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A Hedonic Analysis Of Overeducation And Undereducation

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A Hedonic Analysis of Overeducation and Undereducation

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Abstract

Prior work suggests coordination failure between the labour and education markets leads some workers to have educational qualifications in excess of those specified by the firm (overeducation) and others to have less (undereducation). This paper theoretically models and empirically tests the hypothesis that overeducation and undereducation arise out of a common equilibrium matching process that maximises net benefits to workers and firms over the life of the match. The theoretical model predicts that the overeducated begin in low-paying, entry-level jobs early in their career that train them for higher-paying future positions that require their educational background, whereas the undereducated start in low-paying, exactly-educated jobs that can signal the worker has the necessary skills for promotion. This result suggests that prior comparisons of overeducated, undereducated, and exactly-educated workers in a cross-section or short panel may be misleading because all workers are exactly-educated during some portion of their career. However, the theoretical model predicts that the type of education match can be identified in a cross section by differences between predicted and observed qualifications of the worker and predicted and observed requirements of the firm. This hypothesis is tested using data on British, working-age males to identify overeducated and undereducated workers and confirm that these workers trade off a lower return to education for training and a promotion return.

JEL Classification: J24, J31

Key Words: Over and Undereducation

I. Introduction

There has been much recent concern by researchers and policy makers over the apparent lack of coordination between the labour market and the educational system. A number of studies have found that the education level of many workers either exceeds or falls short of that required by their employer as "necessary to perform the job" and that their return to education differ significantly from those whose qualifications match employer requirements (e.g., Hersch,1991; Groot and Oosterbeck, 1994). This paper develops and empirically tests a hedonic matching model of the qualifications required by the firm and those actually held by the worker, which shows that the matching process can naturally lead some workers to have more education than is required (overeducation) early in a career and others to have less education than the stated requirements (undereducation) later in a career.

A significant portion of the workforce in industrialised countries can be classified as either overeducated or undereducated. For example, Sicherman (1991) compares the years of education reported by workers as required for the job in the 1976 and 1978 waves of the PSID with their actual years of education. He finds that 40 percent of workers have more education than is required for the job, whereas 16 percent have fewer years of education than required. The percentage of workers classified as overeducated or undereducated in Europe, while smaller than in the U.S., ranges from 30 to 40 percent (e.g., Alba-Ramirez, 1993). Thus, the phenomena of overeducation/undereducation is pervasive in the labour markets of industrialised countries.

Two rationales for overeducation or undereducation have been examined. First, a large empirical literature treats both overeducation and undereducation as evidence of inefficiency in the labour market and/or the education system. For example, Rumberger (1981; 1987) argues

that the overeducated are underutilised workers, whereas Duncan and Hoffman (1981) contend that both overeducation and undereducation represent a short-run coordination failure between firms and workers who eventually adjust their education requirements and investments to changes in the supply and demand for human capital. These and other studies test this mismatch hypothesis by estimating wage regressions that include years of required education and measures of whether the worker has more or less education than required (e.g., Cohn and Kahn; 1995). The results indicate that workers in a "good match", where their qualifications equal firm requirements, earn a higher return to education than those who appear to be mismatched.

Second, several papers model overeducation as a result of career mobility. For example, Sicherman and Galor (1990) develop a theoretical model in which workers start in jobs for which they are overeducated in exchange for a higher probability of moving up the job hierarchy. They test this hypothesis using data for working-age males from the 1976-81 waves of the PSID and find that the correlation between the effect of education on wages and its effect on the probability of moving to a "better" job is negative and significant. This result suggests that overeducated workers trade off a lower return to education for an increased probability of promotion.

Our paper takes the first holistic approach to career mobility by theoretically modelling and empirically testing the hypothesis that overeducation and undereducation arise out of a common equilibrium matching process whereby workers and firms each maximise net benefits over the life of the match. The theoretical model predicts that the overeducated begin in low-paying, entry-level jobs early in their career that train them for higher-paying future positions, which require their educational background. At the same time, the undereducated start in low-paying jobs for which they are exactly educated and that provide an opportunity to signal that

they have the necessary skills for promotion. These results suggest that prior work that identifies and compares the economic aspects of overeducation or undereducation relative to that of the exactly educated in a cross-section or a short panel may be misleading, because all workers are likely to be exactly-educated during some portion of their career.

Data for working-age males from the Social Change and Economic Life Initiative survey (SCELI) are used to test and confirm the predictions of the discrete-hedonic-matching model. In particular, the model shows how the type of educational match can be identified by differences between the predicted and observed education qualification of the worker and the predicted and observed education requirement of the firm. Following the theoretical model, these differences are used to identify the type of educational match in probit models for on-the-job training and promotion and in several wage equations. The results show that traditional wage equations can, in some circumstances, understate the return to education because workers in an overeducated- and an undereducated-type match trade off a lower return to education for future wage gains due to training and promotion.

II. Two Illustrations of Career Mobility

By definition, overeducation or undereducation occur when the observed educational qualifications of the worker (Q) do not match the stated educational requirements for the job (R) at a particular point in time. However, a worker-firm match often occurs over multiple periods and, thus, may reflect the objectives of the worker and firm over the life of the match and not just for a single period. We develop a simple two-period model that shows overeducation (i.e., $Q>R$) and undereducation (i.e., $R>Q$) can result if some workers move up the job hierarchy with

experience. To lay a foundation for the model, it is useful to begin with two simple illustrations where career mobility can yield an overeducated- or an undereducated-type of match.

There are a number of practical examples of an overeducated-type match. For example, most U.K. police officers enter the force with secondary school qualifications, which qualifies them to be a patrol officer (i.e., a bobby on the beat). However, some people enter the police force with a university degree. These people generally begin their career as a patrol officer, because this experience improves their subsequent performance when they are promoted into jobs that require their qualifications, such as a detective. Thus, university-educated patrol officers accept jobs for which they are overeducated in exchange for training and a future promotion.

Alternatively, whereas most detectives have a college degree, some patrol officers with only secondary school qualifications are promoted to detective because their on-the-job experience in the field signals that they have the necessary skills and personal attributes to be successful detective. These secondary-educated detectives may be viewed as undereducated because their qualifications are below those of many detectives who have a university degree. It follows that the experience of these secondary-educated detectives substitute, in part, for the signal provided by a university degree and permit them to move up the job hierarchy.

These simple examples illustrate two important points. First, they suggest that standard wage equations may confound the return to education and experience, because the level of education can affect subsequent opportunities for promotion. In fact, our theoretical model predicts that the wage profile is steeper for workers in an overeducated- and undereducated-type of match because workers trade off an initial return to education for a promotion return.

Second, the illustrations suggest that the pool of exactly-educated workers may include workers who are exactly-educated throughout their career, previously overeducated workers who have been promoted into exactly-educated jobs, and undereducated-type workers who have yet to move up the job ladder. Prior work on overeducation and undereducation has not distinguished between these several groups of exactly-educated workers. Moreover, the predicted transition from or to exactly-educated jobs cannot be observed directly using existing data sources, which are cross-sectional or include only short panels. Our theoretical model suggests a possible means of indirectly distinguishing the overeducated, undereducated, and exactly-educated-type of match within a cross-section by comparing the discrete values of the educational qualifications and requirements, Q and R, with their predicted continuous values.

Workers and firms may select among several discrete values for Q and R because these variables represent a bundle of skills that permit the holder to perform tasks that could not be adequately done in the absence of any single component of the required educational background. In this case, a firm may willingly hire overeducated workers if their "excess" education improves their productivity on current and/or future jobs. This could occur because a marginal increase in the education level is directly productivity enhancing or because a degree provides a signal of desirable worker attributes that are difficult to observe at the time of hire. Moreover, if a signal can be obtained by other means such as time on the job, experienced workers may be promoted into jobs for which they are "undereducated" if they have the necessary qualification to perform the job. Thus, the return to education may be higher at the discrete qualification levels. Our analysis focuses on a secondary school qualification and university degree, which are the only values of Q and R enumerated in our data and where prior work suggests there is a significant

clustering of workers (Jaeger and Page, 1996). For simplicity, the analysis first models how workers choose their utility-maximising educational qualification and firms select the profit-maximising educational requirement in isolation before considering the joint matching process.

III. Discrete-Choice Models of Actual and Required Qualifications

A. The Individual Qualification Choice

Human capital theory predicts that individuals choose their education level in order to maximise utility, which depends on the rate of return to education. To formalise this process, we adopt a random utility approach where an individual *i* obtains a level of education, E_i^*, if the utility from this choice exceeds that of its alternatives. The actual level of education for person *i*, E_i^*, is unobserved and is modelled as a linear index function:

$$E_i^* = a' X_i + e_i \qquad \textbf{(1)}$$

where a' is a vector of parameters associated with personal, family-background, and labour market measures (X_i) that determine the rate of return to education, and e_i is a normally distributed error term that measures individual-specific random variation in the education level. In other words, (1) indicates that workers choose E_i^* based on the rate of return to education, which depends on factors such as personal ability and attitudes towards work, family access to financial and human capital, and differences in the job mix and job-market information of local labour markets.

The optimal education level in (1) is continuous, but a qualification is obtained when a worker's education level meets or surpasses a discrete, externally-verifiable threshold. For example, in the United Kingdom, a individual must attend school from the age 5 until age 16. However, a student who completes 13 years of schooling can take exams that, if passed, yield a

superior secondary qualification (i.e., an A level). At the same time, students who have one year of university have not crossed the threshold for a university degree and, thus, have a secondary school qualification as their highest qualification.

In our data the actual qualification levels are comprised of three ordered values, the government minimum education level ($Q_i=0$), at least one A-level or equivalent ($Q_i=1$), and a university degree ($Q_i=2$). Thus, following our subsequent empirical analysis, equation (1) can then be expressed as:

$$Q_i = 0 \; if \; a'X_i + e_i \leq 0 \qquad \textbf{(2.1)}$$

$$Q_i = 1 \; if \; m_A \geq a'X_i + e_i > 0 \qquad \textbf{(2.2)}$$

$$Q_i = 2 \; if \; a'X_i + e_i > m_A \qquad \textbf{(2.3)}$$

Equations (2.1) through (2.3) form the basis of an ordered-probit model of qualification choice for individual *i*. Q_i is the qualification level that results from the latent, utility-maximising education level, E_i^*.

B. <u>The Firm Requirement Choice</u>

Following producer theory, we assume that a firm hires a workers with a given education level in order maximise profits. Like the individual model, the profit-maximising education level for a workers (E_K^*) is unobserved and is expressed as a linear index function:

$$E_K^* = b'Z_k + u_k \qquad \textbf{(3)}$$

where b' is a vector of coefficients for a set of firm, job, and labour market characteristics, Z_k, that affect the return to a given education level, and u_k is a normally distributed error term that measures firm-specific random variation in the return. In other words, (3) indicates that workers with E_k^* are hired based on their return to the firm, which depends on factors such as how firm and job attributes affect the net return to education and how labour-market conditions affect the cost of changing educational requirements.

Although the education level of a worker is continuous, a qualification requirement is the smallest discrete qualification that is sufficient to properly perform the job. For example, a firm may require a university degree because a secondary school qualification does not provide the necessary skills to perform the job properly. On the other hand, while a university degree may be sufficient, one year of college may be what is necessary to properly perform the job. Thus, the stated educational qualification may exceed what is necessary to properly perform the job.

Our data, like that for individual qualifications, include three possible requirement levels. Thus, the firm's qualification choice can be represented as an ordered-probit model using (3):

$$R_k = 0 \ \ if \ \ b'Z_k + u_k \leq 0 \qquad \textbf{(4.1)}$$

$$R_k = 1 \ if \ \ m_R \geq b'Z_k + u_k > 0 \qquad \textbf{(4.2)}$$

$$R_k = 2 \ \ if \ \ b'Z_k + u_k > m_R \qquad \textbf{(4.3)}$$

where R_k represents the discrete required qualification level that is necessary to properly perform the job, which must meet or exceed the latent, profit-maximising education level, E_k^*.

III. The *Q*-*R* Matching Process

A. An Overeducated Versus and Exactly-Educated Match

In this section, we develop a simple hedonic matching model where the worker and firm can match if they share a common utility-maximising and profit-maximising education level, E^*. Figure 1 illustrates a specific case where workers and firms have selected *Q* and *R* at either the government minimum, *0*, or a secondary school qualification, *1*.

For simplicity, the analysis focuses on two firms, *X* and *Y*, that operate in a competitive market and earn zero economic profit in each of two periods. Jobs in each firm have upward-sloping, zero-profit, iso-profit lines (ð) in the wage-education space. The iso-profit lines are upward sloping because revenue and costs are assumed to increase on the margin with *E*. On the other hand, the height of the iso-profit lines differs between jobs at a qualification level because the worker has acquired the bundle of skills necessary to move up the job hierarchy. Productivity in Firm *Y* is assumed to be solely a function of education, whereas Firm *X* provides on-the-job training in the first period in an entry-level job, which links productivity to both education and experience. In other words, we assume that workers in Firm *X* move up the job hierarchy in period 2 with experience (e.g., $p^{1}_{X} \rightarrow p^{2}_{X}$). Following the discrete choice model, the iso-profit lines are also indexed by *R=0* or *R=1*, which represent the minimum discrete qualification to properly perform the job.[1]

[1]For notational convenience, workers climb the job ladder only in their current firm. The results do not change, however, if experience in the current firm improves the promotion prospects in other firms.

The analysis focuses on the utility-maximising match for two workers, *A* and *B*. For simplicity, Worker *A* is assumed to have an optimal education level equal to the governmentally mandated minimum (i.e., $Q_A=E^*=0$), whereas Worker *B* has an optimal education level equal to a secondary school qualifications (i.e, $Q_B=E^*=1$). Consider the equilibrium in Figure 1. The minimum education level permits Worker *A* to match in the lower-rung job of Firm *X* that pays W_0. Worker *A* is exactly educated because the minimum education level matches the education requirements (i.e., $Q_A=R=0$).

However, Worker *B*, who has an A-level, can match with Firm *X* or *Y*. In Firm *Y*, Worker *B* is exactly educated (i.e., $Q_B=R=1$) and earns W_2 in both periods, because earnings do not increase with experience. In firm *X*, Worker *B* earns W_1 in the entry-level job in the first period and is overeducated because his or her A-level exceeds the minimum education level that is necessary to perform the job (i.e., $Q_B>R=0$). However, in period 2, Worker *B* is promoted into a job for which the A-level is necessary (i.e, $Q_B=R=1$) and earns W_3. In equilibrium, the earnings in *X* and *Y* must be the same in order for worker 2 to be indifferent between the two jobs. Thus, it must be the case that $W_1+W_3=2W_2$, abstracting from discounting and assuming the periods are of the same length. It follows that overeducation occurs early in a career.

The wage predictions in Figure 1 match the wage findings of Sicherman (1991) for overeducated workers in the PSID. Specifically, Worker *B* is overeducated in period 1 in Firm *X* (i.e., $Q_B>R=0$) and earns more than the exactly-educated Worker *A* in the same job (i.e., $Q_A=R=0$), so that $W_1>W_0$. At the same time, Worker *B* earns less in the first period working for Firm *X* in the overeducated job than for the exactly-educated job in Firm Y (i.e., $Q_B=R=1$), so that $W_1<W_2$. The worker and firm match based on a common E^*. However, overeducation can

occur in equilibrium, because workers place in entry-level jobs that prepare them for future jobs that require their formal education and job-related experience.

The wage differential between Worker *A* and *B*, W_3-W_0, can be divided into two components. First, comparing an exactly-educated worker to an overeducated worker in the same job (i.e., Worker A versus B on p^1_X), an overeducated worker has higher qualifications than would be predicted for a typical worker in a low *R* job, $Q_B > E^*_0$. Worker *B* earns a wage premium, W_1-W_0, for these excess qualifications.

Second, comparing the same worker in an exactly-educated versus an overeducated match (i.e., Worker *B* on p^1_X versus p^2_X), the firm has lower requirements than would be predicted for a firm that hires workers with an A-level, $R < E^*_1$. Worker *B* earns a wage premium, W_3-W_1, for the promotion into a job with greater requirements. Note, however, that Worker *B* could also match with Firm *Y* that pays more in the first period but less in the second period than Firm *X*. Thus, Worker *B* trades off an initial low rate of return to human capital for a promotion return. It follows that an overeducated worker is more likely to have $Q>E^*$ relative to a comparably-placed, exactly-educated worker and is more likely to work for a firm that has $R<E^*$ relative to a comparably-educated, exactly-educated worker.

B. <u>An Undereducated Versus an Exactly-Educated Match</u>

Figure 2 compares the wage-requirement relationship for undereducated and exactly-educated workers using the notation in Figure 1. Specifically, there are two competitive firms that earn zero economic profit in each of two periods. In Firm *X*, worker productivity depends on both education and experience, whereas productivity depends solely on education in Firm *Y*. In this case, however, suppose that one year of university is the minimum education level necessary

to properly perform job 2 for Firm *X* (i.e., $E_1^* = 1.5$). It follows that the minimum sufficient requirement is a university degree (i.e., *R=2*), because qualifications are discrete and must meet or exceed the education level that is necessary to perform the job. Nonetheless, the discrete jump in the iso-profit curve could occur in-between qualification levels (p_X^1 to p_X^2 at $E_1^* = 1.5$) if a significant portion of the benefit to a qualification, like a university degree, is a signal of innate unobservable attributes. Thus, if workers can provide the signal through some other means, such as work experience and/or successfully completing on-the-job training, they would be qualified to move up the job hierarchy.[2]

Suppose Worker *A* has an A-level (i.e., $Q_A=1$) plus one year of college, which meets the necessary education level to match with Firm *X* or *Y*. In Firm *X*, Worker *A* earns W_0 in the first period and is exactly educated because an A-level meets the requirements (i.e, $Q_A=R=1$). In the second period, Worker *A* moves into job 2 and earns W_2 and is undereducated (i.e., $Q_A<R=2$). Alternatively, in Firm *Y*, Worker *A* earns W_1 in both periods and is exactly educated because a secondary degree is sufficient (i.e, $Q=R=1$). In equilibrium, Worker *A* must be indifferent between the two jobs such that $2W_1=W_0+W_2$, abstracting from discounting and period length differences. Nonetheless, Worker *A* earns less than an exactly-educated type *B* Worker who has a university degree (i.e., $Q=R=2$), who earns W_3 in the second period.

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[2]Similarly, Alba-Ramirez (1993) contends that educational mismatch can result from the substitution of experience, tenure, or training for formal educational qualifications to obtain the desired aggregate human capital bundle of a firm for its workers. He finds empirical evidence in support of this 'substitution hypothesis' using cross-sectional Spanish labour market data, which is replicated for the U.K. using the SCELI data by Sloane et al (1996).

This process yields the same wage-education pattern observed in Sicherman (1991) for undereducated workers. Specifically, in period 2, Worker *A* earns more in the undereducated match of Firm *X* (i.e., $Q_A<R=2$) than in the exactly-educated match of Firm *Y* (i.e., $Q_A=R=1$) so that $W_2>W_1$. Worker *A* also earns less than an exactly-educated Worker B who is matched in a job with the same requirements (i.e., $Q_B=R=2$) so that $W_2<W_3$. Thus, workers and firms match on the basis of a common E^*. Nonetheless, experienced workers can appear undereducated because the on-the-job experience early in a career "substitutes" for the educational signal and permits them to move up the job ladder into a position where they have the necessary skills to properly perform the job, but do not meet the discrete qualification level required of "typical" workers.

Again, the wage differential between Worker *A* and Worker *B*, W_3-W_0, can be divided into two components. First, comparing the same worker in an exactly-educated versus an undereducated match (i.e., Worker *A* on p_X^1 versus p_X^2), the firm in the undereducated match has higher requirements than would be predicted given that it hires workers with an A-level, $R > E_1^*$. The firm pays a return for a job with excess requirements, W_2-W_0. Note, however, Worker *A* could also work for Firm *Y*, which pays more in the first period but less in the second period than Firm *X*. Thus, Worker *A* trades off an initially low rate of return to education for a subsequent promotion return.

Second, comparing an exactly-educated worker to an undereducated worker in the same job (i.e., Worker A versus B on p_X^2), an undereducated worker has lower qualifications than would be predicted for a typical worker in a job that require a university degree, $Q < E_2^*$. Worker *A* earns less than Worker *B*, W_3-W_2, reflecting the marginal return to additional

educational qualifications on a given job. In summary, an undereducated worker is more likely to work for a firm that has $R>E^*$ relative to comparably-educated, exactly-educated workers and more likely to have $Q<E^*$ relative to comparably-placed, exactly-educated workers.

C. Predictions

The theoretical model yields three predictions. First, a worker in an overeducated type of match is predicted to have $Q>E^*$ and $R<E^*$, and a worker in an undereducated type of match is predicted to have $Q<E^*$ and $R>E^*$. The ordered probit models in 2.1-2.3 for the qualification choice of workers and 4.1-4.3 for the requirement choice of firms permit a comparison between the observed Q or R and the predicted E^* independent of the observed match. However, because matching process is predicted to jointly determine Q and R, the ordered probit models are estimated simultaneously and include a parameter for the correlation of Q and R. The joint ordered probit estimates are used to predict whether $Q \gtreqless E^*$ controlling for the R-type of the firm (i.e., a movement along an iso-profit curve), and to predict whether $R \gtreqless E^*$ controlling for the Q-type of the individual (i.e., a movement between iso-profit curves for the same person). The predicted match types from the model are tested by comparing the differences between Q and E^* and R and E^* for workers who are observed to be overeducated, undereducated, or exactly-educated.

Second, the model predicts that both overeducated and undereducated workers may be more likely to receive training and move up the job hierarchy than exactly-educated workers who are comparably-placed and educated. Thus, two probit models are estimated for the probability of receiving training and earning a promotion, including controls for workers who are predicted to be in an overeducated- and undereducated-type match from the ordered probit model.

Finally, the model predicts that workers in an overeducated and undereducated type of match trade off a lower rate of return to education for a subsequent promotion return. Thus, the wage profile is expected to be relatively steep for workers in overeducated and undereducated types of matches. This hypothesis is tested by estimating several wage regressions that include controls for workers who are predicted by the ordered probit model to be in an overeducated- and undereducated-type match, and the interactions of these controls with years of education.

IV. The Data and Derivation of the Match Variables

A. The Data Source

The data source for the empirical analysis is the Social Change and Economic Life Initiative (SCELI) that surveyed 6,110 people in roughly equal numbers from six different labour markets - Aberdeen, Coventry, Kirkcaldy, Northampton, Rochdale and Swindon. These data are unique in their detail of the individual, job, and firm attributes, which are necessary to conduct the empirical analysis. These data were collected in June and July of 1986, using stratified random sampling to obtain a respondent sample representative of British working-age adults. The sample includes wage and salary workers and people who are self-employed, unemployed, or out of the labour force.

The analysis uses a subset of these data that includes 1556 observations for male, wage and salary workers who report all relevant information. Women are excluded to make our analysis comparable to prior work on overeducation (e.g., Cohn and Khan, 1995; Sicherman, 1991; Verdugo and Verdugo, 1989). The self-employed are excluded because SCELI includes only limited information regarding firm and job attributes for these workers. Persons who are

unemployed or out of the labour force are excluded for the obvious reason that a person must be employed in order for us to observe differences between *Q* and *R*.

B. The Ordered Probit Specification

The data are first used to estimate the ordered-probit models. The actual and required qualifications (*Q* and *R*) are delineated as low, medium, and, high with a numerical ordering of 0 through 2. Highly qualified workers obtain an advanced degree (i.e., a degree or diploma from a university or college), medium-qualified workers obtain either an A-level, apprenticeship, or equivalent qualification, whereas the low-qualified workers obtain none of these qualifications.[3] These categories are sufficiently narrow to ensure differences among the qualification levels (i.e., 2>1>0), and are sufficiently broad to ensure that workers within a given category have similar qualifications (e.g., nurses and teachers are similarly educated).

Following the empirical model, the ordered-probit specification for *Q* includes family attributes that measure access to financial and human capital, and attitudinal/first-job attributes that measure labour-market commitment and opportunities, and the ordered-probit specification for *R* includes measures of firm, job, and labour market attributes. For brevity, the means of the explanatory variables used in the ordered-probit models for *Q* and *R* are included in Appendix

[3]A high qualification includes a Higher National Certificate (Diploma), a University Diploma, a Nursing and Teaching Qualification, and other professional, university or CNAA degree. A medium qualification includes a General or Scottish Certificate of Education (i.e., an A-level or Higher), a Certificate of Sixth Year Studies, City and Guilds, Ordinary National Certificate (Diploma), a Scottish Vocational training degree, a Clerical and Commercial or Trade apprenticeship. A low-skill qualification includes all other qualifications.

Tables 1 and 2, respectively, for categories 0-2 and for the match types $Q>R$, $Q=R$, and $Q<R$. However, consistent with the theoretical models prediction, the descriptive statistics do indicate that overeducated workers tend to be younger and undereducated workers older than their exactly educated counterparts.

C. The Predicted Match Type

Maximum-likelihood estimates of the joint ordered-probit models for Q and R are presented in Table 1. The estimated correlation coefficient between the errors for Q and R is 0.573 and significantly different from zero, which supports the contention that Q and R should be estimated simultaneously. The correlation coefficient is also significantly different from one, which indicates that the match of actual and required qualifications, although correlated, is far from exact. The coefficients on the explanatory variables are generally significant and suggest that family background and labour-market opportunities affect the choice of actual qualifications whereas firm and job attributes affect required qualifications.

The tests of the model hinge on correctly predicting the type of match. Thus, the discussion focuses on whether overeducated workers are predicted to have $Q>E^*$ and $R<E^*$ and whether undereducated workers are predicted to have $Q<E^*$ and $R>E^*$ by the ordered probit model. Table 2 presents a comparison between E^*, which is defined as the educational category that has the maximum joint probability from the ordered-probit models, and the observed values of Q and R for workers who are observed to be overeducated ($Q>R$), exactly-educated ($Q=R$), and undereducated ($Q<R$). The bold cells in Table 2 indicate that 89 percent of the 303 overeducated workers are predicted to have $Q>E^*$ (i.e., row 3) or $R<E^*$ (i.e., column 1). Similarly, 89 percent of the 207 undereducated workers are predicted to have $Q<E^*$ (i.e., row 1)

or $R>E^*$ (i.e., column 3). Moreover, whereas the majority of exactly-educated workers place in the centre cell where $Q=R=E^*$, 46 percent of workers are predicted to be in the surrounding cells that may not expected to be in an exactly-educated match through-out their career. Thus, the results in Table 2 broadly support the predictions of the theoretical model regarding the relationship between the predicted education level and the actual qualifications and requirements.

For simplicity, four dummy variables are used to identify the type of match in the probit and wage specifications. Specifically, an overeducated-type match is defined by two binary variables that equal one if the observed qualification exceeds the predicted qualification, $Q>E^*$, or if the observed requirement is less than the predicted requirement, $R<E^*$. Similarly, an undereducated-type match is also defined by two binary variables that equal one if the observed qualification is less than the predicted qualification, $Q<E^*$, and if the observed requirement is exceeds the predicted requirement, $R>E^*$. Thus, the excluded categories are $Q=E^*$ and $R=E^*$, which are predicted for an exactly-educated type of match.

The use of two dummy variables for each match type permit a distinction between predicted movements along and between iso-profit curves. Moreover, for exactly-educated workers, the dummy variables can potentially separate those workers who are expected to be exactly-educated through out their career from those who are predicted to be overeducated and undereducated at some point in their career. Although the identification of the match type is not likely to be exact, the coefficients on the dummy variables in the probit and wage models would

not be expected to support the predictions of the theoretical model to the extent they are imprecise measures of the type of match.[4]

V. Current Training, Promotion, and Wage Analyses

The dependent variables for training and promotion are defined by two binary variables that equal one if a worker indicates that he or she received training on the current job or has a good or excellent chance of promotion. Weekly earnings are used in the wage model following prior work that suggests that this measure has less measurement error than hourly earnings and controls for part-time work unlike annual earnings (e.g., Borjas, 1980). Following Sicherman (1991), each specification includes a vector of standard worker attributes used as explanatory variables in a Mincer-earnings equation. Our analysis differs from prior work by including four binary variables that measure the type of match.

The probit results for training and promotion prospects in the current job are provided in Table 3. A likelihood-ratio test between the specifications that do and do not distinguish by the type of educational match (i.e., columns 1 vs. 2 and columns 3 vs. 4) yields a value of 17.52 in the training equation and 11.8 in the promotion equation, which are significant at the 5 and 10

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[4]The empirical model is also estimated identifying an overeducated type of match as workers who are observed to be overeducated or those who are exactly educated but have $Q>E^*$ and $R<E^*$, and the undereducated type of match as workers who are observed to be undereducated or those who are exactly educated but have $Q<E^*$ and $R>E^*$. The results for the match variables from the probit and wage models are qualitatively equivalent to those presented, but are generally less significant. This result may suggest that those workers who are overeducated or undereducated but are not predicted to be are truly mismatched.

percent level, respectively. Overall, the sign and magnitude of the coefficients on the match variables support the contention that the training and promotion opportunities vary with the type of educational match. For brevity, the empirical discussion focuses on educational match issues.[5]

The coefficients on match variables are positive in the probit model for current training, but only the coefficients on the qualification and requirement differences for an overeducated type of match are significant at traditional levels. Thus, workers that select an overeducated-type of match and the firms that hire them are more likely to be engaged in training than their exactly-educated counterparts, whereas those workers and firms in an undereducated type match are not. This result may indicate that the promotion process for overeducated-type jobs reflects the acquisition of on-the-job training, but that the promotion process for undereducated-type jobs may arise more from a worker signalling to the firm that he or she has an aptitude for the job.[6] The coefficients on the requirement differences in an overeducated- and undereducated-type

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[5]The probit and wage models are identified both by exclusion restrictions and through the nonlinearity of the first-stage ordered-probit model. To test the possible sensitivity of the results to overidentifying restrictions in the probit and wage models, each specification is reestimated including all the explanatory variables in the ordered-probit model and relying on nonlinearity for identification. In each case, the sign and significance of the coefficients on the match variables do not change. Thus, the results are robust to changes in the identifying restrictions.

[6]Sloane et al (1999) find that overeducated workers are more likely to leave their current firms, while the undereducated are more likely to stay with their current firms. This would be the expected result if the training in an overeducated type match is general, whereas the signal in an undereducated type match is firm specific.

match are also significantly positive in the probit model of promotion, which supports the prediction of the theoretical model that the promotion opportunities are better in an overeducated and undereducated-type of match.

Three specifications of the wage equation are provided in Table 4.[7] A standard earning equation is included in column 1 and provides a source of comparison for Model 2 that includes the match variables. An F-statistic comparing Models 1 and 2 equals 7.5, which is significant at the 1 percent level. The specification in Model 3 examines possible interaction effects between the educational match variables and the level of education. The F-statistic comparing the specifications in Models 2 and 3 is 6.60, which is also significant at the 1 percent level. Thus, the interaction effect appears to be important for wages.

In general, the sign and significance of the coefficients support the predictions of the theoretical model.[8] In Model 2, the coefficient on the qualification differences are positive and significant for both the overeducated- and undereducated-type match. This finding is consistent with the prediction of the theoretical model that changes in qualifications along the iso-profit curve yield higher wages. In addition, the coefficient on the requirement differences is

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[7]Wage specifications that include quadratic terms for education and experience are also estimated and yield the same qualitative conclusions as those presented. Thus, we focus on the most parsimonious of specifications for ease of presentation.

[8]The number of observations is smaller in the wage equations than in the ordered probit model because some workers do not report their wage. However, the mean *Q* and *R* of workers who do and do not report their wage does not significantly differ and, thus, is not expected to bias the results in a particular direction.

insignificant for the overeducated-type match, but positive and significant for the undereducated match type. The theoretical model predicts the sign of the coefficients on the requirement differences are indeterminate, because overeducated- and undereducated-type workers are expected to trade off a low initial return to education for a subsequent promotion return. In the interactive specification in Model 3, the coefficient on the requirement differences are positive and significant, whereas its interaction with years of education in negative and significant. Thus, the results confirm the predicted tradeoff between the schooling and promotion return for workers in an overeducated- and undereducated-type match.[9]

VI. Concluding Remarks

Prior evidence from the U.S. and Europe indicates that the educational qualifications of a third or more of the work force either exceed or fall short of the employer-specified education requirements for the job. This paper theoretically models and empirically tests the hypothesis that overeducation and undereducation arise out of a common equilibrium matching process whereby

[9]The coefficients in the wage equations, although different from those found using U.S. data sources, are typical of those found using U.K. data sources with the exception of a relatively low return to education. Our return to education estimates are not directly comparable to most U.K. studies that calculate the return using qualification dummies and not years of education. However, Polacheck and Siebert (1993) use data on men and women drawn from the 1972 General Household Survey of the U.K. to estimate a wage specification including the number of years of education and find a rate of return equal to 6.2 percent. We replicate their specification using men and women in SCELI (not presented), which also yields a return to education of 6.2 percent. Thus, the results are unlikely to be due to some unique attributes of the SCELI data.

workers choose a discrete qualification level to maximise lifetime income and firms set a discrete qualification requirement to maximise profits. The theoretical model predicts that the overeducated begin in low-paying, entry-level jobs early in their career that train them for higher-paying future positions that require their educational background. Likewise, the undereducated start in low-paying, exactly-educated jobs that, in time, can signal the worker has the necessary skills for promotion. Thus, our model suggests that prior work that identifies and compares the economic aspects of overeducation or undereducation relative to the exactly educated in a cross-section or a short panel may be misleading, because all workers are likely to be exactly-educated during some portion of their career.

The predictions of the theoretical model are tested by several related empirical analyses that use a sample of British working-age males from the Social Change and Economic Life Initiative (SCELI) data. The discrete-hedonic-matching model provides the basis for a joint ordered-probit model of worker qualifications and firm requirements. The results confirm the prediction of the theoretical model that the type of educational match relates to differences between the predicted and observed qualifications of the worker and the predicted and observed requirements of the firm. These differences are used to identify the type of educational match in probit models for on-the-job training and promotion and in several wage equations. The results show that traditional wage equations can understate the return to education because workers in an overeducated- and undereducated-type match trade off a lower return to education for future wage gains from promotion.

Overall, the theoretical model provides the first holistic approach to the matching process between workers are firms that can lead to overeducation or undereducation and extends the

equilibrium interpretation of overeducation in Sicherman and Gabor (1990) to undereducation. The empirical work support the contention that workers and firms can benefit from a match where worker qualifications do not equal firm requirements. Thus, the paper show that, although workers and firms may not always be appropriately matched, the degree of mismatch in the labour market is likely to be smaller than the 30 to 50 percent of workers who are overeducated or undereducated at any point in time in the labour market.

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Figure 1 Overeducation

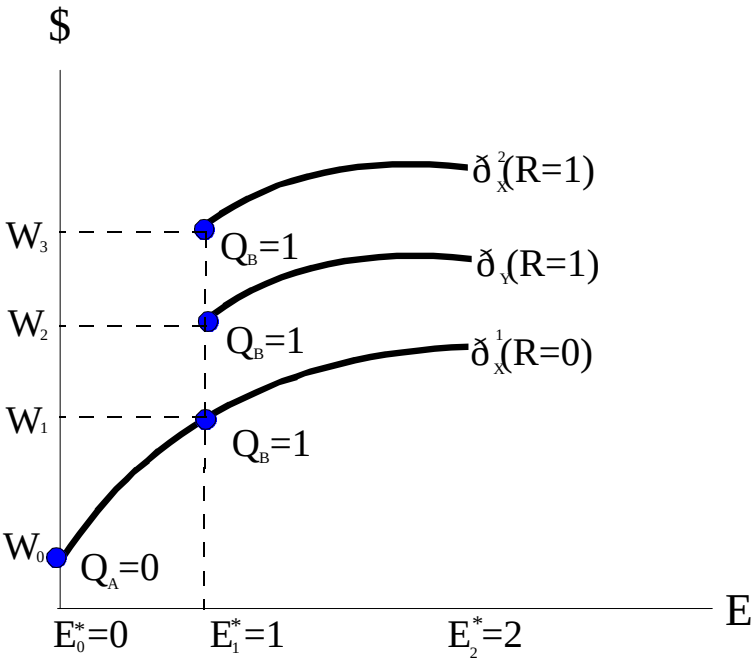

Figure 2 Undereducation

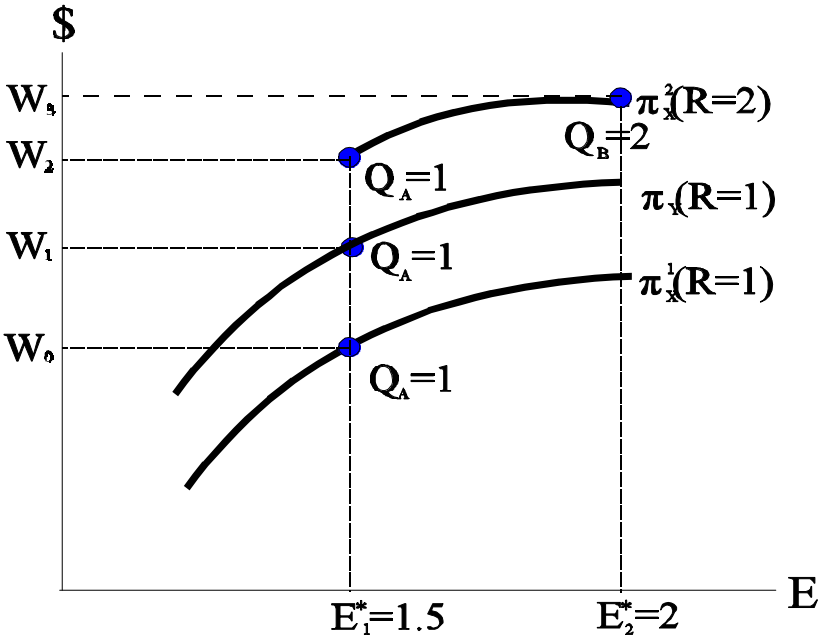

Table 1 Bivariate Ordinal Probit Results

Qualifications (*Q*)			Requirements (*R*)		
Variable	Coefficient	Asymp. *t*-value	Variable	Coefficient	Asymp. *t*-value
Mother Out of Work	-0.202	-3.466	Professional	1.244	10.806
Mother White Collar	0.179	0.739	Non Manual	1.045	9.517
Mother Self Employed	-0.242	-0.899	Skilled Manual	0.514	5.06
Father Out of Work	-0.163	-1.797	Employees>500	0.206	3.083
Father White Collar	0.415	4.554	Insider is Important	-0.056	-0.769
Father Self Employed	0.124	1.292	Union	-0.099	-1.601
Age	-0.006	-2.222	Requirements Nec.	0.767	11.702
Married at Age 20	-0.259	-2.995	Time to Proficiency	0.15	6.151
Kids at Age 20	-1.422	-2.815	Years of Training	0.062	2.538
Work Natural	-0.298	-2.797	Good Promotion Prspt.	0.078	1.204
Work if Rich	0.084	1.47	Sprvis. Effects Wrk.	-0.073	-1.119
Men are Prm. Earner	0.363	5.194	Reorg. in Last 5 Yrs.	0.148	2.47
Men's Jobs Come First	0.22	3.305	Part-Time Job	-0.223	-0.793
Public Sector Job	0.279	4.172	Log of Hours Worked	-0.21	-1.319
Hours Worked: 35-40	-0.223	-1.962	Unemployment Rate	0.009	1.202
Hours Worked: >40	-0.278	-2.358	-	-	-
Supervisory Resp.	0.495	3.481	-	-	-
Cowrks. Mainly Men	-0.036	-0.593	-	-	-
Good Promotion Prspt.	0.18	3.282	-	-	-
Central England[a]	-0.168	-2.128	-	-	-
Northern England	-0.009	-0.104	-	-	-
Urban Scotland	0.011	0.141	-	-	-
Rural Scotland	0.672	2.019	-	-	-
Other Countries	0.014	0.074	-	-	-
Constant	0.537	3.128	Constant	-0.705	-1.144
μ_2	1.01	26.361	μ_1	1.002	22.295

Number of observations = 1556
Log-likelihood = -2614.97
Estimated correlation (ñ) = 0.573, standard error = 0.030

Table 2 Predicted and Observed Qualifications and Requirements

Overeducated: $Q > R$ (Number of Observations = 303)				
	$R < E^*$	$R = E^*$	$R > E^*$	Total
$Q < E^*$	**5.61**	0.33	0.00	5.94
$Q = E^*$	**10.23**	10.23	0.00	20.46
$Q > E^*$	**3.30**	**63.04**	**7.26**	73.60
Total	19.14	73.60	7.26	100.00
Exactly Educated: $Q = R$ (Number of Observations = 1046)				
	$R < E^*$	$R = E^*$	$R > E^*$	Total
$Q < E^*$	6.69	7.84	0.00	14.53
$Q = E^*$	2.39	**53.73**	2.10	58.22
$Q > E^*$	0.00	6.21	21.03	27.24
Total	9.08	67.78	23.13	100.00
Undereducated: $Q < R$ (Number of Observations = 207)				
	$R < E^*$	$R = E^*$	$R > E^*$	Total
$Q < E^*$	**8.21**	**16.43**	**3.38**	28.02
$Q = E^*$	0.48	10.63	**43.96**	55.07
$Q > E^*$	0.00	0.00	**16.91**	16.91
Total	8.69	27.06	64.25	100.00

Table 3 Probit Models for Training and Promotion

		Current Training		Promotion Prospects	
Variable	Means	Model 1	Model 2	Model 1	Model 2
Personal Attributes					
Constant		-0.671 (-2.561)	-0.895 (-3.309)	0.190 (0.702)	0.102 (0.370)
Years of Education	11.198	0.003 (0.147)	0.014 (0.819)	0.002 (0.117)	0.008 (0.440)
Total Experience	20.846	-0.015 (-4.133)	-0.013 (-3.493)	-0.020 (-5.454)	-0.019 (-5.004)
Employees>500	0.279	0.322 (4.305)	0.311 (4.140)	0.369 (4.706)	0.357 (4.531)
Professional	0.224	0.660 (5.899)	0.554 (4.786)	0.665 (5.977)	0.587 (5.116)
Non-Manual	0.241	0.678 (6.357)	0.576 (5.207)	0.530 (5.038)	0.448 (4.106)
Skilled Manual	0.328	0.331 (3.422)	0.291 (2.915)	0.077 (0.843)	0.038 (0.399)
Union Firm	0.523	0.354 (5.019)	0.357 (5.044)	0.166 (2.338)	0.169 (2.367)
Unemployment Rate	13.2	-0.009 (-1.013)	-0.009 (-1.081)	-0.006 (-0.653)	-0.006 (-0.670)
Married	0.702	0.065 (0.685)	0.054 (0.558)	0.157 (1.646)	0.138 (1.435)
Number of Kids	0.79	0.067 (1.813)	0.081 (2.168)	0.028 (0.725)	0.042 (1.093)
Overeducation					
Qualification Differences ($E^*<Q$)	0.326	-	0.129 (1.691)	-	-0.071 (-0.925)
Requirement Differences ($E^*>R$)	0.098	-	0.423 (3.458)	-	0.381 (2.760)
Undereducation					
Qualification Differences ($E^*>Q$)	0.135	-	0.128 (1.188)	-	0.027 (0.247)
Requirement Differences ($E^*<R$)	0.241	-	0.053 (0.630)	-	0.143 (1.695)
Log-likelihood	—	-976.874	-968.115	-958.179	-952.279

Note. Asymptotic *t*-values are in parentheses. All models have 1556 observations.

Table 4 Wage Regressions

Variable	Mean	Model 1	Model 2	Model 3
Personal Attributes				
Constant		4.479 (49.659)	4.409 (48.136)	4.342 (45.878)
Years of Education	11.198	0.034 (5.710)	0.036 (6.082)	0.043 (6.691)
Total Experience	20.846	0.008 (6.039)	0.008 (6.344)	0.008 (6.223)
Employees>500	0.279	0.177 (6.826)	0.176 (6.842)	0.172 (6.704)
Professional	0.224	0.382 (10.285)	0.380 (9.962)	0.371 (9.711)
Non-Manual	0.241	0.147 (4.149)	0.139 (3.810)	0.134 (3.692)
Skilled Manual	0.328	0.169 (5.410)	0.144 (4.499)	0.137 (4.253)
Union Firm	0.523	0.020 (0.842)	0.026 (1.071)	0.028 (1.187)
Unemployment Rate	13.2	-0.014 (-4.808)	-0.015 (-5.147)	-0.015 (-5.093)
Married	0.702	0.095 (2.938)	0.090 (2.813)	0.089 (2.766)
Number of Kids	0.79	0.067 (5.265)	0.069 (5.484)	0.069 (5.467)
Overeducation				
Qualification Differences (E^*<Q)	0.326	-	0.051 (1.964)	0.051 (1.951)
Requirement Differences (E^*>R)	0.098	-	-0.016 (-0.382)	0.584 (2.479)
(Yrs of Educ)×(E^*>R)	1.129	-	-	-0.052 (-2.596)
Undereducation				
Qualification Differences (E^*>Q)	0.135	-	0.109 (3.003)	0.100 (2.736)
Requirement Differences (E^*<R)	0.241	-	0.112 (3.938)	0.363 (2.503)
(Yrs of Educ)×(E^*<R)	2.638	-	-	-0.023 (-1.756)
R^2		0.252	0.268	0.273

Note. *T*-values are in parentheses. All models have 1383 observations.

Appendix Table 1 Variable Means for Qualifications

Variable	*Q = 0* (633 obs.)	*Q = 1* (530 obs.)	*Q = 2* (393 obs.)	*Q > R* (303 obs.)	*Q = R* (1046 obs.)	*Q < R* (207 obs.)
Family Background						
Mother Out of Work	0.403	0.285	0.277	0.281	0.341	0.353
Mother White Collar	0.008	0.013	0.018	0.017	0.011	0.01
Mother Self Employed	0.009	0.011	0.01	0.013	0.01	0.01
Father Out of Work	0.134	0.094	0.069	0.092	0.111	0.087
Father White Collar	0.057	0.091	0.221	0.109	0.114	0.092
Father Self Employed	0.077	0.079	0.117	0.083	0.093	0.072
Work Attitudes						
Age	38.87	35.438	36.962	34.716	37.256	40.696
Married at Age 20	0.148	0.125	0.051	0.096	0.118	0.135
Kids at Age 20	0.011	0.004	0	0	0.006	0.014
Work Natural	0.093	0.066	0.038	0.069	0.069	0.077
Work if Rich	0.611	0.668	0.715	0.63	0.67	0.628
Men are Primary Earner	0.158	0.213	0.31	0.261	0.206	0.198
Men's Jobs Come First	0.18	0.257	0.293	0.188	0.249	0.232
Labour Market Attributes						
Public Sector Job	0.156	0.2	0.356	0.205	0.234	0.184
Hours Worked: 35-40	0.463	0.489	0.471	0.508	0.476	0.411
Hours Worked: > 40	0.491	0.457	0.407	0.432	0.447	0.551
Supervisory Resp.	0.019	0.03	0.109	0.026	0.054	0.029
Coworkers Mainly Men	0.717	0.747	0.618	0.696	0.703	0.71
Good Promotion Prspt.	0.427	0.485	0.649	0.465	0.507	0.536
Central England[a]	0.294	0.283	0.226	0.238	0.273	0.324
Northern England	0.177	0.183	0.204	0.188	0.193	0.145
Urban Scotland	0.291	0.37	0.252	0.337	0.303	0.29
Rural Scotland	0.005	0.002	0.02	0.017	0.005	0.01
Other Countries	0.025	0.017	0.033	0.023	0.024	0.029

a - the excluded region is Southern England

Appendix Table 2 Variable Means for Requirements

Variable	*R = 0* (758 obs.)	*R = 1* (397 obs.)	*R = 2* (401 obs.)	*Q > R* (303 obs.)	*Q = R* (1046 obs.)	*Q < R* (207 obs.)
Firm Attributes						
Professional	0.111	0.161	0.501	0.175	0.225	0.295
Non Manual	0.165	0.237	0.389	0.264	0.229	0.266
Skilled Manual	0.358	0.504	0.1	0.307	0.328	0.362
Employees>500	0.261	0.264	0.327	0.244	0.27	0.377
Insider is Important	0.773	0.776	0.81	0.799	0.774	0.807
Union	0.544	0.531	0.476	0.508	0.537	0.473
Job Attributes						
Requirements Necessary	0.222	0.768	0.778	0.363	0.518	0.643
Time to Proficiency	0.856	1.802	1.762	1.123	1.315	1.716
Years of Training	0.349	0.896	1.026	0.652	0.608	0.957
Good Promotion Prspt.	0.542	0.62	0.786	0.611	0.614	0.7
Supervision Effects Wrk.	0.259	0.307	0.262	0.287	0.27	0.261
Job Reorg. in Last 5 Yrs.	0.409	0.401	0.529	0.419	0.424	0.531
Part-Time Job	0.021	0.013	0.017	0.02	0.018	0.014
Log of Hours Worked	3.67	3.662	3.642	3.671	3.655	3.673
Labour Market Attributes						
Unemployment Rate	13.267	13.523	12.753	12.905	13.266	13.295