DISCUSSION PAPER SERIES

IZA DP No. 132

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Robert A. Hart

March 2000

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Robert A. Hart
University of Stirling and IZA, Bonn

Discussion Paper No. 132
March 2000

IZA

P.O. Box 7240
D-53072 Bonn
Germany

Tel.: +49-228-3894-0
Fax: +49-228-3894-210
Email: iza@iza.org

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ABSTRACT

Hours and Wages in the Depression: British Engineering, 1926-1938*

On their intensive margins, firms in the British engineering industry adjusted to the severe falls in demand during the 1930s Depression by cutting hours of work. This provided an important means of reducing labour input and marginal labour costs, through movements from overtime to short-time schedules. Nominal wages dropped relatively modestly while real wages continued to rise throughout the trough years of the recession. Empirical work is based on cell data from a panel of 28 local labour markets for the period 1926-38. The data dichotomise between skilled fitters and unskilled labourers and between time-rate and piece-rate workers. The findings have interesting implications for Phillips curve and wage curve studies.

JEL Classification: E24, J31, N34

Keywords: British engineering, the Great Depression, hours of work, Phillips Curve, wage curve

Robert A. Hart
Department of Economics
University of Stirling
Stirling FK9 4LA
Scotland, UK
Tel.: + 44 1786 467471
Fax: + 44 1786 467279
Email: r.a.hart@stir.ac.uk

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*I am grateful to David Bell, David Blanchflower, Felix FitzRoy, Olaf Hübler and Andrew Oswald as well as to seminar participants at the Universities of Hanover and Manchester for helpful comments on earlier drafts. Rosalind Hart and Elizabeth Roberts provided research assistance. The usual disclaimer applies.

1 Introduction

During the Great Depression, British national unemployment rates reached a peak of 22 percent of the total insured workforce in 1933. It was not uncommon during the first half of the 1930s for local labour markets to experience rates exceeding 30 per cent. High unemployment itself suggests directly that firms responded to severe demand downturns by laying-off significant numbers of workers. But there were two other potentially important labour market response-mechanisms. The first was to reduce hourly wage rates. The second was to cut the length of the workweek. For many firms, shorter hours had the dual impact of reducing the size and the marginal cost of labour input. For the most important and strategic industry in the inter-war period, the engineering industry, this paper shows that hours adjustment was considerably more important than wage adjustment. The findings have interesting implications for Phillips curve and wage curve studies of the wage-unemployment relationship.

The action of reducing wage rates in response to a recession carries clear advantages to the firm. It helps to maintain competitive prices in a declining market as well as avoiding some of the adjustment costs of layoffs. Possible offsetting losses include declines in worker morale and efficiency. An alternative strategy is to cut weekly hours. On the benefit side to the firm, reduced working time may involve unit cost reductions. These arise from two main sources. First, there may exist diminishing marginal productivity in daily and/or weekly hours. Second, where workers receive overtime premiums, cuts in hours entail reduced marginal wage rates. Given that annual national agreements had considerable bearing on wage-rate setting (see below), hours' adjustments may also offer the relative benefits of greater and speedier response flexibilities.[1] Moreover, within plants, it may well have been easier to discriminate between efficient and less efficient workers over their working time allocations rather than their hourly wage rates. On the cost side, reduced hours are likely to be associated with spare capacity and inefficient use of plant. Further, as with wage rate cuts, reduced weekly hours involve a drop in take-home pay among workers.[2]

At the intensive margin, the overwhelming response of engineering firms to the deepening recession was to reduce average working hours. By contrast, nominal wage rates displayed modest downward adjustments while real wages generally rose.[3] In fact, several of the key observations of British labour market performance in the 1930s find strong echoes in contemporary U.S. experience. Bernanke and Powell (1986) find that real wages in U.S. manufacturing were countercyclical in the interwar period. These authors observed rising real wages between 1929 and 1937 against the background of extremely high unemployment rates. They also find that variations in hours constituted a major adjustment mechanism, displaying a contribution to variation in total labour input that was almost on a par with that of employment. Further, Bernanke (1986) finds that hours provide a fairly rapid adjustment mechanism.

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[1] Apart from the national agreement to set the standard workweek at 47 hours in 1919, employers experienced relatively weak constraints on their abilities to set weekly hours (overtime and short time) (Marsh, 1965, pp. 150-162).

[2] *Ceteris paribus*, there is a potential relative gain associated with hours rather than wage rate reductions since falls in the former concomitantly entail a rise in utility due to less time spent in the workplace.

[3] Dimsdale et al. (1989) provide an analysis and explanation of real wage growth during this period.

Empirical work is based on a unique annual panel of 28 local labour markets in England and Scotland. For federated engineering firms within each market, the Engineering Employers' Federation (EEF) has constructed payroll-based data on working time and wages.[4] The period of analysis is 1926 to 1938. While statistics refer only to EEF federated firms, there is strong reason for believing that the data are strongly reflective of the industry taken as a whole.[5] The study also incorporates unemployment rates that are constructed to match each local market (Hart and MacKay, 1975). There are two important dichotomies featured in the data set. First, it distinguishes between skilled fitters and unskilled labourers. Second, it differentiates between timeworkers and pieceworkers.[6] The latter group comprises a significant part of the total workforce in this industry. Over our entire sample, 57% of fitters and 15% of labourers were pieceworkers.[7]

Background information is presented in Section 2. Theoretical developments concerning hours' equations are set out in Section 3; a critical emphasis here is on the distinction between time-rate and piece-rate workers. Section 4 outlines the specification of hours and wage functions. The former links closely to the theory in

[4] More details concerning the EEF and data coverage are provided in the Appendix.

[5] With some gaps, the EEF collected these data up to 1968. In 1964 and 1968, the timings of the EEF survey and the (then) Ministry of Labour's broader engineering coverage coincided. Hart and MacKay (1975) show, for the four groups of workers included here, the two sources produced very close earnings' estimates.

[6] The total numbers of fitters and labourers by the two payments methods always exceeded 60,000 each year.

[7] The proportions of pieceworkers as a percentage of total workers in engineering grew considerably within these two groups in the first half of the century. In 1906, they comprised 29.8% of fitters and 8.6% of labourers with these pecentages increasing, respectively, to 60.8% and 22.6% by 1948 (Knowles and Robertson, 1951b).

Section 3. The latter are based on Phillips curve and wage curve specifications in order to reflect the fact that wage bargaining occurred at a more aggregate level within the industry. Empirical estimates of hours and wage formulations are presented in Sections 5. Concluding comments are made in Section 6.

2 Facts and figures

The structure of wages in British engineering between the wars was subject to important elements of national agreements. Prior to the First World War, wages were negotiated locally and large variations in district rates evolved. With the advent of the National Wages Agreement in 1917, uniform national increases came into force. However, there was no prior cancellation of the district rates; the structure was frozen throughout the inter-war period. The national increases had the effect of gradually narrowing the district differentials (Knowles and Hill, 1954).[8] The wage provisions at national-level determined the minimum national time rates for fitters and labourers. These minima then formed a point of reference for establishing district-level wage differentials for these and other occupations.[9] This process was not uniform since some districts[10] paid more than the national minima. Examinations of wage

[8] The overall composition of wages contains a further complication. During the First World War, a supplementary bonus was paid to compensate for the increased cost of living. While intended as a temporary payment, it continued for the whole of the interwar period and beyond (and referred to as the National Bonus). Knowles and Hill (1954, especially Table 1) provide a detailed analysis of the impact of the bonus on basic rates.

[9] See, especially, Marsh (1965, Chapter 6). The EEF reported on nine broad occupational categories. Apart from fitters and labourers, they included turners, patternmakers, moulders, boilermakers, sheet metal workers, coppersmiths, and 'other' classes.

[10] There were three organisational tiers of industrial relations in engineering, which were works, district and national levels. There were about 50 District Committee areas covering clusters of engineering firms in defined geographical areas. Marsh (1965, pp. 22-26 and Appendix A2) provides detailed information for 1963 which serves as a reasonable reflection of earlier organisation.

differentials between fitters and labourers have featured most prominently in the earlier literature[11] and the work here also concentrates on these two occupations.

Given the simple structure of wage schedules in engineering, it is possible to distinguish, with a reasonable degree of precision, between the hourly basic wage rate (which excludes overtime hours) and hourly earnings (including overtime). EEF data provide statistics on weekly earnings (E) and weekly hours (h), and so average hourly earnings are e = E/h. Fortunately, the premium payments pertaining to overtime hours followed quite simple rules during this time period[12]. These allow for an estimate of the average hourly wage rate, w, given by

$$w = e = \frac{E}{h} \qquad \text{if } h \leq 47$$
$$w = \frac{E}{47 + (h-47)1.5} \qquad \text{if } h > 47 \tag{1}$$

where 47 is the length of the standard workweek that applied to all workers in the industry and 1.5 is the premium rate.[13]

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[11] Detailed discussions of the earnings evolutions of, and differentials between, these two occupations can be found in Knowles and Robertson (1951a).

[12] Overtime was paid on a daily basis in the form a premium rate on all hours in excess of 47 standard, hours. Up to 1931, the premium was 1.5 on all overtime hours except on Sundays and public holidays (during which double-time applied). Between 1931 and 1946, time-and-one-third was paid on the first two hours of overtime for non-Sunday/public holiday working and thereafter the same rates applied as before. Small differences between pieceworkers and timeworkers and other minor complications over calculating overtime earnings are enumerated in Knowles and Hill (1954, p.285 and Appendix B).

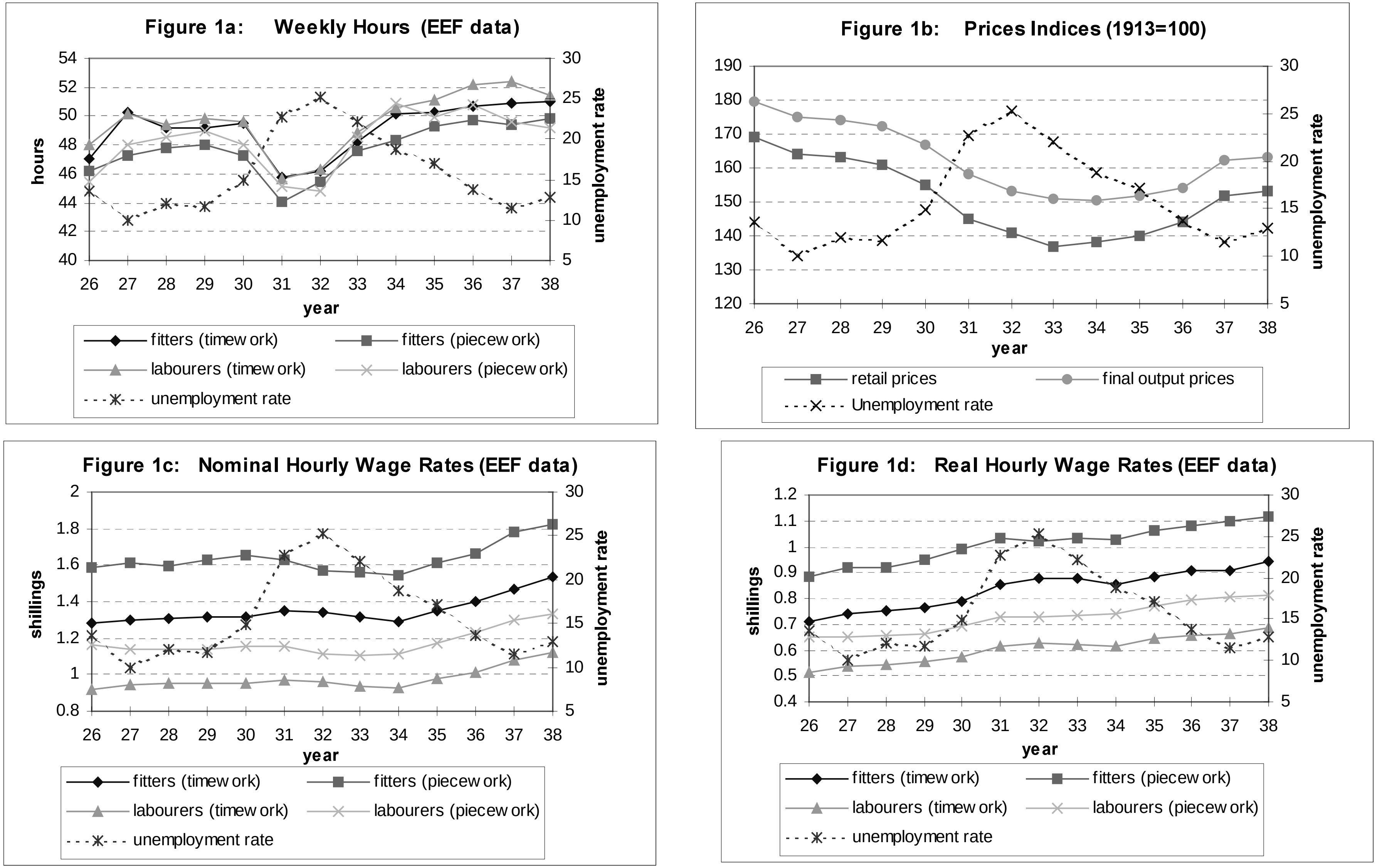
[13] This formula for w has been used by other authors (e.g. Braun, 1971) and by the (then) Department of Employment.

It is also important to distinguish between timeworkers and pieceworkers given considerable proportions of engineering workers in each category. How were numbers of workers in these two groups distributed among firms? Hill and Knowles (1956) have undertaken a detailed analysis of the 1952 EEF returns of 3786 individual firms. They find that, in the case of fitters, 60 per cent of firms paid their workers exclusively on a timework basis, 17 per cent exclusively by piecework while less than a quarter used a mixture of the two payments systems. As with timeworkers, there was an attempt in the inter-war period to impose some degree of national structure on piece-rates. The general practice was to fix piecework rates so that pieceworkers earned a given percentage more than the equivalent occupational basic time-rate.[14] As discussed by Knowles and Hill (1954), the structure was by no means uniform, however.

Trends in hours, prices and wages against the background of unemployment rates are presented in Figure 1. The unemployment rates are the weighted averages of the 28 local labour markets used in this study. Hours and wages are also weighted averages of the EEF returns from these markets and they are presented separately for fitters and labourers by payments method. The price indices are taken from Feinstein (1972), with retail prices based on the expenditures of working class families.

[14] The differences were set at a minimum of 33.33 per cent between 1914 and 1931 and 35 per cent between 1931 and 1943. The percentage applied to the basic rate only; it did not include, for example, the National Bonus.

Figure 1: Hours, wages, prices and unemployment, 1926-1938



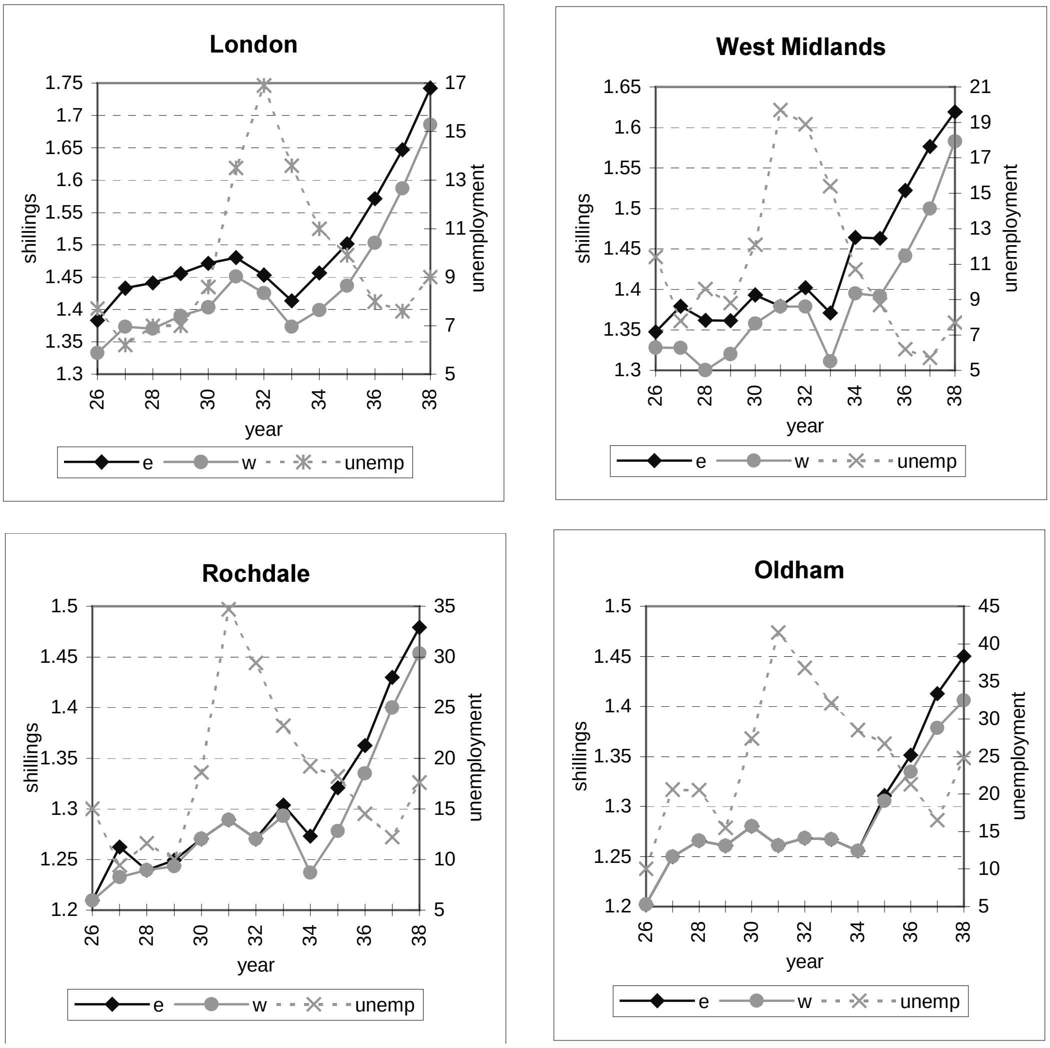
A strong negative association between industry-level hours and unemployment is immediately obvious from Figure 1a. Between 1929 to their peak in 1932, unemployment rates more than doubled, from 11.7 per cent to 25.3 per cent. In 1929, weekly hours of timeworking fitters averaged 49.2. These fell to a trough of 45.8 hours in 1931 - i.e. a 7 per cent reduction in 2 years - and then recovered slightly to 46.2 in 1932. Recalling that the standard workweek was 47 hours, short time was worked on average in engineering in these last two years. About one-third of labour markets - mainly in Scotland and the North of England - experienced short time working which averaged more than 3 hours below weekly standard hours. Equivalent hours' movements are observed for the other three work groups. Note that the hours of timeworking fitters and labourers correspond closely throughout most of the period. These groups worked longer hours than pieceworking fitters but were much closer to those of pieceworking labourers, especially in the second half of the period. Knowles and Robertson (1951a) show that pieceworkers' hours were generally shorter than those of timeworkers for other occupations in the industry. In general, however, differences in hours among the four groups included here were modest, with closely corresponding cyclical hours' movements.

What are the observed cyclical movements in nominal and real wages? The deflation of both retail and final output prices commenced in 1921 and prices fell to their trough values in 1934. During the study period, as shown in Figure 1b, final output prices fell by 16.2 per cent. The hourly wage rate data follow the construction of equation (1); that is, they *exclude* overtime hours. Figure 1c shows the changes in nominal hourly wage rates. Taking (the representative) example of timeworking fitters, nominal wages reached a peak of 1.35 shillings per hour in 1931 and fell to a trough of 1.29 shillings in 1934, a reduction of 4.5 per cent. The wages of pieceworking fitters and labourers exceeded those of their timeworking equivalents throughout the entire period. When wages are deflated by the final output price index, real wage rates rose throughout the period with the exception of 1934 when three of the four employment groups experience very modest reductions.

Figure 2 provides more disaggregate details on nominal wages and hours of timeworking fitters in a sample of 4 of the 28 labour markets.[15] The wage data in Figure 2, showing trends in e and w, are set against each market's unemployment rate. The first two markets, London and the West Midlands - fared relatively well during the Depression. Their unemployment rates peaked at 16.9 and 19.7 percent, respectively. Interestingly, except for one year in the case of the West Midlands, average hourly earnings, e, always exceeded the hourly wage rate, w. In other words, average overtime was positive over the entire period. In sharp contrast, the northern labour markets of Oldham and Rochdale experienced respective unemployment peaks of 41.5 and 34.7 percent. Moreover, these markets averaged short time working (i.e. under 47 weekly hours) for significant numbers of years. Accordingly, e and w coincided during these periods. It is also noticeable that nominal wages rose for most of the period. Nominal wage reductions were experienced around 1933 and 1934 in these and other markets but these took place two or three years after unemployment peaked. Unsurprisingly, given the aggregate results in Figure 1, the real wage paths shown in Figure 3, display virtually persistent upward trends. The real wage falls in 1933/4 are very slight in relation to the wage growth over the full period.

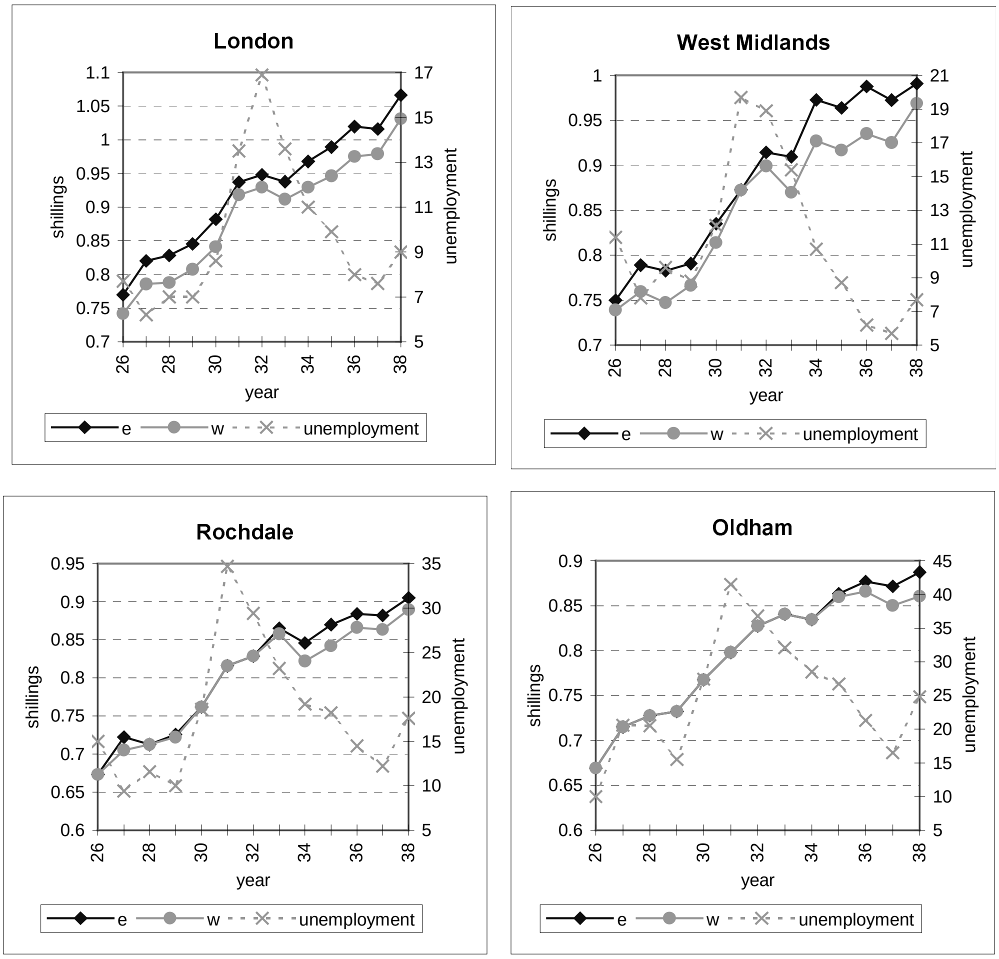
[15] Hart and MacKay (1975) provide decompositions of hours and wages for combined time-rate/piece-rate fitters and labourers in all 28 markets.

Figure2: Nominal wage rates, nominal wage earnings and unemployment in selected labour markets (fitters, time-rates)



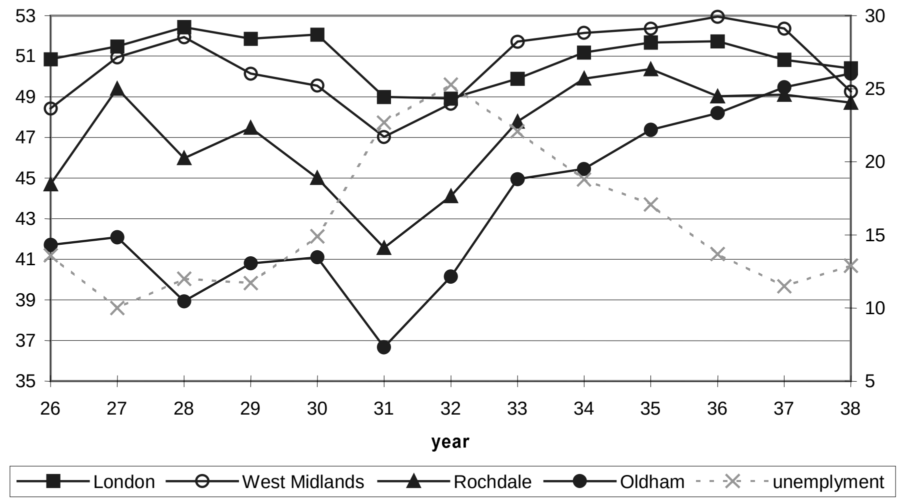
Associated weekly hours' movements are shown in Figure 4. As a marker, the aggregate unemployment rates shown in Figure 1 are also included. All four markets experienced hours' reductions, albeit shallower in the more resilient London and West Midlands markets. Note that hours reduce steeply in 1929 and 1930, thereby displaying a much more contemporaneous response to the deepening recession. This contrast sharply with the long lag in nominal wage responsiveness.

Figure 3: Real wage rates, real wage earnings and unemployment in selected Labour markets (fitters, time-rates)



Figures 1- 4 suggest the quantitative importance of hours' cutbacks as a means of reducing labour input. Such hours' responses also serve to reduce hourly compensation by narrowing, or eliminating, the gap between e and w. As examples, this latter effect is noticeable in London and the West Midlands in Figures 3 where the real e - w gaps narrow appreciably during the early 1930s. By contrast, in a labour market like Oldham where short time working was the norm, this influence on the hourly rate of compensation was not so important.

Figure 4: Weekly hours in selected labour markets (fitters, time-rates)



3 Hours of work by payment method under cost minimisation

Significant elements of wage setting in engineering took place outside the workplace of an individual firm, at national and district levels. I approximate this process by wage curve and Phillips curve specifications that disaggregate to the level of the local labour market. By contrast, apart from the length of the standard workweek and the rates of overtime premia, firms were free to vary labour utilisation on intensive margins. In this dimension, some modelling is required.

The 'typical' engineering firm is assumed to adopt a simple cost minimising strategy. It 'takes' the (national-/district-level) wage rate and finds the optimal combination of workers and hours.[16] As I show below, this process is slightly more complicated in the case of pieceworkers. In the piece-rate specification, simultaneous wage-hours determination is an issue. In conformity with the actual data configuration, the firm operates in a local labour market in which the transaction costs of changing jobs are

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[16] There are two main reasons for favouring the demand-side approach. First, the data are based on firm-level payroll statistics. Second, the demand model more straightforwardly integrates unemployment into the analysis.

relatively low. In the short-term, significant labour mobility between local markets is ruled out. The firm is treated as if all its employees are *either* timeworkers *or* pieceworkers.[17] Capital stock is assumed fixed and workers are homogeneous. For ease of analysis, therefore, no differentiation is made between labour skills.

A timeworker firm

Remuneration of each worker consists of a wage rate w_T for h_T per-period hours where T denotes a timeworker. Total variable cost is given by

$$W = w_T h_T N \qquad (2)$$

where N is the size of the workforce.

The workforce also incurs fixed (or hours-independent) labour costs, given by

$$Z = (z + tq)N \qquad (3)$$

where Z is total fixed cost, z is (exogenous) non-human capital fixed cost, t is training cost and q is the quit rate. Training standards are assumed to be laid down at industry level and so, together with occupational homogeneity, training cost is treated as an exogenously determined constant.[18] The quit rate is assumed to depend on (i) the firm's w_T relative to the rate in other firms in the local market, w_T^* and (ii) the unemployment rate which represents the (inverse of the) probability of finding alternative employment in the market (see Schlicht, 1978; Salop, 1979; Hoel and Vale, 1986). Thus

[17] We have already noted that this assumption is realistic for most firms in the British engineering industry. Lazear (1986) carries out a detailed comparative analysis of time-rate and piece-rate working. For a recent analysis of the coexistence of piece rates and time rates see Baland et al. (1999). Seiler (1984) presents an illuminating analysis of sources of variation in pay for timeworkers and pieceworkers.

[18] In general, the menu of skills required to qualify as a fitter were generally understood throughout the industry although formalisation of training standards was more of an immediate post-war phenomenon (Marsh, 1965, pp. 170-5).

$$q = q(r,u) \text{ where } r = w_T/w_T^* \qquad (4a)$$

with $q_r < 0$, $q_{rr} > 0$, $q_u < 0$, $q_{ur} > 0$. Low intra-market information and mobility costs - together with important elements of national and district elements of wage setting - are assumed to ensure that r = 1 (i.e. $w_T = w_T^*$). Therefore, the adopted special case of (4a) is given by

$$q = q(1,u). \qquad (4b)$$

Setting output price to unity, the Lagrangian function, L, for the firm's cost minimising problem is expressed

$$\min L(N, h_T, \lambda) = Z + W + \lambda[Q - F(N, h_T)] \qquad (5)$$

where Q is the firm's output, and λ is a Lagrangian multiplier. It is assumed that $F_i >$ 0, $F_{ii} < 0$ and $F_{ij} > 0$ (i = N, h_T). From the first-order conditions, we obtain

$$\frac{w_T N^*}{z + tq + w_T h_T^*} = \frac{\partial F/\partial h}{\partial F/\partial N} \qquad (6)$$

where N* and h_T^* denote equilibrium values of the decision variables. Thus, the firm equates the ratio of marginal costs on the intensive (hours) and extensive (employment) margins to their respective marginal products. This model produces the equilibrium hours demand function

$$h_T^* = h_T^*(w_T, z, u, Q)\,. \qquad (7)$$

Totally differentiating the first order conditions and solving the h (and N) variables establishes in (7) that $h_1^* < 0, h_2^* > 0, h_3^* < 0, h_4^* > 0.$ The first three conditions derive from the fact that a rise in hours-independent relative to variable costs induces hours-worker substitution. It is noted that $\partial h_T^*/\partial Q = 0$ in (7) if there is an underlying homothetic (e.g. Cobb Douglas) production technology. Following Ehrenberg (1971), this latter outcome is taken advantage of in the subsequent hours' estimating equations.

The variable of particular interest to this study is the rate of unemployment. Its role in equation (7) stems from the result that rises in fixed labour costs cause hours-worker substitution in the cost minimising firm. As unemployment increases, the quit rate reduces due to falls in alternative employment opportunities. Accordingly, fixed costs associated with labour turnover are reduced. *Ceteris paribus*, starting from an equilibrium position, the cost minimising firm reacts to falls in fixed to total labour costs by reducing the variable labour input, hours of work.

A pieceworker firm[19]

Remuneration of pieceworkers is performance-related. With fixed capital, the firm can attempt to control per-period output or performance by changing (i) average piece-rate hours (h_P), and (ii) work intensity per hour (θ).[20] Let piecework performance be indexed by Φ and so $\Phi = \Phi(h_P, \theta)$. It is assumed that $\Phi_{h_P}, \Phi_{\theta} > 0$ and $\Phi_{h_P h_P}, \Phi_{\theta\theta} < 0$ with the second derivatives capturing the influences of, respectively, worker fatigue and organisational/ technological constraints. Let the piece-rate be given by π and so the total variable cost (P) is given by

$$P = [\pi\, \Phi(h_P, \theta)]N \,. \qquad (8)$$

[19] This sub-section is based on Pencavel (1977) who analyses an equivalent supply-side problem.

[20] The ability of the firm to vary work intensity would be expected to be very systems-oriented. For example, it is more likely to be feasible within a firm that adopts line-production techniques and perhaps less likely in a firm involved in small-batch production.

As for pieceworkers' fixed costs, it is assumed that (3) and (4b) apply.[21]

The new cost minimising problem is

$$\min L(N, h_P, \theta, \lambda) = Z + P + \lambda[Q - G(N, h_P, \theta)] \qquad (9)$$

where $G_i > 0$, $G_{ii} < 0$ and $G_{ij} > 0$ ($i = N, h_P, \theta$). First-order conditions give

$$z + tq + \pi\Phi - \lambda\frac{\partial G}{\partial N} = 0;\ \ \pi\frac{\partial \Phi}{\partial h_P}N - \lambda\frac{\partial G}{\partial h_p} = 0;\ \ \pi\frac{\partial \Phi}{\partial \theta}N - \lambda\frac{\partial G}{\partial \theta} = 0;\ \ Q = G\,.$$

We obtain the outcome that the firm equates the ratio of the marginal costs of hours and work intensity with their respective ratio of marginal returns, that is

$$\frac{\partial\Phi/\partial h_P}{\partial\Phi/\partial\theta} = \frac{\partial G/\partial h_P}{\partial G/\partial\theta}\,. \qquad (10)$$

The piecework equilibrium hours demand function is given by

$$h_P^* = h_P^*(\pi, z, u, Q)\,. \qquad (11)$$

On totally differentiating the first-order conditions and solving for the endogenous variables, it is established that all the partials now have ambiguous signs. The intuition is as follows. In the timeworker model it is found that $\partial h_T^*/\partial w_T < 0$. A rise in variable cost reduces the cost of employment on the extensive relative to the intensive margin and thereby encourages the firm to substitute N* for h_T^*. A comparable result, i.e. $\partial h_P^*/\partial\pi < 0$, occurs in the pieceworker model iff $\partial\Phi/\partial\theta = 0$.

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[21] The equivalent quit function to (4a) for pieceworkers is $q(\pi/\pi^*, u)$ where π^* is the piece-rate in other firms. In like manner to time-rates it is assumed that $\pi = \pi^*$ given low mobility and other transaction costs within local labour markets. I ignore the possibility of switching between time-rate and piece-rate work.

In this event, the wage-rate and the piece-rate clearly play strictly comparable roles. However, if $\partial\Phi/\partial\theta > 0$, the sign of $\partial h_P^*/\partial\pi$ is indeterminate. A *ceteris paribus* rise in the piece-rate not only alters the relative prices of intensive margin inputs, h_P and θ, relative to extensive margin input (N) but also of intensive margin inputs relative to one another. Knowledge of the degree of complementarity or substitutability between h_P and θ is required before unambiguous causation is established.

From an empirical viewpoint, the hours' demand functions (7) and (11) are not compatible since workers are compensated by unit of time in (7) and by unit of output in (11). Instead, for pieceworkers, I adopt the hours' function

$$h_P^* = h_P^*(w_p, z, u, Q) \qquad (12)$$

where w_p is the hourly rate of pay of pieceworkers. In terms of (8), let p = P/N be the average variable cost. Then, we have $w_P = p/h_P = \pi\Phi/h_P$. So, w_P is functionally related to π, h_p and θ.[22] Therefore, estimation of hours' demand, i.e. equation (12), should accommodate two features. First, some attempt to capture the influence of θ is necessary. Second, estimation must take account of simultaneity between h_P and w_P.

4 Hours and wage specifications

Data consist of 28 local labour markets observed over 13 years and are dichotomised between fitters and labourers and between timeworkers and pieceworkers. This gives a maximum of 1456 cell-observations although, in practice only 1188 are available for estimation purposes (see the Appendix). Pooling the cross sections in this way allows

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[22] Following Pencavel (1977), if we take the Cobb-Douglas form of the X-function, that is $w_P = \pi d h_P^{d_1} \theta^{d_2} / h_P$, we obtain $\ln w_P$ = constant + $\ln\pi + (d_1 - 1)\ln h_P + d_2 \ln\theta$.

for tests of differences among the employment groups. Unemployment rates are available for each labour market in each year. The EEF produce hourly wages for timeworkers and pieceworkers separately.

Hours' estimation is based on the demand equations (7) and (12). The estimating equation is designed to capture both shift- and slope-effects of piecework relative to timework compensation systems. The underlying production function is assumed to be homothetic, in which case $\partial h / \partial Q = 0$ would hold. The hours equation also includes labour market and time series dummies. The cross-section dummies capture two effects. First, they allow for regional price differences. Second, at least as a first approximation, they control for the influence of work intensity (θ) in the pieceworker hours equation (12). As already noted (in footnote 20), differences in work intensity would be expected to relate to type of production system and method. Different labour markets are associated with different sectors of engineering[23] and so probably act as a reasonable proxy for θ.

Let I and S be dichotomous variables that denote, respectively, the operation of an incentive pay scheme (pieceworking) and a skilled worker (fitter). Denote $\ln h_{it}$ as the log of average hours of workers in local labour market i at time t. Let X_{jit} denote the j^{th} determinant - also expressed as a market average - of $\ln h_{it}$. The basic estimating hours' equation is given by

$$\ln h_{it} = a_0 I_{it} + a_1 S_{it} + \sum_j b_j X_{jit} + r_m + f_t + \varepsilon_{it} \qquad (13)$$

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[23] For example, the West Midlands is associated with motor manufacturing, North West Scotland with marine engineering, St. Helens with chemical engineering, and Halifax and Rochdale with textile engineering. (See Knowles and Robertson 1951a).

where r_m and f_t are unrestricted labour market and time intercepts, ε_{it} is an error term and where a and b are parameters to be estimated. Included in X are: (i) the log of the unemployment rate ($\ln u_{it}$); (ii) the log of the straight-time hourly wage ($\ln w_{it}$). The hours' equations also contain hours'-independent fixed costs, z. It is possible to obtain measures of fixed costs consisting of employers' per worker contributions to unemployment and health insurance (Chapman, 1952, Table 91). However, payroll tax funding of this social welfare coverage was such that costs per-worker were constant across all workers in a given year. Therefore, they are fully captured by the time dummies, f_t.

In order to gain some insight into the speed of hours' adjustment - and despite econometric problems associated with dynamic panel specifications (e.g. Hsiao, 1986) - an extended version of (13) was estimated that included the lagged dependent variable. These results are also included in the following section.

Hours' estimation was extended to allow for I- and S- worker slope differences as well as to allow for which I × S interaction dummies.[24] In the event, slope and interaction terms proved to be insignificant (see the discussion in the following section) and so attention is concentrated on equation (13). Estimation of (13) is carried out using weighted two- stage least squares, with w treated as an endogenous variable (see Notes to Table 1).

[24] The full specification is given by:

$$\ln h_{it} = a_0 I_{it} + a_1 S_{it} + a_2 I_{it} S_{it} + \sum_j b_{1j} X_{jit} + \sum_j b_{2j} I_{it} X_{jit} + \sum_j b_{3j} S_{it} X_{jit} + \sum_j b_{4j} I_{it} S_{it} X_{jit} + r_m + f_t + \varepsilon_{it}.$$

On the wages' side, I specify simple wage-unemployment relationships in order to capture the national and local labour market wage setting. An obvious augmented wage formulation, since it too is based on regional cell means, is the wage curve specification of Blanchflower and Oswald (1994). This is given by

$$\ln w_{it} = \alpha_0 I_{it} + \alpha_1 S_{it} + \beta \ln u_{it} + \gamma \ln w_{it-1} + r_m + f_t + \upsilon_{it} \qquad (14)$$

where w is constructed as in (1), α, β, γ and δ are parameters to be estimated, and ν is an error term. Blanchflower and Oswald argue that a finding of $\gamma = 0$ is supportive of a wage curve specification while $\gamma = 1$ supports the Phillips curve.[25] With an eye on problems associated with the inclusion of a lagged dependent variable in panels, Card (1995) and Card and Hyslop (1996) suggest that first-differencing equations like (14) provides a test of the wage curve versus the Phillips curve. In terms of (14), this produces

$$\Delta \ln w_{ijt} = \beta_1 \ln u_{it} + \beta_2 \ln u_{it-1} + g_t + \Delta \nu_{it-1} \qquad (15)$$

where g_t is the re-normalised time effect. If in (15) β_1 is found to be significant and β_2 insignificant then this provides empirical support for the Phillips curve. Alternatively,

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[25] See, especially, Table 5 of the Blanchflower and Oswald U.K. study based on 11 UK standard regions between 1973-90. Apart from region and time dummies, these authors additionally control for occupation, industry, qualifications, marital status and several other variables. However, their main controls are not essential in this study. Occupation is far more rigorously defined here, consisting of two quite homogenous blue-collar groups. There is only one industry. (Although, there would be an advantage in a more detailed delineation of types of engineering outside those captured by the regional dummies.) Nor is it important to control for pre-work education in the case of fitters and labourers. Added to this, the labour markets here are much better defined than standard geographical regions; in fact, the great majority define travel-to-work areas.

estimates of β_1 and β_2 reveal equal sized parameters with opposite signs then the wage curve is supported.

Wages in equations (13), (14) and (15) are, through (1), adjusted to remove the influence of overtime working; in other words, they are straight-time, or basic, hourly wage rates. If hourly earnings replace basic rates in the wage equations - and if both hours and wages are related to unemployment - then it would be difficult to know the extent to which observed wage-unemployment interactions were due purely to the process of wage rate determination. This issue is raised by Card (1995), and explored in some detail by Black and FitzRoy (1999), in relation to estimating the wage curve. This issue is explored below by re-estimating equations (14) and (15) and replacing w with e.

5 Hours and wage estimates

Estimates of the hours' equation (13) are presented in Table 1. The results in column (i) match closely to the theory presented in Section 3. In line with the cost minimisation models, hours' elasticities indicate significantly negative wage and unemployment responses. The estimated unemployment elasticity of hours is -0.03, so that a doubling of local labour market unemployment is associated with a 3 per cent reduction in hours. In fact, unemployment more than doubled in magnitude between 1929 and 1932 (see Figure 1) and would have accounted for, at least, an average work time reduction of 90 minutes per week. Since wages rose significantly in most labour markets between 1928 and 1932 (see, for example, Figure 2), this would also have contributed to the decline in working hours. The S- dummy indicates that fitters worked longer weekly hours than labourers. Contrary to the impression of the aggregate graph in Figure 1a, the I- dummy suggests that pieceworkers worked longer hours than timeworkers. It should be added that, in general, hours' differences among the four groups are small.

While we must be tentative about the results in column (ii) of Table 1, the estimated coefficient on lagged hours indicates that hours adjust relatively speedily to their desired levels, with around 70 per cent of adjustment achieved in the current year. Comparing columns (i) and (ii), the unemployment result remains very robust while the coefficient on the lagged wage halves in size - though remaining significantly negative - when lagged hours are added.

Accommodating slope influences of I and S on the explanatory variables in the hours' equations - as well as allowing for interactions between I and S - added nothing to the results shown in Table 1. It is indicated in Section 2 that, in important respects, the determination of piece-rates in engineering was formulaically linked to time-rates. The results with respect to the incentive-pay slope dummies suggest that, to all intents and purposes, firms did not differentiate their hours' responses as between the two rates. Nor did they apparently differentiate in their responses in relation to fitters and labourers. This might well indicate large degrees of interrelated work activities between these two occupational groups.

Wage equation results are shown in Table 2. Columns (i) and (ii) contain, respectively, the wage rate and earnings rate regressions equivalent to equation (15). Results in the former case are weak with neither a wage curve nor a Phillips curve receiving any support. The equivalent earnings results in column (ii) transform the picture. Unemployment now plays a 'traditional' role, with the results strongly supporting a wage curve specification. But these findings are not due to wage-unemployment relationships; the negative association between hours and unemployment is chiefly responsible for underpinning the observed fit. In other words, it is the h-, and not the w-, effect within e that dominates these findings. It should be emphasised, however, that wage earnings equations are essentially *ad hoc* constructions. Underlying Phillips curve and wage curve theories refer, essentially, to basic hourly rates of pay and they are based on underlying theories that differ in important respects from the derivation of hours' equations.

Table 1 Hours' estimates (Weighted 2SLS: dependent variable: ln h_t)

	(i)	(ii)
Unemployment (ln u_t)	-0.029	-0.026
	(0.008)	(0.008)
Wage rate (ln w_t)	-0.369	-0.181
	(0.038)	(0.071)
Incentive pay dummy (I)	0.023	0.004
	(0.007)	(0.011)
Skill dummy (S)	0.115	0.055
	(0.013)	(0.023)
Lagged hours (h_{t-1})	-	0.334
		(0.065)
Dummy 1	0.505	0.411
	(0.018)	(0.034)
Dummy 2	0.212	0.159
	(0.013)	(0.021)
Labour market and time dummies	Yes	Yes

Notes: No. of observations = 1188. Figures in parentheses are heteroscedastic consistent standard errors (White, 1980). The instrument for ln w_t is obtained by regressing this variable on deviations from the mean wage (by occupation group) for each year, unemployment, lagged unemployment as well as occupation, regional and time dummies and using the resulting fitted wage. Weights are the number of employees recorded by the Engineering Employers' Federation in each occupation and pay group in each local labour market.

Dummy 1 applies to Barrow in 1927 where exceptionally high hours and wages resulted from work on the trials of H.M.S Cumberland during a large part of October, the month of data collection.

Dummy 2 applies to Barrow in 1930 were a number of naval trials accounted for unusually high hours and earnings per worker.

Table 2 Hourly wage/earnings - unemployment relationships (Weighted OLS)

Independent Variables	$\Delta \ln w_t$ (i)	$\Delta \ln e_t$ (ii)	$\ln w_t$ (iii)	$\ln e_t$ (iv)
Unemployment ($\ln u_t$)	-0.009	-0.021	-0.009	-0.020
	(0.008)	(0.006)	(0.009)	(0.006)
Lagged unemployment ($\ln u_{t-1}$)	0.006	0.022	0.003	0.024
	(0.007)	(0.006)	(0.010)	(0.009)
Lagged wage ($\ln w_{t-1}$ or $\ln e_{t-1}$)	-	-	0.690	0.681
			(0.039)	(0.048
Incentive pay dummy (I)	-	-	0.050	0.046
			(0.007)	(0.008)
Skill dummy (S)	-	-	0.104	0.106
			(0.013)	(0.016)
Dummy 1	0.464	0.567	0.453	0.560
	(0.010)	(0.090)	(0.008)	(0.008)
Dummy 2	0.276	0.319	0.276	0.324
	(0.106)	(0.098)	(0.006)	(0.006)
Labour market and time dummies	-	-	Yes	Yes
Time dummies	Yes	Yes	-	-

Notes: No. of observations = 1188. Figures in parenthesis are standard errors and are heteroscedastic consistent. Hourly wages (w) exclude overtime and follow the construction of equation (1). Hourly earnings (e) include overtime. Weights are the number of employees recorded by the Engineering Employers' Federation in each occupation and pay group in each local labour market.

Columns (iii) and (iv) in Table 2 present results to the wage curve specification in equation (14) for wages and earnings, respectively. The shift dummies indicate that pieceworkers enjoyed higher wage rates than timeworkers, and fitters higher wages than labourers. The lagged wage coefficient suggests slow adjustment relative to the adjustment speeds obtained in the hours' equations. [26] The w-u elasticities are insignificant with, again, no evidence supporting either a Phillips or wage curve for

[26] These results contrast to those of Blanchflower and Oswald (1994) who do not find significant autoregression in their equivalent wage equations, based on cell means. They are more in line with the US findings of Blanchard and Katz (1997), although these authors find an even more sluggish wage adjustment process.

this period. By contrast, the earnings results in column (iv) corroborate the equivalent Δe regression results in column (ii).

6 Conclusions

Hours, not wages, provided the principal intensive margin response by British engineering firms during the inter-war recession. Significant cuts in working time in the early 1930s were undertaken in the face of rising unemployment and rising wage rates. Hours' changes allowed firms to reduce labour input while offsetting upward pressures on labour costs as the recession deepened. The cost reductions occurred because most labour markets moved from workweeks in which average hours exceeded standard hours to those in which short-time working was the norm. A related advantage of hours' reductions was that, due to the prevalence of short-time working, levels of labour utilisation were relatively costlessly reversible as and when cyclical upturns took place. Somewhat more cautiously, there are indications that hours provided a relatively speedy form of adjustment.

By contrast, wage-rate changes did not adapt well to the prevailing economic climate. Two factors are important in explaining this latter observation. First, the wage determination process was relatively cumbersome. Minimum time-rates of fitters and labourers - both timeworkers and pieceworkers - were set by national-level industry agreements and then consolidated at district level. Second, national agreements were made against a background of a wide heterogeneity of local labour market economic climates and industrial activities. The constraints arising from divergent market needs and objectives would have made it extremely difficult to reach agreements over large *reductions* in nominal rates that matched, let alone exceeded, the accompanying price deflation. In effect, real wage rates were allowed to adapt very gradually with the main cyclical buffers provided within firms themselves.

It is almost certain that the scenario described above in respect of engineering was closely matched in a wider industrial perspective. Observed wage changes (real and nominal) in the Phillips curve literature clearly point to similar cyclical patterns to those reported here.[27] As emphasised by Black and FitzRoy (1999), a potentially serious problem with Phillips curve and wage curve studies has been the fact that they have largely ignored the labour utilisation dimension of market adjustment. During the inter-war years, this is a particularly critical omission. When hourly earnings replace hourly rates, it appears that well- behaved wage formulations result. This is something of an artefact, however; it is the hours' component of earnings that displays the critical unemployment response.

[27] Phillips' original scatter diagram of British annual nominal wage changes and unemployment between 1923 and 1957 (Phillips, 1958) - reproduced and analysed in detail by Lipsey (1960) - reveals a set of points between 1923 and 1939 that under no stretch of the imagination support a negative wage-unemployment relationship. Lipsey is especially interested in the (centralised first-difference) rates of change of wages ($\dot{W}$) and of unemployment $(\dot{U})$. He compares the periods 1923-39 and 1947-57 with the period1862-1913 and finds that the regression coefficient on $\dot{U}$ changes signs. He goes on to observe that "on the average experience of the post-1922 period, other things being equal, times of falling unemployment were associated with lower $\dot{W}$'s than were times of rising unemployment".

Appendix

The EEF and local labour market data

The EEF acted as a trade union on behalf of the management of its federated firms (Marsh, 1965, Ch. 3). It represented the whole range of activities of the engineering industry with firms organised into 30 manufacturing sub-sectors. These included aircraft, agricultural machinery, commercial vehicles, construction engineering, foundries, general engineering, machine tools, marine engineering, motor cars and cycles (see Hill and Knowles, 1954, Appendix A, and Marsh, 1965, Appendix B). During the period of study, the EEF represented on average 2000 firms and 800,000 workers nation-wide. The title, EEF is used for convenience. The Federation was formed in 1896 and the title EEF adopted in 1899. Federated membership grew significantly up until the early 1920s, with a particular boost in 1919 when it amalgamated with the National Employers' Federation. This led to an eventual change of name to the Engineering and Allied Employers' National Federation in 1924.

With less disaggregation than incorporated here, these data were originally described in Hart and MacKay (1975) and a detailed breakdown of each local labour market is given in Marsh (1965, Appendix B). The EEF hours and wage data refer to a particular pay week, which falls in the month of October for the years 1926-8 and 1932-7, March for 1929-31 and July for 1938. The twenty-eight labour markets are Aberdeen, Barrow, Bedfordshire, Birmingham, Blackburn, Bolton, Burnley, Burton, Coventry, Derby, Dundee, Halifax, Hull, Leicester, Lincoln, Liverpool, London Area, Manchester, N.E. Coast, North Staffs, North West Scotland, Nottingham, Oldham, Preston, Rochdale, St. Helens, Sheffield, Wigan.

The potential sample size in the regressions is 1456 (= 28 markets × 13 periods × 4 work groups.) In effect, 1188 are available for estimation purposes for two main reasons. First, one period is lost due to the use of lagged values of economic variables. (In the main hours' regression - see column (i), Table 1 - the estimated wage is obtained from an equation that includes lagged unemployment.) Second, for each categories of worker, some labour markets in some time periods recorded zero returns. Where this occurred in a given market and for a given occupation category, observations for all periods were deleted. There were no returns in the following cases: (**fitters, time-rates**) North Staffs (1932); (**fitters, piece-rates**) Burnley (1929, 30, 38), North Staffs (1932, 35), St Helens (all years); (**labourers, time-rates**) Aberdeen (1927-38); (**labourers, piece-rates**) Burnley (1929, 30, 32, 38), Dundee (1930, 31, 35-38), Halifax (1928 -30), Liverpool (1929, 31, 33, 35, 37, 38), North Staffs (1929, 31- 33, 36, 37), St Helens (1931, 33), Wigan (1926-36, 38)

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