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INTER-INDUSTRY WAGE DIFFERENCES AND INDIVIDUAL HETEROGENEITY: HOW COMPETITIVE IS WAGE SETTING IN THE UK?

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Abstract

There are two findings that are conspicuous in almost all studies of individual wage determination. First, standard cross-section wage equations rarely account for more than half of the total variance in earnings between individuals. Second, there are large and persistent inter-industry wage differentials and these are frequently attributed to non-competitive forces in wage determination. This paper explores these two issues using cross-section, pooled and panel data drawn from the first six waves of the British Household Panel Survey. We show that much of the residual variation in wages can be explained by significant *unobserved* differences between workers, perhaps reflecting innate ability or other characteristics of individuals not captured by observed data. Moreover, our wage equations explain a substantial proportion of the variation in earnings between individuals in terms of their observed and unobserved characteristics, and we find only a small role for job characteristics and almost no role for industry affiliation once we allow for unobserved individual heterogeneity. One interpretation of our findings is that wages are determined principally by individual characteristics - as human capital theory presupposes - rather than by compensating differentials or by non-competitive factors.

JEL Classification: C21, C23, J31

Keywords: Wage Structure, Wage Differentials, Panel Data.

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1. Introduction

A major empirical regularity in the literature on the analysis of wage structure is the existence of large and persistent inter-industry wage differentials for workers of equal quality in equivalent occupations (Dickens and Katz, 1987a, 1987b; Krueger and Summers, 1987, 1988; Katz and Summers, 1989). These differentials exhibit a high degree of stability over time and appear to hold across a variety of countries with distinct institutional and structural arrangements (Gittleman and Wolff, 1993; Kahn, 1998). They also persist across different types of workers and establishment size. Such disparities are difficult to explain by the distribution of human capital accumulation across industries or by compensating differentials for non-pecuniary job attributes affecting the utility of workers. Their persistence is also inconsistent with the notion of transitory disequilibrium phenomena brought about by adjustments to labour supply or demand in the presence of imperfect short-run labour mobility. Accordingly, a number of non-competitive explanations have been proposed.

Standard human capital theory asserts that job attributes that do not directly affect the utility of workers should have no effect on the determination of individual wages. In contrast, non-competitive theories of wage determination assert that such attributes can have a systematic effect on wages because they influence the optimal wage for firms to set. The purpose of these theories is to determine why firms may find it profitable to pay wages higher than the market-clearing rate. In addition, such explanations must also explain why the importance of such factors differs by industry. A number of possibilities have been suggested. Efficiency wage models embody the need for high wages to elicit worker effort. Motivations here are varied but include the firm’s wish to prevent shirking (Shapiro and Stiglitz, 1984), minimise turnover costs (Stiglitz, 1985), diminish adverse selection (Weiss, 1980) and improve worker morale (Akerlof, 1984). Insider-outsider models (Lindbeck and Snower, 1986) stress the incumbent power of employees when bargaining for a share of industry rents. Finally, union threat models (Dickens, 1986) emphasise the threat of collective action as a reason for firms paying higher than competitive wages.

An alternative competitive explanation is that observed wage differentials are *true* differentials that reflect *unobserved* differences in worker quality. Several studies (Murphy and Topel, 1987; Krueger and Summers, 1988; Gibbons and Katz, 1992; Keane, 1993; Shippen, 1999) have utilised longitudinal data and fixed effects models to test this hypothesis, with mixed results. Krueger and Summers (1988) and Gibbons and Katz (1991), for example, present little evidence to support the importance of unobserved heterogeneity in the determination of industry pay. Murphy and Topel (1987) and Keane (1993), in contrast, find that unobserved heterogeneity explains 66 and 84 percent respectively of the apparent differential in log wages across industries.

Identifying the true nature and source(s) of observed inter-industry wage differentials is important on both research and policy grounds and also with regard to individual welfare. Renewed interest in the structure of wages has occurred at a time when wage inequality in both the US and the UK is higher than at any other time this century (Katz *et al*., 1995; Machin, 1996). This increased dispersion has occurred both between and within groups with the same observable characteristics. Competitive models of the labour market imply that changes in dispersion should be largely transitory in nature. Increased inequality, in this regard, may be considered as being shared amongst individuals. In contrast, non-competitive models of the labour market imply that such changes may be largely permanent. The acceptance of such explanations thus has significant positive and normative implications.

This paper sets out to examine the existence and stability of inter-industry wage differentials for the UK using longitudinal data drawn from the first six waves of the British Household Panel Study (BHPS). The BHPS is a nationally representative sample of more than 5,000 households (approximately 10,000 individual interviews) and provides a rich source of socio-economic information for issues concerning household organisation, labour market activity, income and wealth, housing, health and education amongst others. We take advantage of the data's features and examine both cross-section and pooled evidence for UK inter-industry wage differentials between 1991 and 1996. In addition, we utilise the panel dimension of the data to assess the importance of unobserved worker heterogeneity on the cross-section and pooled results. There are extremely few panel studies of the inter-industry wage structure in the existing literature and, to our knowledge, none previous for the UK. Thus our use of the BHPS data to examine this issue provides an original contribution to a sparse literature.

The remainder of the paper proceeds as follows. Section 2 presents a brief overview of recent research and a more detailed discussion of the theoretical explanations for the inter-industry wage structure. Section 3 outlines the methodology employed while section 4 discusses the data and its relative merits. Empirical results are reported in section 5. Section 6 concludes.

2. Inter-industry Wage Differentials: An Overview

The existence of inter-industry wage differentials is not a new phenomenon.[1] Slichter (1950) provides the seminal paper concerning 'regularities' in the US wage structure. Using hourly wage data for unskilled male workers of 20 US manufacturing industries over the period 1923-1946, he reports the rank order correlation of average hourly earnings to be 0.73. He also reports significant correlations between earnings and a number of financial variables. Unskilled male earnings appear to be positively correlated with value added per worker, value product of labour, and firms' profit margins. This, he concludes, provides evidence of 'managerial discretion' in wage determination. Such discretion undermines the role of competitive forces in determining wage outcomes. Consequently, it may also account for the apparent stability over time.

Recent literature revolves around American research provided by Krueger and Summers (1987) and Dickens and Katz (1987a). Neither of these authors utilises panel data in their analyses. Instead, they use both historical data on average industry earnings and large cross-section Current Population Survey (CPS) data on individual earnings to investigate the importance of inter-industry wage differentials across different occupations. Their findings suggest inter-industry differentials to be both substantial and significant, even when controlling for observable characteristics such as human capital and other demographics. They too report remarkable stability in the wage structure over long periods of time.

Krueger and Summers (1987) extend Slichter's analysis of manufacturing data and match the original 1923 data to wage differentials estimated from May 1984 CPS data. They observe

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[1] See Carruth and Oswald (1989) for an overview of the early literature on wage structure.

that relatively high wage industries in 1923 continued to be high wage industries in 1984, whilst low wage industries continued likewise.[2] This finding is not confined to manufacturing. They present evidence that the industry wage structure for all industries has also remained constant.[3] Such stability is surprising but it is not unique. Papola and Bharadwaj (1970) study the rank correlation of industry earnings for 17 countries in the period 1948 to 1965 and report a high degree of stability for developed countries. Tarling and Wilkinson (1982) and Lawson (1982) similarly remark on the stability of the UK industry wage structure in the years after World War II. Thus, the structure of relative industry wages appears to change only moderately over time.

Evidence concerning the pattern of industry wages is equally pervasive. Krueger and Summers (1987) present evidence of similarity in the industry wage structure for both the south and non-south regions of the US. They also provide evidence of similarity in manufacturing industry wages across 14 countries in 1982. Correlations amongst developed, capitalist countries are particularly high.[4] The UK has the strongest correlation with US industry wages (0.95) while the former USSR has the weakest (0.33). Such findings are broadly consistent with the earlier work of Lebergott (1947) who finds a high rank correlation for industry wages between the US and Canada, the UK, Switzerland and Sweden in the 1940's. They are also consistent with the more recent results of Gittleman and Wolff (1993) and Kahn (1998) who both report considerable stability in the rank order of industries for a variety of countries.

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[2] The rank correlation coefficient is 0.56, which is remarkable given the length of time between the two periods and subsequent changes in industry definition. Moreover, changes in industry definitions and sampling error suggest this correlation could be an underestimate. The wage structure thus appears to have remained stable for a very long time.

[3] Correlations in the wage structure between 1984 and 1915 range from 0.76 to 0.98.

[4] Eight of the thirteen correlations exceed 0.8 and eleven are above 0.6.

It is important to note that the existence of inter-industry wage differentials is not necessarily inconsistent with competitive labour market theory. Several plausible explanations for observed differences in industry pay can be hypothesised in such a framework, including that industry wage differences may reflect unobserved heterogeneity, or compensating differentials for non-pecuniary job attributes, or transitory phenomena as an adjustment to sectoral change. However, the stability of the industry wage structure over long periods of time is inconsistent with transitory skill premia in periods of rapid sectoral change. Moreover, the evidence for favour compensating differentials is also rather weak. If wage premia do serve to compensate for non-pecuniary job attributes, one would expect to find the inclusion of job characteristics in wage equations to significantly reduce observed industry effects. Similar findings should also hold for fringe benefits. Krueger and Summers (1988) find no evidence to support either of these hypotheses. Results of 1984 CPS wage equations with the dependent variable adjusted to reflect non-wage compensation reveal an increase in industry wage dispersion. The inclusion of a number of potentially important job attributes[5] using cross-section data from the 1977 Quality of Employment Survey (QES) produces a similar result: estimates with and without controls differ little in the observed pattern of industry wages.[6]

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[5] These are weekly hours, commuting time, choice of overtime, health hazards (2), shift work (2), and working conditions (2).

[6] Evidence from quit rates provides an additional argument against compensating differentials. Industry wage effects which are truly compensating should not yield any observable correlation with industry quit rates. However, Krueger and Summers (1988) and Katz and Summers (1989) find evidence that high wage industries tend to be those with the lowest rate of quits. Such evidence appears to suggest that workers feel that they are being paid in excess of their opportunity costs.

The importance of unobserved heterogeneity is more difficult to ascertain. Krueger and Summers (1988) adopt two methods to test for the presence of unobserved differences in labour quality. First they compare cross-section wage equations for May 1979 CPS data both with and without controls for human capital (age, gender, race, education, tenure and occupation). The inclusion of labour controls is reported to have no impact on estimated industry differentials.[7] Second they use matched CPS data sets along with the 1984 Displaced Workers Survey (DWS) to estimate first-difference equations on industry movers. These estimates appear broadly similar to their cross-section results. Both methods thus lead the authors to reject arguments for unobserved differences in labour quality. Gibbons and Katz (1992) add support to this conclusion. They estimate first-difference models using data from the DWS for the period 1984-1986 and report that industry switchers appear to earn, on average, 97 percent of the relevant cross-section differential. The authors accordingly reject simple unobserved ability explanations and conclude that industry effects are indeed important in explaining inter-industry wages.

Murphy and Topel (1987) present evidence to the contrary. They use first-differences equations on a sample of matched CPS data for the period 1977-1984 and report industry switchers to receive only 27 to 36 percent of the cross-sectional differential. They conclude "that nearly two-thirds of the observed industry differences are estimated to be caused by unobserved individual components" (p. 135). Similar findings are reported in Keane (1993) and Shippen (1999). Keane estimates inter-industry wage differentials using a fixed-effects estimator on a long panel, namely the National Longitudinal Survey of Young Men (NLS).

[7] Krueger and Summers argue that unmeasured labour quality is probably correlated with measured quality. As such, one would expect the inclusion of labour quality controls to substantially reduce the dispersion of industry wages.

His results indicate that unobserved differences in labour quality account for a substantial 84 percent of the inter-industry log wage variance. Shippen reports likewise. He uses matched CPS data from 1983-1995 and retrospective data from the DWS from 1984-1992 to determine the effects of unmeasured skill on wages in the apparel industry. Results indicate that between 64 and 80 percent of the earnings differential between displaced apparel workers and other displaced workers can be attributed to unobserved heterogeneity not captured in standard cross-section wage equations.

Perhaps the most convincing argument against unobserved heterogeneity comes from evidence concerning inter-industry wage differentials and the industry's ability to pay. Dickens and Katz (1987a) provide a comprehensive review of this literature. They report industry wages to be highly correlated with a wide range of industry characteristics including the capital to labour ratio, firm and establishment size, union density, monopoly power and several measures of industry profit. These correlations appear to account for a large proportion of inter-industry wage variation across both time and space. They also hold after controlling for personal and demographic characteristics. Blanchflower *et al.* (1988) and Nickell and Wadhwani (1987) report similar findings for the UK. They show that product market characteristics and the prosperity of the employer positively affect the level of pay. Since there are no identifiable reasons why unmeasured labour quality and product market characteristics should be correlated, these findings serve to undermine the role of unobserved heterogeneity as an explanation for inter-industry differentials.

Efficiency wage theories can perhaps provide a more convincing explanation for inter-industry wage differentials and the observed correlation between profitability and pay. These theories predict that higher than competitive wages can be profitable for firms where induced productivity gains ensure that changes in wages have less than proportionate effects on firms costs. Yellen (1984) provides the generic model. The central premise these models is that effort per worker is a positive function of the wage rate. Four conceptually distinct though analogous motivations may be identified. These include that the firms wish to prevent shirking (Shapiro and Stiglitz, 1984), minimise turnover costs (Stiglitz, 1985), diminish adverse selection (Weiss, 1980), and improve worker morale (Akerlof, 1984). Each of these motives predicts correlations between industry wage premia and industry characteristics consistent with the available evidence although none of these models attest to all of the evidence. The shirking, turnover and adverse selection models, for example, are difficult to reconcile with the uniformity of industry wages across occupations. Fair wage models, in contrast, are difficult to reconcile with cross-national evidence regarding similarities in wage setting between former Eastern bloc and Western industrialised countries.

The threat of collective action provides an alternative rationale for employee receipt of industry rents. Dickens (1986) argues that threat of unionisation can benefit non-union workers if employers pay above the competitive wage to prevent collective action.[8] His model predicts industries with high wages to be those where the threat of unionisation is high and the costs of collective action to workers low. Evidence concerning correlates of industry wage premia support this hypothesis.[9] Krueger and Summers (1987), however, argue against this threat of unionisation. They report that historical evidence for the US suggests that high wage industries paid relatively high wages before the advent of widespread unionisation. Furthermore, the inter-industry wage structure appears highly correlated across both union

[8] Collective action can take several forms including threat of strike and work-to-rule measures.
[9] High wages in the US are strongly correlated with both union density and industry profits.

and non-union workers. This latter evidence is contrary to the predictions of the union threat model. It also conflicts with the predictions of a range of union bargaining models that argue that 'strong' unions are the source of inter-industry wage differentials.

A more plausible rent sharing explanation of inter-industry wage differentials comes from the concept of insider power (Lindbeck and Snower, 1986; Solow, 1985).[10] Insider-outsider models emphasise the incumbent market power of employees whose positions are protected by significant costs of turnover. These models assert that the presence of large transactions costs in the hiring and firing of workers provide firms with the incentive to pay current employees supra-competitive wage premia in order to retain their services. This view of rent sharing is again consistent with observed correlates for the inter-industry wage structure. Krueger and Summers (1987) argue that it is also consistent with the existence of inter-industry wage differentials for workers of different *occupations*. Rent sharing models in which firms are willing to share rents equally across all types of workers certainly support this claim. Equality constraints based on sociological 'norms' provide the most feasible argument.

This paper explicitly addresses the role of unobserved heterogeneity as an explanation of the observed inter-industry differentials. We utilise genuine panel data (rather than matched data) to show explicitly that much of the observed cross-section inter-industry wage differentials can be accounted for by unobserved individual-specific effects. Thus, our paper is most similar in spirit to that of Keane (1993). However, using the BHPS means that we can also largely dismiss the compensating differentials argument since, unlike in his work, we can also control for job characteristics. Of course, it remains to be explained why these unobserved

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[10] Blanchflower *et al.* (1988) report evidence of both insider and outsider power in the UK.

individual effects should be correlated with industry, although we suggest some possible explanations in the conclusion.

3. Methodology

We adopt a two-step approach to the analysis of inter-industry wages. Our first approach follows the standard procedure popularised by Krueger and Summers (1988) (hereafter KS), and recently improved by Haisken-DeNew and Schmidt (1997) (hereafter HDS).[11],[12] We estimate cross-section (and pooled) wage equations of the form:

$$\ln w_{ij} = \alpha + \beta x_i + \varphi Z_j + \varepsilon_{ij} \quad (1)$$

where $\ln w_{ij}$ is the natural logarithm of the real hourly wage of worker *i* in industry *j*, α is the constant, x_i is a vector of personal and workplace characteristics, occupations and regions, Z_j is a vector of industry dummies which includes *all* industries, β and φ are vectors of parameters to be estimated, and ε_{ij} is a random disturbance term. Since in equation (1) the

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[11] KS utilise a two step procedure: first, they estimate standard cross-section wage equations that include a vector of dummy variables indicating industry affiliation and a constant term that corresponds to an omitted industry; second, they renormalise the estimated industry differentials to yield deviations from a hypothetical employment-share weighted mean. Instead of calculating the standard errors of the renormalised coefficients, KS suggest approximating them by the unadjusted standard errors of the coefficients in the original regression, and using the standard error of the constant term to approximate the standard error of the omitted industry. HDS argue that the above procedure overstates both the standard error of renormalised coefficients and their variance. They also demonstrate empirically that the estimated standard errors vary drastically depending on the choice of omitted industry, irrespective of sample size. Such variation inevitably inhibits sensible economic interpretation of individual elements of the renormalised coefficient vector and the estimated summary measure of overall wage dispersion. HDS also show that the overall measure of industry wage dispersion is always underestimated using the KS methodology. As described in equations (1) and (2) below, the HDS procedure provides economically sensible coefficients and their correct standard errors in a single regression step.

[12] See Arbache (1998) for a detailed discussion of the KS and HDS methodologies and a comparison of both methodologies using Brazilian manufacturing data.

cross-product matrix of regressors is not of full rank, a linear constraint is imposed on the φ's as follows:

$$\sum_j n_j \varphi_j = 0 \qquad (2)$$

where n_j is the employment share in industry *j*.

Our second approach considers a panel fixed-effects model also using the improved methodology of HDS.[13] In this case, the constraint of equation (2) is imposed on a regression model of the form:

$$\ln w_{ijt} = \alpha_i + \beta x_{it} + \varphi Z_{jt} + v_{it}, \quad i = 1,\ldots,N \quad t = 1,\ldots,T\ , \qquad (3)$$

where $\ln w_{ijt}$ is the natural logarithm of the real hourly wage of worker *i* in industry *j* at time *t*, α_i is an individual-specific component of wages reflecting unobserved individual characteristics (possibly correlated with the observables), and v_{it} is a random error term independently and identically distributed over *i* and *t*. The α_i are eliminated in the standard way (by differencing from individual means) to produce the fixed-effects (or within) estimator. The within estimator produces consistent and efficient estimates of the parameters when the time-invariant effects are assumed correlated with the regressors.

Having controlled for other factors important in the determination of wages, the reported industry coefficients, φ_j, may be interpreted as the proportionate difference in wages between a worker in industry *j* and the average worker across all industries. To describe the overall

[13] As far as we are aware, this improved methodology has never before been implemented using panel data.

variability in industry wages, we use two different measures. First, as in the standard literature, we calculate the standard deviation of the industry wage differentials:

$$SD(\varphi) = \sqrt{\sum_j n_j \varphi_j^2 - \sum_j n_j \sigma_j^2} \qquad (4)$$

where σ_j^2 are the variances of the estimated φ_j. $SD(\varphi)$ gives the weighted and adjusted standard deviation of industry coefficients.[14]

Our second measure of the inter-industry variation in wages is the weighted average absolute differential:

$$|\varphi| = \sum_j |n_j \varphi_j| \qquad (5)$$

Thus, $|\varphi|$ is the average proportionate deviation from the mean for a randomly chosen worker.

4. Data

We estimate UK inter-industry wage differentials using longitudinal micro data drawn from the 1991-1996 (six) waves of the BHPS, a nationally representative survey of households randomly selected south of the Caledonian Canal.[15] The BHPS was designed as an annual survey of each adult member (age 16 or over) from a nationally representative sample of more than 5,000 households, providing a total of approximately 10,000 individual interviews. The first wave of the BHPS was conducted from September 1991 to January 1992, subsequent waves have been collected annually thereafter.[16]

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[14] The second term in equation (4) is the correction for the least squares sampling error - see KS and HDS.
[15] The very north of Scotland is thus excluded.
[16] See Taylor *et al.* (1996) for details.

The BHPS provides a rich source of socio-economic information at the individual and household level. The dependent variable that we derive from these data is the natural logarithm of the real hourly wage. This is calculated as the ratio of usual gross pay per month (a derived variable that measures usual monthly wage or salary payment before tax and other deductions in current main job for employees), and the total number of hours normally worked per week, scaled by average weeks per month.[17] This is then deflated by the RPI (base year 1992).

The richness of the BHPS permits a wide variety of both personal and workplace controls in our wage equations. Personal controls include gender, race, marital status, highest educational qualification achieved, head of household indicator, and the number of children in the household and their age profile. Additional information regarding an individual's health along with their recent labour market history are also included. A piecewise linear spline for age is used to capture the expected profile of lifetime earnings.[18]

Workplace and workforce controls which can be expected to impinge upon earnings include unionisation (both recognition and membership), full or part time job status, promotion opportunities, a number of variables capturing the structure of pay and pay increases, seasonal or temporary work, rotating shifts, managerial duties and supervisory tasks and travel to work time. Any remaining firm-specific effects are captured by the inclusion of firm size and

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[17] The data provides separate information regarding the number of hours normally worked per week (excluding overtime and meal breaks), the number of overtime hours worked in a normal week, and the number of overtime hours worked as paid overtime. We define total hours as normal hours plus overtime.

[18] The linear spine is preferred to imposing the constraints implied by the usual quadratic in age or experience.

public-private sector indicators.[19] Occupational affiliation is coded to the 1990 OPCS Standard Occupational Classification and we utilise 1-digit occupational dummies to control for variation of wages across occupation. Regional dummies and time dummies are also included to capture any remaining effects on wages brought about by geographical differences in industry and institutional structure, and cyclical effects on wages.[20]

The data report industry affiliation at the 4-digit level using the 1980 Standard Industrial Classification (SIC). We report two sets of estimates in the results presented below. First we use 1-digit industry identifiers. While these are sufficient to illustrate the principal finding of the paper, we also present result using 2-digit industry dummies (after appropriate aggregation of comparable industries where cell size is small). For panel purposes, this finer disaggregation permits a greater number of inter-industry transitions to be observed. However, out central results are not sensitive to the level of disaggregation of the industry identifiers.

The sample is selected on the basis that the individual is of working age (aged 16 to retirement) and has a current status of "employee". Retired and self-employed workers', the unemployed, individuals working on government schemes and 'inactive' members of the working-age population are thus excluded. Individuals who have missing relevant information or who are not interviewed at a particular wave are also excluded. However, individuals who enter and exit the sample across the panel are included. While this results in an unbalanced

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[19] A positive association between wages and firm size is well established. See Brown and Medoff (1985) and Green *et al.* (1996) for details.

[20] The BHPS distinguishes 18 standard regions, but given the strong correlation between industry and location, we reclassify this regional information and identify four aggregate regions for the UK.

panel, it does serve to minimise potential attrition biases and yields greater numbers of observations in the panel when controlling for fixed-effects (and also maximises the number of inter-industry transitions recorded). Finally, to alleviate potential biases from serious over or under estimation of earnings, we symmetrically trim the data and omit the 0.5 percent of observations with the highest and lowest real hourly wages.[21]

The resulting sample available for estimation has 25,261 data points across the six waves, comprising observations on 7,159 individuals. The gender distribution across the panel is presented in Table 1 while Table 2 details the total number of waves for which each individual is observed. Data definitions and summary statistics are presented in Table A1 of the Appendix.

5. Empirical Results

Table 3A, column 1 reports the 'raw' 1-digit inter-industry wage differentials for the pooled data. All but two of the differentials are statistically significant at conventional levels and the point estimates for the individual industry differentials are economically important. Taken across all six waves, workers in energy and water supplies earn 49 percent above the average wage, while those in distribution, hotels and catering earn 26 percent below the average.[22] The employment-weighted adjusted standard deviation of the raw industry log differentials is 17 percent and the average absolute deviation is 14 percent. Table 4A, column 1 reports similar findings based on the 2-digit classification; 26 of the 31 differentials are statistically

[21] We also investigate the robustness of our results to a number of other specification and sample selection criteria.

[22] Percentage differentials are calculated as $100 \times (e^{\varphi_j} - 1)$ - see Halvorsen and Palmquist (1980).

significant, and workers earn from between 54 percent above (solid fuels, oil etc.) to 46 percent below the average (personal and domestic services).

The differentials are remarkably stable and persistent across the six waves (cross-sections) treated separately. The rank order correlation of 1-digit (2-digit) differentials between wave 1 and wave 6 is 0.94 (0.97), and the $SD(\varphi)$ measure of dispersion ranges from between 0.156 and 0.179 (0.207 and 0.220) compared with the value for the data pooled of 0.170 (0.217). These findings are consistent with previous studies which identify the stability and regularity of the wage structure as discussed above.[23]

Table 3A, column 2 reports proportionate industry wage differentials with controls for personal characteristics. Most controls are individually significant, and their collective significant is shown by the F-test in the diagnostics at the bottom of the table. However, their inclusion has relatively little impact on the ranking of industries in that the rank order is broadly similar to that observed in column 1 (the rank order correlation coefficient is 0.99). A similar pattern in the stability of the wage structure is observed when we consider the analogous results for the 2-digit industry categorisation in Table 4A, column 2. Again, the personal controls are individually and jointly significant, but the ranking of the inter-industry differentials is little affected.

The main effect of personal controls is to reduce the size, significance and dispersion of the estimated industry wage differences - most industry coefficients are reduced by a factor of

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[23] The results for individual cross-sections are available from the authors on request.

between one third and one half when personal controls are included.[24] The standard deviation of the 1-digit differentials falls to 10 percent, and to 14 percent for the 2-digit differentials. This represents a decrease of around 40 percent in each case, and this is similar to the fall in the alternative measure of dispersion, $|\varphi|$. This decrease in dispersion is very similar to that reported by Krueger and Summers (1987) for US data, and indicates observed labour quality to be an important factor in the determination of inter-industry pay.

Although it is difficult to capture all non-pecuniary job attributes precisely, the inclusion of workplace controls should also effect estimated industry differentials if they are important in the wage determination process. The third columns of Tables 3A and 4A reports the results when workplace controls are also included alongside personal controls in the 1-digit and 2-digit specifications. The addition of such controls again alters the size, significance and dispersion of industry wage differences. The number of statistically significant industries is, however, reduced only slightly. Workers in the highest paid 1-digit (2-digit) industry now earn a premium of 22 percent (29 percent), while those in the lowest paid 1-digit (2-digit) industry group face wages which are 10 percent (17 percent) less than the wage that the average worker receives.

With both personal and workplace controls, the standard deviation of 1-digit (2-digit) industry differentials is 7.4 percent (9.9 percent) across the pooled six waves of data. This further fall in the calculated dispersion suggests that workplace characteristics can account for about 17

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[24] The highest paying 1-digit industry is still energy and water supplies, but workers in this industry now earn 28% above the average wage, conditional on personal characteristics. Similarly, while solid fuels, oil etc still heads the 2-digit ranking, the associated differential is now 35 percent. These compare with the raw differentials of 49 and 54 percent respectively.

percent of the observed wage variation. Overall, personal and workplace controls explain around 55 percent of the observed inter-industry wage differences.[25]

These results concerning the importance of personal and workplace variables in explaining wage dispersion are consistent with previous (cross-section) studies investigating the inter-industry wage structure. They differ, however, in that the richness of the BHPS data is such that over one half of the total variation of wages is explained by these control variables as seen in the R^2's reported in the diagnostics. However, there is still a considerable degree of inter-industry wage variation that remains unaccounted for, and it is this residual dispersion that is usually attributed to non-competitive forces in wage determination.

Of course, pooled/cross-section estimates cannot control for *unobserved* differences between individuals which are correlated with their wages. Such differences may reflect productivity enhancing attributes that are not measured or captured in the data available to the econometrician, innate ability, any job-specific skills not measured by formal qualifications or accounted for by measured job characteristics etc. These unobserved individual-specific differences may, of course, explain the remaining inter-industry differences and the unexplained residual wage dispersion. Thus, in order to gauge the potential importance of such unobserved heterogeneity, we proceed to estimate a fixed-effects model as outlined in equation (3) by utilising the panel element of the data.

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[25] For $SD(\varphi)$, the proportion of 1-digit differentials explained by personal and workplace controls is $(1-\frac{0.0741}{0.1704})\times 100 = 57\%$, while for the 2-digit differentials, it is $(1-\frac{0.0992}{0.2165})\times 100 = 54\%$. For $|\varphi|$, the corresponding values are 56% and 50% respectively.

Tables 3B and 4B present fixed-effects estimates of the three wage equation specifications considered previously for 1-digit and 2-digit industry identifiers respectively. Column 1 reports the raw differentials; column 2, controls for personal characteristics and column 3 includes workplace control variables as well as personal controls. In each case, we estimate by fixed-effects and thus also account for unobserved individual heterogeneity.[26, 27]

Contrasting these results with the pooled regression results in Tables 3A and 4A highlights a number of important issues, and reveals some exceedingly interesting findings. Firstly, the inclusion of individual fixed-effects significantly reduces the size and significance of the industry coefficients. It also has a considerable impact on the degree of industry wage dispersion. For the 1-digit classification, comparing the first columns of Tables 3A and 3B, we see that much of the inter-industry wage dispersion can be ascribed to individual characteristics (which do not vary over time). Indeed, only half of the industry dummies are now statistically significantly different from zero at conventional levels, and the $SD(\varphi)$ measure of industry wage dispersion is only 3.1 percent. This result indicates that over 80 percent of the observed deviation in 'raw' industry wages can be attributed to unobserved heterogeneity not measured in standard cross-sections. The inclusion of personal and

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[26] Controlling for individual fixed-effects eliminates any workers who do not change industry over the six waves since their fixed-effect α_i is exactly correlated with the industry identifier. Hence, since estimation is only effectively undertaken on industry switchers, the coefficient on the industry dummy indicates the 'true' penalty or premium earned in that industry.

[27] Full results for pooled and fixed-effects specifications are presented in Table A2 (1-digit) and A3 (2-digit) of the appendix. These reveal that the estimated wage equations appear to be meaningful and appropriate in that the returns to the different personal and workplace characteristics are consistent with the large previous literature on wage determination. Thus, for example, *ceteris paribus*, age-earnings profiles are concave (although earnings increase over any individual's lifetime); women are paid significantly less than men; there are significant private returns to education; recent periods of unemployment or inactivity have a detrimental effect on earnings; unionised workers enjoy a wage premium of about 7 percent over their non-unionised colleagues; workers are compensated for long travel-to-work times; and wages are higher in the south of Britain.

workplace controls in columns 2 and 3 reduces the measured inter-industry wage dispersion even further to only 2.2 percent. Thus observed and unobserved differences between employees can together account for just over 87 percent of industry wage differentials. Similar findings are evident when we compare Tables 4A and 4B for the 2-digit classification: 82 percent of the raw inter-industry differentials can be 'explained' by unobserved and observed differences between individuals and the jobs that they do. This result is remarkably similar to those of Keane (1993) and Shippen (1999).[28]

The second notable feature of the results in Tables 3B and 4B is the high proportion of the variation in wages between individuals that is now 'explained'. For the full specification in column 3, the R^2 are 0.88 for both 1-digit and 2-digit industrial classifications. This implies that there is only a very limited residual variation in wages that cannot be accounted for by observed and unobserved characteristics of individuals and the jobs they do within the industries that they are employed. Moreover, as we have just seen, most of the variation in wages can in fact be attributed directly to differences between individuals and the characteristics of their jobs rather than simply their industry affiliation. This contrasts with much of the previous literature on wage determination which finds that there is considerable residual variation in wages that is unexplained by the variables in the wage equation.

Despite the fall in magnitude and significance of the estimated inter-industry wage differentials, there are still some substantial differences in wages between industries. For

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[28] Of course, we cannot control for any differences in returns to unobserved individual ability which vary by industry since industry-specific individual effects cannot be identified separately from true industry effects. As workers are gradually sorted into the industries which reward their particular abilities most highly, then we will observe positive industry wage differentials. Such a process may account for the small degree of inter-industry wage variation that remains (Keane, 1993).

example, in the 2-digit specification, workers in solid fuels, oil etc earn a premium of almost 16 percent over the average worker, while those in hotels and catering are paid 7 percent less than their measured and unmeasured attributes and their job conditions would imply. Of course, it could be argued that these remaining differentials are evidence of non-competitive pressures in wage determination. However, the important result in this paper is that such non-competitive differences, if they do exist, are of a much smaller degree than previously thought. Our findings suggest that much of the variation in wages previously attributed to inter-industry differentials is actually a reflection of unobserved differences between individuals which could not be eliminated in standard cross-section or pooled estimates of wage equations, and that these differences are correlated with industry affiliation (indeed they may indicate a successful matching process between workers and jobs).

Given that the fixed-effects estimates of the inter-industry differentials only reflect the premia earned by individuals who move industry, an alternative explanation for the remaining inter-industry wage differences is that there are unmeasured individual abilities which are not fixed (and thus eliminated by the within transformation) but differ according to the job that the individual is doing (or the industry s/he is working in). The unexplained industry differentials could, however, also be explained by unobserved fixed-effects at the firm and establishment level. Given the importance of measured job characteristics in cross-section estimates, and the fact that measured and unmeasured characteristics appear highly correlated in the fixed-effects model, this latter explanation appears equally plausible. In any event, it would appear that non-competitive forces have only a very minor role in explaining the industry wage structure.

In order to confirm the generality and robustness of our results, a number of additional specifications were examined. First, we investigated the sensitivity of our results to the fact that our sample is an unbalanced panel of individuals, some of whom were only interviewed on relatively few occasions (see Table 2). The results obtained from re-estimating the pooled and fixed-effects specifications using only the balanced panel (and thus only pooling individuals who were observed in all 6 waves) are qualitatively identical, and qualitatively very similar to those presented and discussed above.

Secondly, we examined the impact of using the (individual) weights provided with the BHPS data to correct for the sample design and non-response rates. Technically, these should be used in any analysis utilising the BHPS to ensure that the marginal distributions in the data match the known distribution in the population. Cross-section weights are supplied for each wave, and longitudinal weights (which also correct for possible attrition biases in the panel) are provided for individuals who have been interviewed in all six waves. However, none of our conclusions are affected by the use of these weights in either the pooled cross-section or fixed-effects results, and indeed, our conclusions hold *a fortiori* in the weighted regression results.

Third, we estimated our wage equations separately for men and women. It is well known that rates of return to educational qualifications, for example, can differ markedly between men and women. Once again, our substantive findings are not sensitive to this dichotomisation of the data.

6. Summary and Conclusions

This paper has investigated the nature and existence of UK inter-industry wage differentials using longitudinal data drawn from the BHPS. Results using the improved methodology of Haisken-DeNew and Schmidt (1997) cast doubt on established findings utilising cross-section techniques to estimate the inter-industry wage structure and suggest non-competitive explanations of industry wages to be largely redundant. Pooled cross-section results indicate that observed heterogeneity in worker and workplace characteristics accounts for about 55 percent of raw industry wage differentials, and slightly more than half of the dispersion in wages. Our fixed-effects estimates that additionally capture unobserved individual heterogeneity suggest that, in total, observed and unobserved differences account for 82 percent of the 1-digit industry wage pattern (or 87 percent if we use the finer 2-digit classification).

The most direct and immediate interpretation of our results, especially given that there is very little variation in wages that remains unexplained, is that they support standard human capital theory. This presupposes workers are paid according to their marginal productivity which in turn will be correlated with both observed and unobserved individual characteristics, and characteristics of their job. This finding is in direct contrast to the conclusions of Dickens and Katz (1987a, 1987b) and Krueger and Summers (1987, 1988), who firmly reject competitive explanations of inter-industry phenomena. The result is consistent, however, with other panel studies reported recently for the US.

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Table 1

Distribution of Observations for BHPS Waves 1-6

Wave of interview	Males	Females	Total
Wave 1	2,308	2,291	4,599
Wave 2	2,091	2,105	4,196
Wave 3	1,971	2,052	4,023
Wave 4	2,008	2,092	4,100
Wave 5	2,006	2,073	4,079
Wave 6	2,105	2,159	4,264
Total	12,489	12,772	25,261

Table 2

Distribution of Individuals for BHPS Waves 1-6

No. of waves individual is observed	Males	Females	Total
1 wave	906	885	1,791
2 waves	514	510	1,024
3 waves	365	396	761
4 waves	362	387	749
5 waves	400	461	861
6 waves	1,002	971	1,973
Total	3,549	3,610	7,159

Table 3A

1-digit Inter-Industry Wage Differentials 1991-1996: Pooled Regressions

1-digit industry	**Specification 1**		**Specification 2**		**Specification 3**	
Agriculture, forestry and fishing	-0.292	(10.36)	-0.244	(10.78)	-0.024	(1.17)
Energy and water supplies	0.396	(20.03)	0.244	(15.28)	0.200	(13.88)
Minerals, metal manufacture and chemicals	0.129	(8.29)	0.094	(7.51)	0.070	(6.07)
Metal goods, engineering and vehicles	0.105	(12.04)	0.044	(6.10)	0.063	(8.93)
Other manufacturing	-0.087	(9.99)	-0.021	(2.91)	0.005	(0.68)
Construction	0.022	(1.32)	-0.001	(0.07)	0.053	(4.26)
Distribution, hotels and catering	-0.306	(49.85)	-0.179	(35.57)	-0.101	(18.82)
Transport and communication	0.021	(1.80)	-0.005	(0.52)	-0.003	(0.31)
Banking, finance, insurance and business services	0.171	(22.27)	0.121	(19.54)	0.119	(19.47)
Other services	0.064	(15.57)	0.030	(8.24)	-0.033	(6.33)
Diagnostics						
R^2	0.1190		0.4406		0.5649	
$SD(\phi)$	0.1704		0.1024		0.0741	
$\lvert\phi\rvert$	0.1368		0.0762		0.0601	
F(industry dummies)	379.0 [0.00]		201.2 [0.00]		109.6 [0.00]	
F(personal controls)	-		518.0 [0.00]		228.2 [0.00]	
F(workplace controls)	-		-		218.2 [0.00]	
NT	25,261		25,261		25,261	

<u>Notes</u>

1. Specification 1 reports the raw 1-digit inter-industry wage differentials.
2. Specification 2 includes personal controls: 5 segment piecewise linear spline for age and dummies for gender, race (2), marital status (3), highest qualification (7), registered disabled, health limits work (2), head of household, own children in household, age of children in household (3), recent labour market experience (2), region (4).
3. Specification 3 includes personal controls (see note 2) and workplace controls: dummies for occupation (9), firm size (8), full-time work, temporary work, private sector, union recognition, union member (2), manager, supervisor, shift worker, bonus in pay, annual increments in pay, travel to work time greater than 1 hour, time (wave) dummies (6).
4. The F-tests are for the joint exclusion of the variables in parentheses; p-values in [].
5. For comparison, the R^2's for Specification 2 and 3 excluding the industry effects are 0.4005 and 0.5479 respectively.
6. $SD(\varphi)$ is the weighted and adjusted standard deviation of the inter-industry differentials calculated according to the HDS methodology; $\lvert\varphi\rvert$ is the weighted average absolute differential. See text for details.

Table 3B

1-digit Inter-Industry Wage Differentials 1991-1996: Panel (fixed-effects) Regressions

1-digit industry	Specification 1		Specification 2		Specification 3	
Agriculture, forestry and fishing	-0.058	(2.06)	-0.046	(1.70)	-0.034	(1.30)
Energy and water supplies	0.111	(4.71)	0.104	(4.54)	0.083	(3.69)
Minerals, metal manufacture and chemicals	0.030	(1.92)	0.025	(1.65)	0.024	(1.61)
Metal goods, engineering and vehicles	0.010	(1.04)	0.016	(1.70)	0.022	(2.37)
Other manufacturing	-0.016	(1.65)	-0.010	(1.14)	-0.004	(0.45)
Construction	-0.005	(0.30)	-0.002	(0.12)	0.010	(0.66)
Distribution, hotels and catering	-0.054	(8.36)	-0.046	(7.51)	-0.032	(5.03)
Transport and communication	-0.002	(0.18)	-0.016	(1.20)	-0.031	(2.36)
Banking, finance, insurance and business services	0.026	(3.05)	0.018	(2.18)	0.029	(3.57)
Other services	0.014	(2.43)	0.013	(2.27)	-0.001	(0.09)
Diagnostics						
R^2	0.8649		0.8746		0.8806	
$SD(\phi)$	0.0309		0.0270		0.0222	
$\lvert\phi\rvert$	0.0247		0.0222		0.0174	
F(industry dummies)	11.08 [0.00]		9.24 [0.00]		6.46 [0.00]	
F(personal controls)	-		56.35 [0.00]		26.62 [0.00]	
F(workplace controls)	-		-		27.40 [0.00]	
NT	25,261		25,261		25,261	

<u>Notes</u>

1. See notes to Table 3A.
2. Specification 1 reports raw 2-digit differentials controlling for unobserved individual heterogeneity; Specification 2 includes personal controls; Specification 3 includes both personal and workplace controls.
3. For comparison, the R^2's for Specification 2 and 3 excluding the industry effects are 0.8740 and 0.8802 respectively.

Table 4A

2-digit Inter-Industry Wage Differentials 1991-1996: Pooled Regressions

2-digit industry	**Specification 1**		**Specification 2**		**Specification 3**	
Agriculture, horticulture, forestry and fishing	-0.292	(10.81)	-0.243	(11.06)	-0.030	(1.49)
Solid fuels, oil and natural gas, nuclear fuel	0.432	(14.60)	0.303	(12.54)	0.254	(11.63)
Energy and water production and distribution	0.371	(14.90)	0.221	(10.90)	0.191	(10.25)
Metallic and non-metallic minerals	0.034	(1.52)	0.056	(3.07)	0.041	(2.46)
Chemicals and man-made fibres	0.209	(10.24)	0.136	(8.17)	0.106	(6.91)
Metal goods, office machinery etc.	0.015	(0.71)	0.005	(0.29)	0.046	(2.70)
Mechanical engineering	0.097	(5.74)	0.031	(2.26)	0.065	(5.10)
Electrical and electronic engineering	0.088	(4.98)	0.049	(3.44)	0.063	(4.80)
Instrument engineering etc.	0.182	(11.52)	0.096	(7.40)	0.089	(7.30)
Food, drink and tobacco	-0.137	(8.49)	-0.068	(5.17)	-0.045	(3.64)
Textiles, footwear and clothing, leather goods	-0.283	(12.84)	-0.119	(6.58)	-0.120	(7.11)
Timber and wooden furniture	-0.159	(6.56)	-0.086	(4.33)	0.005	(0.29)
Paper and paper products	0.115	(6.89)	0.100	(7.42)	0.112	(8.98)
Rubber, plastics and other manufacturing	-0.092	(4.01)	0.008	(0.45)	0.031	(1.84)
Construction	0.022	(1.38)	0.007	(0.51)	0.059	(4.82)
Wholesale distribution, dealing in scrap and waste	-0.082	(5.68)	-0.065	(5.50)	0.002	(0.20)
Retail Distribution	-0.315	(36.84)	-0.174	(24.65)	-0.123	(15.64)
Hotels and Catering	-0.481	(36.07)	-0.298	(27.13)	-0.175	(16.44)
Repair of consumer goods and vehicles	-0.286	(10.17)	-0.229	(9.96)	-0.096	(4.52)
Air/land/sea transport services and storage	-0.048	(3.40)	-0.060	(5.19)	-0.039	(3.66)
Postal services and telecommunications	0.140	(7.49)	0.105	(6.90)	0.097	(6.86)
Banking and Finance	0.232	(15.36)	0.214	(17.26	0.147	(12.24)
Insurance, except for social security	0.192	(9.44)	0.173	(10.44)	0.145	(9.55)
Business Services	0.168	(15.76)	0.089	(10.15)	0.132	(15.77)
Owning and dealing in real estate	-0.043	(1.59)	-0.024	(1.10)	-0.009	(0.48)
Public admin., defence, social security	0.233	(25.92)	0.150	(20.42)	0.072	(8.80)
Education, R&D	0.150	(17.58)	0.016	(2.08)	-0.056	(6.42)
Hospitals and other medical institutions	0.019	(1.88)	0.063	(7.27)	-0.073	(7.97)
Social welfare, charities etc.	-0.098	(7.81)	-0.080	(7.77)	-0.104	(9.84)
Film, radio and television, literature, museums etc	-0.130	(6.21)	-0.076	(4.44)	-0.042	(2.74)
Personal and domestic services	-0.608	(25.23)	-0.392	(19.88)	-0.185	(10.05)
Diagnostics						
R^2	0.1925		0.4699		0.5771	
$SD(\phi)$	0.2165		0.1358		0.0992	
$\|\phi\|$	0.1777		0.1090		0.0881	
F(industry dummies)	200.6 [0.00]		110.1 [0.00]		58.08 [0.00]	
F(personal controls)	-		471.0 [0.00]		201.2 [0.00]	
F(workplace controls)	-		-		193.5 [0.00]	
NT	25,261		25,261		25,261	

Notes:

1. See notes to Table 3A.

Table 4B

2-digit Inter-Industry Wage Differentials 1991-1996: Panel (fixed-effects) Regressions

2-digit industry	Specification 1		Specification 2		Specification 3	
Agriculture, horticulture, forestry and fishing	-0.069	(2.44)	-0.057	(2.10)	-0.038	(1.45)
Solid fuels, oil and natural gas, nuclear fuel	0.177	(5.60)	0.170	(5.59)	0.146	(4.89)
Energy and water production and distribution	0.056	(1.57)	0.045	(1.33)	0.034	(1.02)
Metallic and non-metallic minerals	0.013	(0.60)	0.014	(0.68)	0.014	(0.68)
Chemicals and man-made fibres	0.064	(2.91)	0.050	(2.34)	0.053	(2.51)
Metal goods, office machinery etc.	0.014	(0.85)	0.018	(1.10)	0.034	(2.08)
Mechanical engineering	0.009	(0.61)	0.015	(1.06)	0.024	(1.69)
Electrical and electronic engineering	0.010	(0.66)	0.018	(1.17)	0.022	(1.48)
Instrument engineering etc.	0.027	(1.74)	0.031	(2.06)	0.039	(2.59)
Food, drink and tobacco	-0.025	(1.47)	-0.019	(1.12)	-0.010	(0.58)
Textiles, footwear and clothing, leather goods	-0.066	(2.59)	-0.063	(2.57)	-0.061	(2.49)
Timber and wooden furniture	-0.012	(0.49)	-0.012	(0.52)	0.010	(0.44)
Paper and paper products	0.014	(0.70)	0.021	(1.09)	0.031	(1.63)
Rubber, plastics and other manufacturing	-0.003	(0.16)	0.003	(0.14)	0.008	(0.40)
Construction	0.003	(0.18)	0.004	(0.28)	0.018	(1.16)
Wholesale distribution, dealing in scrap and waste	-0.004	(0.31)	-0.006	(0.53)	0.008	(0.72)
Retail Distribution	-0.077	(8.14)	-0.055	(6.00)	-0.044	(4.56)
Hotels and Catering	-0.093	(7.22)	-0.101	(8.13)	-0.075	(5.96)
Repair of consumer goods and vehicles	-0.041	(1.61)	-0.024	(0.97)	-0.008	(0.32)
Air/land/sea transport services and storage	-0.031	(1.92)	-0.049	(3.12)	-0.054	(3.44)
Postal services and telecommunications	0.078	(3.13)	0.073	(3.05)	0.041	(1.74)
Banking and Finance	0.099	(4.81)	0.107	(5.40)	0.094	(4.78)
Insurance, except for social security	0.016	(0.73)	0.022	(1.01)	0.018	(0.83)
Business Services	0.022	(2.15)	0.012	(1.22)	0.034	(3.45)
Owning and dealing in real estate	0.006	(0.27)	-0.012	(0.59)	-0.007	(0.38)
Public admin., defence, social security	0.050	(4.88)	0.044	(4.40)	0.027	(2.77)
Education, R&D	0.042	(3.52)	0.037	(3.24)	0.012	(0.98)
Hospitals and other medical institutions	-0.022	(1.57)	-0.032	(2.41)	-0.046	(3.47)
Social welfare, charities etc.	-0.021	(1.64)	-0.024	(1.95)	-0.040	(3.22)
Film, radio and television, literature, museums etc	-0.041	(2.00)	-0.045	(2.26)	-0.036	(1.81)
Personal and domestic services	-0.143	(5.16)	-0.102	(3.82)	-0.062	(2.32)
Diagnostics						
R^2	0.8660		0.8757		0.8813	
$SD(\phi)$	0.0504		0.0465		0.0393	
$\lvert\phi\rvert$	0.0420		0.0398		0.0358	
F(industry dummies)	8.23 [0.00]		7.70 [0.00]		5.46 [0.00]	
F(personal controls)	-		56.32 [0.00]		26.30 [0.00]	
F(workplace controls)	-		-		26.06 [0.00]	
NT	25,261		25,261		25,261	

Notes:

1. See notes to Table 3B.
2. Specification 1 reports raw 2-digit differentials controlling for unobserved individual heterogeneity; Specification 2 includes personal controls; Specification 3 includes both personal and workplace controls.

APPENDIX

Table A1: Data Definitions and Summary Statistics

Variable	*Definition and Description*	*Mean*	*SD*
Dependent Variable:			
Log of real hourly wage	Log of hourly wage deflated by RPI	1.639	0.495
Independent Variables			
Age	Age of individual at December of interview	37.069	11.195
Gender	(1,0) if female	0.506	
Race			
White (reference)	(1,0) if white	0.967	
Black	(1,0) if black ethnic origin	0.010	
Other non-white	(1,0) if other ethnic origin	0.023	
Marital Status			
Never Married	(1,0) if never married	0.204	
Married or Living as a Couple (reference)	(1,0) if married or living as a couple	0.722	
Widowed/Separated/Divorced	(1,0) if widowed, separated or divorced	0.073	
Highest Qualification			
Higher or First Degree, Teaching	(1,0) qualification dummy	0.157	
Other Higher Education	(1,0) qualification dummy	0.185	
GCE A-level	(1,0) qualification dummy	0.129	
GCE O-level (reference)	(1,0) qualification dummy	0.239	
CSE Grade1-5	(1,0) qualification dummy	0.048	
Apprenticeship, Nursing, Other	(1,0) qualification dummy	0.073	
No Qualification	(1,0) qualification dummy	0.169	
Health			
Registered Disabled	(1,0) if registered disabled	0.008	
Limits types of work	(1,0) if health limits type or amount of work	0.070	
Other Personal Controls			
Head of Household	(1,0) if head of household	0.492	
Own Children	(1,0) if own children in household	0.357	
Children aged 0-4 Years	(1,0) if children aged <5 years in hhold	0.127	
Children aged 5-15 Years	(1,0) if children aged 5-15 years in hhold	0.206	
Children aged 16-18 Years	(1,0) if children aged 16-18 years in hhold	0.035	
Unemployed in Past Year	(1,0) if unemployment spell(s) in past year	0.061	
Non-Participant in Past Year	(1,0) if non-participation spell(s) in past year	0.061	
Size of Establishment			
<10 Employees (reference)	(1,0) if <10 employees	0.168	
10-24 Employees	(1,0) if 10-24 employees	0.161	
25-49 Employees	(1,0) if 25-49 employees	0.148	
50-99 Employees	(1,0) if 50-99 employees	0.119	
100-199 Employees	(1,0) if 100-199 employees	0.107	
200-499 Employees	(1,0) if 200-499 employees	0.133	
500-999 Employees	(1,0) if 500-999 employees	0.068	
>1000 Employees	(1,0) if >1000 employees	0.096	
Workplace and Other Controls			
Full-time	(1,0) if work >30 hours per week	0.813	
Not Private Sector	(1,0) if not private sector employment	0.318	
Seasonal/Temporary Work	(1,0) if job seasonal/temporary	0.064	
Promotion Opportunities	(1,0) if job has promotion opportunities	0.507	
Bonuses or Profit	(1,0) if pay includes bonuses or profits	0.289	
Annual Increments	(1,0) if pay includes annual increments	0.464	
Union or Staff Association	(1,0) if union or staff association at w'place	0.513	
Member of Union	(1,0) if member of workplace union	0.338	
Member of Other Union	(1,0) if member of non-workplace union	0.025	
Rotating Shifts	(1,0) if work involves rotating shifts	0.104	
Manager	(1,0) if manager	0.189	
Supervisor	(1,0) if supervisor	0.175	
Travel 60+ Minutes	(1,0) if travel to work 60+ Minutes	0.032	

Regions of the UK			
South (reference)	(1,0) regional dummy	0.386	
North	(1,0) regional dummy	0.256	
East	(1,0) regional dummy	0.116	
West	(1,0) regional dummy	0.241	
Occupation Major Groups			
Managers and Administrators	(1,0) occupation dummy	0.124	
Professional Occupations	(1,0) occupation dummy	0.103	
Associate Professionals & Tech	(1,0) occupation dummy	0.108	
Clerical and Secretarial (reference)	(1,0) occupation dummy	0.202	
Craft and Related	(1,0) occupation dummy	0.110	
Personal and Protective Services	(1,0) occupation dummy	0.107	
Sales	(1,0) occupation dummy	0.071	
Plant and Machine Operatives	(1,0) occupation dummy	0.100	
Other Occupations	(1,0) occupation dummy	0.075	
1-digit industry groups			
Agriculture, forestry and fishing	(1,0) industry dummy	0.011	
Energy and water supplies	(1,0) industry dummy	0.021	
Minerals, metal manufacture & chemicals	(1,0) industry dummy	0.034	
Metal goods, engineering and vehicles	(1,0) industry dummy	0.100	
Other manufacturing	(1,0) industry dummy	0.100	
Construction	(1,0) industry dummy	0.029	
Distribution, hotels and catering	(1,0) industry dummy	0.185	
Transport and communication	(1,0) industry dummy	0.060	
Banking, finance, insurance & business services	(1,0) industry dummy	0.127	
Other services	(1,0) industry dummy	0.333	
2-digit industry groups			
Agriculture, horticulture, forestry and fishing	(1,0) industry dummy	0.011	
Solid fuels, oil and natural gas, nuclear fuel	(1,0) industry dummy	0.009	
Energy and water production and distribution	(1,0) industry dummy	0.012	
Metallic and non-metallic minerals	(1,0) industry dummy	0.015	
Chemicals and man-made fibres	(1,0) industry dummy	0.018	
Metal goods, office machinery etc.	(1,0) industry dummy	0.018	
Mechanical engineering	(1,0) industry dummy	0.027	
Electrical and electronic engineering	(1,0) industry dummy	0.025	
Instrument engineering etc.	(1,0) industry dummy	0.031	
Food, drink and tobacco	(1,0) industry dummy	0.029	
Textiles, footwear and clothing, leather goods	(1,0) industry dummy	0.016	
Timber and wooden furniture	(1,0) industry dummy	0.013	
Paper and paper products	(1,0) industry dummy	0.028	
Rubber, plastics and other manufacturing	(1,0) industry dummy	0.015	
Construction	(1,0) industry dummy	0.029	
Wholesale distribution, dealing in scrap and waste	(1,0) industry dummy	0.036	
Retail Distribution	(1,0) industry dummy	0.097	
Hotels and Catering	(1,0) industry dummy	0.042	
Repair of consumer goods and vehicles	(1,0) industry dummy	0.010	
Air/land/sea transport services and storage	(1,0) industry dummy	0.038	
Postal services and telecommunications	(1,0) industry dummy	0.022	
Banking and Finance	(1,0) industry dummy	0.033	
Insurance, except for social security	(1,0) industry dummy	0.019	
Business Services	(1,0) industry dummy	0.065	
Owning and dealing in real estate	(1,0) industry dummy	0.010	
Public admin., defence, social security	(1,0) industry dummy	0.088	
Education, R&D	(1,0) industry dummy	0.097	
Hospitals and other medical institutions	(1,0) industry dummy	0.070	
Social welfare, charities etc.	(1,0) industry dummy	0.048	
Film, radio and television, literature, museums etc	(1,0) industry dummy	0.017	
Personal and domestic services	(1,0) industry dummy	0.013	
N		25,261	

Table A2

Earnings Equations: BHPS 1991-1996: 1-digit Industries

	Pooled		Fixed-Effects	
Dependent Variable: log real hourly wage	**Table 3A Specification 3**		**Table 3B Specification 3**	
Personal Controls				
Age 16-26	0.040	(24.43)	0.194	(1.17)
Age 26-33	0.014	(9.59)	0.159	(0.96)
Age 34-40	-0.002	(1.12)	0.147	(0.89)
Age 40-48	-0.000	(0.05)	0.144	(0.87)
Age 48-64	-0.002	(2.13)	0.137	(0.83)
Gender	-0.130	(21.50)	-	
Black	-0.015	(0.69)	-	
Other	-0.023	(1.64)	-	
Widowed, Separated or Divorced	-0.077	(8.99)	0.000	(0.03)
Never married	-0.038	(5.69)	-0.019	(1.84)
Higher or First Degree, Teaching	0.181	(21.86)	0.125	(4.28)
Other Higher Education	0.069	(10.26)	0.024	(1.57)
GCE A-level	0.048	(6.66)	0.061	(3.35)
CSE Grade1-5	-0.040	(3.76)	-0.052	(1.43)
Apprenticeship, Nursing, Other	-0.036	(4.02)	0.052	(1.94)
Other Qualification	-0.117	(16.47)	0.013	(0.52)
Registered Disabled	-0.136	(5.66)	-0.056	(1.85)
Health Limits types of work	-0.036	(4.31)	-0.035	(4.44)
Head of Household	0.062	(10.64)	0.011	(1.39)
Own Children	-0.015	(2.04)	0.005	(0.56)
Children aged 0-4 Years	0.041	(5.27)	-0.009	(1.22)
Children aged 5-15 Years	-0.005	(0.67)	-0.004	(0.52)
Children aged 16-18 Years	-0.016	(1.37)	-0.003	(0.30)
Unemployed in past year	-0.085	(9.33)	-0.028	(3.66)
Non-participant in past year	-0.104	(11.20)	-0.053	(6.60)
Workplace Controls				
10-24 Employees	0.114	(15.65)	0.036	(4.93)
25-49 Employees	0.117	(15.45)	0.045	(5.78)
50-99 Employees	0.168	(20.64)	0.057	(6.72)
100-199 Employees	0.171	(20.13)	0.054	(6.12)
200-499 Employees	0.181	(22.10)	0.065	(7.31)
500-999 Employees	0.194	(19.40)	0.064	(6.18)
>1000 Employees	0.208	(22.66)	0.075	(7.32)
Full-time Employment	-0.002	(0.32)	-0.135	(16.78)
Not private sector	0.073	(9.31)	0.037	(4.52)
Seasonal/Temporary Work	-0.016	(1.74)	-0.008	(0.92)
Promotion Opportunities	0.031	(6.62)	0.008	(1.76)
Bonuses or Profit	0.051	(10.31)	0.032	(6.28)
Annual Increments	0.033	(7.12)	0.022	(4.72)
Union or Staff Association	0.042	(6.58)	0.051	(6.71)
Member of Union	0.081	(12.67)	0.068	(8.13)
Member of Other Union	0.080	(5.95)	0.039	(2.77)
Rotating Shifts	0.069	(9.38)	0.029	(3.26)
Manager	0.134	(17.30)	0.037	(5.06)
Supervisor	0.062	(10.75)	0.027	(5.01)
Travel 60+ Minutes	0.124	(10.36)	0.008	(0.68)

Region Dummies				
North	-0.113	(20.96)	-0.032	(1.15)
East	-0.125	(17.87)	-0.037	(1.34)
West	-0.108	(19.87)	-0.042	(1.68)
Occupation Major Groups				
Managers and Administrators	0.151	(15.42)	0.010	(1.04)
Professional Occupations	0.183	(18.52)	0.040	(3.28)
Associate Professionals and Technical	0.144	(16.89)	0.034	(3.31)
Craft and Related	-0.033	(3.74)	-0.007	(0.60)
Personal and Protective Services	-0.127	(14.77)	-0.076	(6.38)
Sales	-0.069	(6.89)	-0.067	(5.96)
Plant and Machine Operatives	-0.084	(9.10)	-0.028	(2.33)
Other Occupations	-0.198	(20.57)	-0.065	(5.03)
Industry Classes (1-digit)				
Agriculture, forestry and fishing	-0.024	(1.17)	-0.034	(1.30)
Energy and water supplies	0.200	(13.88)	0.083	(3.69)
Minerals, metal manufacture and chemicals	0.070	(6.07)	0.024	(1.61)
Metal goods, engineering and vehicles	0.063	(8.93)	0.022	(2.37)
Other manufacturing	0.005	(0.68)	-0.004	(0.45)
Construction	0.053	(4.26)	0.010	(0.66)
Distribution, hotels and catering	-0.101	(18.82)	-0.032	(5.03)
Transport and communication	-0.003	(0.31)	-0.031	(2.36)
Banking, finance, insurance & business services	0.119	(19.47)	0.029	(3.57)
Other services	-0.033	(6.33)	-0.001	(0.09)
Time Dummies				
Wave 2	0.031	(4.42)	-0.104	(0.63)
Wave 3	0.022	(3.07)	-0.250	(0.75)
Wave 4	0.013	(1.84)	-0.392	(0.79)
Wave 5	0.017	(2.37)	-0.526	(0.80)
Wave 6	0.026	(3.67)	-0.651	(0.79)
Constant	0.369	(9.07)	4.796	(0.84)
Diagnostics				
R^2	0.5649		0.8806	
$SD(\phi)$	0.0741		0.0222	
$\lvert\phi\rvert$	0.0601		0.0174	
F(industry dummies)	109.6 [0.00]		6.46 [0.00]	
F(personal controls)	228.2 [0.00]		26.62 [0.00]	
F(workplace controls)	218.2 [0.00]		27.40 [0.00]	
NT	25,261		25,261	

Notes: t-ratios in parentheses.

Table A3

Earnings Equations: BHPS 1991-1996: 2-digit Industries

	Pooled		Fixed-Effects	
Dependent variable: log real hourly wage	**Table 4A Specification 3**		**Table 4B Specification 3**	
Personal Controls				
Age 16-26	0.038	(23.54)	0.193	(1.17)
Age 26-33	0.014	(9.78)	0.158	(0.96)
Age 34-40	-0.002	(1.31)	0.146	(0.88)
Age 40-48	0.000	(0.29)	0.143	(0.87)
Age 48-64	-0.002	(1.95)	0.136	(0.82)
Gender	-0.104	(17.12)	-	
Black	-0.004	(0.18)	-	
Other	-0.013	(0.92)	-	
Widowed, Separated or Divorced	-0.068	(7.99)	0.002	(0.16)
Never married	0.035	(5.32)	-0.019	(1.84)
Higher or First Degree, Teaching	0.184	(22.40)	0.124	(4.24)
Other Higher Education	0.071	(10.69)	0.023	(1.48)
GCE A-level	0.047	(6.54)	0.059	(3.24)
CSE Grade1-5	-0.039	(3.78)	-0.056	(1.54)
Apprenticeship, Nursing, Other	-0.027	(2.96)	0.050	(1.87)
Other Qualification	-0.106	(15.00)	0.012	(0.48)
Registered Disabled	-0.138	(5.82)	-0.057	(1.89)
Health Limits types of work	-0.033	(4.09)	-0.035	(4.38)
Head of Household	0.061	(10.62)	0.010	(1.32)
Own Children	-0.015	(2.16)	0.003	(0.38)
Children aged 0-4 Years	0.037	(4.81)	-0.009	(1.24)
Children aged 5-15 Years	-0.003	(0.45)	-0.004	(0.50)
Children aged 16-18 Years	-0.018	(1.55)	-0.003	(0.33)
Unemployed in past year	-0.081	(9.07)	-0.028	(3.60)
Non-participant in past year	-0.102	(11.14)	-0.053	(6.62)
Workplace Controls				
10-24 Employees	0.107	(14.73)	0.034	(4.63)
25-49 Employees	0.109	(14.44)	0.043	(5.47)
50-99 Employees	0.153	(18.84)	0.054	(6.34)
100-199 Employees	0.155	(18.32)	0.051	(5.69)
200-499 Employees	0.168	(20.59)	0.061	(6.84)
500-999 Employees	0.179	(17.93)	0.060	(5.80)
>1000 Employees	0.194	(20.87)	0.073	(7.03)
Full-time Employment	-0.011	(1.59)	-0.136	(16.90)
Not private sector	0.060	(7.50)	0.037	(3.82)
Seasonal/Temporary Work	-0.018	(1.98)	-0.008	(0.97)
Promotion Opportunities	0.026	(5.74)	0.008	(1.66)
Bonuses or Profit	0.046	(9.36)	0.030	(5.96)
Annual Increments	0.030	(6.70)	0.021	(4.65)
Union or Staff Association	0.039	(6.07)	0.049	(6.49)
Member of Union	0.078	(12.29)	0.067	(7.90)
Member of Other Union	0.084	(6.38)	0.040	(2.78)
Rotating Shifts	0.069	(9.40)	0.031	(3.49)
Manager	0.135	(17.62)	0.038	(5.12)
Supervisor	0.064	(11.11)	0.027	(5.00)
Travel 60+ Minutes	0.117	(9.94)	0.008	(0.65)

Region Dummies				
North	-0.105	(19.64)	-0.035	(1.25)
East	-0.118	(17.01)	-0.038	(1.37)
West	-0.102	(18.89)	-0.043	(1.74)
Occupation Major Groups				
Managers and Administrators	0.175	(17.96)	0.014	(1.50)
Professional Occupations	0.228	(22.15)	0.043	(3.54)
Associate Professionals and Technical	0.178	(20.40)	0.038	(3.75)
Craft and Related	0.001	(0.06)	-0.003	(0.26)
Personal and Protective Services	-0.080	(8.87)	-0.061	(5.02)
Sales	-0.055	(5.25)	-0.063	(5.48)
Plant and Machine Operatives	-0.057	(6.12)	-0.026	(2.18)
Other Occupations	-0.172	(17.52)	-0.059	(4.55)
Industry Classes (2-digit)				
Agriculture, horticulture, forestry and fishing	-0.030	(1.49)	-0.038	(1.45)
Solid fuels, oil and natural gas, nuclear fuel	0.254	(11.63)	0.146	(4.89)
Energy and water production and distribution	0.191	(10.25)	0.034	(1.02)
Metallic and non-metallic minerals	0.041	(2.46)	0.014	(0.68)
Chemicals and man-made fibres	0.106	(6.91)	0.053	(2.51)
Metal goods, office machinery etc.	0.046	(2.70)	0.034	(2.08)
Mechanical engineering	0.065	(5.10)	0.024	(1.69)
Electrical and electronic engineering	0.063	(4.80)	0.022	(1.48)
Instrument engineering etc.	0.089	(7.30)	0.039	(2.59)
Food, drink and tobacco	-0.045	(3.64)	-0.010	(0.58)
Textiles, footwear and clothing, leather goods	-0.120	(7.11)	-0.061	(2.49)
Timber and wooden furniture	0.005	(0.29)	0.010	(0.44)
Paper and paper products	0.112	(8.98)	0.031	(1.63)
Rubber, plastics and other manufacturing	0.031	(1.84)	0.008	(0.40)
Construction	0.059	(4.82)	0.018	(1.16)
Wholesale distribution, scrap and waste	0.002	(0.20)	0.008	(0.72)
Retail Distribution	-0.123	(15.64)	-0.044	(4.56)
Hotels and Catering	-0.175	(16.44)	-0.075	(5.96)
Repair of consumer goods and vehicles	-0.096	(4.52)	-0.008	(0.32)
Air/land/sea transport services and storage	-0.039	(3.66)	-0.054	(3.44)
Postal services and telecommunications	0.097	(6.86)	0.041	(1.74)
Banking and Finance	0.147	(12.24)	0.094	(4.78)
Insurance, except for social security	0.145	(9.55)	0.018	(0.83)
Business Services	0.132	(15.77)	0.034	(3.45)
Owning and dealing in real estate	-0.009	(0.48)	-0.007	(0.38)
Public admin., defence, social security	0.072	(8.80)	0.027	(2.77)
Education, R&D	-0.056	(6.42)	0.012	(0.98)
Hospitals and other medical institutions	-0.073	(7.97)	-0.046	(3.47)
Social welfare, charities etc.	-0.104	(9.84)	-0.040	(3.22)
Film, radio and television, literature, museums	-0.042	(2.74)	-0.036	(1.81)
Personal and domestic services	-0.185	(10.05)	-0.062	(2.32)
Time Dummies				
Wave 2	0.032	(4.60)	-0.103	(0.62)
Wave 3	0.023	(3.23)	-0.248	(0.75)
Wave 4	0.014	(1.96)	-0.390	(0.79)
Wave 5	0.017	(2.49)	-0.523	(0.79)
Wave 6	0.026	(3.82)	-0.646	(0.78)
Constant	0.394	(9.79)	-4.725	(0.83)

Diagnostics		
R^2	0.5771	0.8813
$SD(\phi)$	0.0992	0.0393
$\lvert\phi\rvert$	0.0881	0.0358
F(industry dummies)	58.08 [0.00]	5.46 [0.00]
F(personal controls)	201.2 [0.00]	26.30 [0.00]
F(workplace controls)	193.5 [0.00]	26.06 [0.00]
NT	25,261	25,261

Notes: t-ratios in parentheses.