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THE UK WAGE CURVE: NEW EVIDENCE FROM THE BRITISH HOUSEHOLD PANEL SURVEY

Bill Collier

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Abstract

This paper investigates the UK wage curve using longitudinal micro data drawn from the first eight waves of the British Household Panel Survey (BHPS). We estimate a fixed-effects model that controls for observed and unobserved individual-specific heterogeneity. Our results suggest that there is evidence of a negative relationship in wage-unemployment space. The estimated unemployment elasticity of pay for UK males is approximately -0.14 and this elasticity is robust to a number of alternative specifications. There is no evidence of a significant wage curve for women. These findings are consistent with panel studies reported for other countries. They contrast with previous studies for the UK, however, in that they reject the inclusion of higher order polynomial terms for unemployment. The main findings of the paper, therefore, are that the wage-unemployment relationship is robust but not as non-linear as has been previously thought.

JEL Classification: C23, J30, J60

Keywords: Wage Structure, Wage Curve, Panel data, Unemployment, Regional Labour Markets

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Correspondence Address: Bill Collier, Department of Economics, Keynes College, University of Kent at Canterbury, Canterbury, KENT CT2 7NP, UK; Tel: +44 (0)1227 823432; Fax: +44 (0)1227 827850; email: wjc@ukc.ac.uk.

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I. Introduction

Recent contributions to the literature by Blanchflower and Oswald (1990, 1994a, 1994b, 1995) adhere to the existence of a new empirical law of economics, a stable inverse non-linear relationship between individual pay and the local unemployment rate. They name this new regularity the 'Wage Curve'. The empirical foundation of this relationship is a Mincerian earnings equation augmented with the unemployment rate for an individual's local labour market. The local unemployment rate provides a measure for the degree of joblessness in the local market. The purpose of such equations is thus to examine the role of local unemployment in the determination of local pay, "where causality is to be thought of as running from the amount of joblessness to the level of wages".[1]

Evidence for the existence of a wage curve appears irrefutable. Blanchflower and Oswald (1994b) present evidence utilising information on approximately three and a half million people from a dozen countries. Additional papers utilising datasets from countries as diverse as Belgium, Norway, South Africa and the Ivory Coast extend the result further. The relationship appears virtually identical across a variety of countries, regardless of institutional and industry structure. Results for the US, Britain, South Korea, Canada and a number of other Western European Countries suggest that the unemployment elasticity of pay is -0.1, that is, a 10% increase in local unemployment results in a 1% decrease in local pay. Such uniformity in wage flexibility appears remarkable, particularly in Europe where differences in

[1] Blanchflower and Oswald (1994b), p.3.

international wage setting behaviour are frequently cited as a potential explanation of aggregate unemployment.[2] It is not, however, without criticism. Card (1995), in a searching review of the Wage Curve, accepts Blanchflower and Oswald's conclusion of a negative correlation between wages and the local unemployment rate. The origin and interpretation of this correlation remains, however, a source for debate.

Critiques of Blanchflower and Oswald emphasise issues concerning choice of econometric technique. Model specification, sample selection, lagged dependent variables, and endogeneity between unemployment and wages have all been asserted as potential sources of bias in the estimated relationship. Most of these problems arise from the use of repeated cross-section or time-series data. Time-series data frequently suffers from structural instability and the inability to discern important aspects of economic behaviour that are masked by aggregate data. Cross-section data, by contrast, suffers from an inability to study the dynamics of adjustment. Both of these features run the risk of obtaining misleading results. They also give rise to the increased likelihood that observed effects are the consequence of errors in model specification. Panel data, that is, data that follow a given sample of individuals over time, provide a number of significant advantages in this regard. Data that record multiple observations for an individual provide more informative data, more degrees of freedom, less collinearity among explanatory variables and greater control of individual heterogeneity. It also allows for the control of individual fixed effects, effects that are either missing or unobserved but correlated with explanatory variables. The ability to control for missing or unobserved data significantly reduces the probability of specification bias. For the estimation of earnings equations, such features help capture inter and intra-individual differences

[2] See Bean *et al* (1989) for details.

inherent in the determination of individual pay. They also alleviate both aggregation[3] and composition bias.[4]

A number of recent studies document the existence of the wage curve using panel data. Bratsberg and Turunen (1996) present panel evidence for the US drawing on data from the National Longitudinal Survey of Youth (NLSY). Janssens and Konings (1998) report evidence using the Belgian Social Economic Panel. Finally, Pannenberg and Schwarze (1998) and Baltagi and Blien (1998) report evidence for Germany utilising the German Socio Economic Panel (GSOEP) and data from the Institut für Arbeitsmarkt und Berufsforschung (IAB). None of these studies provide evidence for the UK. The purpose of this paper, therefore, is to test for the existence of a wage curve utilising genuine panel data drawn from the British Household Panel Survey Waves 1-8. In addition, we perform a variety of diagnostic tests concerning functional form and sample selection to test the robustness of the results.

The remainder of the paper is organised as follows. Sections 2 and 3 present a brief overview of recent research on the relationship between wages and unemployment and a more detailed discussion of the theoretical explanations for the Wage Curve. Section 4 discusses the data while Section 5 outlines the methodology employed. Empirical results and diagnostics are reported in Section 6. Section 7 concludes.

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[3] Moulton (1986) points out that aggregate variables used as explanatory variables in regressions based on microeconomic data typically result in the substantial downward bias of standard errors. This bias arises from correlation across individuals brought about by a lack of controls for individual heterogeneity.

[4] Solon *et al* (1994) demonstrate that the use of wage data from repeated cross sections rather than genuine panel data may result in an upward bias of up to 50 percent in the estimated unemployment elasticity of pay.

II Early Literature

The wage curve challenges economic orthodoxy. Traditional neoclassical analysis built upon the models of Harris-Todaro (1970) and Hall (1970, 1972) posits a positive relationship between regional unemployment and pay. Compensating differentials, it is argued, imply that regions of high unemployment should be regions of higher pay. Firms faced with high unemployment pay higher wages to compensate for higher search costs. Higher wages become affordable since high unemployment reduces quits and thus the costs of hiring and training. A positive locus in wage-unemployment space is therefore predicted.

Table 1 documents early research concerning the spatial distribution of wages and unemployment to support the existence of a positive wage locus.[5] Hall (1970, 1972) reports weak evidence "that wages and unemployment rates are positively related in a cross section of cities".[6] Reza (1978) and Roback (1982) report likewise. Reza extends Hall's analysis to demonstrate that a positive unemployment elasticity of pay is neither the result of sample selection nor model misspecification. Roback, in contrast, provides strong evidence of compensating differences across regional space. The precise role of unemployment in this process remains, however, ambiguous.

Adams (1985) extends the above framework to differentiate between temporary and permanent movements in the analysis of compensating differentials across space. He develops a contract model where employees who lose their jobs in the face of random demand shocks receive unemployment insurance at a level below the full value of their wage. He shows that for a job package offering the going market-utility rate, regional wages will be an

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[5] See Blanchflower and Oswald (1994b) for a comprehensive survey of this literature.
[6] Hall (1972), p. 733.

increasing function of the risk of unemployment and a decreasing function of the replacement ratio. Empirical work supports this premise. A well-defined and significant average state unemployment elasticity of the wage of 0.2 is reported. This implies that a doubling of state unemployment would raise wages by 20 percent. Curiously, current industry unemployment delivers an elasticity of –0.9. Adams interprets this result as evidence of the need to distinguish temporary from permanent movements in wage-unemployment space. Marston (1985) derives similar conclusions. He reports that shocks that disturb the steady-state relationship between regions' unemployment tend to be eliminated rapidly. Predominant influences on observed unemployment rates appear thus to be the persistent ones of regional amenities and pay.

Evidence to the mid 1980's clearly supports the existence of a positive relationship in wage-unemployment space. By the late 1980's this evidence had, however, begun to weaken. Blackaby and Manning (1987) estimate Phillips curve and Mincer-style wage equations. They report the rate of wage change to depend upon the rate of change of prices, the rate of change of unemployment and the level of unemployment. Microeconometric earnings level estimations using local unemployment as an independent variable additionally yield a significant negative unemployment elasticity of pay of –0.16. Subsequent papers (Blackaby and Manning 1990a, 1990b, 1990c) extend this result to include the impact of regional fixed effects, costs of living and long-term unemployment. These additions enter individual and regional earnings level equations as significant but reduce only slightly the estimated unemployment elasticity of pay.

The debate regarding the role of the long-term unemployed in the wage determination process

Table 1 - A Selective Summary of the Literature on the Relationship Between Wages and Unemployment

Study	Country	Data	Estimation notes	Findings
Hall (1970, 1972)	US	1966 Data for 12 Cities	Descriptive analysis and OLS wage equations	Positive relationship between city pay and city unemployment for men. Weak evidence of a positive relationship between both nominal and real wages and the unemployment rate.
Reza (1978)	US	1967, 1970-74 data for 18 metropolitan areas	OLS wage equations	Positive relationship between both nominal and real wages and unemployment.
Roback (1982)	US	1973 CPS Data for 98 Cities	OLS wage and land rental rate equations	Weak evidence of a positive relationship between male weekly earnings and local unemployment.
Adams (1985)	US	1970-76 PSID Data	OLS wage equations	Positive average unemployment elasticity of pay (≈0.2). Negative industry unemployment elasticity of pay (–0.09).
Marston (1985)	US	1970 CPS Data	OLS wage equations and probit equations for employment	Positive relationship between real area wage and unemployment for both types of equation.
Blackaby and Manning (1987)	UK	1964-84 Regional Data 1974 GHS Data	OLS Phillips Curve and Mincer-Style wage equations	Negative unemployment elasticity of pay (–0.16) for Mincer-style wage equations. Standard Phillips Curve results.
Blackaby and Manning (1990a)	UK	1970-86 Regional data	Dynamic earnings equations	Negative unemployment elasticity of pay for several UK regions
Blackaby and Manning (1990b)	UK	1970-86 Regional data 1975, 1982 GHS data	Mincerian/dynamic earnings equations	Negative unemployment elasticity of pay for both types of equation.
Blackaby and Manning (1990c)	UK	1975, 1982 GHS data	Mincerian/dynamic earnings equations	Negative local unemployment elasticity of pay (–0.13 and -0.19).
Blackaby and Manning (1992)	UK	1972-88 Regional data	Dynamic wage equations	Negative unemployment elasticity of pay .
Layard and Nickell (1986, 1987)	UK	1950-83 Aggregate data	Real dynamic wage equations	Negative unemployment elasticity of wages (-0.06).
Nickell (1987)	UK	1956-83 Aggregate data	Real dynamic wage equations	Negative unemployment elasticity of wages (-0.1)
Carruth and Oswald (1989)	UK	1956-83 Aggregate data	Real dynamic wage equations	Negative unemployment elasticity of wages (–0.05 and -0.1)
Pissarides and McMaster (1990)	UK	1961-82 Regional data	Error Correction models for pooled wage equations	Negative short-run unemployment elasticity of pay. Positive long-run steady-state unemployment elasticity of pay.
Freeman (1988)	US, UK	1979-85 State/County data	OLS real wage equations	Weak negative correlation between changes in regional pay and changes in unemployment.
Holmund and Skedinger (1990)	Sweden	1969-85 Regional data for the wood industry	Regional Panel wage drift equations	Negative unemployment elasticity of pay (zero to -0.04).
Card (1990)	Canada	1963-83 Union Contracts Data	OLS and IV first-differenced real wage equations	Negative unemployment elasticity of pay (–0.05 to -0.1).

is an interesting one. Blackaby and Manning (1990c, 1992) and Blackaby and Hunt (1992) report long-term unemployment to reduce the impact of total unemployment on earnings, a finding which conforms to the prediction of Layard and Nickell (1986, 1987) that the long-term unemployed exert little or no influence in wage determination. Layard and Nickell derive this prediction from two findings in time-series econometric work: first, that the log rather than the level of the total unemployment rate appears to be a more robust specification when entered into a wage equation; second, that estimations including both the total and long-term unemployment rates reveal exactly equal and opposite signs. Both of these findings suggest that it is the short-term unemployed that exert downward pressure on wages. Such findings do not exist in isolation. Nickell (1987), Budd *et al* (1988) and Carruth and Oswald (1989) also identify the importance of the duration composition of unemployment in the wage determination process. They too report the proportion of long-term unemployed to attenuate the downward pressure on wages exerted by total unemployment. Precisely *when* the long-term unemployed cease to exert downward pressure remains, however, unanswered.

Further evidence to support the existence of a negative relationship in wage-unemployment space is found in Pissarides and McMaster (1990). They report changes in a region's relative wage to be correlated with movements in the region's unemployment level; these changes vary, however, between the short and long-run. This result could, of course, reflect incorrect dynamic specification of their model. The result does, however, re-affirm the need to distinguish between temporary and permanent unemployment. As previously discussed, actual wages may be negatively correlated with contemporaneous unemployment. Permanent wages could, however, be positively related to permanent unemployment.

Consensus for the collapse of a positive association between regional unemployment and pay is not constrained to the UK. Freeman (1988) offers weak evidence of a negative unemployment elasticity of pay for both the US and the UK. Card (1990) reports similarly for Canada, while Holmlund and Skedinger (1990) present evidence for Sweden.[7] Most of the debate regarding the wage curve centres, however, around Blanchflower and Oswald (1990). Utilising four microeconomic datasets (one from the US and three from the UK) and controlling for a number of individual and establishment characteristics, Blanchflower and Oswald estimate a series of cross-section and pooled cross-section wage equations and provide evidence of a significant inverse non-linear association between pay and unemployment. They investigate this non-linearity with the inclusion of higher order polynomials for the unemployment rate and proffer the level of unemployment and its square or alternatively the natural logarithm of unemployment and its cube as their preferred specifications. An unrestricted specification where the distribution of unemployment is split into intervals of equal width confirms this curvature and again traces out a negative locus in wage-unemployment space. This locus becomes horizontal between 9 per cent and 15 per cent unemployment. Increases in unemployment above these levels fail thus to exert downward pressure on wages.

Subsequent papers (Blanchflower and Oswald 1994a, 1995) and a comprehensive monograph (Blanchflower and Oswald, 1994b) extend this analysis to deliver a simple log-linear function as the preferred specification for the wage curve. Controlling for regional and industry fixed effects and estimating a variety of model specifications for both weekly and hourly earnings,

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[7] This latter finding is particularly interesting given the degree of centralised wage bargaining that has previously been thought to provide little scope for the existence of regional wage premia.

results indicate an inverse relationship between the level of regional pay and local unemployment. The estimated unemployment elasticity of wages is approximately –0.1. This result is robust to changes in the sample period and the inclusion of higher order unemployment measures. It additionally turns insignificant or positive when regional fixed effects are excluded. The failure of previous researchers to identify a negative locus in wage-unemployment space is attributed thus to a failure to adequately control for the influence of regional fixed effects. Regional fixed effects are correlated with the local unemployment rate. Estimations that exclude such effects thus suffer from classic omitted variable bias.

III Theoretical Issues

The evidence and debate summarised in the previous section presents overwhelming support for the existence of a new empirical law of economics. This law appears robust with respect to both specification and country. It also appears stable over time. As such, further investigation into the precise nature of this relationship is clearly warranted. Such investigation requires, however, a theoretical foundation. Competitive theory fails in this regard. Explaining the wage curve is thus a stimulating challenge.

Some commentators argue the wage curve is some form of misspecified labour supply function where unemployment may be regarded as the inverse of employment for a fixed labour force. If the wage curve is such a function, the unemployment rate should perform statistically worse in a wage equation than conventional labour supply variables such as the participation rate or the employment to population ratio. Blanchflower and Oswald (1994a) test this hypothesis using 1973-1990 GHS data for Britain and report no evidence to support the idea of the wage curve as a labour supply function. A variable for the regional participation rate always enters wage equations as insignificantly different from zero. Local unemployment also dominates it. This suggests that it is local unemployment rather than the size of the local labour market that influences wages. Competitive theory is thus rejected.

Instead of being a mismeasured labour supply curve, the wage curve could be a misspecified Phillips Curve.[8] Here, model specification should relate a change in the regional wage to unemployment rather than the level of wages itself. Blanchflower and Oswald (1994b) reject this proposition. They argue that the Phillips Curve is primarily concerned with inflation and the effect of aggregate unemployment. As such, it essentially proposes a disequilibrium adjustment mechanism. The wage curve, in contrast, focuses on the role of local unemployment. It represents an equilibrium locus in wage-unemployment space that is derived from microeconomic analyses rather than macroeconomic analyses.[9] This theoretical distinction is reinforced by econometric consideration where the distinction between the two concepts essentially rests upon wage dynamics. A significant autoregressive component in dynamic wage equations would support the Phillips Curve specification. Blanchflower and Oswald find little evidence, however, to support this. Instead, their results suggest the idea of a Phillips Curve to be misleading. Failure to estimate using suitable control variables, particularly those for fixed effects, results in spuriously large coefficients on lagged dependent wage variables. They assert, therefore, that the correct specification should indeed express the level of wages as a function of the unemployment level.

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[8] See Paldam (1990) and Black and FitzRoy (1997) for detailed discussion.

[9] The Phillips Curve is traditionally estimated using time-series macroeconomic data. The wage curve, in contrast, is estimated using longitudinal and pooled cross-sections of microeconomic data.

Having rejected the wage curve as a misspecified labour supply curve or indeed a Phillips Curve, Blanchflower and Oswald argue that the wage curve may represent a non-competitive account of the labour market. They offer several explanations consistent with this empirical phenomenon including a bargaining model and an efficiency wage model.[10]

The bargaining model utilises a conventional framework similar to that presented in Carruth and Oswald (1989). This model asserts that a high degree of joblessness might be expected to reduce the ability of workers to bargain for a share of economic rents. High unemployment serves here as a potential threat to the employee. In the event of a permanent impasse, workers may be forced to seek alternative employment. The probability of re-employment falls as local unemployment increases. Assuming that unions have concerns for both employed and unemployed members, rising joblessness might then incline union preferences towards the preservation of jobs rather than the share of rents. A reduced concern for rents may result in a lower level of negotiated pay. An inverse association between the level of wages and unemployment should then be observed.

Efficiency wage models operate in a manner not dissimilar from the arguments presented above. The approach, however, is typically non-union and is thus ideally suited to economies where unionisation and coverage is reported as low. Shapiro and Stiglitz (1984) provide the archetypal model. Firms set pay in a working environment where the wage influences productivity. Workers are risk-neutral and choose between exerting effort or shirking. Utility is derived from wages and disutility from work. Regional equilibrium prevails if firms offer

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[10] A labour contract model is also presented. This model, as in the case for labour supply, relies, however, on the movement of wages and employment. As such, it too rests on the key assumption of unemployment as the inverse of employment. See Card (1995) for additional details.

pay packages of equal expected utility across regions. A non-shirking constraint necessitates, however, that firms offer a net wage greater than the value of unemployment. Workers caught shirking are fired. Expected utility when fired depends on the level of unemployment insurance and the probability of re-employment. The probability of re-employment decreases with the level of unemployment. Increases in unemployment serve thus to discipline workers into providing greater efforts. Greater efforts ensure that the non-shirking condition requires a lower wage at higher unemployment. An efficiency wage is thus also consistent with a negative locus in wage-unemployment space.

Theoretical justification of the wage curve by non-competitive models of the labour market does not mean that the Harris-Todaro concept of compensating differentials is necessarily wrong. The Harris-Todaro locus sits comfortably alongside the existence of the wage curve once permanent and transitory movements in pay and unemployment are accounted for. The above models do, however, pertain to a number of interesting caveats. Card (1995), for example, points out that efficiency wage models comfortably entertain differences in the slope of the wage curve across different groups of workers. He argues that for such models, wages of a particular group of workers are related to the group-specific unemployment rate. High unemployment for one group of workers should thus have no effect on another group. This is an interesting implication, especially with regard to the identification of unemployment elasticities across disaggregated curves.[11] More important, however, is the implication that the models replace the conventional labour supply curve with a wage-fixing function, a function that lies flatter and to the left of the true Marshallian labour supply. This function is compatible with a new generation of macroeconomic models in which an aggregate wage

[11] See, for example, Blanchflower and Oswald (1994a), Card (1995) and Turunen (1998).

curve is the distinguishing feature.[12] The wage curve may thus provide the missing empirical foundation for such models. There remains, however, much to be learned.

This paper explicitly addresses the existence of a wage curve by utilising genuine panel data for the UK. Previous studies for the UK rely on pooled and cross-section data for the 1970's and 1980's. Our paper, in contrast, utilises data drawn from the 1990's. Thus, our paper presents two major additions to the existent UK literature. First, it provides a framework for analysis during the 1990's, a period where the level and structural composition of unemployment has witnessed a marked change from the preceding decades. Second, the panel dimension of the data allows us to take account of the role of unobserved worker heterogeneity in the wage determination process. This latter feature enables us to explain a substantial proportion of the variation in earnings between individuals.

IV Data

We estimate the UK wage curve using longitudinal micro data drawn from the 1991-1998 (eight) waves of the British Household Panel Survey (BHPS), a nationally representative survey of households randomly selected south of the Caledonian Canal.[13] 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

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[12] See Layard *et al* (1991) for an overview of this literature.
[13] The north of Scotland is thus excluded.

10,000 individual interviews.[14] The first wave of the BHPS was conducted from September 1991 to January 1992, subsequent waves have been collected annually thereafter.[15]

The BHPS provides a rich source of socio-economic variables 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.[16] This is then deflated by the monthly RPI (base period January 1991).

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, head of household indicator, and the presence 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.[17]

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[14] From Wave Seven the BHPS has incorporated a sub-sample of the original United Kingdom European Community Household Panel (UKECHP), including all households still responding in Northern Ireland. For consistency purposes across the panel, these new sample members are excluded from analysis.

[15] See Taylor (1998) for details.

[16] 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.

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

Workplace and workforce controls which can be expected to impinge upon earnings include unionisation (recognition and membership), full or part time job status, promotion opportunities, a number of variables capturing the structure of pay and pay increases, seasonal/temporary or contract work, rotating shifts, managerial duties and supervisory tasks. Any remaining firm-specific effects are captured by the inclusion of firm size and public-private sector indicators.[18] Industry and occupational affiliation are coded using the 1980 Standard Industrial Classification (SIC) and the 1990 OPCS Standard Occupational Classification. We utilise 1-digit classification dummies to control for variation of wages across both occupation and industry.

Regional dummies are included to capture the multitude of effects brought about by geographical differences in industry and institutional structure. Regional fixed-effects help to explain why, for certain regions, real wages appear lower regardless of the unemployment rate.[19] The regional unemployment rate is an appropriate measure for wage adjustment when individuals reside and work within the same regional domain. However, highly mobile individuals who commute outside of their region of residence present a problem to this analysis. Workers who reside in high unemployment areas but commute to work in a high wage area, for example, generate a spurious positive relationship between the regional unemployment rate and regional pay. Fortunately, the BHPS contains information concerning both the location of work and the amount of time the individual usually spends travelling to work each day. We include a dummy variable therefore if the individual's travel time is

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[18] A positive association between wages and firm size is well established. See Brown and Medoff (1989) and Green *et al* (1996) for details.

[19] Regional unemployment is drawn from NOMIS and is matched to the data at the level of the standard region by month and year of interview.

greater than 45 minutes. This should help capture movement across regional boundaries and reduce potential underestimation of the unemployment effect brought about by movement from high unemployment regions to regions of high pay. Time dummies and the natural logarithm of the ratio of regional to national consumer prices are additionally included to capture cyclical effects on wages and the impact of regional price variations.[20,21]

The sample is selected on the basis that the individual is aged 16 to retirement age and has a current status of employee. Retired and self-employed 'workers', the unemployed, individuals working on government schemes and 'inactive' sections 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. Individuals who enter and exit the sample across the panel are, however, allowed. Whilst this results in an unbalanced panel in our econometric analysis, it does serve to minimise potential attrition biases and yields a greater numbers of observations in the panel when controlling for fixed effects.

We estimate our wage equations separately for men and women.[22] In addition, to alleviate potential biases from serious over or under estimation of earnings, we symmetrically trim the male and female samples and omit the one percent with both the highest and lowest real

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[20] Blackaby *et al* (1991) show that the usual practise of calculating the real wage by simply deflating nominal wage rates by the national retail price index is inadequate where workers recognise regional price variations and act upon it in wage bargaining. They argue that, unless the national price index is all important, the omission of a relative regional to national price term is likely to seriously mis-specify the wage relationship and bias the coefficients of explanatory variables that capture other regionally varying factors. Since the unemployment term is one such variable in our wage equations, we include the natural logarithm of the ratio of regional to national prices in our analysis.

[21] Regional price information is provided by The Reward Group (2000).

[22] The problems of measuring the labour market experiences of married women are well recognised. Concerns regarding gender differences in the rates of return to educational attainment are also acknowledged.

hourly wages. These additional restrictions result in a male sample of 17,080 data points (4,224 individuals) and a female sample of 17,421 (4,286 individuals). The gender distribution across the panel is presented in Table A1 of the Appendix. Table A2 details the total number of waves for which each individual is observed. Data definitions and summary statistics are presented in Tables A3 and A4.

V Methodology

We use an econometric technique that takes into account the panel nature of the data and estimate a fixed-effects model where unobserved individual-specific heterogeneity is assumed to be time-invariant but correlated with explanatory variables.

The basic framework is a regression model of the form:

$$\ln w_{it} = \alpha_i + \beta x_{it} + v_{it}, \qquad i = 1, \ldots, N, \;\; t = 1, \ldots, T, \tag{1}$$

where $\ln w_{it}$ is the natural logarithm of the real hourly wage of worker *i* at time *t*, α_i is an individual-specific component of wages reflecting observed time-invariant individual heterogeneity such as gender and race, and v_{it} is a random error term independently and identically distributed over *i* and *t*.

Assuming unobserved individual-specific heterogeneity to be time-invariant, the error term v_{it} can be decomposed as:

$$v_{it} = u_i + e_{it}. \tag{2}$$

where u_i denotes the individual-specific unobserved effect and e_{it} denotes the remainder disturbance.

Equation (1) may now be written:

$$\ln w_{it} = \alpha_i + \beta x_{it} + u_i + e_{it} \tag{3}$$

Averaging over time gives:

$$\ln \overline{w}_{i.} = \alpha_i + \beta \overline{x}_{i.} + u_i + \overline{e}_{i.} \tag{4}$$

Subtracting equation (4) from (3) thus yields:

$$\ln w_{it} - \ln \overline{w}_{i.} = \beta(x_{it} - \overline{x}_{i.}) + (e_{it} - \overline{e}_{i.}) \tag{5}$$

This is the fixed-effects (or within) estimator. The within estimator produces consistent and efficient estimates of the identifiable parameters when the time-invariant effects are assumed correlated with x_{it}.

VI Empirical Results

Table 2 reports results for alternative specifications of log earnings equations for UK males 1991-1998. Column 1 adopts a semi-logarithmic specification that relates the log of real hourly wages to the level of unemployment implying the wage–unemployment relationship is exponential. The reported coefficient is significant and provides an estimated elasticity of -0.14 evaluated at the mean. This elasticity is statistically significantly different from -0.1 but lies within the rough band of zero to -0.15 proposed by Blanchflower and Oswald (1994b). The existence of a well-defined unemployment effect for UK males is thus supported.

Column 3 replaces the semi-logarithmic specification with a double-log specification. The estimated elasticity is again significant but is approximately -0.05. This result is surprising and contrasts with Blanchflower and Oswald (1990, 1994a) and Blackaby *et al* (1991) both of

Table 2

Estimates of the UK Wage Curve: Males 1991-1998

Dependent Variable: log real hourly wage				
Unemployment	**1**	**2**	**3**	**4**
U	-0.0188 (3.43)†	-0.0133 (1.77)*		
U^2		-0.0004 (1.04)		
Log U			-0.0489 (2.08)**	-0.0040 (0.14)
Log U^3				-0.0108 (2.51)**
ε	-0.14	-0.15	-0.05	-0.13
Diagnostics				
F	30.94	30.60	30.83	30.56
R^2	0.9323	0.9324	0.9323	0.9323
Specification Test	-0.0100 [0.488]	-0.0102 [0.490]	-0.0094 [0.508]	-0.0099 [0.494]
NT	17,080	17,080	17,080	17,080

Notes
1. All specifications control for unobserved individual heterogeneity and include the following controls: 7 segment piecewise linear spline for age and dummies for marital status (3), highest qualification (7), registered disabled, health limits work, head of household, own children in household, age of children in household (3), recent labour market experience (2), region (11), occupation (9), industry (9), firm size (8), full-time work, temporary work, contract work, employment sector (8), union recognition, union member, manager, supervisor, shift worker, bonus in pay, annual increments in pay, travel to work time greater than 45 minutes, time (8 waves).
2. Estimations by Intercooled Stata 6.0. Coefficient t-values in parentheses. Significance levels: †(0.01), **(0.05), *(0.10); p-values of diagnostics in [].
3. The Hausman test for random-effects models is rejected for all specifications.
4. The specification test is due to Pregibon (1980). Similar to a standard RESET test in time series analysis, it is distributed as standard normal under the null hypothesis of no misspecification: 5% critical value N(0,1)=±1.96.

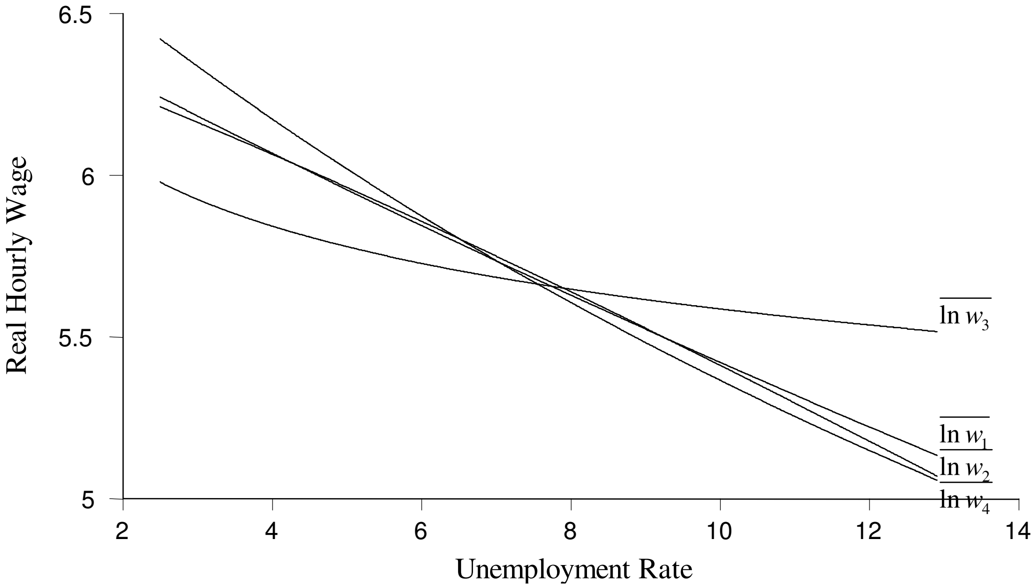
whom find little to choose statistically between the log of unemployment and the unemployment level. The double-log specification is often preferred on the basis of expositional ease: the reported coefficient may be immediately interpreted as the elasticity in question. It imposes, however, significant constraints on the data. A double-log specification considers the relationship between wages and unemployment to be log-linear across the whole range of observed data. This implies a constant unemployment elasticity of wages. It also implies, in the levels, that the relationship between wages and unemployment is either increasing or decreasing without limit. The semi-logarithmic equation, by contrast, is not so restrictive. It also has desirable features in terms of interpretation in that the estimated function will be asymptotic. A negative sign on unemployment implies a downward sloping locus in wage-unemployment space. This locus will, however, never reach the x-axis. In reality, wages will never equal zero. For this purpose, the semi-logarithmic specification is our preferred equation.

Non-linearities provide a recurring theme in the wage curve literature. Evidence from Blanchflower and Oswald is, however, mixed. Blanchflower and Oswald (1990) find different polynomial structures to fit the data well. Though hard to interpret economically, they find, for example, that the inclusion of a cubic term for the logarithm of unemployment improves their estimates. Later evidence, by contrast, rejects the inclusion of such higher order unemployment terms.[23] We test for non-linearities by adding cubic or squared terms of unemployment in logs and levels.[24] Column 2 imposes a quadratic on the unemployment-log-wage relationship. The estimated unemployment elasticity of pay is little different from that of the semi-logarithmic specification. The inclusion of a square term for unemployment fails, however, to improve the performance of the original equation and its coefficient is small and insignificantly different from zero. Column 4 adopts a specification including the natural logarithm of unemployment and its cube. Again, there is evidence of a well-defined unemployment effect. The cubic term in unemployment is highly significant, although the coefficient on the log of unemployment becomes small and insignificantly different from zero. This evidence, illustrated in Figure 1, suggests that the previous literature may be wrong to assume a double-log specification as the appropriate functional form for estimation of the UK wage curve. We test this assumption further and utilise a J-test to select between the semi-logarithmic and double-log specifications of unemployment.[25] The test rejects the double-log

[23] See Blanchflower and Oswald (1994a).
[24] We also estimated our wage equations using the inverse of unemployment, and the inverse of unemployment and its square. Neither of these specifications identified a significant unemployment effect nor added to the overall fit of the equation. Thus, these additional results are not reported.
[25] See Davidson and MacKinnon (1981) for details.

Figure 1

Alternative Specifications of the UK Wage Curve: Males 1991-1998



Notes $\overline{\ln w_1} = \alpha + \hat{\beta}\overline{u}$, $\overline{\ln w_2} = \alpha + \hat{\beta}\overline{u} + \hat{\gamma}\overline{u}^2$, $\overline{\ln w_3} = \alpha + \hat{\beta}\overline{\ln u}$, $\overline{\ln w_4} = \alpha + \hat{\beta}\overline{\ln u} + \hat{\gamma}\overline{\ln u}^3$.

specification against the semi-logarithmic specification and accepts the semi-logarithmic specification against the double-log specification at conventional levels. Thus, the semi-logarithmic specification is statistically preferred and our original preference for the level of unemployment is supported.

Table 3 presents equivalent estimates for the female sample.[26] The main finding is that there is no evidence of a significant wage curve for women. The estimated elasticity of pay for our

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26 Given the focus of this paper, and constraints on space, it is not possible to report the coefficients on other controls variables utilised in estimation across both the male and female samples. Full results for the semi-logarithmic specification are, however, reported in Table A5 of the appendix. These reveal that the estimated wage equations appear to be both meaningful and appropriate in that they are consistent with a large previous literature on wage determination. Thus, for example, *ceteris paribus*, age-earnings profiles are concave (although earnings increase over any individual's lifetime); households with children depress female earnings; there are significant private returns to college qualifications (e.g. degree or teaching certificate) though the effect is greater for women than for men; seasonal or

preferred equation is identical to that of Blanchflower and Oswald (1994b).[27] The coefficients for alternative specifications of unemployment are, however, either small and/or insignificantly different from zero. This result is consistent with the panel findings of both Janssens and Konings (1997) and Pannenberg and Schwarze (1998). The lack of a significant wage curve for women may indicate that the female labour market is more competitive than the male labour market. It might also indicate problems concerning non-employment (unemployment) and/or non-participation. Simultaneity bias due to the endogeneity of local unemployment provides another likely cause.[28] We do not test for endogeneity in this paper. Recent work by Baltagi and Blien (1998) suggests, however, accounting for endogeneity to be an important task for future work.

Table 3

Estimates of the UK Wage Curve: Females 1991-1998

Dependent Variable: log real hourly wage				
Unemployment	**1**	**2**	**3**	**4**
U	-0.0090 (1.61)	-0.0056 (0.72)		
U^2		-0.0002 (0.60)		
Log U			-0.0143 (0.59)	0.0177 (0.57)
Log U^3				-0.0075 (1.70)*
ε	-0.07	-0.07	-0.01	-0.07
Diagnostics				
F	27.55	27.23	27.52	27.24
R^2	0.9189	0.9189	0.9189	0.9189
Specification Test	-0.0024 [0.734]	-0.0024 [0.744]	-0.0025 [0.731]	-0.0024 [0.739]
NT	17,421	17,421	17,421	17,421

Notes
See notes to Table 2.

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temporary workers earn less than their permanent counterparts; workers in large firms earn more than those in smaller enterprises; unionised workers enjoy a wage premium over their non-unionised colleagues; recent periods of unemployment or inactivity have a detrimental effect on earnings; workers are compensated for long travel-to-work times; and wages are higher in the south of Britain.

[27] Blanchflower and Oswald report a significant unemployment elasticity of pay for UK women of –0.07.

[28] The fixed effects estimator does not control for simultaneity bias due to the endogeneity of local unemployment unless local unemployment is only correlated with time and/or region effects.

Previous studies for the UK report the addition of regional fixed effects as having little impact on estimated wage curve elasticities.[29] Pencavel (1994) argues that this may reflect a greater degree of permanence in the geographical distribution of unemployment. Permanence in unemployment rates is certainly reflected in UK data for the 1980's. Unemployment rates for the 1990's, however, exhibit a significant downward trend with marked changes regarding both structure and composition. We test the above hypothesis, therefore, and re-estimate our wage equations on the original male sample excluding regional fixed effects. The results are reported in Table 4. The exclusion of regional fixed effects reduces the absolute size of the coefficients for the unemployment terms for all specifications. There is, however, comparatively little difference to the findings reported earlier in Table 2. Estimated elasticities of pay are biased downwards but remain within close proximity of –0.1. The coefficient for the level of the unemployment rate in our preferred equation also remains significant at conventional levels. The robustness of these results suggests the inclusion of regional fixed effects to not be necessary in identifying a significant negative locus in wage-unemployment space. In this context, permanence in UK unemployment rates is again supported.[30]

Many studies estimate the wage curve on the basis of *weekly*, *monthly* or *annual earnings*. To test the robustness of our results we therefore re-estimate male earnings equations using two alternative specifications for the dependent variable. Table 5 reports results using the log of

[29] This contrasts with studies for US data where the omission of regional dummies exerts an upward bias on estimated elasticities and in some instances turns them positive.
[30] The inclusion of regional fixed effects eliminates the 'permanent' components of unemployment from the wage-unemployment relationship. Thus, similarity across estimates when regional fixed effects are excluded suggests that the dominant component of the estimated unemployment effect is largely permanent in nature.

Table 4

The UK Wage Curve: Males 1991-1998 Excluding Regional Fixed Effects

Dependent Variable: log real hourly wage				
Unemployment	**1**	**2**	**3**	**4**
U U^2 Log U Log U^3	-0.0143 (3.28)†	-0.0090 (1.29) -0.0004 (0.99)	 -0.0480 (2.26)**	 -0.0034 (0.11) -0.0083 (2.19)**
ε	-0.11	-0.11	-0.05	-0.10
Diagnostics				
F R^2 Specification Test	34.79 0.9323 -0.0107 [0.463]	34.35 0.9323 -0.0109 [0.463]	34.70 0.9322 -0.0099 [0.487]	34.32 0.9323 -0.0106 [0.467]
NT	17,080	17,080	17,080	17,080

Notes
See notes to Table 2.

Table 5

The UK Wage Curve: Males 1991-1998

Dependent Variable: log real monthly pay				
Unemployment	**1**	**2**	**3**	**4**
U U^2 Log U Log U^3	-0.0190 (3.72)†	-0.0154 (2.18)** -0.0003 (0.74)	 -0.0526 (2.40)**	 -0.0083 (0.30) -0.0107 (2.66)†
ε	-0.14	-0.15	-0.05	-0.13
Diagnostics				
F R^2 Specification Test	95.58 0.9415 -0.0214 [0.000]	94.50 0.9415 -0.0217 [0.000]	95.43 0.9414 -0.0207 [0.000]	94.47 0.9415 -0.0212 [0.000]
NT	17,080	17,080	17,080	17,080

Notes
Controls are as those reported for Table 2. However, the log of hours worked is additionally included.

real monthly pay as the dependent variable. In contrast, Table 6 presents estimates when the real hourly wage is derived using usual hours of work (i.e. excluding overtime). The issue of hours worked is complex. Blanchflower and Oswald (1994b) and others, for example, define wages as annual earnings. This is often due to the lack of a more appropriate measure. Card (1995) indicates, however, that this may be inappropriate and asserts that part of the negative

Table 6

The UK Wage Curve: Males 1991-1998

Dependent Variable: log real hourly wage excluding overtime				
Unemployment	**1**	**2**	**3**	**4**
U U^2 Log U Log U^3	-0.0192 (3.46)†	-0.0153 (2.00)** -0.0003 (0.73)	 -0.0533 (2.24)**	 -0.0089 (0.30) -0.0107 (2.45)**
ε	-0.14	-0.15	-0.05	-0.13
Diagnostics				
F R^2 Specification Test	35.34 0.9308 -0.0009 [0.860]	35.13 0.9308 -0.0010 [0.853]	35.44 0.9308 -0.0008 [0.880]	35.11 0.9308 -0.0008 [0.879]
NT	17,080	17,080	17,080	17,080

Notes
See notes to Table 2.

relationship between annual earnings and local unemployment may be caused by a response in hours worked.[31] Evidence to support this criticism is mixed. Blanchflower and Oswald (1994a, 1994b) report similar elasticities for both annual and/or weekly earnings and hourly wages. Card, in contrast, reports an unemployment elasticity of pay for annual earnings twice that of the estimated elasticity for hourly wages. Such results are surprising. They are, however, indicative of the problems faced by labour economists in the use of retrospective data and reported hours of work.[32]

The results for the UK wage curve utilising alternative measures of the dependent variable are remarkably similar to those reported in Table 2. The semi-logarithmic equation is again preferred to the double-log specification. Estimated elasticities also remain virtually identical with both the unemployment level and the logarithm and its cube, delivering an

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[31] Card argues that since annual earnings are the product of annual hours and hourly wages, and annual hours are highly correlated with contemporaneous unemployment, the wage curve may in fact reflect an ‘hours curve’.
[32] See Hamermesh (1998) for discussion of this data and the misapplication of standard econometric techniques in labormetric research.

unemployment elasticity of pay significantly different from –0.1. Such robustness would appear to suggest that the wage curve is largely insensitive to demand shocks and the adjustment of individuals' working hours. It also indicates that switching from an hourly wage to monthly pay variable has no impact on the main conclusions of the paper.

To confirm the generality and robustness of our results, a number of additional specifications were examined. First, to test that the results were not heavily influenced by a few outliers, we adopt the approach of Miles (1997) and re-estimate the preferred equation with the weight on observation *i* the reciprocal of its squared residual. This technique provides a good test for heteroscedasticity since a lower weight is attached to large residuals. Neither the parameter estimates nor their statistical significance are substantially different from the original estimates. This suggests that heteroscedasticity is not a significant problem in the data.[33] Normality of the residuals' distribution was additionally checked by residual histograms. Again, there is no evidence of non-normality though the distribution reveals weak leptokurtosis.[34]

Second, we investigate 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 A2). The results obtained from re-estimating the male earnings equations using only the balanced panel (and thus only individuals who were observed in all 8 waves)

[33] Accordingly, these weighted regressions are not reported.
[34] Kurtosis measures the degree of peakedness of a probability function near the mode. The normal distribution is said to be *mesokurtic*, one less peaked is said to be *platykurtic*, and one more peaked is said to be *leptokurtic*.

are reported in Table 7.[35] Again, there is evidence of a negatively sloped relationship in wage-unemployment space. However, this relationship is neither statistically significant nor well-defined. Insignificance of the coefficients may indicate a problem concerning estimation.[36] Nonetheless, sample selection provides a more likely reason. Balanced panels are often preferred when sample selection issues brought about by attrition are considered to

Table 7

The UK Wage Curve: Male Balanced Panel 1991-1998

Dependent Variable: log real hourly wage				
Unemployment	**1**	**2**	**3**	**4**
U	-0.0041 (0.57)	-0.0038 (0.39)		
U^2		-0.0001 (0.05)		
Log U			-0.0245 (0.81)	-0.0286 (0.76)
Log U^3				-0.0010 (0.18)
ε	-0.03	-0.04	-0.03	-0.04
Diagnostics				
F	13.58	13.42	13.58	35.11
R^2	0.9200	0.9200	0.9200	0.9308
NT	6,368	6,368	6,368	6,368

Notes
See notes to Table 2.

be important. Selecting observations for those individuals who report earnings across all eight waves, however, raises significant issues of its own. The main effect of this selection criterion is to considerably reduce the sample size and thus information by which an unemployment effect may be identified. Another significant effect concerns the selection of those individuals for whom unemployment may *not* serve as an appropriate disciplining device. Balanced panels, observed over the business cycle, suppress compositional change in

[35] These results additionally utilise the longitudinal respondent weights provided with the BHPS data to correct for the sample design and non-response rates. Technically, these individual weights 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.

[36] Card (1995) points out that the local unemployment rate does not vary across individuals. The 'degrees of freedom' in estimation of the wage curve is thus equal to the number of regions times the number of time periods. This paper uses data for eleven standard regions across eight waves of data. The actual 'degrees of freedom' is thus 88.

the labour market brought about by changes in the experience and composition of unemployment.[37] Recognising the nature of sample restrictions is thus of critical importance.

Finally, we estimate the UK wage curve utilising a non-parametric approach. The estimates in Tables 2-7 impose assumptions regarding the functional form of unemployment. Table 8 adopts the approach of Blanchflower and Oswald (1994a, 1994b) and reports results utilising an unrestricted specification where the distribution of unemployment is split into 5% segments of approximately equal size, each segment being replaced by an unemployment dummy.[38] Taking the first interval as the reference group, all nineteen dummies are negative

Table 8

5% Disaggregations: UK males 1991-1998

Unemployment (%)	Coefficient	Unemployment (%)	Coefficient
2.5-3.1	- -	8.5-8.9	-0.1158 (3.62) †
3.2-4.0	-0.0437 (2.74) †	9.0-9.2	-0.1271 (3.91) †
4.1-4.9	-0.0468 (3.01) †	9.3	-0.1256 (3.55) †
5.0-5.4	-0.0564 (3.08) †	9.4-9.5	-0.1395 (3.98) †
5.5-5.7	-0.0660 (3.68) †	9.6-10.0	-0.1375 (3.78) †
5.8-6.0	-0.0582 (2.88) †	10.1-10.4	-0.1652 (4.27) †
6.1-6.6	-0.0859 (4.12) †	10.5-11.1	-0.1700 (4.30) †
6.7-6.9	-0.0995 (4.10) †	11.2-12.9	-0.1863 (4.12) †
7.0-7.5	-0.0869 (3.42) †		
7.6-7.7	-0.1026 (3.78) †	F	25.84
7.8-8.2	-0.0933 (3.41) †	R^2	0.9325
8.3-8.4	-0.1169 (4.17) †	NT	17,080

Notes: The dependent variable is log real hourly wage.

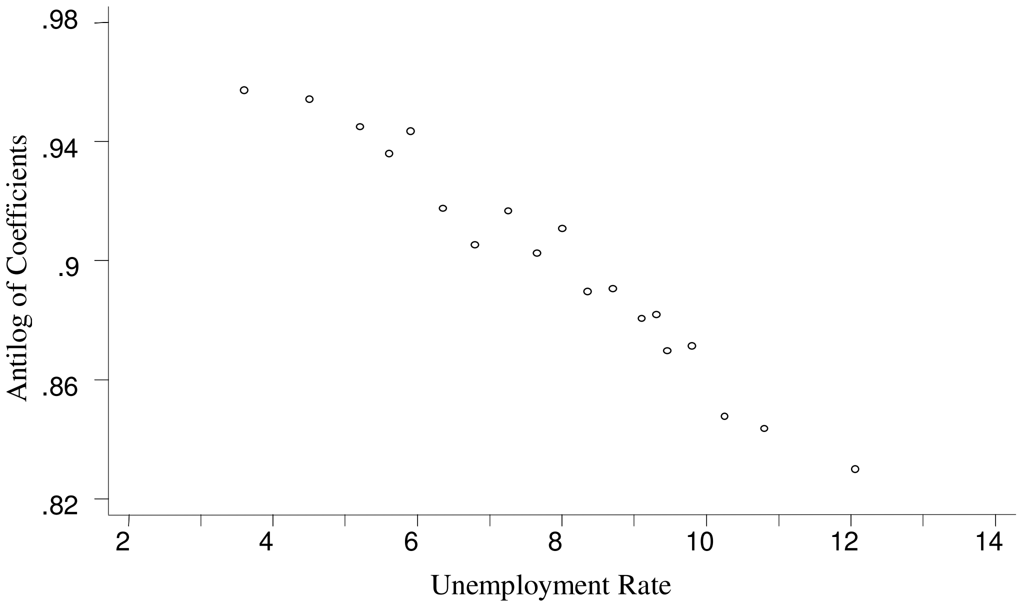
and statistically significant at conventional levels. The absolute size of the coefficients also increases as the unemployment rate rises. Figure 2 plots the antilogs of the coefficients against the mid-point of the unemployment range for each dummy. There is clear evidence

[37] Gregg *et al* (1999) present recent evidence that suggests that the cost of job loss for an average worker following involuntary unemployment is approximately 9 percent of previous earnings.

[38] Each dummy identifies between two and ten regions depending on the number of observations.

Figure 2

Unrestricted Estimates for UK Males 1991-1998



for a downward sloping locus in wage-unemployment space. A curve linking the antilogged coefficients additionally suggests this locus to be broadly linear. Rejection of higher order polynomial terms for unemployment earlier in the paper is thus clearly supported.

VII Summary and Conclusions

This paper investigates the empirical evidence for a UK wage curve using longitudinal micro data drawn from the first eight waves of the British Household Panel Survey. The main finding is that there is evidence of a negative relationship in wage-unemployment space. This finding is robust to alterations in the nature of the dependent variable and the exclusion of regional fixed effects. It is, however, sensitive to sample selection and indicates distinct differences across identifiable labour market groups. The estimated unemployment elasticity of pay for UK males is approximately equal to –0.14. There is no evidence of a female wage curve. These findings are consistent with the **panel** studies reported for other countries. They contrast with previous studies for the UK, however, in that they reject the inclusion of higher order polynomial terms for unemployment. The main findings of the paper, therefore, are that the wage-unemployment relationship is robust but not as non-linear as has been previously thought.

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APPENDIX

Table A1

Distribution of Observations for BHPS Waves 1-8

Wave of Interview	*Males*	*Females*
Wave 1	2280	2278
Wave 2	2068	2087
Wave 3	1967	2043
Wave 4	1986	2075
Wave 5	1978	2051
Wave 6	2084	2144
Wave 7	2320	2319
Wave 8	2397	2424
N	17,080	17,421

Table A2

Distribution of Individuals for BHPS Waves 1-8

No. of Waves Individual is observed	*Males*	*Females*
1 Wave	1055	1014
2 Waves	699	713
3 Waves	408	413
4 Waves	330	348
5 Waves	275	327
6 Waves	287	317
7 Waves	374	419
8 Waves	796	735
N	4,224	4,286

Table A3: Data Definitions

Variable	*Definition and Description*
Dependent Variable:	
Log of real hourly wage	Log of real hourly wage
Independent Variables:	
Age	Age of individual at December of interview
Race	
White	(1,0) if white
Black	(1,0) if black ethnic origin
Other non-white	(1,0) if other ethnic origin
Marital Status	
Never Married	(1,0) if never married
Married or Living as a Couple	(1,0) if married or living as a couple
Widowed/Separated/Divorced	(1,0) if widowed, separated or divorced
Highest Qualification	
Higher or First Degree, Teaching	(1,0) qualification dummy
Other Higher Education	(1,0) qualification dummy
GCE A-level	(1,0) qualification dummy
GCE O-level	(1,0) qualification dummy
CSE Grade1-5	(1,0) qualification dummy
Apprenticeship, Nursing, Other	(1,0) qualification dummy
No Qualification	(1,0) qualification dummy
Health	
Registered Disabled	(1,0) if registered disabled
Limits types of work	(1,0) if health limits type or amount of work
Other Personal Controls	
Head of Household	(1,0) if head of household
Own Children	(1,0) if own children in household
Children aged 0-4 Years	(1,0) if children aged <5 years in household
Children aged 5-11 Years	(1,0) if children aged 5-11 years in household
Children aged 12-15 Years	(1,0) if children aged 12-15 years in household
Unemployed in Past Year	(1,0) if unemployment spell(s) in past year
Non-Participant in Past Year	(1,0) if non-participation spell(s) in past year
Size of Establishment	
<10 Employees	(1,0) if <10 employees
10-24 Employees	(1,0) if 10-24 employees
25-49 Employees	(1,0) if 25-49 employees
50-99 Employees	(1,0) if 50-99 employees
100-199 Employees	(1,0) if 100-199 employees
200-499 Employees	(1,0) if 200-499 employees
500-999 Employees	(1,0) if 500-999 employees
>1000 Employees	(1,0) if >1000 employees
Workplace and Other Controls	
Full-time	(1,0) if work >30 hours per week
Seasonal or Temporary Work	(1,0) if job seasonal or temporary
Fixed time or Contract Work	(1,0) if job fixed time or contract
Promotion Opportunities	(1,0) if job has promotion opportunities
Bonuses or Profit	(1,0) if pay includes bonuses or profits
Annual Increments	(1,0) if pay includes annual increments
Union or Staff Association	(1,0) if union or staff association at workplace
Member of Union	(1,0) if member of workplace union
Member of Other Union	(1,0) if member of non-workplace union
Rotating Shifts	(1,0) if work involves rotating shifts
Manager	(1,0) if manager
Supervisor	(1,0) if supervisor
Travel ≥45 Minutes	(1,0) if travel to work time ≥45 Minutes
Regional Unemployment	NOMIS Unemployment by Standard Region

Employing Organisation	
Private	(1,0) if private sector
Civil Service	(1.0) if civil service
Local Govt.	(1,0) if local government
NHS or Hospital	(1,0) if NHS or hospital
Nationalised Industry	(1,0) if nationalised Industry
Non-profit organisation	(1,0) if non-profit organisation
Armed Forces	(1,0) if armed forces
Other	(1,0) if other sector
Occupation Major Groups	
Managers and Administrators	(1,0) occupation dummy
Professional Occupations	(1,0) occupation dummy
Associate Professionals and Technical	(1,0) occupation dummy
Clerical and Secretarial	(1,0) occupation dummy
Craft and Related	(1,0) occupation dummy
Personal and Protective Services	(1,0) occupation dummy
Sales	(1,0) occupation dummy
Plant and Machine Operatives	(1,0) occupation dummy
Other Occupations	(1,0) occupation dummy
1-digit industry groups	
Agriculture, forestry and fishing	(1,0) industry dummy
Energy and water supplies	(1,0) industry dummy
Minerals, metal manufacture and chemicals	(1,0) industry dummy
Metal goods, engineering and vehicles	(1,0) industry dummy
Other manufacturing	(1,0) industry dummy
Construction	(1,0) industry dummy
Distribution, hotels and catering	(1,0) industry dummy
Transport and communication	(1,0) industry dummy
Banking, finance, insurance and business services	(1,0) industry dummy
Other services	(1,0) industry dummy
Regions of the UK	
Greater London	(1,0) regional dummy
Rest of South	(1,0) regional dummy
East Anglia	(1,0) regional dummy
South West	(1,0) regional dummy
West Midlands	(1,0) regional dummy
East Midlands	(1,0) regional dummy
Yorkshire	(1,0) regional dummy
North West	(1,0) regional dummy
North	(1,0) regional dummy
Wales	(1,0) regional dummy
Scotland	(1,0) regional dummy

Table A4: Summary Statistics

Variable	Males		Females	
	Mean	*SD*	*Mean*	*SD*
Dependent Variable:				
Log of real hourly wage	1.737	0.482	1.464	0.464
Independent Variables:				
Age	37.13	11.54	37.09	10.86
Race				
White (reference)	0.967	0.180	0.968	0.177
Black	0.008	0.091	0.012	0.108
Other non-white	0.025	0.157	0.020	0.142
Marital Status				
Never Married (reference)	0.231	0.421	0.176	0.381
Married or Living as a Couple	0.721	0.448	0.724	0.447
Widowed/Separated/Divorced	0.048	0.214	0.010	0.300
Highest Qualification				
Higher or First Degree, Teaching	0.164	0.370	0.152	0.359
Other Higher Education	0.244	0.429	0.154	0.361
GCE A-level	0.148	0.355	0.116	0.320
GCE O-level (reference)	0.202	0.402	0.269	0.444
CSE Grade1-5	0.055	0.228	0.041	0.198
Apprenticeship, Nursing, Other	0.037	0.188	0.099	0.298
No Qualification	0.150	0.357	0.169	0.375
Health				
Registered Disabled	0.010	0.099	0.007	0.083
Limits types of work	0.063	0.243	0.082	0.274
Other Personal Controls				
Head of Household	0.773	0.419	0.219	0.414
Own Children	0.354	0.478	0.366	0.482
Children aged 0-4 Years	0.145	0.352	0.102	0.302
Children aged 5-11 Years	0.190	0.393	0.204	0.403
Children aged 12-15 Years	0.115	0.320	0.151	0.358
Unemployed in Past Year	0.070	0.255	0.047	0.212
Non-Participant in Past Year	0.035	0.185	0.084	0.277
Size of Establishment				
<10 Employees (reference)	0.142	0.349	0.198	0.400
10-24 Employees	0.138	0.345	0.184	0.387
25-49 Employees	0.134	0.341	0.160	0.366
50-99 Employees	0.128	0.334	0.108	0.309
100-199 Employees	0.118	0.323	0.098	0.296
200-499 Employees	0.154	0.361	0.111	0.311
500-999 Employees	0.080	0.271	0.054	0.229
>1000 Employees	0.106	0.308	0.087	0.285
Workplace and Other Controls				
Full-time	0.973	0.161	0.656	0.475
Seasonal or Temporary Work	0.025	0.156	0.043	0.203
Fixed time or Contract Work	0.030	0.171	0.032	0.177
Promotion Opportunities	0.562	0.496	0.445	0.497
Bonuses or Profit	0.370	0.483	0.229	0.420
Annual Increments	0.433	0.496	0.484	0.500
Union or Staff Association	0.500	0.500	0.500	0.500
Member of Union	0.348	0.476	0.304	0.460
Rotating Shifts	0.133	0.340	0.072	0.259
Manager	0.242	0.428	0.140	0.347
Supervisor	0.179	0.383	0.166	0.372
Travel ≥45 Minutes	0.156	0.363	0.107	0.309
Regional Unemployment	7.496	2.378	7.519	2.356

Employing Organisation				
Private (reference)	0.773	0.419	0.612	0.487
Civil Service	0.048	0.215	0.039	0.194
Local Govt.	0.092	0.289	0.186	0.389
NHS or Hospital	0.035	0.184	0.108	0.311
Nationalised Industry	0.021	0.143	0.004	0.059
Non-profit organisation	0.017	0.131	0.038	0.190
Armed Forces	0.008	0.089	0.001	0.030
Other	0.006	0.076	0.012	0.110
Occupation Major Groups				
Managers and Administrators	0.168	0.374	0.087	0.283
Professional Occupations	0.106	0.307	0.097	0.296
Associate Professionals and Tech	0.102	0.302	0.113	0.316
Clerical and Secretarial (female reference)	0.099	0.299	0.300	0.458
Craft and Related (male reference)	0.191	0.393	0.027	0.162
Personal and Protective Services	0.067	0.250	0.148	0.355
Sales	0.045	0.208	0.099	0.299
Plant and Machine Operatives	0.156	0.363	0.045	0.207
Other Occupations	0.066	0.248	0.084	0.278
1-digit industry groups				
Agriculture, forestry and fishing	0.016	0.125	0.006	0.076
Energy and water supplies	0.032	0.176	0.008	0.087
Minerals, metal manufacture and chemicals	0.051	0.220	0.018	0.131
Metal goods, engineering and vehicles	0.153	0.360	0.045	0.207
Other manufacturing	0.125	0.330	0.073	0.261
Construction	0.054	0.225	0.007	0.082
Distribution, hotels and catering	0.154	0.361	0.223	0.416
Transport and communication	0.088	0.283	0.034	0.181
Banking, finance, insurance and business services	0.124	0.330	0.133	0.340
Other services (reference)	0.203	0.402	0.453	0.498
Regions of the UK				
Greater London	0.096	0.295	0.105	0.307
Rest of South (reference)	0.195	0.396	0.201	0.401
East Anglia	0.039	0.194	0.036	0.185
South West	0.094	0.292	0.083	0.276
West Midlands	0.091	0.288	0.089	0.285
East Midlands	0.086	0.280	0.079	0.271
Yorkshire	0.094	0.292	0.093	0.290
North West	0.104	0.306	0.103	0.304
North	0.067	0.249	0.064	0.245
Wales	0.049	0.217	0.046	0.209
Scotland	0.085	0.278	0.101	0.301
NT	17,080		17,421	

Table A5: Earnings Equations using BHPS 1991-1998

	Males		Females	
Dependent Variable: log real hourly wage	**Table 2 Column 1**		**Table 3 Column 1**	
Unemployment	-0.019	(3.43)†	-0.009	(1.61)
Log of Regional to National Price Deflator	0.117	(0.69)	-0.065	(0.37)
Personal Controls				
Males Age 16-24 / Females Age 16-24	0.111	(0.83)	0.191	(0.82)
Age 24-29 / Age 24-29	0.078	(0.58)	0.145	(0.63)
Age 29-34 / Age 29-34	0.065	(0.49)	0.138	(0.59)
Age 34-39 / Age 34-39	0.051	(0.39)	0.129	(0.56)
Age 39-44 / Age 39-45	0.049	(0.37)	0.133	(0.57)
Age 44-51 / Age 45-50	0.046	(0.35)	0.126	(0.54)
Age 51-64 / Age 50-59	0.032	(0.24)	0.127	(0.55)
Married or Living as a Couple	0.002	(0.17)	0.030	(2.49)*
Widowed, Separated or Divorced	-0.022	(1.15)	0.022	(1.24)
Higher or First Degree, Teaching	0.096	(3.15)†	0.119	(3.92)†
Other Higher Education	0.038	(2.30)	0.037	(2.28)*
GCE A-level	0.054	(2.82)†	0.037	(1.78)
CSE Grade1-5	-0.038	(1.09)	0.033	(0.80)
Apprenticeship, Nursing, Other	0.087	(1.63)	0.036	(1.48)
Other Qualification	0.045	(1.58)	0.013	(0.47)
Registered Disabled	-0.007	(0.22)	-0.069	(1.65)
Health Limits types of work	-0.031	(3.12)†	-0.035	(3.84)†
Head of Household	-0.001	(0.03)	0.012	(1.32)
Own Children	-0.007	(0.63)	0.015	(1.19)
Children aged 0-4 Years	0.009	(0.99)	-0.033	(3.13)†
Children aged 5-11 Years	0.014	(1.67)*	-0.028	(3.00)†
Children aged 12-15 Years	0.011	(1.07)	-0.014	(1.45)
Unemployed in past year	-0.041	(4.76)†	-0.019	(1.91)
Non-participant in past year	-0.074	(5.83)†	-0.056	(6.89)†
Workplace Controls				
10-24 Employees	0.032	(3.59)†	0.035	(4.33)†
25-49 Employees	0.032	(3.42)†	0.056	(6.31)†
50-99 Employees	0.052	(5.29)†	0.068	(6.74)†
100-199 Employees	0.052	(5.12)†	0.065	(6.23)†
200-499 Employees	0.071	(7.07)†	0.069	(6.50)†
500-999 Employees	0.081	(6.94)†	0.068	(5.46)†
>1000 Employees	0.094	(7.99)†	0.069	(5.56)†
Full-time Employment	-0.154	(9.44)†	-0.101	(13.58)†
Seasonal/Temporary Work	-0.072	(4.62)†	-0.027	(2.27)**
Contract Work	-0.020	(1.54)	0.006	(0.43)
Promotion Opportunities	0.003	(0.51)	0.006	(1.04)
Bonuses or Profit	0.032	(6.38)†	0.026	(4.19)†
Annual Increments	0.012	(2.45)†	0.016	(3.01)†
Union or Staff Association	0.017	(2.09)**	0.058	(6.85)†
Member of Union	0.080	(8.57)†	0.035	(3.93)†
Rotating Shifts	0.027	(2.97)†	0.009	(0.80)
Manager	0.040	(4.71)†	0.038	(4.08)†
Supervisor	0.023	(3.66)†	0.029	(4.48)†
Travel 45+ Minutes	0.022	(3.05)†	0.025	(2.99)†

Employing Organisation				
Civil Service	0.013	(0.70)	0.044	(2.04)**
Local Govt.	0.037	(2.08)**	0.055	(4.14)†
NHS or Hospital	-0.034	(1.44)	0.030	(2.00)**
Nationalised Industry	0.047	(2.55)**	0.057	(1.47)
Non-profit organisation	-0.022	(0.92)	0.022	(1.32)
Armed Forces	0.096	(2.59)†	0.083	(1.16)
Other	-0.068	(2.33)**	0.035	(1.42)
Occupation Major Groups				
Managers and Administrators	0.015	(1.24)	0.026	(2.24)**
Professional Occupations	0.026	(1.91)*	0.051	(3.23)†
Associate Professionals and Technical	0.014	(1.12)	0.051	(4.14)†
Clerical and Secretarial	-0.031	(2.59)†	-	-
Craft and Related	-	-	-0.051	(2.16)*
Personal and Protective Services	-0.076	(4.62)†	-0.070	(5.61)†
Sales	-0.018	(1.18)	-0.095	(7.92)†
Plant and Machine Operatives	-0.033	(3.22)†	-0.029	(1.51)
Other Occupations	-0.080	(5.72)†	-0.098	(6.47)†
Industry Classes (1-digit)				
Agriculture, forestry and fishing	0.019	(0.65)	-0.003	(0.08)
Energy and water supplies	0.076	(3.20)†	0.157	(4.50)†
Minerals, metal manufacture and chemicals	0.031	(1.66)*	0.032	(1.23)
Metal goods, engineering and vehicles	0.016	(1.07)	0.088	(4.77)†
Other manufacturing	0.026	(1.72)*	-0.001	(0.09)
Construction	0.016	(0.94)	0.093	(2.82)†
Distribution, hotels and catering	-0.031	(2.17)**	-0.030	(2.71)†
Transport and communication	-0.001	(0.01)	-0.017	(0.84)
Banking, finance, insurance and business services	0.038	(2.68)†	0.032	(2.51)**
Region Dummies				
Greater London	0.079	(2.38)**	0.048	(1.55)
East Anglia	-0.018	(0.42)	0.005	(0.09)
South West	0.027	(0.71)	-0.108	(2.93)†
West Midlands	-0.037	(0.84)	-0.134	(3.12)†
East Midlands	0.012	(0.32)	-0.023	(0.55)
Yorkshire	-0.022	(0.43)	0.001	(0.01)
North West	-0.031	(0.69)	0.020	(0.41)
North	0.001	(0.01)	0.077	(1.18)
Wales	0.088	(1.71)*	-0.203	(3.00)†
Scotland	0.024	(0.43)	-0.022	(0.44)
Time Dummies				
Wave 2	-0.002	(0.02)	-0.092	(0.40)
Wave 3	-0.048	(0.18)	-0.213	(0.46)
Wave 4	-0.111	(0.28)	-0.348	(0.50)
Wave 5	-0.185	(0.35)	-0.471	(0.51)
Wave 6	-0.229	(0.34)	-0.596	(0.51)
Wave 7	-0.300	(0.38)	-0.737	(0.53)
Wave 8	-0.337	(0.36)	-0.850	(0.52)
Constant	-1.949	(0.43)	-4.161	(0.53)
Diagnostics				
F	30.94 [0.000]		27.55 [0.000]	
R^2	0.9323		0.9189	
NT	17,080		17,421	

Notes: t-ratios in parentheses. Significance levels: †(0.01), **(0.05), *(0.10); p-values in [ ]