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Evidence on the relationship between firm-based screening and the returns to education

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Abstract

We explore the relationship between the signalling role of education and direct screening measures adopted by employers using a matched employee–employer data set drawn from the 1998 *Workplace Employee Relations Survey* for Great Britain. We identify which firms use personality/attitude and/or performance/competency tests during the hiring process and, by combining this and other firm level information with employee level characteristics, investigate whether such tests affect the signalling role of education. Our results suggest that hiring tests inhibit the signalling role of education, and that a failure to control for such tests may bias estimates of the returns to education.

JEL classification: J31; J24

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1. Introduction

According to the screening hypothesis schooling is a signal of productivity. The strong screening hypothesis (SSH) argues that schooling is used exclusively as a signal (Psacharopoulos, 1979), whilst the weak screening hypothesis (WSH) argues that schooling may have a productivity enhancing as well as a signalling role (Arrow, 1973; Spence, 1973).[1] Whether strong or weak screening prevails, education enhances lifetime earnings and is a good investment for individuals (Psacharopoulos, 1994). Whether or not schooling is a good investment for society is less clear.[2] The screening hypothesis has been subject to many empirical tests (Weiss, 1995). Many of these studies have found little or no support for the SSH and some support for the WSH

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[1]In signalling models employees choose the level of education necessary to signal their productivity to potential employers. In contrast, in screening models employers set a required level of education that discriminates between applicants. In what follows we use the term sorting to describe both signalling and screening.

[2]The debate is arguably also redundant at the social level. The fact that firms pay higher wages to more educated workers means that either education raises productivity or that it signals desirable unobservable individual characteristics (Lang, 1994). The social rate of return to schooling may exceed the private rate of return if sorting improves the match between workers and jobs (Stiglitz, 1975).

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(Brown & Sessions, 1998; Cohn, Kiker, & Mendes De Oliveira, 1987; Fredland & Little, 1981; Grubb, 1993; Katz & Ziderman, 1980; Riley, 1979; Shah, 1985; Tucker, 1985; Wolpin, 1977).

It is surprising that the role of the employer—the recipient of the signal—has attracted relatively scant attention in the literature. Given the human capital and consumption aspects of education, any signal derived from the latter will be inevitably noisy and may encourage employers to adopt their own, more efficient, screening measures. Such practices are likely to impact on the sorting role of education—individuals with relatively less-attractive private information, for example, may be more inclined to apply to firms that do not utilise direct testing (Weiss, 1995).[3] The paucity of empirical research into this important area is perhaps a reflection of data limitations—progress clearly requires information about both employees and employers.

In what follows, we attempt to redress this imbalance in the literature by exploring the interaction between education and direct screening measures adopted by employers. We derive a matched employee–employer data set from the 1998 *Workplace Employee Relations Survey* (*WERS*) for Great Britain, which enables us to identify which firms use personality/attitude or performance/competency tests during the hiring process. By combining such information with data on employee level characteristics, we are able to explore how the use of hiring tests by employers impacts on the signalling role of education. Our results suggest that hiring tests inhibit the signalling role played by education certificates, and that a failure to control for such tests may bias estimates of the returns to education. In addition, our results suggest that the different types of hiring test impact differentially on the signalling role of education.

2. Data and methodology

Our data are derived from the 1998 cross-section *WERS*. This is the fourth in a Government funded series of surveys conducted at British workplaces, the previous three surveys having been conducted in 1980, 1984 and 1990. The aim of the survey is to provide nationally representative data on the current state of workplace relations and employment practices in Britain, and it is widely regarded as the principal source of information pertaining to changes in British industrial relations (Airey et al., 1999).[4]

The *WERS* comprises three main sections; the 'Management Questionnaire', the 'Worker Representative Questionnaire' and the 'Employee Questionnaire'. For the purposes of this study, we have used data from the Management and Employee Questionnaires. The survey population for the *WERS* is all British workplaces with at least ten employees except for those in agriculture, hunting and forestry, fishing, mining and quarrying, private households with employed persons, and extra-territorial organisations.[5] Approximately, 3200 firms were asked to take part in the *WERS*—thereby covering a virtually complete cross-section of the working population in Britain. Out of these 3200 firms, Management Questionnaires providing firm level information, were completed via face-to-face interviews with 2191 managers, yielding a response rate of approximately 80%.[6] The Management Questionnaire includes two questions that relate to the screening of applicants during the hiring process:

(i) For which occupational groups are personality or attitude tests routinely used in filling vacancies?
(ii) For which occupational groups are performance or competency tests routinely used in filling vacancies?[7]

[3] As pointed out by an anonymous referee, testing by firms can be interpreted as an 'out-of-equilibrium' action, since all workers may have to acquire education to insure against the possibility of lay-off and re-employment within a non-testing firm.

[4] The *National Centre for Social Research* is responsible for sampling and statistical consultancy, the conduct of the fieldwork, coding and preparation of the final data.

[5] The exclusion of very small firms from the *WERS* sample may have some implications for our findings. It may be the case, for example, that small firms are less inclined to use hiring tests given the associated costs or because monitoring of employees may be relatively easier in small establishments. Moreover, empirical evidence suggests that wages increase with firm size (see Evans & Leightonm, 1989; Gerlach & Schmidt, 1990; Lever & van Werkhooven, 1996), and this may bias upwards our estimated earnings function.

[6] The management respondent was defined as 'the senior manager dealing with personnel, staff or employee relations' at the establishment.

[7] The nine occupational groups specified are as follows: managers and senior administrators, professional, associate professional and technical, clerical and secretarial, craft and skilled service, personal and protective service, sales, operative and assembly and other occupations.

For the first time in the *WERS* series, employees were included in the 1998 survey. Twenty-five employees were randomly selected from each work place and were sent an 'Employee Questionnaire.' Out of the 2191 establishments, 1880 agreed to take part in the employee survey. Approximately, 28,250 employee questionnaires were completed yielding detailed information such as the employees' earnings, occupation, age and educational qualifications. Matching the workplace information derived from the management questionnaires with this employee level information enabled us to identify which employees were employed by firms which conducted personality or attitude tests and/or performance or competency tests during the hiring process for particular occupations.[8] The final data set which pools employee data across work places comprises 25,990 employees from 1776 work places.[9] The minimum (maximum) number of observations per firm is one (25) and the average number of observations per firm is 14.6. Hence, we are able to construct an unbalanced panel of data. Out of our total sample of employees, 3832 employees from 450 workplaces were employed by firms who conduct personality or attitude tests during the hiring process whereas 8157 employees from 912 workplaces were employed by firms who conduct performance or competency tests during the hiring process.

Our matched employer–employee panel enables us to explore how firm-based screening measures affect the role of education in the wage determination process. If employees need to signal their ability in the labour market, they will obtain a return from both the sorting and productivity augmenting functions of education. A positive correlation between education and earnings clearly supports both human capital and screening interpretations of the education-productivity nexus. Our focus is how the presence of additional screening measures affects the sorting role of education. One might presume that if education does signal ability, then the inclusion of controls for direct screening measures in employee-level wage equations would dampen the role of education. Moreover, since ability is a multi-faceted concept, one might presume that the two tests play quite distinct roles in the wage determination process, perhaps reflecting the differing nature of the information they are designed to elicit.

It is difficult to predict ex ante the relationship between testing and education. Firms may require a minimum level of skill in a specific area—for example, numeracy—in which case one would observe more testing at relatively low levels of education. If, however, firms are searching for particular qualities amongst their senior managers—for example, leadership skills—then one might expect to see testing in the recruitment process at relatively higher levels of education.

Our variables are defined in Table 1 and summary statistics are presented in Table 2. Table 3 lists the proportions of employees employed in firms conducting hiring tests by highest level of education and by occupation, and shows that, with the exception of the lowest and highest levels of educational attainment, the proportions are relatively stable across the educational attainment levels.

To explore how hiring tests affect the role of educational attainment in the wage determination process, we estimate a variety of Mincerian wage equations (Mincer, 1974) by pooling employee level information across the sample of workplaces. We employ a random effects estimator to allow for the pooling of data across the 1776 work places and, initially, do not control for the use of tests in the hiring process implying a Mincerian earnings equation of the following form:

$$\ln w_{fi} = \beta' X_{fi} + \beta_0 E_{fi} + \beta_1 E_{fi}^2 + \alpha' Educ_{fi} + v_{fi}, \quad (1)$$

$$v_{fi} = \alpha_f + \eta_{fi}, \quad (2)$$

where w_{fi} represents the hourly earnings of an individual i employed in firm f, X_{fi} represents a vector of personal/workplace characteristics, E_{fi} (age less age left full-time education) denotes labour force experience, $Educ_{fi}$ represents a vector of variables denoting highest level of educational attainment, α_f is the 'firm' specific unobservable effect and η_{fi} is a random error term.

We then explore how the introduction of dummy variables denoting the presence or otherwise of (i) performance/competency tests (*ptest*) and

[8]Note that firms may not adopt hiring tests for every occupation. Also note that the *WERS* provides information relating to the use of such tests at the time of the survey, and it may be the case that some current employees were hired prior to their introduction. We would presume that information relating to the testing or otherwise of individual employees would serve only to strengthen our findings.

[9]Thus, 81% of the total number of firms who took part in the *Management Questionnaire* are incorporated into our final matched employee–employer data set indicating that the data set used for our empirical analysis is highly representative of the original *WERS* sample.

Table 1
Variable definitions

Variable	Definition
Individual characteristics	
Log hourly wage	Log (weekly earnings/weekly hours worked)
Experience	Age—years of full-time education—5 (imputed from highest education qualification)
GCSE grade<C	Dummy variable = 1 if 'GCSE' (grade<c) is highest education qualification[a]
GCSE grade⩾C	Dummy variable = 1 if 'GSCE' (grade⩾c) is highest education qualification
A level	Dummy variable = 1 'A level' is highest education qualification
Degree	Dummy variable = 1 if undergraduate degree is highest education qualification
Postgraduate degree	Dummy variable = 1 if postgraduate degree is highest education qualification
Train	Six-point index denoting how much training individual has received over the last year paid for/organised by employer
Vocational qualifications	Dummy variable = 1 if the individual has any vocational qualifications
Inf. over range of tasks	Four-point index indicating how much influence individual has over the range of tasks he/she does in the job
Inf. over pace of work	Four-point index indicating how much influence individual has over the pace at which he/she works
Inf. over how you work	Four-point index indicating how much influence individual has over how he/she does his/her/her work
Male	Dummy variable equals 1 if Male
White	Dummy variable = 1 if White
African	Dummy variable = 1 if African
Firm characteristics	
Sales/labour costs	Four-point index indicating the proportion of sales revenue accounted for by labour costs
Monitoring intensity	Seven-point index indicating (the number of non-managerial supervisors)/total number of non-managerial employees
Firm size	Log (total number of employees at the workplace)
Dismissal rate	Total number of dismissals/total number of employees
Unionised work place	Dummy variable = 1 if the workplace is unionised
Quals imp. when hiring	Dummy variable = 1 if the firm believes that qualifications are important when recruiting new employees
Industry	Dummy variable denoting industrial sector of firm[b]

[a]GCSE and A level certificates are secondary (i.e. 'high') school examinations taken at the ages of 16 and 18, respectively.
[b]We control for 12 industrial sectors vis. Agriculture; manufacturing; energy; construction; wholesale/retail; hotel/catering; transport/communications; financial intermediation, public administration; education; health/social work; other social and personal services.

(ii) personality/attitude tests (*atest*) affects the role of education. We also explore interactions between the hiring test variables and the educational attainment variables vis:

$$\ln w_{fi} = \mathbf{\Omega} + \alpha_0 ptest_{fi} + v_{fi}, \quad (3)$$

$$\ln w_{fi} = \mathbf{\Omega} + \alpha_0 ptest_{fi} + \alpha_1'(Educ_{fi}\, ptest_{fi}) + v_{fi}, \quad (4)$$

$$\ln w_{fi} = \mathbf{\Omega} + \alpha_0 atest_{fi} + v_{fi}, \quad (5)$$

$$\ln w_{fi} = \mathbf{\Omega} + \alpha_0 atest_{fi} + \alpha_1'(Educ_{fi}\, atest_{fi}) + v_{fi}, \quad (6)$$

where $\mathbf{\Omega} = \beta' X_{fi} + \beta_0 E_{fi} + \beta_1 E_{fi}^2 + \alpha' Educ_{fi}$. We distinguish between the two types of test to allow for the possibility that they elicit quite distinct information from applicants. It may be the case that the competency/performance test serves to confirm the information provided by the educational certificates, i.e. an individual's general level of ability. For instance, if the individual has a high school certificate in French, then the firm may assume that he/she is proficient in that language. The attitude/personality test, on the other hand, may elicit additional information regarding, for example, an individual's emotional intelligence that cannot necessarily be determined by the presence or otherwise of a qualification.

Initially, we assume that the hiring test variables are exogenous. Table 3, however, reports a wide variation in the use of tests across particular occupations and it may be the case that the hiring test variables are correlated with these and other employee characteristics.

To explore these issues further, we profile the type of individual likely to be employed within a firm that conducts hiring tests through a random effects probit estimator. We exploit the panel element of our matched employer–employee data by employing a random

Table 2
Summary statistics

Variable	All emps		Prf/comp test		No prf/comp test		Pers/att test		No pers/att test	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Individual characteristics										
Log hourly wage	1.876	0.513	1.955	0.463	1.840	0.530	2.043	0.484	1.847	0.512
Experience	21.850	11.900	21.470	11.480	22.0	12.070	20.690	11.350	22.060	11.980
GCSE grade<C	0.108	0.310	0.102	0.303	0.110	0.313	0.098	0.298	0.109	0.312
GCSE grade⩾C	0.259	0.438	0.282	0.450	0.249	0.432	0.255	0.436	0.260	0.439
A level	0.160	0.366	0.169	0.374	0.156	0.363	0.188	0.391	0.155	0.362
Degree	0.188	0.391	0.201	0.401	0.183	0.386	0.226	0.419	0.182	0.386
Postgraduate degree	0.067	0.250	0.077	0.266	0.062	0.242	0.079	0.270	0.065	0.246
Train	3.810	4.660	4.270	4.820	3.600	4.570	5.050	5.084	3.600	4.550
Vocational qualifications	0.371	0.483	0.376	0.485	0.369	0.483	0.398	0.490	0.367	0.482
Inf. over range of tasks	2.730	1.040	2.680	1.030	2.760	1.050	2.850	1.000	2.710	1.050
Inf. over pace of work	2.890	1.060	2.860	1.050	2.900	1.070	2.960	1.030	2.870	1.070
Inf. over how you work	3.230	0.930	3.210	0.930	3.240	0.930	3.300	0.870	3.210	0.940
Male	0.495	0.500	0.492	0.500	0.496	0.500	0.596	0.491	0.478	0.500
White	0.957	0.204	0.953	0.212	0.955	0.207	0.963	0.188	0.955	0.207
African	0.014	0.118	0.016	0.125	0.015	0.121	0.010	0.099	0.015	0.121
Firm characteristics										
Sales/labour costs	2.560	1.117	2.270	1.040	2.610	1.120	2.280	1.040	2.610	1.120
Monitoring intensity	5.318	1.236	5.320	1.190	5.320	1.230	5.280	1.290	5.320	1.230
Firm size	4.811	1.240	4.990	1.230	4.740	1.220	5.220	1.260	4.740	1.220
Dismissal rate	0.011	0.030	0.009	0.026	0.012	0.030	0.009	0.030	0.012	0.029
Unionised work place	0.560	0.497	0.667	0.471	0.539	0.499	0.680	0.467	0.539	0.499
Quals. imp. when hiring	0.117	0.321	0.131	0.338	0.117	0.322	0.112	0.316	0.117	0.322
Sample size	25,990		8157		17,833		3832		22158	

Note: For continuous variables, the figures denote the mean value across the various samples. For dichotomous variables, the figures denote the proportion of respondents within the sample exhibiting a particular characteristic. For example, the mean level of experience for respondents employed within firms that adopt performance/ competency tests is 21.470 years, whilst 20.1% of such individuals hold a degree.

effects framework to ascertain how much of the variation in the data can be explained by unobservable intra-firm correlations. Hence, we are able to explore the importance of unobservable intra-firm effects in determining whether hiring tests are used.

In the following random effects probit model, the dependent variable takes the value of one if the individual is employed by a firm, which conducts hiring tests (otherwise the dependent variable is zero). The model is specified as follows:

$$Y^*_{fi} = \beta' X_{fi} + v_{fi}, \tag{7}$$

$$v_{fi} = \alpha_f + \eta_{fi}, \tag{8}$$

where Y^*_{fi} is the unobservable propensity of individual i to be employed in firm f where firm f conducts hiring tests for individual i's occupational status. Y_{fi} is the individual's observed hiring test experience, X_{fi} is a vector of exogenous characteristics which are expected to influence Y^*_{fi}, β is the associated vector of coefficients, α_f is the 'firm' specific unobservable effect which captures differences in the propensity of encountering a hiring test across employees and η_{fi} is a random error term. We adopt a random effects specification, where $\eta_{fi} \sim IN(0, \sigma^2_f)$. To marginalise the likelihood, it is assumed that, conditional on X_{fi}, α_f are $IN(0, \sigma^2_\alpha)$ and independent of η_{fi} and X_{fi}. Hence, the correlation between the error terms of individuals employed in the same firm is a constant given by

$$\rho = corr(v_{il}, v_{ik}) = \frac{\sigma^2_\alpha}{\sigma^2_\alpha + \sigma^2_\eta} \quad l \neq k. \tag{9}$$

Thus ρ represents the proportion of the total variance contributed by the panel level variance component. For a full discussion of the random effects probit model see Arulampalam (1999). The likelihood is computed using 20 point Gauss–Hermite quadrature (see Butler & Moffitt, 1982).

Table 3
Proportion of employees employed in firms conducting hiring tests by highest level of education and by occupation

Variable	Personality/ attitude tests	Performance/ competency tests
Education		
No educational qualifications	0.09	0.22
GCSE grade < C	0.12	0.28
GCSE grade ⩾ C	0.14	0.32
A level	0.16	0.31
Degree	0.17	0.31
Postgraduate degree	0.16	0.36
Occupation		
Manager/senior administrator	0.32	0.26
Professional	0.14	0.33
Associate prof. and technical	0.14	0.25
Clerical and secretarial	0.13	0.50
Craft and skilled service	0.10	0.34
Personal and protective staff	0.07	0.24
Sales	0.25	0.21
Operative and assembly	0.12	0.33
Other	0.06	0.11

Note: Figures denote the proportion of respondents holding a particular attribute who are employed within firms that adopt a personality/aptitude or performance/competency test. For example, 9% of respondents without educational qualifications are employed in firms that conduct personality/attitude tests.

Our probit model calculates the estimated probability of an individual with the given attributes, as indicated by the vector of explanatory variables, being employed by a firm that conducts hiring tests. These probabilities are interesting per se, but they also allow us to control for sample selection bias in our estimated wage equation. It is possible that the allocation of workers to a 'testing' or 'non-testing' firms is not random, and also that the factors affecting the probability of assignment may also impact on an individual's wage within a particular sector. For example, it may be the case that high-ability individuals are attracted to firms conducting hiring tests. We therefore follow the Heckman (1979) procedure by splitting the sample of employees into two groups: (i) 'directly screened' *vis* those employed by firms that conduct hiring tests; and (ii) 'indirectly screened' *vis* those employed by a firms that do not conduct hiring tests. We then estimate separate wage equations for each type and use the estimated probabilities derived from the random effects probit analysis to control for sample selection bias. We then compare the estimated coefficients from each wage equation in order to assess how hiring tests affect the signalling role of education.

Our approach mirrors the standard approach adopted in the literature whereby the role of education in the wage determination process is ascertained by comparing the estimated coefficients on the educational attainment variables across a group of 'screened' (i.e. employees) and 'unscreened' individuals (i.e. the self-employed). We extend this methodology by utilising a matched employer–employee level panel of data that permits characteristics of the firm, the recipient of the signal, to be incorporated into the analysis.

The vector of explanatory variables X_{fi} in our probit regression (7) contains a mixture of individual and firm level characteristics. Individual characteristics include the explanatory variables incorporated in the earnings functions plus 'over-identifying' variables that are presumed to affect the probability that an individual is employed within a firm that conducts tests, but not his/her wages therein. We focus here on variables that capture how much control the individual has over various aspects of his/her work (*Influence over Range of Tasks, Influence over Pace of Work, Influence over How you Work)*. The rationale behind the inclusion of such variables is the presumption that the more freedom an employee has in a workplace, the more screening an employer may undertake at the hiring process. Similarly, we include an index of how much training the employee has received over the last 12 months (*Train*)—it may be the case that firms will screen employees more intensively if they intend to invest heavily in their human capital.

Our other over-identifying variables include various characteristics of the firm *vis* the importance of labour costs in the firm (*sales/labour costs*), the degree of monitoring (*monitoring intensity*), the size of the firm (*firm size*), dismissals (*dismissal rate*). There may be economies or diseconomies of scale associated with employee monitoring such that larger firms may be more or less inclined to use hiring tests to determine who is most suited to the job.[10] Dismissals may be regarded as an indicator of hiring employees who are ill suited to the job—we

[10]There is a degree of tension regarding the inclusion of *firm size* as an over-identifying instrument. If Stiglitz's argument—cf. Footnote 2—regarding the productivity effects of sorting is correct, and if *firm size* does affect the probability of testing, then one would expect *firm size* to also affect earnings. The effect of changes in the set of over-identifying instruments is explored in the following section.

might expect an inverse relationship between the use of hiring tests and the number of dismissals. We also include a dummy variable, which equals one if the firm believes that employee qualifications are important when employing new recruits (*qualifications important when hiring*).

Note that we are presuming that our *over-identifying* variables affect earnings only through the selection equation. The specification of over-identifying variables in selectivity equations is always a contentious issue. In our case it may be that some job and firm characteristics are actually outcomes from education rather than an independent regressor. For example, more educated individuals may be more likely to find employment within certain occupations and/or sectors, or within particularly sized firms. Similarly, an individual may have a relatively large degree of control over their work not because they work in a firm that tests, but because firms use tests to recruit the best people and then allow them freedom to get on with the job.

To explore the appropriateness of our over-identifying restrictions we performed two robustness tests. We first included the over-identifying variables from the selectivity model in the earnings function, and tested whether the estimated coefficients for each educational variable were significantly different from those derived with the imposed restrictions. We also explored the robustness of the estimated coefficients on the education variables to changes in the set of over-identifying variables.

3. Results

Table 4 sets out a variety of results based on seven specifications of the standard Mincerian wage equation. All specifications conform to the standard result that experience impacts concavely on hourly wages and that educational attainment serves to enhance earnings. We also control for a number of additional influences namely union membership, contract type, gender, ethnicity and occupation. It is apparent that the various coefficients display a considerable degree of robustness across the seven specifications.

Specification (ii) introduces a dummy variable denoting whether the firm conducts performance and/or competency tests during the hiring process. The positive and significant estimated coefficient on this variable suggests that such tests raise an individual's earnings ceteris paribus, and lends support to the argument that high ability individuals might conglomerate in firms, which conduct such tests (Weiss, 1995). Moreover, the tests attenuate the positive correlation between education and earnings, the estimated coefficients on the educational attainment dummy variables exhibiting a slight decrease in magnitude relative to the standard Mincerian regression reported in specification (i). The suggestion that performance/competency tests attenuate the correlation between education and earnings is confirmed for university level qualifications by the significant and negative estimated coefficients on the interactive terms reported in specification (iii).

Specifications (iv)–(v) focus on the effects of personality/attitude tests. Results here are similar to those for performance/competency tests, the estimated coefficient on the personality/attitude test dummy variable in specification (iv) suggesting that these tests play an even larger role in the wage determination process. Indeed, the interactive terms reported in specification (v) are characterised by significant and negative estimated coefficients for all levels of educational attainment, suggesting that the signalling role of education is abated by such tests.

Specifications (vi)–(vii) allow for the fact that firms may adopt both performance/competency and personality/attitude tests. The estimated coefficients on the two test dummy variables in specification (vi) are again significant and positive, and relatively stable as compared to the separate dummy variables' coefficients reported in specifications (ii) and (iv). The interactive terms reported in specification (vii) reflect the findings from the two separate interactive regressions—specifications (iii) and (v)—with all levels of educational attainment and university level education being characterised by significant and negative estimated coefficients when interacted with the personality/attitude and performance/competency test dummies, respectively. This might indicate a degree of substitutability between tests and education certificates as potential signals.

The regressions reported in Table 4 presume that the hiring test variables are exogenous. Clearly, this may not be the case—it may be that certain types of firms and/or employees are more or less likely to be associated with such tests. For example, larger firms may (or may not) be particularly inclined to set such tests, and all firms may be disinclined to set such tests for university-educated applicants. The reality or otherwise of these possibilities may be gleaned

Table 4
Mincerian wage equations
Dependent variable = log hourly earnings[a]
Sample = all employees

Variable	No tests Specification (i)		Performance/competency tests Specification (ii)		Specification (iii)		Personality/attitude tests Specification (iv)		Specification (v)		Both tests Specification (vi)		Specification (vii)	
	Coef	*T*-stat	Coef	*T*-stat	Coef	*T*-stat	Coef	*T*-stat	Coef	*T*-stat	Coef	*T*-stat	Coef	*T*-stat
Experience	0.0292	41.03	0.0294	41.03	0.0291	41.02	0.0292	41.05	0.0291	40.98	0.0292	41.05	0.0291	40.98
Experience^2	−0.0005	−32.35	−0.0005	−32.33	−0.0005	−32.34	−0.0005	−32.34	−0.0005	−32.28	−0.0005	−32.32	−0.0005	−32.28
GCSE grade < C	0.0308	3.75	0.0304	3.70	0.0359	3.75	0.0309	3.75	0.0380	4.35	0.0305	3.71	0.0404	4.13
GCSE grade ⩾ C	0.0878	12.84	0.0871	12.74	0.0899	11.42	0.0879	12.84	0.0935	12.94	0.0873	12.76	0.0938	11.71
A level	0.1484	18.41	0.1479	18.36	0 .1558	16.76	0.1481	18.38	0.1550	18.06	0.1478	18.34	0.1597	16.81
Degree	0.2628	30.02	0.2616	29.88	0.2781	28.26	0.2627	30.02	0.2708	29.26	0.2617	29.90	0.2820	28.02
Postgraduate degree	0.3061	26.59	0.3042	26.43	0.3267	24.43	0.3059	26.58	0.3157	25.52	0.3043	26.44	0.3314	23.87
Performance/competency test	—	—	0.0366	5.82	0.0646	5.54	—	—	—	—	0.0320	5.01	0.0540	4.54
Personality/attitude test	—	—	—	—	—	—	0.0438	4.95	0.0929	5.58	0.0356	3.96	0.0779	4.59
GCSE grade < C*competency test	—	—	—	—	−0.0221	−1.29	—	—	—	—	—	—	−0.0133	−0.76
GCSE grade ⩾ C*competency test	—	—	—	—	−0.0138	−1.01	—	—	—	—	—	—	−0.0066	−0.47
A level*competency test	—	—	—	—	−0.0289	−1.86	—	—	—	—	—	—	−0.0222	−1.39
Degree*competency test	—	—	—	—	−0.0573	−3.69	—	—	—	—	—	—	−0.0505	−3.18
Postgraduate degree*competency test	—	—	—	—	−0.0727	−3.49	—	—	—	—	—	—	−0.0648	−3.07
GCSE grade < C*personality test	—	—	—	—	—	—	—	—	−0.0607	−2.60	—	—	−0.0570	−2.39
GCSE grade ⩾ C*personality test	—	—	—	—	—	—	—	—	−0.0502	−2.64	—	—	−0.0495	−2.53
A level*personality test	—	—	—	—	—	—	—	—	−0.0563	−2.74	—	—	−0.0492	−2.34
Degree*personality test	—	—	—	—	—	—	—	—	−0.0622	−3.05	—	—	−0.0469	−2.25
Postgraduate degree*personality test	—	—	—	—	—	—	—	—	−0.0705	−2.61	—	—	−0.0537	−1.97
Constant	1.0162	52.11	1.0075	51.56	1.0001	50.81	1.0076	51.53	1.0010	50.97	1.0016	51.16	0.9904	50.10
Number of observations	25,990		25,990		25,990		25,990		25,990		25,990		25,990	
Number of groups	1781		1781		1781		1781		1781		1781		1781	
R^2	0.4783		0.4804		0.4813		0.4811		0.4813		0.4823		0.4834	
Wald χ^2	16949 $_{21df}$		17011 $_{22df}$		17056 $_{26df}$		17005 $_{22df}$		17023 $_{27df}$		17050 $_{23df}$		17104 $_{33df}$	

[a]Controls are also included for unionised workplace, permanent contract, vocational qualifications, gender, ethnicity, and occupation.

Table 5
Random effects probit analysis
What type of individual is likely to be employed by a firm operating hiring tests?
Sample = all employees

Variable	Comp/perf tests		Att/pers tests	
	Coef	*T*-stat	Coef	*T*-stat
Individual characteristics				
Experience	0.0015	0.32	0.0197	2.65
Experience^2	−0.0001	−0.91	−0.0004	−2.60
GCSE grade < C	0.1099	1.95	−0.0037	−0.04
GCSE grade ⩾ C	0.1491	3.23	0.0037	0.05
A level	0.0939	1.75	0.1123	1.35
Degree	0.1966	3.38	0.0586	0.66
Postgraduate degree	0.2850	3.84	0.0728	0.63
Vocational qualifications	−0.0532	−1.80	0.0331	0.74
Male	0.0535	1.53	0.1399	2.61
White	−0.0075	−0.09	0.1333	1.04
African	−0.0955	−0.64	0.0542	0.24
Occupation	Yes		Yes	
Train	0.0105	3.32	0.0188	4.03
Influence over range of tasks	−0.0192	−1.14	−0.0141	−0.53
Influence over pace of work	0.0074	0.45	−0.0259	−1.00
Influence over how you work	−0.0237	−1.24	0.0673	2.14
Firm characteristics				
Unionised work place	0.0533	1.29	0.0898	1.45
Sales/labour costs	0.0791	2.80	−0.0398	−1.04
Monitoring intensity	−0.0153	−0.74	−0.0486	−2.18
Firm size	0.1406	5.70	0.4072	15.75
Dismissal rate	−0.1296	−0.19	1.5472	2.04
Qualifications important when hiring	0.0842	1.82	−0.0120	−0.16
Industry	Yes		Yes	
Constant	−2.4506	−10.45	4.6964	−7.24
Number of observations	25990		25990	
Number of groups	1781		1781	
Log likelihood	−7476.01		−3483.80	
ρ	0.7578*		0.8647*	

*Significant at the 1% level.

from Table 5, which sets out the results from our random effects probit analysis. Given our focus of ascertaining how hiring tests impact on the signalling role of education, we comment on the salient findings only.

It is clear that the intensity of training enhances the probability that an individual is employed by a firm that conducts hiring tests. Such a result accords with a priori expectations—a firm, which devotes resources to training may be inclined to devote more resources to hiring. Firm size is positively associated with hiring tests, perhaps reflecting the possibility that larger firms find monitoring employees more costly and hence are more inclined to use hiring tests to determine who is most suited to the job. Finally, the educational qualifications are all characterised by significant and positive coefficients, suggesting that higher ability individuals may be drawn to firms that conduct hiring tests.

The random effects framework allows us to establish how much of the variation in the data can be explained by unobservable intra-firm correlations. The proportion of the total variance in the dependent variable contributed by the panel level variance component is given by ρ. It is evident that ρ is highly significant and its magnitude suggests that 76–86% of the total variance in the dependent variable is explained by unobservable firm specific

effects, the balance being explained by unobservable individual specific effects. Given that the firm specific effect is based on correlations across the dependent variable within firms, our findings provide evidence of intra-firm correlation within the dependent variable, which suggests that firms which conduct hiring tests are likely to do so for all occupations.

Table 6 reports selectivity-corrected earnings equations for individuals employed by firms that do and do not conduct performance/competency and attitude/personality tests for the individuals' particular occupation grouping. In general, our results here conform to our previous findings. Both test (non-test) samples are characterised by a significant negative (positive) sample selection coefficient. This suggests that the correlates of the likelihood that an individual is (not) employed within a firm that conducts tests, as set out in Table 5, are negatively (positively) related to the log hourly earnings of those individuals. Hence, ignoring the selectivity issue would imply a positive (negative) bias in the estimated earnings of individuals employed within firms that (do not) perform tests.

It is apparent that the magnitude of the estimated coefficients on *all* of the educational variables is greater for the *indirectly* screened sample—i.e. those individuals employed by firms who do not conduct performance/competency tests at the hiring process—suggesting that educational certificates may play a more pronounced screening role in this particular case. Furthermore, the magnitude of the χ^2 Test Statistic indicates that the estimated coefficients are significantly different across the two samples.

Such findings suggest that the signalling role of education is heightened when firms do not conduct hiring tests. From a human capital viewpoint, it is not clear why the earnings equations of employees employed by firms who do not conduct hiring tests should be characterised by relatively large estimated coefficients with respect to the education variables. According to human capital considerations, such findings would suggest that these are the less able and less productive employees. As pointed out by Weiss (1995), one might predict that the less able and productive individuals may be drawn towards firms not operating such tests.

In terms of the two tests themselves, it is evident that the use of an attitude/personality test is associated with a relatively lower return to education for all education levels whereas the use of a performance/competency test is only associated with lower returns to education for university level qualifications. This would seem to be consistent with a screening model where education is signalling motivation and personality rather than particular cognitive skills. It may be the case that only where the value of a particular qualification (in terms of the set of skills it bestows) is unclear, are performance/competency tests acting to dampen the screening role of education.

To explore the robustness of our results we included the over-identifying variables from our probit into the earnings function and tested whether the estimated coefficients for each educational variable differed statistically significantly from those reported in Table 6. The estimated coefficients on the educational variables labelled '*d*' in Table 6 were not statistically significantly different at the 1% level across the two samples, suggesting that the coefficients reported in Table 6 are robust. We also found the educational variables labelled '*e*' in Table 6 to be insignificantly different at the 1% level to those obtained by changes in the set of over-identifying instruments such as including firm size and industry in the earnings function. It would appear then, that although some of the selectivity estimates are sensitive to the over-identifying restrictions, our findings are generally consistent with the strong results that emerge from Table 4.

To summarise, our analysis suggests that educational screening plays an important role in the labour market, especially where firms do not conduct their own hiring tests. Such tests are found to raise an individual's earnings *ceteris paribus*, and to reduce the impact of educational certificates on such earnings. This would suggest that neglecting the distinction between direct and indirect screening would bias any attempt to estimate the returns to education.

4. Conclusion

Despite the huge interest in the relationship between education and earnings, and in particular, the question as to whether education augments or merely signals pre-existing productivity, relatively little is known about the firm's role as the recipient of these signals. It is in the firm's interest to screen out potentially less productive applicants, but relying on educational achievement is perhaps an

Table 6
Mincerian wage equation with selectivity
Dependent variable = log hourly earnings[a]

	Perf/comp test sample		Non-perf/comp test sample		Att/pers test sample		Non-att/pers test sample	
	Coef	*T*-stat	Coef	*T*-stat	Coef	*T*-stat	Coef	*T*-stat
Experience	0.0294	23.13	0.0284	30.82	0.0283	15.92	0.0288	35.11
Experience^2	−0.0005	−17.83	−0.0005	−23.89	−0.0005	−11.68	−0.0005	−27.68
GCSE grade < C	0.0062[b,c]	0.42	0.0288[d,b,c]	2.68	−0.0050[b,c]	−0.24	0.0381[e,b]	4.02
GCSE grade ⩾ C	0.0567[b,c]	4.48	0.0801[e,b,c]	8.95	0.0575[b,c]	3.22	0.0940[e,b]	11.92
A level	0.1139[b,c]	7.88	0.1507[e,b,c]	14.16	0.1042[b,c]	5.22	0.1543[e,b]	16.34
Degree	0.1788[b,c,f]	11.01	0.2684[e,b,c]	23.32	0.2349[b,c,f]	10.92	0.2643[e,b,c]	25.80
Postgraduate degree	0.1961[b,c,f]	9.46	0.3129[e,b,c]	20.05	0.2850[b,c,f]	10.47	0.3067[b,c]	22.48
Sample selection term	−0.1923	−8.88	0.2629[e,b,c]	8.50	−0.0816	−7.14	0.0828[e]	2.86
Constant	1.5964	20.33	1.0197	36.43	1.6460	20.12	1.0732	49.12
Number of observations	8157		17833		3832		22158	
Number of groups	840		1525		407		1548	
R^2	0.4540		0.5045		0.5100		0.4707	
Wald χ^2	3908 $_{22\ df}$		10263 $_{22\ df}$		2032 $_{22\ df}$		12619 $_{22\ df}$	
χ^2 test statistic[g]	82.88 $_{5\ df}$				37.49 $_{5df}$			

[a]Controls are also included for unionized workplace, permanent contract, vocational qualifications, gender, ethnicity and occupation.

[b]Denotes that the estimated educational coefficient satisfied the first robustness check: in order to explore the implications of excluding the over-identifying variables in Table 5 from the earnings function, we included the over-identifying variables in the earnings function and tested whether the estimated coefficients for each educational variable differed statistically significantly from those obtained by adopting the restrictions associated with over-identification. The estimated coefficients on the educational variables labelled 'd' were not statistically significantly different at the 1% level across the two estimation procedures, suggesting that the coefficients presented in Table 6 are robust. Full results are available from the authors on request.

[c]The second robustness check explores the robustness of the estimated coefficients on the education variables to changes in the set of over-identifying variables. The educational variables labelled 'e' were found to be insignificantly different at the 1% level to those obtained by including industry and firm in the earnings function. Again, full results are available from the authors by request.

[d]Denotes that the estimated educational coefficient is significantly different across the 'test' and 'no test' samples at the 5% significance level.

[e]Denotes that the estimated educational coefficient is significantly different across the 'test' and 'no test' samples at the 1% significance level.

[f]Denotes that the estimated educational coefficient is significantly different across the performance/competency test and attitude/personality test samples at the 1% level.

[g]Test for equality of the group of education variables across the test and no test samples.

inefficient method of achieving this. Economists have unearthed scant evidence of strong signalling, and it would seem indutible that education raises productivity. Any signal picked up from education will therefore be necessarily noisy, and to overcome this many firms choose to conduct their own screening tests before hiring. One might expect that relatively more able applicants will be attracted to firms conducting such tests, and that these firms will also pay relatively less attention to conventional educational signals.

In this paper, we investigate the use of such tests in Britain. Using a matched employee–employer data set drawn from the 1998 WERS we are able to identify which firms use personality-attitude and/or performance-competency tests during the hiring process. Combining employee and firm-level information, we find that firm-based screening significantly raises a successful applicant's earnings *ceteris paribus*. Moreover, such tests weaken the relationship between education achievement and earnings. This is an important finding because it implies that failing to control for such tests may bias any attempt to establish the true relationship between education and earnings.[11]

An interesting question concerns why only some firms adopt their own screening procedures. Such tests are expensive and must guarantee, or at least raise the probability, that they will be generate a reward. An issue for future research is to establish the costs and benefits of such tests—for example, such as lower turnover or absent rates.

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[11]As pointed out by an anonymous referee, why this is important is not always obvious. Many estimates of the return to education are averages across a number of employer types—for example, public sector, private sector, large/small firms—and workers are unlikely to know ex ante which type of firm they will end up working for. Thus, from an individual's perspective it is perhaps the average return to education across a range of firms that is relevant. It is in terms of the impact on aggregate productivity and growth that an accurate measure of the screening component of education is important.

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