \psi_{1,i}, \tag{12}$$

$$P5_i^* = \mathrm{K}_i^{'}\varsigma + \psi_{5,i}, \tag{13}$$

Where an individual will participate in wave 1 if $P1_i^* > 0$, and in wave 5 if $P5_i^* > 0$. The decisions to participate in wave 1 and 5 are not independent and the error terms from the latent variable models will be correlated, $\rho_{\psi 1,\psi 5} \neq 0$. In this case, the error terms from the wage growth equation and the two latent variables $(\varepsilon_i, \psi_{1,i}, \psi_{5,i})$ are jointly normally distributed, with mean zero and covariance matrix

$$\Sigma = \begin{bmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon\psi 1} & \sigma_{\sigma\psi 5} \\ & \sigma_{\psi 1}^2 & \sigma_{\psi 1 \psi 5} \\ & & \sigma_{\psi 5}^2 \end{bmatrix}, \tag{14}$$

where, consistent with standard practice, we normalise the variance of the error terms from the latent variable models $\sigma_{\psi 1}^2, \sigma_{\psi 5}^2$ to unity for identification purposes. Results of the bivariate probit are shown in **Table 4.9.** Estimation of the bivariate probit by maximum likelihood allows us to calculate to two selection correction terms, $\lambda_{i,1}$ and $\lambda_{i,5}$:

$$\lambda_{i,1} = \frac{\phi\left(\Omega_i^{'}\hat{\delta}\right)\Phi\left(\dfrac{\mathrm{K}_i^{'}\hat{\varsigma} - \rho\Omega_i^{'}\hat{\delta}}{\left(1-\rho^2\right)^{1/2}}\right)}{F\left(\mathrm{K}_i^{'}\hat{\varsigma}, \Omega_i^{'}\hat{\delta}, \rho\right)}, \tag{15}$$

$$\lambda_{i,5} = \frac{\phi\left(\mathrm{K}_i^{'}\hat{\varsigma}\right)\Phi\left(\dfrac{\rho\Omega_i^{'}\hat{\delta} - \mathrm{K}_i^{'}\hat{\varsigma}}{\left(1-\rho^2\right)^{1/2}}\right)}{F\left(\mathrm{K}_i^{'}\hat{\varsigma}, \Omega_i^{'}\hat{\delta}, \rho\right)}, \tag{16}$$

Where $\rho = \rho_{\psi 1, \psi 5}$ is the correlation in the error terms, as estimated by the bivariate probit (Table 4.9), $\phi(\bullet)$ and $\Phi(\bullet)$ are the standard normal density and distribution functions respectively, and $F(\bullet)$ is the bivariate standard normal distribution function. The lamda selection correction terms given by (15) and (16) are included as regressors in the wage growth equation.

Table 4.9 Results of bivariate probit for employment in wave 1 and wave 5

	Employment (wave 1)	Employment (wave 5)
Log of hourly pay+	1.8499	1.8788
	(29.21)**	(29.11)**
Male	0.2230	0.1653
	(9.39)**	(6.89)**
Age	0.1353	0.1308
	(20.67)**	(20.01)**
Age Squared	-0.0018	-0.0018
	(22.28)**	(21.93)**
Number of dependent children	-0.1978	-0.1853
	(30.24)**	(28.49)**
Married/partner	0.3871	0.3615
	(23.66)**	(22.05)**
NVQ level 2	0.1316	0.1400
	(7.27)**	(7.64)**
NVQ level 3	0.0115	0.0042
	(0.50)	(0.18)
NVQ level 4	-0.1778	-0.1933
	(4.41)**	(4.72)**
NVQ level 5	-0.7289	-0.7373
	(13.59)**	(13.49)**
Constant	-5.1323	-5.0104
	(48.79)**	(47.86)**
Rho (Standard error)	0.9274575	0.0018
Observations	73736	73736

Robust z statistics in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

Notes: LFS 1997 – 2003. The sample includes the three groups, single mothers, and married/couples fathers and married/couples mothers. Robust z statistics in parentheses; (+) significant at 10%; (*) significant at 5%; (**) significant at 1%. (+) Hourly pay for individuals not in employment is estimated as the fitted value from a regression of log hourly pay on experience, experience squared, schooling and qualifications, marital status, number of dependent children, controls for health status (work limiting disability), region (Government office regions) and time (year dummy variables). We do not report the results from estimating the wage equation in this chapter. Chapter 4 also uses selection correction terms for employment, and the results from estimating the same wage equation are shown at the end of that chapter.

4.5.4. Instrumenting FC/WFTC status

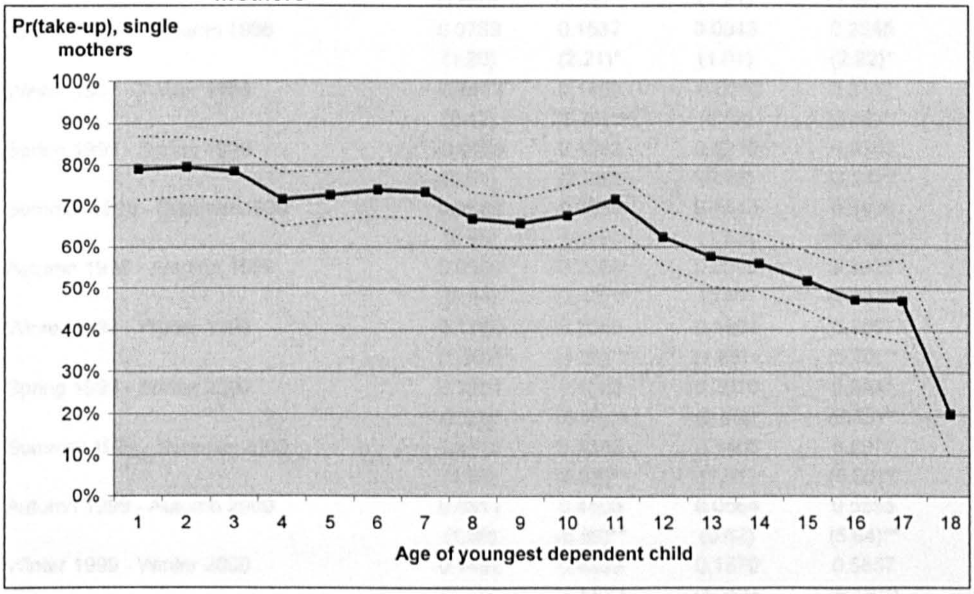
Individuals who chose to take up FC/WFTC are not a randomly selected bunch of people. Indeed, some of the characteristics that lead to them to taking up the credit are also likely to be correlated with wage growth. This means that the coefficients on FC/WFTC status in the wage growth equation (1) are likely to be biased. In order to obtain unbiased estimates of the effect of FC/WFTC status on wage growth, we instrument take-up in wave 1 and wave 5. Equations (2) and (3) specified the latent variables that underlie the observed variables 'On FC/WFTC' wave 1, and 'On FC/WFTC' wave 5. Then, equations (4) to (11) showed how these latent variables translate to the observed *Always on, Never on, Off-on,* and *On-off* groups.

In order to identify the effect of FC/WFTC status on wage growth we need a valid instrument, that is, a variable that affects take-up of FC/WFTC but not wage growth. We use age of the youngest dependent child in the household as the instrument. Every individual in the sample is a parent , and therefore potentially eligible for FC/WFTC. One of the key factors that determines take-up (and eligibility) is how old the dependent children are. **Table A4.16** in the appendix shows that amongst the eligible group, age of the youngest dependent child does affect the decision to take up. If the eldest child is closest to the age when the family becomes ineligible for FC/WFTC , and eligible individual is less likely to take up. This is also illustrated in **Figure 4.19,** which shows the probability of take-up for single mothers (who are all eligible) by age of the youngest dependent child. The dotted lines in the figure show the confidence interval around the mean.

The results from estimating the bivariate probit of FC/WFTC receipt in both waves are shown in **Table 4.9.** The first two columns show the coefficients for receipt in wave 1 and wave 5 for all individuals regardless of whether they were entitled to receive any

FC/WFTC or not. The second two columns restrict the sample to individuals who are entitled, or eligible, for some FC/WFTC amount. Given the arguments outlined above, the effect of the NVQ variable is we would expect – FC/WFTC recipients have fewer qualifications. The effect of the age of the youngest dependent child also goes in the right direction - the older the youngest dependent child, the less likely you are to either be receiving the credit (columns 1 and 2), or taking up the credit (columns 3 and 4). The bivariate probit also includes a control for the total award (or entitlement) for which a family is eligible. As in Brewer *et al* (2003b), the amount of the credit for which you are eligible (equal to zero for the non-entitled) positively affects the probability of receipt and take-up.

Figure 4.19 Take-up of FC/WFTC by age youngest dependent child – single mothers



Notes: LFS 1997 – 2003. Figure shows the probability of a single mother taking up the credit conditional on eligibility for the credit

Table 4.10 Results from estimating the bivariate probit for take-up in wave 1 and wave 5 (OLS)

Bivariate probit estimation for FC/WFTC receipt in both waves	Eligible and non-eligible		Sample restricted to people eligible in each wave	
	On FC/WFTC wave 1	On FC/WFTC, wave 5	On FC/WFTC wave 1	On FC/WFTC, wave 5
Age youngest child in the household (*)	-0.0097	-0.0133	-0.0180	-0.0149
	(5.19)**	(8.58)**	(6.86)**	(6.17)**
Entitlement	0.0042	0.0047	0.0018	0.0024
	(22.10)**	(25.79)**	(6.70)**	(9.16)**
NVQ Level 2	-0.1232	-0.1092	-0.2002	-0.1429
	(5.63)**	(5.11)**	(6.82)**	(4.75)**
NVQ Level 3	-0.2688	-0.2639	-0.2243	-0.1846
	(10.53)**	(10.88)**	(6.32)**	(5.17)**
NVQ Level 4	-0.5103	-0.4523	-0.5063	-0.3950
	(14.80)**	(14.41)**	(10.59)**	(8.34)**
NVQ Level 5	-0.8787	-0.8081	-0.7718	-0.7036
	(21.74)**	(22.44)**	(12.54)**	(11.26)**
Cohort effects Summer 1997 - Summer 1998	0.1091	0.2124	0.1127	0.2717
	(1.66)+	(3.08)**	(1.21)	(2.69)**
Autumn 1997 - Autumn 1998	0.0789	0.1537	0.0943	0.2245
	(1.20)	(2.21)*	(1.01)	(2.22)*
Winter 1997 - Winter 1998	-0.0113	0.1880	-0.0089	0.3112
	(0.17)	(2.71)**	(0.09)	(3.06)**
Spring 1998 - Spring 1999	-0.0008	0.1533	0.0210	0.3242
	(0.01)	(2.28)*	(0.22)	(3.24)**
Summer 1998 - Summer 1999	0.0658	0.0889	0.1443	0.3466
	(0.98)	(1.29)	(1.52)	(3.40)**
Autumn 1998 - Autumn 1999	0.0560	0.2286	0.0395	0.3975
	(0.84)	(3.42)**	(0.43)	(4.03)**
Winter 1998 - Winter 1999	0.1236	0.3010	0.1694	0.5067
	(1.90)+	(4.58)**	(1.85)+	(5.20)**
Spring 1999 - Spring 2000	0.1304	0.4503	0.2010	0.6441
	(2.01)*	(6.86)**	(2.20)*	(6.63)**
Summer 1999 - Summer 2000	0.0715	0.4282	0.1406	0.5977
	(1.08)	(6.49)**	(1.51)	(6.06)**
Autumn 1999 - Autumn 2000	0.0911	0.4503	0.0564	0.5398
	(1.39)	(6.86)**	(0.62)	(5.64)**
Winter 1999 - Winter 2000	0.1462	0.4299	0.1570	0.5857
	(2.27)*	(6.55)**	(1.76)+	(6.16)**
Spring 2000 - Spring 2001	0.1849	0.7675	0.1206	0.7088
	(2.89)**	(12.19)**	(1.36)	(7.57)**
Summer 2000 - Summer 2001	0.3208	0.7999	0.2793	0.8041
	(5.17)**	(12.81)**	(3.22)**	(8.69)**
Autumn 2000 - Autumn 2001	0.2625	0.6842	0.2353	0.7145
	(4.14)**	(10.72)**	(2.66)**	(7.60)**
Winter 2000 - Winter 2001	0.2388	0.6448	0.3303	0.7467
	(3.74)**	(10.03)**	(3.66)**	(7.79)**
Spring 2001 - Spring 2002	0.6115	0.7029	0.6722	0.8001
	(10.17)**	(11.07)**	(7.83)**	(8.68)**

Bivariate probit estimation for FC/WFTC receipt in both waves	Eligible and non-eligible		Sample restricted to people eligible in each wave	
	On FC/WFTC wave 1	On FC/WFTC, wave 5	On FC/WFTC wave 1	On FC/WFTC, wave 5
Summer 2001 - Summer 2002	0.5369	0.6881	0.7028	0.8558
	(8.91)**	(10.91)**	(8.10)**	(9.21)**
Autumn 2001 - Autumn 2002	0.3913	0.5580	0.4800	0.6682
	(6.42)**	(8.75)**	(5.54)**	(7.18)**
Winter 2001 - Winter 2002	0.5398	0.7645	0.6742	0.9152
	(8.83)**	(12.03)**	(7.69)**	(9.74)**
Constant	-1.4642	-1.5661	-0.1778	-0.8379
	(27.82)**	(27.96)**	(2.35)*	(10.19)**
Observations	39177	39177	9693	9693
Rho	0.8592	(0.0051)	0.8749	(0.0062)

Notes: LFS 1997 – 2003. The sample is restricted to individuals with dependent children aged *under* 19 only, who are employess in both waves and report earnings in both waves of the survey. The amount of the tax credit to which individuals are entitled enters the regression in levels, as it takes a value of zero for all non-entitled individuals in the first set of regressions. The omitted categories for the dummy variables are: NVQ level 1, and the cohort spring 1997 – spring 1998.

We now move on to presenting the results from estimating the wage growth equation set out in equation (1). When we control for FC/WFTC receipt in the wage growth equation we only include a dummy variable equal to 1 if an individual was *always on* and equal to zero if the individual was *never on*. That is, we omit the two *on-off* and *off-on* groups. The main reason for this is so that we can make a comparison of the wage growth for FC/WFTC recipients and non-recipients for two 'clean' groups, that is two groups whose wage growth and receipt behaviour is not likely to be further complicated by other types of endogeneity. For example, the *on-off group* could come off FC/WFTC *because* the have higher wage growth, independently of the age of their dependent children (and vice-versa for *off-on*). Therefore, for these groups, the IV outlined above may not allow us to identify the relationship between wager growth and receipt. We leave this analysis for future work.

4.5.5. Results from estimating the wage growth equation

Results from estimating the wage growth equation are presented for two types of individuals (i) all individuals, regardless of eligibility; and (ii) eligible individuals only. The regression results for each of the groups are presented in **Tables 4.11** and **4.12**. In order to keep the sample size reasonably high, the regressions in **Table 4.12** group married parents and single parents.

Looking at the full sample first (**Table 4.11**), the non-IV results show that the *always on* group did enjoy a wage growth premium relative to the *never on* group. The differences range from around 2.8% higher wage growth for married men, to 2.3% for single mothers. However, the inclusion of the other control variables, in particular job change (positive for couples, but negative for single mothers), job tenure (-) and training (+), means that the effect of FC/WFTC receipt is only verging on significance (10% level only for married men). The selection correction terms are also significant in several of the regressions, implying that the omission of these terms from the wage growth regression would perhaps result in biased estimates of the coefficients.

For married/couples men and women, the size of the coefficient on the *always on* dummy variable does not change significantly when we compare the non-IV and IV results. For single mothers, the sign on the coefficient has changed from being positive to being negative – implying a wage growth penalty for single mothers in the *always on* group. However, for all three groups the size of the standard error has also increased, and we would not reject the null here that the wage growth differences between the *always on* and *never on* groups is zero

Finally, in **Table 4.12** we compare the wage growth of FC/WFTC recipients and receipients for all three groups, splitting the sample by eligibility. The non-IV results are very similar to those for each of the groups in **Table 4.11,** we observe a wage growth premium for FC/WFTC recipients of 2.9%. The results for the IV on the full sample show that the wage growth premium falls to around 2.2% (but not significantly different from zero) In the sample of eligible individuals, the IV measure of receipt has fallen to around 1% and is also insignificant. The results for the IV on the eligible sample are consistent with the results we saw above for the natural experiment. Both comparisons used very different approaches to try and compare the wage growth of individuals who only differ according to whether they receive FC/WFTC. Furthermore, the results of both approaches imply that the wage growth of individuals on FC/WFTC is not very different from similar individuals not receiving the credit

Table 4.11 Results from estimating the wage growth equation (OLS), by group

The dependent variable is change in log real hourly pay	Married dads		Married mothers		Single mothers	
	Non-IV	IV	Non-IV	IV	Non-IV	IV
Always on FC/WFTC	0.0282		0.0243		0.0230	
	(1.69)+		(1.55)		(1.53)	
Always on FC/WFTC (Instrumented)		0.0316		0.0174		-0.0071
		(1.08)		(0.44)		(0.28)
Training spell between wave 1 and wave 2 (a)	0.0198	0.0197	0.0213	0.0213	-0.0075	-0.0092
	(2.43)*	(1.88)+	(3.11)**	(2.53)*	(0.50)	(0.51)
Changed jobs between waves	0.0260	0.0261	0.0223	0.0224	-0.0108	-0.0090
	(1.20)	1.03	(1.34)	(1.08)	(0.29)	(0.19)
Job tenure (wave 1)	-0.0001	-0.0001	-0.0001	-0.0001	-0.0002	-0.0003
	(2.91)**	(2.46)*	(2.57)*	(2.12)	(2.40)*	(2.32)
NVQ Level 2	-0.0003	-0.0002	0.0048	0.0050	0.0345	0.0356
	(0.02)	(0.01)	(0.47)	(0.41)	(1.40)	(1.19)
NVQ Level 3	0.0170	0.0169	0.0087	0.0088	0.0230	0.0223
	(1.32)	(1.05)	(0.70)	(0.59)	(0.79)	(0.65)
NVQ Level 4	0.0167	0.0167	0.0059	0.0062	0.0254	0.0206
	(1.05)	(0.82)	(0.41)	(0.36)	(0.76)	(0.51)
NVQ Level 5	0.0218	0.0218	0.0149	0.0151	0.0374	0.0271
	(1.44)	(1.13)	(1.06)	(0.89)	(1.07)	(0.62)
Selection correction (lamda1)	0.1426	0.1454	0.0163	0.0180	0.0517	0.0593
	(1.95)+	(1.64)+	(0.48)	(0.41)	(1.11)	(1.04)
Selection correction (lamda2)	-0.1009	-0.0991	-0.0662	-0.0647	0.0011	0.0081
	(1.66)+	(1.36)	(2.17)*	(1.76)+	(0.02)	(0.13)
Constant	0.0444	0.0445	0.0561	0.0555	0.0305	0.0434
	(2.57)*	(2.44)*	(2.75)**	(2.65)	(0.63)	(0.90)
Observations	5839	0.0316	12440	12440	2052	2052
R-squared	0.0056	1.08	0.0031	0.0030	0.0072	0.0062
Sample probability *always on*	0.052 (0.0028)		0.0244 (0.0013)		0.500 (0.011)	

Notes: LFS 1997 –2003. The sample is restricted to individuals in either the ***always on*** or ***never on*** groups. Wage growth is measured in real terms, deflated by the monthly RPI. (a)Training spell controls for whether or not the individual had at least one of spell of job related training in the year. The wage growth of individuals in cohorts affected by the minimum wage (cohorts where the first wave occurs before April 1999, and fifth wave after that point) might be affected by the introduction of the wage floor. We control for this by filtering out individuals whose wage in the first wave is lower than the introductory level of the NMW. IV estimates bootstrapped (500 replications) to obtain standard errors. Absolute value of z statistics in parentheses, + significant at 10%; * significant at 5%; ** significant at 1%.

Table 4.12 Results from estimating the wage growth equation

	All individuals		Eligible individuals only	
	Non-IV	IV	Non-IV	IV
Always on FC/WFTC	0.0286		0.0198	
	(3.04)**		(1.81)+	
Always on FC/WFTC (Instrumented)		0.0222		0.0097
		(1.37)		(0.52)
Training spell between wave 1 and wave 2 (a)	0.0178	0.0176	0.0142	0.0141
	(3.58)**	(2.92)**	(1.37)	(1.14)
Changed jobs between waves	0.0200	0.0201	-0.0213	-0.0210
	(1.60)	(1.35)	(0.76)	(0.59)
Job tenure (wave 1)	-0.0001	-0.0001	-0.0002	-0.0002
	(4.30)**	(3.61)**	(2.18)*	(1.85)+
NVQ Level 2	0.0050	0.0055	0.0024	0.0034
	(0.73)	(0.72)	(0.19)	(0.21)
NVQ Level 3	0.0107	0.0114	0.0161	0.0172
	(1.36)	(1.25)	(1.00)	(0.87)
NVQ Level 4	0.0071	0.0078	0.0026	0.0034
	(0.81)	(0.75)	(0.11)	(0.12)
NVQ Level 5	0.0163	0.0167	0.0062	0.0061
	(1.86)+	(1.65)+	(0.21)	(0.16)
Selection correction (lamda1)	0.0242	0.0300	0.0014	0.0099
	(1.35)	(1.40)	(0.05)	(0.30)
Selection correction (lamda2)	-0.0612	-0.0579	-0.0279	-0.0227
	(2.96)**	(2.35)*	(0.82)	(0.54)
Constant	0.0556	0.0544	0.0681	0.0678
	(5.81)**	(5.70)**	(3.41)**	(3.31)**
Observations	20331	20331	4429	4429
R-squared	0.0035	0.0031	0.0030	0.0025
Sample probability *always on*	0.08077		0.3186	
	(0.0019)		(0.0007)	

Notes: LFS 1997 –2003. See notes for **Table 4.11.** Absolute value of z statistics in parentheses, + significant at 10%; * significant at 5%; ** significant at 1%. IV estimates bootstrapped (500 replications) to obtain standard errors.

4.6. Conclusions and suggestions for further work

A criticism often levelled at in-work support programmes is that the individuals who respond to the incentives to join the labour market may end up in "dead end jobs" – that is, jobs that have few prospects for progression up the wage/occupation distribution. The argument behind this proposition is never spelled out explicitly but seems to rely on a lack of incentives, for both worker and firm, to make investments in factors that promote wage progression – such as on-the-job search and training in general skills.

The main aim of this paper was to test whether this was indeed the case exploiting the natural experiment offered by the reform of FC to WFTC. The balance of the evidence presented above, which is relies on summary statistics, natural experiments and multivariate analysis, would seem to indicate that *at worst* FC/WFTC recipients experience wage growth that is not significantly different to that for non-recipients – and there is some evidence to suggest that some individuals, receiving the maximum amount of the credit for example, have significantly higher wage growth.

These results suggest that in-work welfare programmes can be designed to offer wider incentives beyond simply promoting the incentive to work. In particular, if such programmes can be designed to promote wage growth then there will be further, long run, effects on work incentives. Indeed, we would expect a policy that promoted wage growth would be good for long run work incentives even if there were no direct effect of the reform on work incentives. This is because work is the utilisation rate of human capital – so policies that promote human capital formation will, in an intertemporal model, also promote future work incentives.

Further research is prompted by the analysis here. A structural model that captures the way in which the net returns to wage progression investments is affected by the *level* of

FC/WFTC receipt and the level of the taper would be amenable to multivariate modelling, and could easily be incorporated into the estimation above. The evidence from such an analysis would provide lessons for how such programmes might be better designed to capitalise on this effect. The level of receipt and the size of the taper play a role in determining how long individuals expect to remain on the programme and so capture the idea that receipt is, to an extent, time limited. A further time limit is created through the dependence on the presence of children in the household - as when children cease to be dependent entitlement ends. Since time limiting sharpens incentives it would be useful to factor this effect into the analysis. We have touched the surface of some of these questions in the analysis presented in this paper, and age of the youngest dependent child is the instrument we use to model FC/WFTC take-up in the wage growth equation. An analysis such as is outlined here should be combined with labour supply modelling to provide a vehicle for simulating the long run impact of in-work welfare. The evidence presented above, takes the behaviour of the spouse as partner as being entirely exogenous (except for single mothers). The different results we observe for single mothers would seem to suggest that the presence of the spouse is important. Any further analysis along the lines suggested above should consider endogenising the wage growth behaviour of the spouse in the model. Finally, the analysis should be applied to consider the impact of the introduction of Working Tax Credit to individuals who are not parents.

Appendices

Constructing the LFS sample

Excluding children, we have a possible total of 416,283 individual observations. The male and female samples are for individuals who were employees in both waves 1 and 5, and who also provided earnings and hours information in both waves. The loss of over two-thirds of the sample as we remove certain individuals may lead to some selection problems. However, as we moved from one level of the data to the other, we crosschecked the individuals in each sample using the means and distributional information for the entire LFS and published data from National Statistics[68]. Further summary statistics are provided in **Table A4.17.**

Table A4.13 Constructing the LFS sample

		Sample size	Breakdown of employed/self-employed by wave			
	Women	217,912				
	Men	198,371				
Total respondents in waves 1 & 5		416,283				
			Employed both waves	Employed (w1), self-employed (w5)	Self-employed (w1), Employed (w5)	Self-employed both waves
Less 243,183 inactive and/or unemployed in one or both waves	Women	81,052	74,387	601	581	5,483
	Men	92,048	73,958	1,301	1,236	15,553
		173,100				
Less 24,755 self-employed in one or both waves	Women	74,387				
	Men	73,958				
		148,345				
Less 42,303 individuals who do not provide hourly earnings information in both waves	Women	54,968				
	Men	51,074				
Total final sample		**106,042**				

Notes: Labour Force Survey, Spring 1997 – Winter 2002.

[68] For example, we compared the age distributions, job tenure data, mean wages, occupation and industry distributions, welfare receipt, region, income, etc. The information is available on request.

Table A4.14 Breakdown of the LFS sample (balanced panel) by household type

Cohort/ female sample	Married women, no childen	Married women, children	Single women, no children	Single women, children
Spring 1997 - Spring 1998	1,179	1,093	494	241
Summer 1997 - Summer 1998	1,115	1,152	502	231
Autumn 1997 - Autumn 1998	1,203	1,091	594	238
Winter 1997 - Winter 1998	1,130	1,102	561	221
Spring 1998 - Spring 1999	1,073	1,088	492	262
Summer 1998 - Summer 1999	1,147	1,033	515	249
Autumn 1998 - Autumn 1999	1,143	1,100	513	271
Winter 1998 - Winter 1999	1,023	1,073	520	256
Spring 1999 - Spring 2000	1,050	1,005	468	287
Summer 1999 - Summer 2000	1,092	985	528	225
Autumn 1999 - Autumn 2000	1,011	950	486	220
Winter 1999 - Winter 2000	960	986	429	225
Spring 2000 - Spring 2001	949	937	412	258
Summer 2000 - Summer 2001	928	932	404	221
Autumn 2000 - Autumn 2001	901	912	451	262
Winter 2000 - Winter 2001	918	917	460	208
Spring 2001 - Spring 2002	953	879	441	246
Summer 2001 - Summer 2002	941	893	459	226
Autumn 2001 - Autumn 2002	909	950	438	242
Winter 2001 - Winter 2002	916	856	474	263
Total	**20,541**	**19,934**	**9,641**	**4,852**
Cohort/male sample	**Married men, no children**	**Married men, children**	**Single men, no children**	**Single men, children**
Spring 1997 - Spring 1998	1,017	1,223	505	100
Summer 1997 - Summer 1998	1,014	1,269	521	102
Autumn 1997 - Autumn 1998	1,050	1,196	532	99
Winter 1997 - Winter 1998	1,013	1,242	542	86
Spring 1998 - Spring 1999	1,011	1,192	480	80
Summer 1998 - Summer 1999	1,053	1,181	520	79
Autumn 1998 - Autumn 1999	1,036	1,141	532	100
Winter 1998 - Winter 1999	925	1,120	494	81
Spring 1999 - Spring 2000	900	1,079	442	72
Summer 1999 - Summer 2000	922	1,032	488	74
Autumn 1999 - Autumn 2000	928	1,049	473	71
Winter 1999 - Winter 2000	900	1,043	512	76
Spring 2000 - Spring 2001	853	999	435	64
Summer 2000 - Summer 2001	826	981	445	80
Autumn 2000 - Autumn 2001	830	1,004	442	86
Winter 2000 - Winter 2001	810	954	415	69
Spring 2001 - Spring 2002	821	916	441	78
Summer 2001 - Summer 2002	812	944	444	71
Autumn 2001 - Autumn 2002	814	1,017	407	89
Winter 2001 - Winter 2002	861	930	463	76
Total	**18,396**	**21,512**	**9,533**	**1,633**

Notes: Labour Force Survey, Spring 1997 – Winter 2002.

Table A4.15 FC/WFTC receipt for married couples and lone mothers – *not conditioning on individuals working and reporting hourly earnings in both waves 1 and 5*

	Married dads		Married mothers		Single mothers	
FC/WFTC history	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Always on	1,919	4.4%	1,973	4.5%	1,922	17.4%
Never on	37,603	86.3%	37,722	85.7%	7,227	65.4%
Off-on	2,229	5.1%	2,304	5.2%	1201	10.9%
On-off	1,845	4.2%	2,011	4.6%	703	6.4%
Staying-on rate		51.0%		49.5%		73.2%
	43,596		44,010		11,053	

Notes: The numbers in the table refer to the balanced panel from the LFS (1997 – 2003), that is, individuals observed in households in waves 1 and 5. However, the sample is neither conditioned on the individual working in both waves, or reporting hourly earnings in both waves.

Table A4.16 Comparing the mean age of the youngest dependent child in the family for eligible families who take-up and do not take-up the credit

	Married dads		Married mothers		Single mothers	
	Mean age child	***Std Err***	**Mean age child**	***Std Err***	**Mean age child**	***Std Err***
Eligible for FC						
Take-up	14.10	*0.4475*	8.54	*0.4476*	8.98	*0.2280*
Never take-up	14.46	*0.3561*	9.12	*0.1331*	10.54	*0.3190*
Eligible for WFTC						
Take-up	13.85	*0.2574*	7.34	*0.2477*	9.16	*0.1482*
Never take-up	14.51	*0.1928*	8.96	*0.0896*	11.48	*0.2011*

Notes: The numbers in the table refer to the balanced panel from the LFS (1997 – 2003).

Figure A4.20 Distribution of job tenure by FC/WFTC history – married fathers

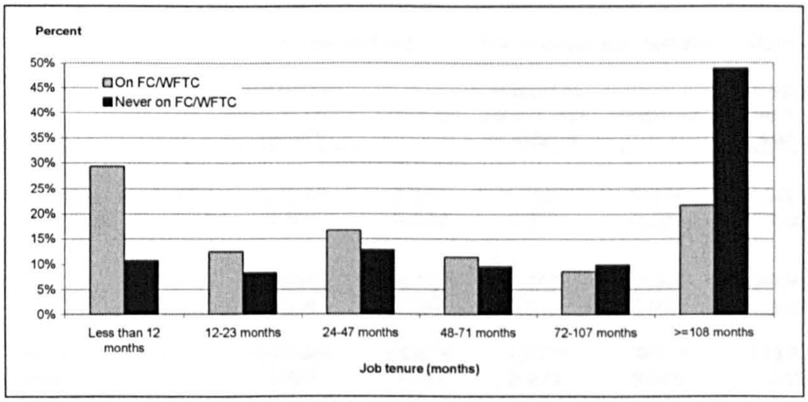


Figure A4.21 Distribution of job tenure by FC/WFTC history – married/mothers

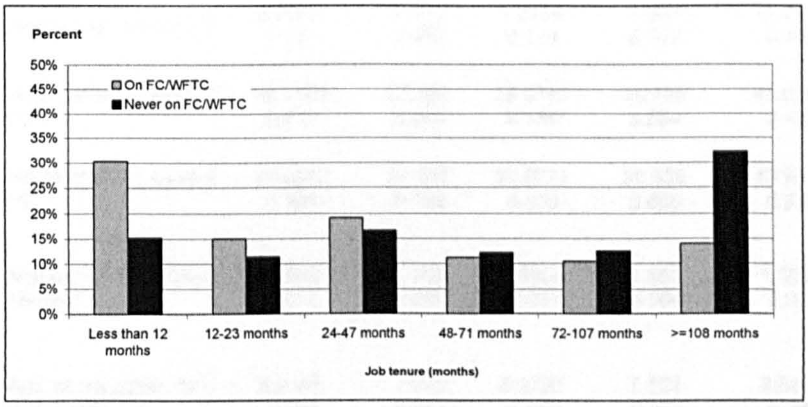
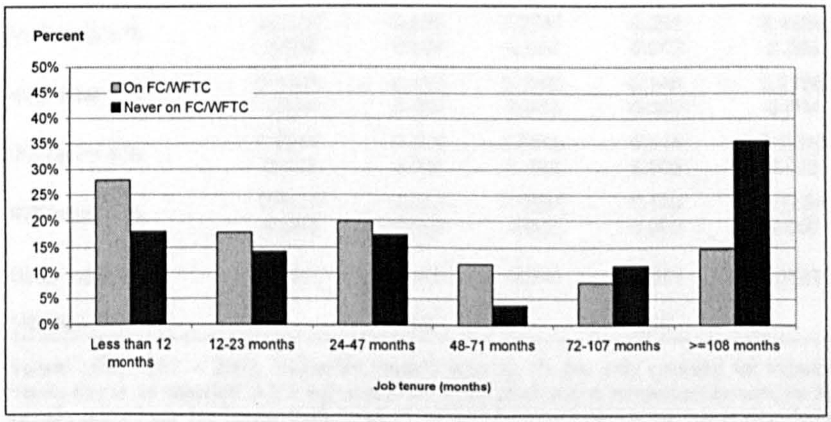


Figure A4.22 Distribution of job tenure by FC/WFTC history – single mothers



Notes: The distributions in Figures A10 – A12 refer to job tenure in wave 1 of theLFS 1997 – 2003. The on FC/WFTC group also refers to wave 1 of the survey and includes individuals in the *always on* group and the *on-off* group.

Table A4.17 Attrition in the LFS, comparison of mean characteristics

	Single mothers		Married/couples mothers		Married/couples fathers	
	Present in wave 1, not in wave 5	Balanced	Present in wave 1, not in wave 5	Balanced	Present in wave 1, not in wave 5	Balanced
Receiving FC/WFTC (wave 1) %	0.1737 *0.005*	0.218 *0.004*	0.0766 *0.002*	0.071 *0.001*	0.0764 *0.002*	0.071 *0.001*
Age (wave 1)	32.9513 *0.141*	34.542 *0.089*	37.3433 *0.070*	37.370 *0.035*	39.9422 *0.076*	39.866 *0.039*
Job tenure months (wave 1) (*)	57.5489 *1.303*	63.817 *1.061*	74.0724 *0.803*	78.612 *0.466*	103.8326 *1.023*	116.124 *0.587*
Hourly pay, wave 1 (*)	6.3015 *0.085*	6.553 *0.064*	7.1512 *0.078*	7.485 *0.038*	10.3372 *0.092*	10.862 *0.046*
Hourly pay, wave 5 (*)	6.7660 *0.157*	7.006 *0.075*	7.3154 *0.110*	7.901 *0.042*	11.2179 *0.196*	11.649 *0.051*
Hours of work, wave 1 (*)	28.7126 *0.278*	27.126 *0.203*	28.0762 *0.155*	26.789 *0.084*	45.0982 *0.133*	44.984 *0.072*
Hours of work, wave 5 (*)	30.3677 *0.490*	27.651 *0.193*	30.0771 *0.300*	26.656 *0.080*	43.9613 *0.289*	44.123 *0.070*
Number of dependent children	1.6519 *0.013*	1.768 *0.009*	1.6903 *0.008*	1.881 *0.004*	1.6917 *0.008*	1.881 *0.004*
Age of youngest child in HH under 19	8.0841 *0.069*	7.665 *0.045*	8.3795 *0.049*	7.527 *0.024*	8.3814 *0.049*	7.523 *0.024*
NVQ level 1 %	0.5113 *0.006*	0.441 *0.005*	0.4129 *0.004*	0.309 *0.002*	0.3738 *0.004*	0.278 *0.002*
NVQ level 2 %	0.2608 *0.006*	0.295 *0.004*	0.2743 *0.004*	0.301 *0.002*	0.1384 *0.003*	0.151 *0.002*
NVQ level 3 %	0.1145 *0.004*	0.126 *0.003*	0.1296 *0.003*	0.146 *0.002*	0.2766 *0.004*	0.302 *0.002*
NVQ level 4 %	0.0616 *0.003*	0.075 *0.003*	0.0848 *0.002*	0.114 *0.002*	0.0688 *0.002*	0.086 *0.001*
NVQ level 5 %	0.0518 *0.003*	0.063 *0.002*	0.0984 *0.002*	0.130 *0.002*	0.1424 *0.003*	0.183 *0.002*
Observations(**)	6781	10796	15905	42241	15881	42107
**Attrition*		*39%*		*27%*		*27%*

Notes: LFS, 1997 – 2003. Variables marked with an (*) are only counted for individuals in work. Hourly pay is as reported in the survey by the respondent and is measured in nominal terms. (**) The sample sizes here are larger than those in Table A4.13 and A4.14, as the comparisons included in this table, although for families with dependent children only, do restrict the sample to workers or reporting of hourly earnings.

5. Tax Credits and training

In the previous paper we discussed how the presence of a wage subsidy, tax credits in the UK for low paid workers, could affect wage growth by changing the incentives workers have to partake in activities that enhance their wages. One activity that we suggested might be affected was (formal) training. In this paper we directly compare the take-up of training by FC/WFTC recipients and non-recipients.

The previous paper outlined in detail *how* the incentives for taking part in any wage-enhancing activity are potentially affected by the tax credit. Furthermore, the means-tested nature of the subsidy meant that different recipients were potentially affected in different ways. Thus, the net effect of the subsidy on wage growth was difficult to determine in theory. The empirical evidence on wage growth showed that many workers receiving Family Credit (FC) or the Working Families' Tax Credit (WFTC) had higher mean wage growth. However, when we controlled take-up of the subsidy in a multivariate model, we found that much of the wage growth premium that FC/WFTC recipients seem to enjoy becomes insignificant.

There are several reasons as to why we might look at the effect of the tax credits on trainging take-up, separately from their effect on the outcome of training, i.e., wage growth. Perhaps the most important reason is that the wage enhancing effects of any training may not be observed during the twelve-month period of the Labour Force Survey (LFS) for which we observe people. It may also be the case that the wage subsidy could affect wage-growth, without actually affecting training (or vice-versa), as discussed in Acemoglu and Pischke (1999). The Acemoglu and Pischke paper argues that the wage subsidy could essentially remove part of the lower tail of the wage distribution, thereby bunching workers around a single point (the minimum wage in their example) and reducing the slope of the experience-earnings profile, independently of the effect on training. Both of these arguments imply that we may want to examine the impact of tax credits on training, independent from their impact on wage growth. We use the extensive training questionnaire in the LFS to compare the both the offer and take-up of training for FC/WFTC recipients and non-recipients. Also, as before, we will make use of the 'natural experiment' induced by the FC-WFTC reform in October 1999 in order to compare individuals who occupy similar positions in the wage distribution.

In the remainder of this paper we present evidence on the take up of training by FC/WFTC recipients and non-recipients. We first discuss the existing literature and evidence on wage subsidies and training, then move on to a comparison of the summary statistics, and finally conclude with some multivariate analysis of training take-up.

5.2. Literature on training and wage subsidies

Previous studies that have examined the impact of wage subsidies on training or skill formation have concentrated on the US Earned Income Tax Credit (EITC), Heckman *et al.* (2002), or the minimum wage; see Arulampalam *et al.* (2004) and Metcalf (2004) for the UK, Fairris and Pedace (2004) and Neumark and Wascher (2001) for the US. The main reasons as to why we would expect training to be affected by a wage subsidy were discussed in the previous paper – the arguments follow directly from the standard model of capital accumulation developed by Ben-Porath and Becker. Human capital theory predicts that in a competitive labour market investment in general training is financed through lower wages on the part of workers receiving the training (Rosen, 1972). In the case of the minimum wage, raising the wage above the lower rate where workers essentially 'pay' for training was thought to reduce training. Alternatively, if the market for low paid workers (i.e. workers affected by the minimum wage or eligible for tax credits) is viewed as a monopsony, as in Arulampalam *et al.* (2004), then the introduction of a minimum wage can increase training. This is because in a monopsony the return to human capital is compressed, thus allowing firms to retain some of the increased surplus associated with higher human capital. The introduction of the minimum wage can further compress the wage structure, thereby increasing the amount of training offered by firms.

The evidence of the impact of the minimum wage on training is mixed. Arulampalam *et al.* (2004) look at the impact of the UK minimum wage on training, and find no evidence that the minimum wage reduced the training of workers covered. Indeed, they report that the introduction of the minimum actually increased the training for workers affected by between 8% and 11%. They conclude on the basis of this evidence that the predictions of the human capital model in a competitive labour market are not supported by the data. Neumark and Wascher (2001) use cross-state variation in the US state minimum wage to test the impact on training. Their findings are strongly supportive of the predictions of the classical human capital model – the incidence of training is reduced by between 1% and 2% for every 1% increase in the minimum wage. Fairris and Pedace (2004) use establishment level data to look at the impact of the minimum wage in the US on training. In contrast to the Neumark and Wascher paper, they find no effect for the minimum wage, on either the take-up *or* intensity of training[69].

The wage subsidy provided by in work benefits like a tax credit is fundamentally different from a minimum wage type subsidy. This is because the subsidy part of the

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69 The contrasting results between Neumark and Wascher (2001) and Farris and Pedace (2004) are at least partly explained by the fact that the latter use establishment level and individual observations of people affected by the minimum wage. The Neumark and Wascher paper uses state level observations of the minimum wage combined with individual observations of the take-up of training, which, as argued by Fairris and Pedace, can lead to incorrect estimates of the effect of the minimum wage on training.

take-home wage is paid for by the state, and not by the employer – or, to put it another way, the costs of training for FC/WFTC recipients are shared with taxpayers. From the employer's perspective the tax credits could increase the provision of training, as there are now more workers willing take up jobs with training that entail a wage sacrifice. From the worker's perspective, the presence of a tax credit wage subsidy can both *increase* and *decrease* their incentives to take up trainingg. The added incentive comes from the fact that the lower paid jobs (with training) that would otherwise be below the reservation wage are raised above the reservation wage by the wage subsidy. At the same time, the tax on wage growth induced by the taper off welfare *reduces* the workers' incentive to take part in any wage enhancing activity as part of the associated wage growth is taxed away.

The only paper to have studied the relationship between training and the wage subsidies due to tax credits is Heckman *at al.* (2002). The Heckman paper considers the impact of the US EITC on recipients' training. The paper looks at two different types of training. Firstly, training that involves learning by doing, that is, training that is complementary to labour supply and working hours (and therefore implicitly involves no wage sacrifice). Secondly, they look at training that they classify as on-the-job, which is assumed to be substitutable for labour supply ('costly time investments') – in other words, time spent in on-the-job training involves a wage sacrifice because it is time *not* spent working. The presence of a tax credit has different implications for the two types of training[70]. They argue (and provide supportive evidence) that the effects on learning-by-doing training are positive, because the subsidy induces a net increase in labour supply.

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70 The LFS definition of on-the-job training is actually closer to the Heckman *et al.* definition of 'learning-by-doing'. Although we clarify the LFS definitions below, in practice, the questions we use from the survey do not allow us to differentiate fully between training that is learning-by-doing and more formal types of training that might involve an implicit or explicit wage sacrifice. As we outline below, we estimate that at least two-thirds of the training we observe is more formal training that potentially involves a wage sacrifice.

In the Heckman *et al.* model, the effect of the subsidy on formal training (on-the-job) depends on whether individual ever leaves the 'phase-out' schedule – or, what we call the 'taper off welfare'. For individuals on the taper, the wage subsidy always declines while wages increase. Heckman *et al.* find that for individuals who *never* come off the taper, typically lower educated high school dropouts, the EITC substantially reduces training. In contrast, individuals who are close to coming off the taper - in particular, early-on in their working life - typically have increased training as a result of the EITC.

5.4 A model of training in the presence of a wage subsidy

In order to motivate our analysis of the training effects of the FC/WFTC we present a simple model of human capital accumulation in the presence of wage subsidies. This is the model developed by Heckman *at al.* (2002) in their analysis of EITC and on-the-job-training. The model is just a formal representation of the human capital accumulation process due to Ben-Porath (1967), but with an added wage subsidy component. For simplicity, assume individuals only live for two periods $t = (1,2)$. Training can only take place in period one to enhance the stock of existing human capital (H_1) in period one. Any time spent training, is time not spent working. The stock of human capital in period two is given by

$$H_2 = H_1 + F(s), \tag{1}$$

where the investment (training) function has the properties $F' > 0, F'' < 0$. The variable s measures the proportion of time spent training, $0 \le s \le 1$. In order to analysis the comparative statics from the first order maximising conditions, we assume that at least some training *and* work takes place in period one, i.e. $0 < s < 1$.

Workers are paid a wage equal to a price per efficiency unit of capital (R) multiplied by the stock of human capital. In the absence of a wage subsidy and with perfect capital markets, individuals chose training s in the first period to maximise lifetime earnings

$$RH_1(1-s)+\frac{RH_2}{1+r}, \tag{2}$$

where r is the interest rate. In the presence of a wage subsidy in both periods (ϖ_1, ϖ_2), equation (2) becomes

$$(1+\varpi_1)RH_1(1-s)+\frac{(1+\varpi_2)RH_2}{1+r}, \tag{3}$$

Choosing a level of training s in order to maximise lifetime earnings, and using the fact that $H_2 = H_1 + F(s)$, gives the optimality condition

$$(1+\varpi_1)RH_1 \leq \frac{(1+\varpi_2)RF'(s)}{1+r} \tag{4}$$

Given $0 < s < 1$, we can see that the choice of s is independent of R, but decreasing in the discount rate r (the investment return) and the initial stock of human capital, and therefore the wage in period one RH_1. The effect of the wage subsidy on training depends on whether the size of the subsidy changes over time[71]. If the subsidy is constant over time $\varpi_1 = \varpi_2$, then investment in training is not affected. If the subsidy is smaller in period two, $\varpi_1 > \varpi_2$, then training is decreased compared to the case where $\varpi_1 = \varpi_2$, and if $\varpi_1 < \varpi_2$, then training is increased compared to the case where $\varpi_1 = \varpi_2$.

71 The appendix in the Heckman *et al.* paper contains a modified version of the first order conditions that take account of the fact that the EITC has both a phase-in and a phase-out schedule.

The question we want to answer in this paper is, do FC/WFTC recipients do less training than non-recipients? The "natural experiment" induced by the FC-WFTC reform allows us to make the comparison using like-for-like individuals. The capital accumulation framework above also allows us to set out some testable hypotheses about the take-up of training by FC/WFTC recipients at different points on or off the taper. In empirical section that follows, we test the following two hypotheses:

Hypothesis 1: Individuals on FC/WFTC and at the top of the taper, who have just come off the maximum, will be less likely to take up training than similar individuals close to the end of the taper who are about to come off FC/WFTC. This is because relative to the latter group, individuals at the top of the taper face a longer period of having their wage growth 'taxed'.

Hypothesis 2: Individuals who become eligible for WFTC as a result of the reform will be less likely to take up training, compared with similar individuals prior to the reform. This is because the groups who become entitled as a result of the reform (and who subsequently take up) face the prospect of having their wage growth taxed.

We test these hypotheses comparing both the summary statistics and the results from a multivariate model training take-up and FC/WFTC receipt.

5.4 Data used to analyse the effect of FC/WFTC on training take-up

We use the five-quarter rolling panel of the quarterly Labour Force Survey (LFS) to analyse the take-up of training amongst FC/WFTC recipients. This is the same dataset that we constructed to analyse the relative wage growth of FC/WFTC recipients in the previous chapter. As before, we also make use of the Tax Benefit model of the UK that was constructed for the analysis of wage growth. We use the tax benefit model to calculate the threshold level of earnings that either moves a recipient from the maximum onto the taper ('maximum kink' point), or from taper and off the tax credit altogether ('run-off point'). We analyse the take up of training separately for each of the three groups: (i) married fathers; (ii) married mothers; and (iii) single mothers. Each sample is restricted to individuals of working age who have completed full time education and who are employees.

The training questionnaire in the LFS contains a significant amount of information about work related training, taking place both within the last quarter and within the last four weeks. The survey usually asks a more detailed set of questions to the subset of individuals that have had some work related training in the last four weeks. These questions cover areas like the number of hours spent training, where the training actually took place (on site/off site) and whether the employer paid for the training. For the purposes of testing the hypotheses outlined above we will concentrate on the questions about training taking place over the entire quarter, not just the last four weeks. The subset of individuals who have had training in the last four weeks is obviously a lot smaller than the full sample. Therefore, using the questions that ask about training in the last quarter has the added appeal of keeping the total sample size large – which was one of the issues we had with the analysis in the last chapter.

The two key questions we use from the LFS are:

(1) *[Have you had] Any job related training in the last three months? [Yes/No],*

(2) *[Is] Education or training offered [in the workplace]?*

The second question is only asked to individuals who answer *'No'* to the first question. Therefore, we assume that individuals who answer *'Yes'* to at least of the questions work for an employer who has offered them some form of work-related training in the last three months[72].

Question (1), above, covers a broad range of types of training, and unfortunately it is not possible to differentiate between different types of training (formal or informal for example), or even training intensity, for training that has occurred within the last quarter. However, as we noted, above, the LFS does ask about the type of training if the training took place in the last four weeks. **Figure 5.1** shows the distribution of the type of training for individuals who say they have had work related training in the last four weeks. The data is shown separately for each of the three groups, and recipients and non-recipients[73]. The figure shows that across all groups, about two-thirds of training occurs 'away from the job', with the remainder taking place on-the-job[74]. The most significant difference between FC/WFTC recipients and non-recipients is that the former have more training which takes place "on-the-job", always at the expense of training "away from the job". We do not believe this difference is attributable to them being on the tax credit, rather it is a direct reflect of the relative position of the two

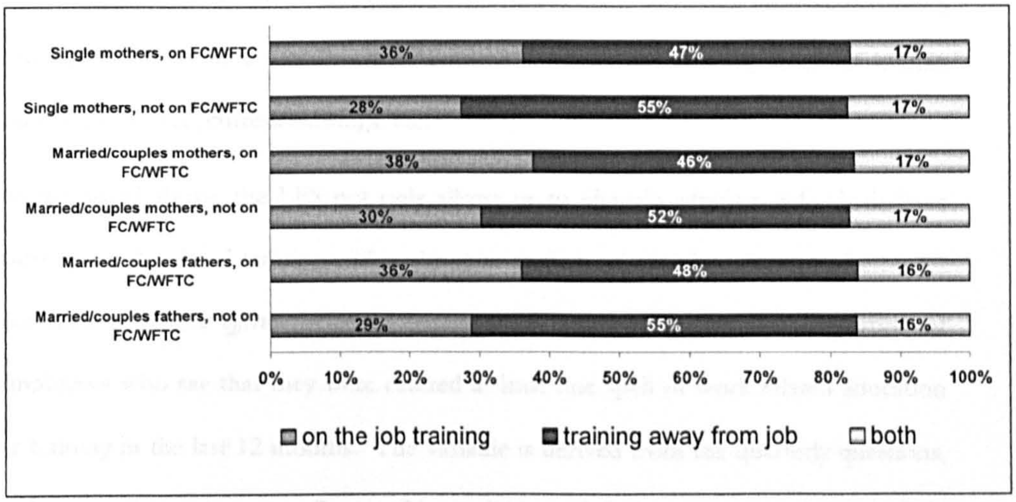
72 The questions are only asked to respondents of working age, 16-64 for men and 16-59 for women. Respondents still at school, on government training programs, or on college-based work placements are not asked the question either.

73 In contrast to the previous Chapter, where we went to some lengths to distinguish identify individuals who remain on the credit for al waves, and those who are never on the credit, we will not make that distinction in this chapter. The reason for this is that for most of the comparisons in the paper we look at the take-up of training within quarter or wave, unlike wage growth, which occurs over all five waves.

74 "On-the-job" training is defined as "...learning by example and practice while actually doing the job. Any training conducted in a classroom or training section, even if on the employer's premises is not "on the job training". (Labour Force Survey User Guide: Volume 3: "Details of LFS variables 2002").

types of individual in the income and skill distributions. FC/WFTC recipients are typically low-skilled, low-income individuals and the proportion of people who say that training in the last four weeks was on-the-job is significantly higher for people with low skills and low income.[75].

Figure 5.1 Type of training in the last 4 weeks, by FC/WFTC status



Notes: LFS 1997 – 2003. The training questions refer to training that occurred in the last four weeks.

If we assume that the proportions in **Figure 5.1** also apply to the training questions that we are interested in – that is, job related training occurring in the last quarter – then we can say that at least two-thirds of the training we observe is consistent with the type of general training that is referred to in the human capital accumulation model, i.e. training that is more likely to be associated with a wage or an earnings sacrifice.

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75 In the sample of married fathers, 44% of fathers with highest qualification equal to NVQ level say training occurred on-the-job, compared with 23% for fathers with NVQ level 5. The same proportions for married mothers (single mothers) are 42% (36%) and 25% (24%) respectively. The pattern across the income distribution is similar, although, somewhat surprisingly, it is n-shaped for married mothers. Although we do not examine it in this paper, an interesting avenue for future research would be to test whether the take-up of FC/WFTC affects the *type* of training recipients undertake, i.e. would it be the type of training that involves more or less wage sacrifice. We discuss this in the conclusion.

5.4 Summary statistics on the effect of FC/WFTC on training

In this section we present summary statistics of the effect of FC/WFTC on the take-up of training. That is, we compare the proportion of individuals taking up training according to certain characteristics, such as whether they are on or off FC/WFTC, whether they are on or off the FC/WFTC taper or how close they are to the run-off point on the taper. In the next section we present some multivariate models of training take-up that include a further set of controls such as the existing stock of human capital, job tenure, current earnings, etc.

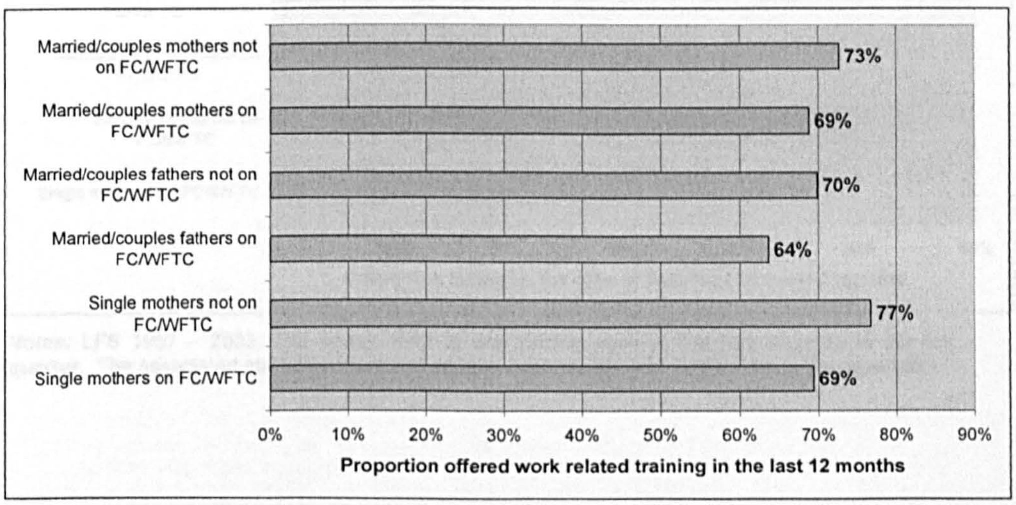
As we noted above, the LFS not only allows us to identify whether individuals have *taken up* work related training within the quarter, but we can also observe whether or not their employer *offered* them any training. **Figure 5.2** shows the proportion of employees who say that they were offered at least one spell of work related education or training in the last 12 months. The variable is derived from the quarterly questions, and, given this, it is not really possible to distinguish between a long single spell of training (between quarters) or multiple single spells – thus, the variable refers to *at least* one training spell or *at least* one offer of training. **Figure 5.3** shows the proportion of individuals who take up training, conditional on the employer offering them some work related training. The sample sizes and standard errors for all of the figures presented in this section are shown in **Table A5.4** in the appendix.

Figure 5.2 shows that individuals on FC/WFTC are less likely to be in jobs where they are offered some work related training. The differences range from about 4% for married mothers to about 8% for single mothers. The figure implies that more than a third of married fathers (and about the same for mothers) receiving FC/WFTC are in jobs where they are offered *no* work related education or training over a period of 12 months. Without controlling for individual characteristics it is not possible to say whether any of this difference is directly attributable to the fact that these individuals are on FC/WFTC.

The next two figures show the proportion in each group who, *conditional on being offered work related training in the workplace*, take up the training. **Figure 5.3** is backward looking and considers the entire previous 12 months. Potential multiple training spells are not double counted.

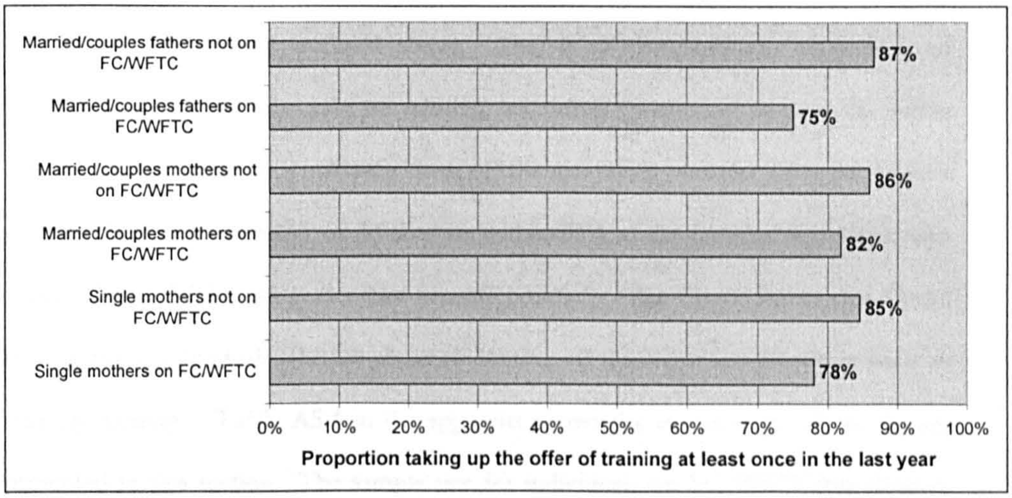
Figure 5.4 is also backward looking, but only considers the last quarter. The pattern in both figures is quite similar - FC/WFTC recipients, when 'offered' training are *less likely* to take it up. A key omitted variable here is likely to be the type of training that is offered – the type of training offered to FC/WFTC is likely to be very different, perhaps offering a lower return Interestingly, the difference in the take up rate of training is similar to the differences in the types of training between groups that we observed in **Figure 5.1** – perhaps the greater proportion of the training that FC/WFTC recipients 'turn down' is just not worth their while taking up.

Figure 5.2 Proportion of employees offered training *at least once* in the last year



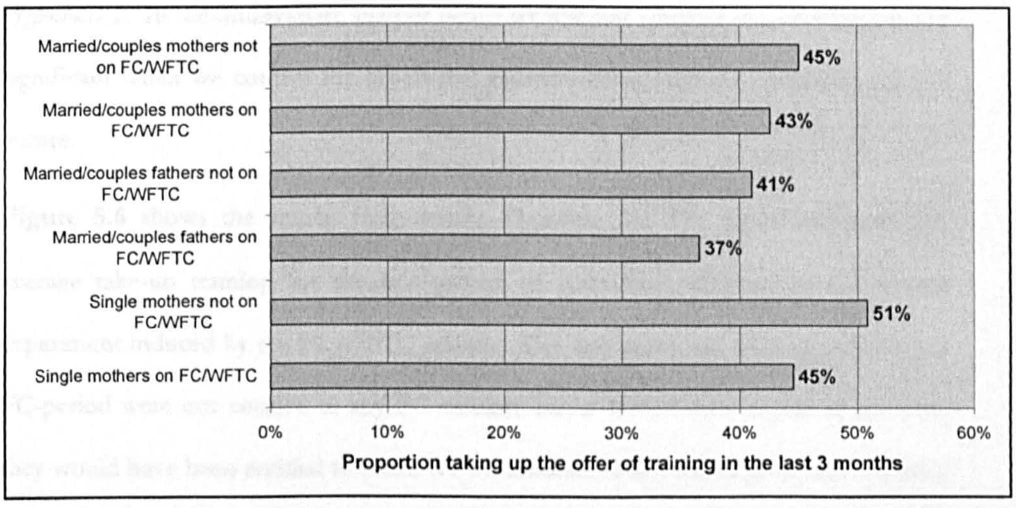
Notes: LFS 1997 – 2003. The figures refer to any offers of work related training in the last 12 months. The associated standard errors and sample sizes are show in **Table A5.4** in the appendix. The sample is restricted to individuals who are employees *in all five waves* of the survey.

Figure 5.3 Proportion of taking up work related training *least once* in the last year, conditional on the employer offering training



Notes: LFS 1997 – 2003. The figures refer to any training spell in that has occurred in the last 12 months. Multiple training spells for the same individual are not double counted. The associate standard errors and sample sizes are show in **Table A5.4** in the appendix. The sample is restricted to individuals who are employees *in all five waves* of the survey.

Figure 5.4 Proportion of taking up work related training in the last quarter, conditional on the employer offering training



Notes: LFS 1997 – 2003. The figures refer to any training spell in that has occurred in the last **quarter**. The associated standard errors and sample sizes are show in **Table A5.4** in the appendix.

In the next two figures, **Figure 5.5** and **Figure 5.6,** we compare the take up of training amongst a subset of FC/WFTC recipients and non-recipients. **Figure 5.5** represents our test of *Hypothesis 1* outlined above. That is, it compares the proportion of FC/WFTC recipients who take up training, according to whether they are (a) within 20% of the earnings that would take them off the maximum onto the taper (individuals close to the maximum kink); or (b) they are within 20% of the earnings that would take them off FC/WFTC altogether (the run-off point).[76] The figure shows that for all three groups, individuals who are closer to coming off the credit are also more likely to take up training. **Table A5.4** in the appendix shows the raw data for all the figures presented in this section. The sample size for individuals on FC/WFTC but close to the run-off point can get relatively small, for married fathers in particular. However, the sample size is still large enough for the difference to be significant for single mothers and married mothers[77]. The comparison of the means would seem to support *Hypothesis* 1. In the multivariate analysis below we will test whether the difference is still significant when we control for observable characteristics, such as education and job tenure.

Figure 5.6 shows the results from testing *Hypothesis 2.* The figure compares the average take-up training for the two groups of individuals affected by the natural experiment induced by the FC-WFTC reform. The first group are workers, who in the FC-period were not entitled to any FC amount, but if WFTC had existed at the time, they would have been entitled to some WFTC amount. The second group are workers,

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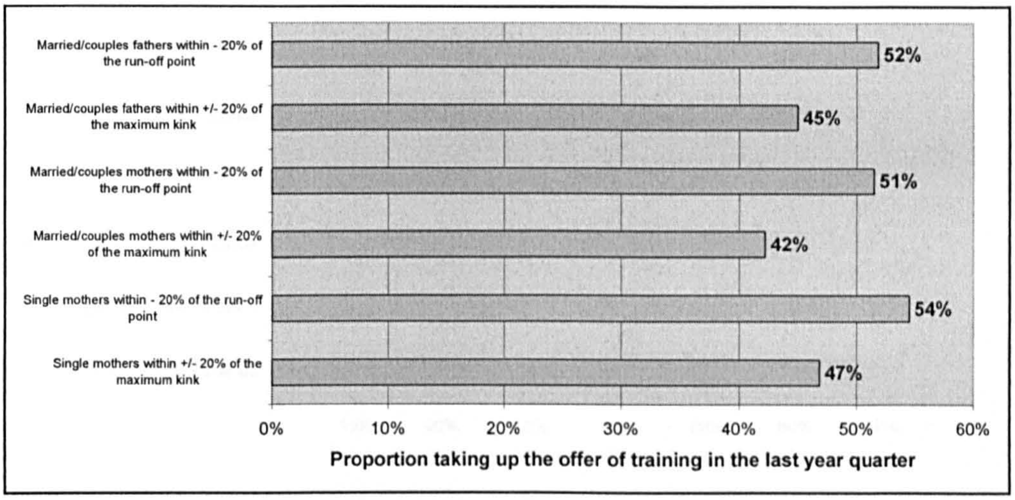
76 The weekly FC/WFTC amount is evaluated on total household net earnings. Therefore, for couples where both partners are earning, we hold the partner's earnings constant in order to estimate the earnings associated with each of these kink points.

77 The fact that a significant number of single mothers *still* go to the effort of collecting the tax credit even when they are relatively close to the runoff point is interesting. This is in contrast to married couples or partners who are *much* less likely to collect the credit when they are close to the runoff point. The marginal value of the welfare payment makes the extra effort worthwhile for single mothers, despite the fact that they might remain on the credit for a relatively short period of time.

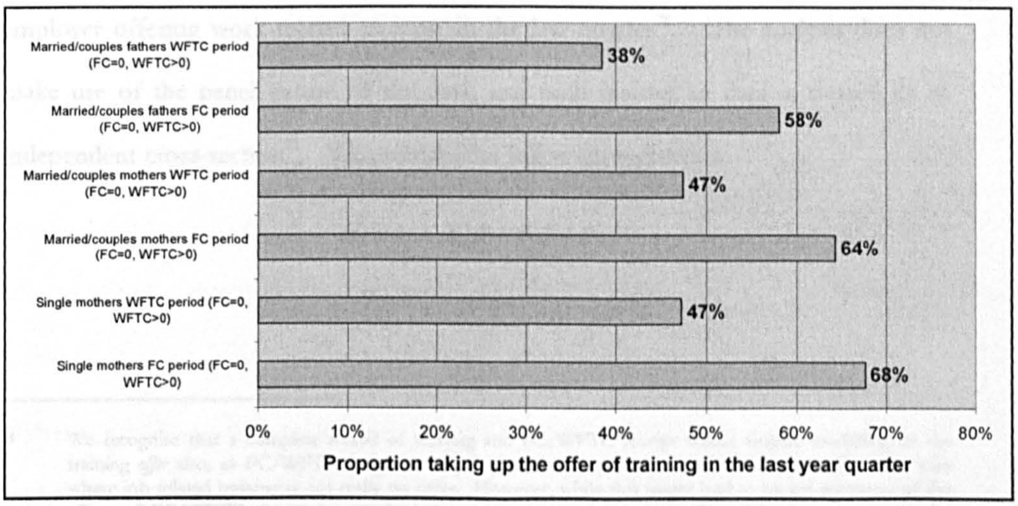
who in the WFTC-period, who, similarly to the first group, were not entitled to FC, but who are entitled to WFTC, *and who take up the credit.* The figure shows significant differences for both groups. Individuals on WFTC are much less likely to take up training (conditional on it being offered to them) than similar individuals in the income distribution who are not on WFTC. If we believe that these comparison groups represent a genuine natural experiment, then the effect of the tax credit is to reduce significantly the take up of training amongst WFTC recipients. This result is slightly puzzling, given that the wage growth comparisons in Chapter 3 showed almost no differences for these two groups. If the difference remains significant in the multivariate analysis below, then the disparity in the results between the wage growth chapter and those presented here would certainly seem to require some explanation. We discuss this in more the detail in the conclusions section at the end of the chapter.

Figure 5.5 **Proportion of taking up work related training in the last 13 weeks – comparing FC/WFTC recipients by position on the taper**



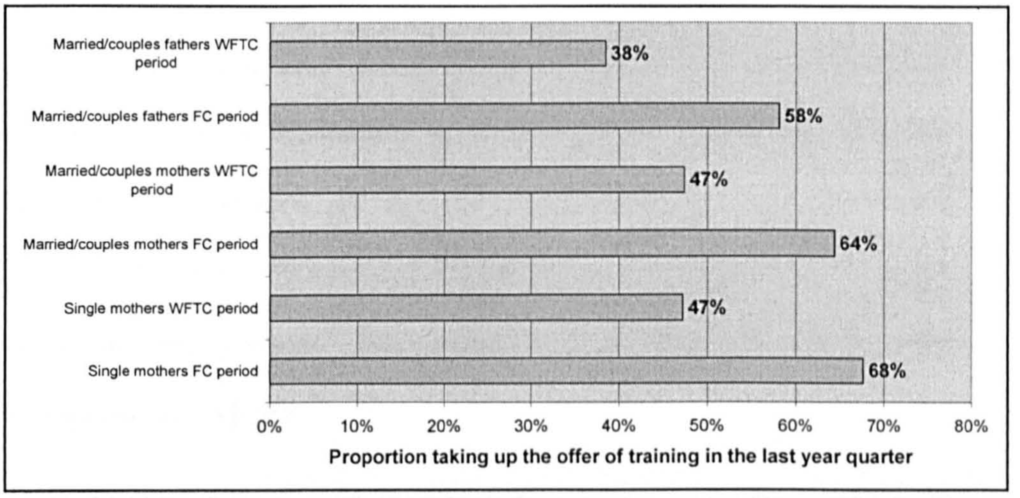
Notes: LFS 1997 – 2003. The figures refer to any training spell in that has occurred in the last **quarter**. The proportion taking up training is conditional on the employer offering job-related training in the quarter. The associated standard errors and sample sizes are show in **Table A5.4** in the appendix. The 'run-off' point in the figure refers to the earnings that the individual would have to earn in order to become ineligible for FC/WTC. The maximum kink refers to the earnings an individual would need to earn to put them at the kink point between the maximum amount of tax credit for which they are eligible (given working hours and the number and age of the dependent children in the household).

Figure 5.6 **Proportion of taking up work related training in the last 13 weeks – comparing FC/WFTC recipients on the taper pre-reform with recipients on the taper post reform**



Notes: LFS 1997 – 2003. See notes for **Figure 5.6**

Figure 5.7 Proportion of taking up work related training in the last 13 weeks, *Natural experiment* – comparing FC/WFTC recipients....



Notes: LFS 1997 – 2003. The figures refer to any training spell in that has occurred in the last **quarter**. The associate standard errors and sample sizes are show in **Table A5.4** in the appendix.

5.3. Multivariate analysis of the effect of FC/WFTC on training

In this section we present the results of the multivariate analysis of the take-up of training. The dependent variable in the analysis is training take-up, conditional on the employer offering work related training, in the last quarter[78]. The analysis does not make use of the panel nature of the data, and each quarter of data is treated as an independent cross-section[79]. We estimate the following regression:

$$s_i = \alpha + X_i'\beta + F_i\delta + \varepsilon_i,$$

78 We recognise that a complete model of training and FC/WFTC receipt would require modelling of the training *offer* also, as FC/WFTC recipients may be more or less likely to self-select themselves into jobs where job related training is not really on offer. However, while this might lead to biased estimates of the effect of FC/WFTC receipt on training, at a *minimum* the results from the regression analysis can be interpreted as correlation coefficients, and perhaps indicative of a stronger causal relationship. One avenue for future work would be to model the offer of training jointly with the decision to take up the training.

79 The LFS panel could be used to control for individual fixed effects that jointly affect the take up of training and FC/WFTC receipt. A linear probability model of changes in training take up and changes in FC/WFTC, similar to that used by Arulampalam *et al.* (2004) to analyse the impact of the minimum wage on training, would be one way to do this. We leave this as an avenue for future research.

where s_i is an indicator variable equal to 1 if an individual took part in some work related training in the last quarter. The matrix X_i contains personal characteristics that affect the decision to do some training. The capital accumulation model outlined above motivates some of the characteristics for inclusion in X_i - current stock of human capital (highest qualification), job tenure, size of firm and industrial sector. The variable F_i is an indicator variable equal to 1 if the individual is receiving FC/WFTC in the quarter and zero otherwise. The parameter ε_i is an error term with the usual assumptions, $\varepsilon_i \sim N(0,\sigma)$.

As we discussed in detail in the previous chapter, FC/WFTC receipt is likely to be endogenous, particularly if there are unobserved characteristics that jointly affect the take up of training and FC/WFTC receipt. In order to deal with this, we instrument FC/WFTC receipt in the training probit. We estimate a FC/WFTC take up equation, although unlike the previous chapter where we were interested in an individual's FC/WFTC status across all waves, here we only wish to model an individual's FC/WFTC status within the quarter in which they are observed. We therefore estimate a probit model (as opposed to a bivariate probit) of FC/WFTC receipt, where the dependent variable equals 1 if the person is currently receiving FC/WFTC and zero otherwise. The instrumental variable (IV) is the age of the youngest dependent child in the household, which we assume affects FC/WFTC receipt, but not the take-up of training[80].

Table A5.7 shows the results from estimating the FC/WFTC receipt regression for each of the three groups, single mothers, married/couples mothers and

80 A regression of training on age of the youngest dependent child shows that the IV does not explain any of the variation in training. This is supportive of its use as an IV.

married/couples fathers. The results show that the probability of being on FC/WFTC is, not surprisingly, decreasing in income. The sign on age of youngest dependent child is also in the direction that we would expect - given household income, a parent is less likely to be on FC/WFTC the older their dependent child. The effect of both the income and age of dependent child variables merely confirm the way in which the rules for eligibility of FC/WFTC work. **Table A5.7** also shows that the probability of being on FC/WFTC is decreasing in education, and, for single mothers is n-shaped in age, but u-shaped in age for married parents. The fitted values from the probits presented in **Table A5.7** are used as an exogenous measure of FC/WFTC receipt in the training equation.

The questions on job related training are only asked to individuals who are in employment. This creates a similar selection problem to the one we encountered in when we looked at wage growth. However, because we do not restrict the sample to individuals employed throughout the 12 months of the survey, the selection problem is more straightforward. The training equations include a term to control for self-selection into employment, which is just the standard inverse mills ratio from two-stage estimation procedure, where the first stage is a probit for participation in employment. The results from estimating the probit for participation in employment are shown in **Table A5.6** in the appendix to this chapter (**Table A5.5** shows the wage equation estimated to calculate a fitted value of log hourly pay for individuals not in employment, which is then included in the participation equation). Finally, the probit models that include the instrumented estimated of FC/WFTC are all bootstrapped (500 replications) in order to obtain the standard errors.

The results from estimating the probit model of training take up on individual characteristics and FC/WFTC receipt are shown in **Table 5.1**. In order to keep the sample size as large as possible (which will become important when we look at some of the sub groups later) we look at take up within the last three months. This means that we are implicitly treating multiple training spells as a single training spell. The results show that the correlation between training and FC/WFTC is negative, consistent with the analysis of the summary statistics in section 2.3. Interestingly, the relationship between training and FC/WFTC receipt remains significantly negative, even when we control for a whole range of other characteristics. The marginal effects associated with being on FC/WFTC are shown at the bottom of the table. Single mothers on FC/WFTC are 7.5% less likely to take up job related training, married mothers are 3.8% less likely and married fathers 5.8% less likely. As we outlined above, these results, though significant, need to be caveated.

The first major caveat relates to the fact that the take-up of training dependent variable is conditional on the employer offering work related training in the first place. A complete model of the effect of FC/WFTC on training would need to model the training offer also. It is unlikely that the type of training offered to FC/WFTC recipients is similar to that offered to other types of workers, and this will affect take up rates (we return to this below in the discussion on the endogeneity of the FC/WFTC receipt variable). That said, however, the other controls included in the regression, in particular, job tenure, income and the current stock of human capital should also pick up some these effects. Indeed, when we run a regression of training take-up on FC/WFTC status only, we find that the negative coefficient increases significantly, implying that these other variables are picking up some of the variation associated with the different types of training that these individuals are potentially offered.

The other major caveat we would place on the results in **Table 5.1** relates to the discussion above on the non-random take-up of FC/WFTC. The second row in the

Table 5.1 shows the coefficient on the instrumented estimate of FC/WFTC receipt, as estimated by the probit model in **Table A5.7.** Using the instrumented value for FC/WFTC receipt renders the effect insignificant in the single mothers and married mothers equations. However, the effect is still negative and significant in the married fathers regressions. In fact, using the instrumented values for FC/WFTC increases the negative correlation between FC/WFTC receipt and training. The marginal effects have increased almost three-fold, now the decrease in training of married fathers is 12.7%.

The IV-results would seem to imply that not accounting for the endogeneity of FC/WFTC receipt introduces a positive bias into the estimates of the effect of FC/WFTC on training. There could several reasons for the positive bias. For example, individuals who expect high wage growth in the future, may be less likely to take up FC/WFTC but more likely to take up training. This explanation of the bias might make sense, if there were no other controls in the equation that were good proxies for future wage growth. However, this is clearly not the case, the equation includes several variables that are reasonable proxies for future earnings – including job tenure (-), highest qualification by NVQ level (+), and firm size (-). Another possible explanation for the positive bias might the *type* of training on offer. If FC/WFTC recipients are more likely to be offered training that is not really worth taking up – because the returns are lower – then this would introduce a positive bias. Clearly, in order to identify the true effect of FC/WFTC receipt on training, we would need to model jointly FC/WFTC receipt, take-up of training, *and* the offer of training from the employer. We are not going to do that in this paper – instead, we are going to estimate the effect of the tax credit by comparing individuals at different points on the taper (or not on the taper as is the case for the natural experiment individuals).

Table 5.1 The determinants of training take-up in the last quarter, comparing FC/WFTC recipients and non-recipients

Dependent variable equals 1 if take up training offered	Married fathers		Married mothers		Single mothers	
	Non-IV	IV	Non-IV	IV	Non-IV	IV
FC/WFTC receipt	-0.1505		-0.0994		-0.2022	
	(3.95)**		(2.48)*		(4.81)**	
FC/WFTC receipt (IV)		-0.3267		-0.3157		0.1393
		-2.09		-0.73		0.42
Log total household earned income	-0.0186	-0.0416	0.013	0.0869	-0.0087	-0.0012
	-1.47	-2.70	-1.13	5.06	-0.3	-0.03
NVQ level 2	0.2324	0.2258	0.2372	0.2386	0.3596	0.3373
	(7.20)**	6.60	(7.73)**	5.40	(5.51)**	5.19
NVQ level 3	0.2389	0.2247	0.361	0.3885	0.4831	0.4719
	(8.78)**	7.49	(11.03)**	8.58	(6.46)**	6.15
NVQ level 4	0.4155	0.4007	0.6135	0.6308	0.7815	0.8003
	(11.16)**	10.50	(15.19)**	11.33	(8.25)**	7.76
NVQ level 5	0.3515	0.3394	0.6242	0.6016	0.7632	0.8243
	(10.66)**	9.02	(17.24)**	11.18	(7.74)**	6.54
Job tenure (months)	-0.001	-0.0010	-0.0009	-0.0011	-0.0017	-0.0015
	(12.05)**	-11.19	(8.22)**	-6.85	(6.18)**	-4.94
Firm size, 11-19 employees	-0.0578	-0.0755	-0.0093	0.0540	0.0247	0.0246
	-1.36	-1.80	-0.27	1.10	-0.31	0.30
20-24 employees	-0.0058	-0.0073	-0.0435	-0.0345	-0.0218	-0.0195
	-0.12	-0.16	-1.07	-0.59	-0.23	-0.21
25-49 employees	0.031	0.0304	0.0164	0.0523	-0.064	-0.0752
	-0.84	0.77	-0.51	1.18	-0.9	-1.10
50+ employees	0.0565	0.0548	-0.013	0.0578	-0.1024	-0.1056
	(1.93)+	1.81	-0.51	1.65	(1.82)+	-1.93
Industry: utilities (electricity gas & water supply)	0.22	0.2403	0.1545	-0.1461	0.0256	0.0204
	(3.41)**	3.57	-1.22	-0.56	-0.12	0.09
Industry: construction	0.0191	0.0312	-0.0097	-0.3914	-0.0085	-0.0001
	-0.56	0.96	-0.1	-0.83	-0.04	0.00
Industry: wholesale, retail & motor trade	0.032	0.0362	0.0543	-0.3769	-0.115	-0.1444
	-0.97	1.10	-1.28	-6.08	-1.19	-1.52
Industry: hotels and restauranting	0.1101	0.1278	0.0105	-0.3025	-0.1014	-0.1100
	-1.35	1.51	-0.17	-1.69	-0.87	-0.94
Industry: storage and communications	0.0661	0.0630	0.0531	-0.2893	-0.2201	-0.2388
	(2.10)*	1.91	-0.9	-2.40	(1.74)+	-1.78
Industry: financial intermediation	0.2975	0.2968	0.1558	-0.2621	0.0917	0.0936
	(7.05)**	6.79	(3.16)**	-6.22	-0.78	0.78
Industry: estate, renting and business activity	0.1982	0.2152	0.1627	-0.2743	-0.1867	-0.1863
	(5.77)**	6.47	(3.32)**	-3.90	(1.72)+	-1.80
Industry: public administration and defense	0.3966	0.3992	0.2284	-0.2708	0.0479	0.0481
	(13.72)**	13.55	(5.17)**	-3.67	-0.47	0.48
Industry: education	0.4204	0.4136	0.3359	-0.1119	0.1433	0.1471
	(11.33)**	10.54	(8.28)**	-1.46	-1.5	1.67

Dependent variable equals 1 if take up training offered	Married fathers		Married mothers		Single mothers	
	Non-IV	IV	Non-IV	IV	Non-IV	IV
Industry: health and social work	0.4674	0.4590	0.3373	0.1157	0.1731	0.1624
	(11.82)**	11.56	(8.67)**	0.65	(1.98)*	1.90
Industry: Other	0.0845	0.0977	0.1588	-0.4747	0.1227	0.1235
	(2.11)*	2.46	(2.80)**	-3.50	-1.05	1.06
Selection correction employment (inverse mills ratio)	0.0285	0.0052	0.1455	0.1445	0.2608	0.1824
	-0.36	0.06	(1.98)*	(1.88)*	(2.31)*	1.63
Constant	-0.1848	-0.0164	-0.4637	-0.4370	-0.1257	-0.2755
	(2.01)*	-0.14	(4.86)**	(4.65)**	-0.58	-0.85
Marginal effects						
FC/WFTC receipt	-0.0756		-0.0382		-0.0581	
	(4.81)**		(2.50)*		(3.96)**	
FC/WFTC receipt (IV)		0.0559		-0.1258		-0.1273
		(0.48)		(1.03)		(2.15)*
Observations	4424		22865	22196	23231	21839
Pseudo R2	0.04	0.04	0.04	0.04	0.03	0.03

Notes: LFS 1997 –2003. Absolute value of z statistics in parentheses, (+) significant at 10%; (*) significant at 5%; (**) significant at 1%. The sample is restricted to employees who are offered training by their employer in the quarter. The marginal effects are coefficients from a linear probability model. IV estimates bootstrapped (500 replications) to obtain standard errors.

5.4 The effect of the FC/WFTC taper on the take-up of training

Hypothesis 1 says we would expect the take-up of training to be higher for those individuals closer to the run-off point of FC/WFTC. In **Table 5.2** we present the results from a probit model of training take-up in the last quarter, where the explanatory variable includes a dummy variable that indicates an individual's relative position on the FC/WFTC taper. The sample used for the estimation in **Table 5.2** is individuals on FC/WFTC *only*. We do not estimate a model to instrument each persons position on or off the taper.

The dummy variable in **Table 5.2**, "*D-min= close to run-off*", is defined as follows:

D-min=1 if Y(current)/Y(run-off)>0.8 and

D-min=0 if 0.8<(Y(current)/Y(max))<1.2,

where *Y(current)* are current net (individual) earnings, *Y(run-off)* is the threshold level of earnings required to take an individual off FC or WFTC altogether, and Y(max) is the threshold level of earnings at the maximum kink point (i.e. between the maximum and the taper). As an alternative to *D-min*, we could have also included in the regression a (bounded) continuous variable equal to the ratio of current earnings to the threshold earnings at the run-off point (i.e. Y(current)/Y(run-off)). However, as we outlined previously, both in the introduction to this chapter and the previous chapter, the net incentive effects of the tax credit for individuals *not* at either end of the taper are not that obvious. Therefore, in order to obtain a 'cleaner' estimate of the effect of the taper, we restrict the sample to individuals who are at the 'sharp' end of the taper.

Table 5.2 shows that the probability of FC/WFTC recipients taking up training is affected by their position on the taper. The effect is strongest for single mothers, where the mean difference in take-up, controlling for observables is almost 14% (on an average training take-up rate of 53%). The marginal effects for married mothers and fathers are also negative, but insignificant.

Table 5.2 The determinants of training take-up in the last quarter – comparing FC/WFTC recipients by position on the taper off welfare.

Dependent variable equals 1 if take up training offered	Single mothers	Married mothers	Married fathers
D-min = Close to run off point (a)	0.3587	0.2757	0.0616
	(3.69)**	(1.53)	(0.26)
Log of total household earned income	-0.1644	-0.0528	-0.0183
	(1.86)+	(0.42)	(0.18)
Job tenure (months)	-0.0031	-0.0021	-0.0027
	(5.01)**	(2.28)*	(5.28)**
NVQ level 2	0.2173	0.1889	0.0148
	(2.26)*	(1.38)	(0.14)
NVQ level 3	0.2718	0.2791	0.1329
	(2.37)*	(1.65)+	(1.29)
NVQ level 4	0.6201	0.4016	0.3518
	(4.66)**	(2.01)*	(2.07)*
NVQ level 5	0.4806	0.6626	0.5798
	(2.90)**	(2.82)**	(3.44)**
Constant	0.5915	-0.0135	-0.0042
	(1.44)	(0.02)	(0.01)
Marginal effects			
Close to run off point (b)	0.1378	0.1074	0.0266
	(3.71)**	(1.52)	(0.30)
E(training in the last quarter)	0.5274	0.5083	0.4428
	(0.0359)	(0.0286)	(0.0179)
Observations	1223	545	1057
Pseudo R2	0.04	0.02	0.03

Notes: LFS 1997 –2003. Absolute value of z statistics in parentheses, (+) significant at 10%; (*) significant at 5%; (**) significant at 1% level. The sample includes employees on FC/WFTC only. (a) Individuals are split between those whose earnings are within +/- 20% of the FC/WFTC maximum kink point (*Close to run off point* equal to zero), and those whose earnings are within 20% of the FC/WFTC run-off point (*Close to run off point* equal to one). (b) The marginal effects are coefficients from a linear probability model.

We recognise that the estimates in **Table 5.2** are unlikely to identify the *true* effect of the taper on training, for the reasons outlined above (unobserved heterogeneity affecting the choice to be on/off the taper, and fact that the training offer is not modelled). However, the inclusion of the other controls in the equation, in particular, current stock of human capital (NVQ) and job tenure, should go some way towards mitigating the problem. Furthermore, the shear size of the effect implies that an instrumentation of *D-min* is unlikely to change the fundamental result – the position on the taper matters. We now move on to consider a different approach to testing the effect of the taper on training, comparing take-up according the FC-WFTC reform natural experiment.

The effect of the FC/WFTC taper on the take-up of training – Natural experiment

The nature of the 'natural experiment' induced by the FC/WFTC reform has already been discussed in some detail, so we will go straight to a discussion of the results in **Table 5.3**. The variable controlling for FC/WFTC receipt in **Table 5.3** (WFTC period, FC=0 & WFTC>0) is equal to 1 for individuals in the WFTC period who would have been ineligible for FC, but post-reform became eligible for WFTC and also took up the credit. The variable (WFTC period, FC=0 & WFTC>0) takes a value of zero for the same type of individual in the FC-period, who were not on the credit (as WFTC was not yet available).

The results show a strong negative correlation between WFTC-receipt and the take-up of training. The marginal effects exceed those observed in **Table 5.2**, ranging from training being around 16% lower for WFTC (married mothers) to being around 20% lower (single mothers and married fathers).

The results in this section, and the previous two sections, would indicate that there is a negative correlation between being on FC/WFTC and taking up training. Furthermore, we find that amongst the group of FC/WFTC recipients, the relative position on the taper has a significant impact. The empirical results are consistent with the predictions of the theoretical model in Heckman *et al.*, in that for individuals close to coming off the taper, the net incentive effects of the subsidy are likely to be positive; whereas for those individuals just coming onto the taper, the net incentive effects are likely to be negative. However, the results on training take-up also seem to be *inconsistent* with the results from the previous chapter, which showed that wage growth for FC/WFTC recipients and non-recipients was quite similar.

Table 5.3 The determinants of training take-up in the last quarter – *Natural experiment sample*

Dependent variable equals 1 if take up training offered	Single mothers	Married mothers	Married fathers
WFTC period, FC=0 & WFTC>0 **(a)**	-0.5945	-0.4464	-0.6414
	(4.56)**	(3.78)**	(7.08)**
Log of total household earned income	0.8932	0.1805	0.7410
	(1.81)+	(0.59)	(2.75)**
Job tenure (months)	-0.0022	-0.0014	-0.0024
	(3.01)**	(2.56)*	(6.10)**
NVQ level 2	0.0044	0.2043	0.1184
	(0.02)	(1.70)+	(1.15)
NVQ level 3	0.2677	0.1541	0.0588
	(1.20)	(1.08)	(0.62)
NVQ level 4	0.4295	0.5374	0.4781
	(1.97)*	(3.99)**	(3.26)**
NVQ level 5	0.3801	0.5439	0.5776
	(1.56)	(3.80)**	(4.25)**
Constant	-5.1402	-1.2319	-4.3767
	(1.83)+	(0.73)	(2.92)**
Marginal effects			
WFTC period, FC=0 & WFTC>0 **(b)**	-0.2162	-0.1711	-0.2403
	(4.61)**	(3.86)**	(7.24)**
E(training in the last quarter)	0.5857	0.6086	0.5238
	(0.0214)	(0.0209)	(0.0188)
Observations	461	958	1281
Pseudo R2	0.07	0.04	0.07

Notes: LFS 1997 –2003. Absolute value of z statistics in parentheses, (+) significant at 10%; (*) significant at 5%; (**) significant at 1% level. **(a)** Individuals are split between those who, in the FC period, are ineligible for FC, but eligible for WFTC were it available *(WFTC period, FC=0 & WFTC>0 equal to zero, the control group)*, and those who, in the WFTC period, are ineligible for FC, but eligible for WFTC and take it up *(WFTC period, FC=0 & WFTC>0 equal to one)*. **(b)** The marginal effects are coefficients from a linear probability model.

5.4. Conclusions

In this paper we set out to test directly whether FC/WFTC receipt affects the training take-up of individuals. We have shown that training is indeed affected by FC/WFTC receipt, and that the effects are significant. Furthermore, the position on the taper occupied by a FC/WFTC recipient has important consequences for how it affects training. We found that individuals close to coming off the taper were much more likely to take up the training than individuals just coming onto the taper. These results are consistent with the incentive effects of the taper as predicted by the standard human capital accumulation model.

The negative effects of FC/WFTC receipt on training are somewhat puzzling, given that in the previous chapter we found FC/WFTC receipt had little impact on the relative wage growth. Thus, the lower training results are difficult to reconcile with the lack of any observable wage growth effect. One explanation might be the type of training that is done by individuals on FC/WFTC – as well as the type of training that is *offered* to them. The analysis we carried out in this chapter did not explicitly control for the *type* of training, nor did it examine in detail the transmission mechanism from training to wage growth. We believe that both these areas represent substantial avenues for future research into the long-term labour market effects of tax credits in the UK.

Table A5.4 Summary statistics for training take up

Table A5.4 Raw data for Figures 2 - 6

Figure 5.2

% offered job related training by employer in the last 12 months	Probability of employer offering work related training	SE	N
Single mothers on FC/WFTC	78.0%	0.0101	1,689
Single mothers not on FC/WFTC	84.6%	0.0112	1,038
Married/couples mothers on FC/WFTC	81.8%	0.0096	1,608
Married/couples mothers not on FC/WFTC	85.9%	0.0030	13,550
Married/couples fathers on FC/WFTC	75.0%	0.0089	2,390
Married/couples fathers not on FC/WFTC	86.6%	0.0027	15,409

Figure 5.3

% accepting the offer of job related training by employer in the last 12 months	Probability of taking up training	SE	N
Single mothers on FC/WFTC	69.4%	0.0127	1,318
Single mothers not on FC/WFTC	76.8%	0.0143	878
Married/couples fathers on FC/WFTC	63.7%	0.0114	1,793
Married/couples fathers not on FC/WFTC	69.9%	0.0040	13,347
Married/couples mothers on FC/WFTC	68.8%	0.0128	1,316
Married/couples mothers not on FC/WFTC	72.7%	0.0041	11,639

% offered job related training by employer in the last 3 months	Probability of employer offering work related training	SE	N
Single mothers on FC/WFTC	59.9%	0.0047	10,655
Single mothers not on FC/WFTC	65.7%	0.0042	12,583
Married/couples fathers on FC/WFTC	49.7%	0.0050	10,016
Married/couples fathers not on FC/WFTC	69.6%	0.0014	43,098
Married/couples mothers on FC/WFTC	68.7%	0.0014	41,371
Married/couples mothers not on FC/WFTC	58.8%	0.0062	6,357

Figure 5.4

% accepting the offer of job related training by employer in the last 3 months	Probability of taking up training	SE	N
Single mothers on FC/WFTC	44.5%	0.0062	6,386
Single mothers not on FC/WFTC	50.9%	0.0055	8,264
Married/couples fathers on FC/WFTC	36.6%	0.0068	4,977
Married/couples fathers not on FC/WFTC	41.1%	0.0018	29,989

Table A5.4 Raw data for Figures 2 - 6

Married/couples mothers on FC/WFTC	42.6%	0.0019	26,910
Married/couples mothers not on FC/WFTC	45.0%	0.0081	3,735

Figure 5.5 **% accepting the offer of job related training by employer in the last 3 months, FC/WFTC recipients on/off taper**	**Probability of taking up training**	**SE**	**N**
Single mothers within +/- 20% of the maximum kink	46.8%	0.0297	284
Single mothers within - 20% of the run-off point	54.5%	0.0193	670
Married/couples mothers within +/- 20% of the maximum kink	42.2%	0.0524	90
Married/couples mothers within - 20% of the run-off point	51.5%	0.0261	367
Married/couples fathers within +/- 20% of the maximum kink	45.0%	0.0186	714
Married/couples fathers within - 20% of the run-off point	51.9%	0.0980	27

Figure 5.6 **% accepting the offer of job related training by employer in the last 3 months, FC/WFTC recipients and non-recipients, *natural experiment (a)***	**Probability of taking up training**	**SE**	**N**
Single mothers FC period (FC=0, WFTC>0)	67.7%	0.0363	167
Single mothers WFTC period (FC=0, WFTC>0)	47.3%	0.0371	182
Married/couples mothers FC period (FC=0, WFTC>0)	64.4%	0.0186	662
Married/couples mothers WFTC period (FC=0, WFTC>0)	47.4%	0.0401	156
Married/couples fathers FC period (FC=0, WFTC>0)	58.1%	0.0174	807
Married/couples fathers WFTC period (FC=0, WFTC>0)	38.5%	0.0315	239

Notes: LFS 1997 – 2003. (a) The *Natural Experiment* is a comparison of the training take up of two groups from identical positions in the wage distribution. The first group, in FC period (FC=0, WFTC>0), are in eligible for FC, but were WFTC available they would be eligible to receive some tax credit. The second group, in the WFTC period, are identical in respect of ineligibility for FC and eligibility for WFTC, the only difference is that they can *and do* receive a tax credit.

Table A5.5 Wage equation to predict log hourly pay for participation in employment regression

Dependent variable is the log of reported hourly pay	Single mothers	Married/couples mothers	Married/couples fathers
Age	0.0411	0.0490	0.0702
	(8.52)**	(17.56)**	(27.84)**
Age2	-0.0004	-0.0006	-0.0008
	(6.77)**	(15.45)**	(23.82)**
Age left full time education	0.0415	0.0383	0.0297
	(12.19)**	(26.29)**	(21.98)**
NVQ level 2	0.1503	0.1393	0.2036
	(13.16)**	(24.84)**	(28.62)**
NVQ level 3	0.1919	0.2036	0.2632
	(12.73)**	(27.07)**	(42.94)**
NVQ level 4	0.5087	0.4953	0.4430
	(29.84)**	(62.27)**	(50.43)**
NVQ level 5	0.6381	0.6540	0.6141
	(26.47)**	(62.62)**	(60.80)**
Number of dependent children	-0.0469	-0.0393	-0.0082
	(7.24)**	(13.36)**	(2.88)**
dda disabled	0.0317	0.0540	0.1265
	(0.96)	(3.17)**	(6.88)**
work-limiting disabled only	-0.0178	-0.0081	0.0597
	(0.53)	(0.45)	(3.43)**
not disabled	0.0595	0.0700	0.1700
	(2.83)**	(5.72)**	(13.77)**
Yorkshire & Humberside	0.0169	-0.0022	0.0114
	(0.82)	(0.23)	(1.13)
East Midlands	0.0207	0.0019	0.0525
	(0.87)	(0.18)	(5.04)**
Eastern	-0.0107	-0.0225	0.0773
	(0.33)	(1.61)	(6.14)**
London	0.1488	0.0866	0.1204
	(7.68)**	(9.21)**	(12.68)**
South East	0.0480	0.0544	0.0509
	(1.90)+	(4.46)**	(4.17)**
South West	0.0087	-0.0007	0.0503
	(0.35)	(0.06)	(4.43)**
West Midlands	0.0533	0.0510	0.0248
	(2.56)*	(4.75)**	(2.25)*
North West	0.0016	0.0289	0.0179
	(0.09)	(3.09)**	(1.89)+
Wales	-0.0392	0.0054	0.0416
	(1.70)+	(0.49)	(3.65)**
Scotland	-0.0494	-0.0008	-0.1240
	(1.49)	(0.06)	(8.79)**
Year 1998	0.0091	0.0010	0.0006
	(0.44)	(0.11)	(0.07)
Year 1999	0.0270	0.0316	0.0281
	(1.37)	(3.37)**	(2.98)**
Year 2000	0.0751	0.0479	0.0316

Dependent variable is the log of reported hourly pay	Single mothers	Married/couples mothers	Married/couples fathers
	(3.73)**	(5.09)**	(3.34)**
Year 2001	0.1523	0.0813	0.0651
	(7.55)**	(8.66)**	(6.87)**
Year 2002	0.1933	0.0990	0.0888
	(8.66)**	(9.55)**	(8.56)**
Year 2003	0.2068	0.1096	0.0689
	(5.50)**	(5.55)**	(3.33)**
Constant	-0.1749	-0.1465	-36.8485
	(1.65)+	(2.52)*	(12.60)**
Observations	8614	42516	44841
R-squared	0.35	0.32	0.30

Notes: LFS 1997 – 2003. Robust t statistics in parentheses, (+) significant at 10%; (*) significant at 5%; (**) significant at 1% level. The omitted values for the categorical variables are NVQ level 1; DDA disabled and work limiting disabled; Northern region; and the year dummy variable 1997.

Table A5.6 Probit regression for participation in employment

Dependent variable is equal to one if an employee, zero if not employed (self-employed omitted)	Single mothers	Married/couples mothers	Married/couples fathers
Log real hourly pay (fitted value)	1.8725	0.6748	2.5116
	(13.66)**	(9.91)**	(37.19)**
Age	0.1293	0.1676	-0.1063
	(13.20)**	(27.40)**	(15.50)**
Age2	-0.0016	-0.0021	0.0008
	(12.81)**	(26.95)**	(10.13)**
Number of dependent children	-0.1859	-0.2216	-0.1183
	(15.81)**	(37.32)**	(22.04)**
NVQ level 2	0.1788	0.3352	-0.2205
	(5.71)**	(21.36)**	(10.19)**
NVQ level 3	0.0996	0.1940	-0.4961
	(2.36)*	(8.71)**	(21.44)**
NVQ level 4	-0.1411	0.3508	-0.7364
	(1.61)	(8.17)**	(18.81)**
NVQ level 5	-0.6013	-0.0715	-1.4807
	(5.14)**	(1.20)	(27.32)**
Yorkshire & Humberside	0.0223	0.0713	0.0286
	(0.55)	(3.20)**	(1.23)
East Midlands	-0.0252	0.0582	-0.0304
	(0.58)	(2.52)*	(1.23)
Eastern	0.0057	0.0570	-0.1354
	(0.10)	(2.07)*	(4.54)**
London	-0.5263	-0.1609	-0.4262
	(12.55)**	(7.56)**	(18.60)**
South East	-0.2067	0.0040	-0.0555
	(4.39)**	(0.15)	(1.97)*
South West	-0.0058	0.0939	-0.0084
	(0.12)	(3.65)**	(0.30)

Dependent variable is equal to one if an employee, zero if not employed (self-employed omitted)	Single mothers	Married/couples mothers	Married/couples fathers
West Midlands	-0.1756	0.1163	-0.0994
	(4.35)**	(4.76)**	(3.98)**
North West	-0.0569	0.0448	-0.0375
	(1.56)	(2.13)*	(1.72)+
Wales	0.1374	0.0701	-0.0377
	(2.92)**	(2.76)**	(1.41)
Scotland	-0.0677	-0.0219	0.1200
	(1.38)	(0.84)	(4.34)**
Year 1998	-0.0208	0.0196	0.0105
	(0.54)	(1.01)	(0.51)
Year 1999	-0.0165	0.0123	-0.0371
	(0.43)	(0.64)	(1.82)+
Year 2000	-0.0827	0.0223	-0.0370
	(2.08)*	(1.14)	(1.80)+
Year 2001	-0.2150	-0.0066	-0.1085
	(4.95)**	(0.33)	(5.17)**
Year 2002	-0.2480	-0.0141	-0.1723
	(5.05)**	(0.62)	(7.30)**
Year 2003	-0.1126	-0.0020	-0.1123
	(1.35)	(0.04)	(2.37)*
Married	NA	0.0767	0.2135
		(5.32)**	(14.18)**
Constant	-5.0732	-3.8721	-1.1437
	(32.10)**	(38.88)**	(11.73)**
Observations	25214	84994	83464
Pseudo-R2	0.13	0.07	0.07

Table A5.7 The determinants of FC/WFTC take-up

Dependent variable is on FC/WFTC in the quarter, families with dependent children only	**Single mothers**	**Married mothers**	**Married fathers**
Log household income (net) (a)	-0.4369	-0.4121	-0.8743
	(15.74)**	(19.06)**	(49.42)**
Age youngest dependent child	-0.0167	-0.0148	-0.0410
	(5.45)**	(5.18)**	(15.96)**
Age	0.0478	-0.0638	-0.0335
	(6.51)**	(5.56)**	(3.69)**
Age squared	-0.0008	0.0005	0.0003
	(7.59)**	(3.29)**	(2.46)*
NVQ level 2	-0.0291	-0.1674	-0.1694
	(0.93)	(7.06)**	(6.58)**
NVQ level 3	-0.0835	-0.2515	-0.3216
	(2.16)*	(8.07)**	(13.74)**
NVQ level 4	-0.4191	-0.3404	-0.5349
	(9.22)**	(8.78)**	(12.31)**
NVQ level 5	-0.7878	-0.4276	-0.6028
	(14.10)**	(9.32)**	(14.56)**
Constant	0.3470	1.0268	1.6563
	(2.54)*	(4.83)**	(9.37)**
Pseudo-R2	0.0813	0.0767	0.2013
Observations	10966	50105	52347

Notes: LFS 1997 –2003. In contrast to the bivariate probit estimation in Chapter 3, we do not make use of the panel nature of the data. The data is essentially treated as a repeated cross-section, where each observation of an individual on FC/WFTC is independent of other observations of the same individual. Absolute value of z statistics in parentheses, (+) significant at 10%; (*) significant at 5%; (**) significant at 1%. (a) FC/WFTC receipt is evaluated in respect of net household income, hence we include net income in the probit.

6. Conclusion

We have analysed the relationship between wages and job satisfaction. We show that job satisfaction is positively effected by earnings, even after controlling for the simultaneity bias between the two equations. The effect of earnings on job satisfaction, is however small. We estimate that an increase in average earnings of about 20% will only tend to increase the probability of an individual being satisfied with their job by around 7%.

The results from the job satisfaction paper also show that earnings comparisons can affect job satisfaction. However, we do not find conclusive evidence that earnings comparisons in the past have a significant impact on job satisfaction in the future. Self-reported job satisfaction judgments are likely to be correlated with unobserved individual heterogeneity. One of these unobserved characteristics could be the extent to which an individual has a positive outlook on life. We include in the regression individual's responses to questions about their future financial situation and find that these are strongly correlated with job satisfaction. Furthermore, we find that the inclusion of these variables in the regression does not really alter the size of the (relative) earnings effect. This implies that unobserved heterogeneity may not be a major issue with the estimates we present here.

Chapter 2 showed that the returns to education in an economy are closely related to the degree of technology bias in the economy. We used to approaches to analyse the relationship. The first approach *a priori* divides countries into technology leaders and technology followers. We show that technology followers can respond to increases in the relative supply of skilled labour by developing more technology and thereby increasing the return to education. In contrast, in those countries that can only develop technologies more slowly, or perhaps through importing them, we observe strong negative correlation between the return to education and the relative supply of skills. The second approach used a model of capital skill complementarity in production, as developed by Griliches, that shows the return to education increasing with the stock of capital equipment per worker. These results are entirely consistent with results in the literature that relates changes in the wage structure to changes in technology, and in particular computer use, over time. Interestingly, our estimates of the elasticity of substitution between skilled labour and capital equipment are very similar to results reported elsewhere in the literature.

In the last two chapters we consider some of the long run labour market effects of tax in work welfare programs that are tax credits in the UK. We show that, contrary to popular beliefs, workers who are receiving the tax credit do not end up in dead end jobs with few prospects for wage growth. The extent to which incentives for wage growth are affected by the means-tested nature of the tax credit is also examined. We find that the incentives are indeed very different for individuals at different points on the taper off welfare.

In contrast to the favourable evidence on the effect of the wage subsidy on wage growth, we find the subsidy has significant negative effects for the take up of training. The results presented in the last chapter are perhaps the most obvious area where significant future research could bear fruit. As we note in the chapter, we ignore the endogeneity of the training offer, the decision to take up the offer of training and the decision to be on the tax credit. We also note that this is likely to bias the effect of the tax credit on training downwards. Future work in this area should consider alternative econometric approaches to identifying the effect of tax credits on training. Methods such as propensity score matching and other semi- or non-parametric approaches might usefully be employed. However, the 'data hungry' nature of such approaches does not bode well for the anlaysis of tax credits. The labour force survey is a sample of over 11,000 households in every quarter, yet we found that many of the comparisons we made in the analysis were restricted by very small cell sizes.

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