Overtime working, the Phillips curve, and the wage curve:

British engineering, 1926-1966

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Abstract:

This paper shows that wage-unemployment elasticities derived from estimated wage curves and Phillips curves may be critically dependent on the measurement of wages. Incorporating hourly wage earnings, that include the influence of overtime payments, can lead to seriously distorted results. Meaningful elasticities are obtained only if hourly standard wages form the basis of analysis. Work is based on a unique data set describing two homogeneous blue-collar occupational groups - skilled fitters and unskilled labourers - in the British engineering industry. Each group is also divided into timeworkers and piece-rate workers. Data are aggregated into a panel of 28 local labour markets and cover the highly contrasting periods, 1928-1938 and 1954-1966.

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1 Introduction

This paper concerns an empirical issue raised by Card (1995) in his critique of the book, *The Wage Curve*, by Blanchflower and Oswald (1994a). He points out that if the wage is specified in terms of earnings then estimated wage-unemployment elasticities might in part reflect variations in hours of work. Card raised this issue in relation to annual earnings - the principal measure used by Blanchflower and Oswald for the U.S. - pointing out that these are the product of annual hours and hourly wages. It becomes important to understand the extent to which estimated elasticities represent wage effects and hours' effects. But the argument does not end with the annual hours/hourly wage dichotomy. The specification of the hourly wage itself may involve a parallel problem. This will be the case if average hourly earnings are used as the representative measure. Average earnings include overtime payments. Since overtime is typically remunerated at a premium rate, a change in the proportion of overtime to total weekly hours will cause average hourly earnings to change even if hourly standard rates of pay remain constant. The potential implications for the analysis of wage-unemployment relationships are clear. *Both* wage rates and weekly hours of work would be expected to relate negatively to unemployment rates and so wage-unemployment elasticities cannot be deduced from an equation that measures the wage in terms of average hourly earnings. This is the central message of the wage estimation undertaken by Black and FitzRoy (2000) - based on annual panel data for fifty-six British counties between 1975 and 1979 - and it is the subject of this paper.

Advantage is taken of a unique British data set that is ideally suited to examining the role of hours in the estimation of wage earnings equations. The Engineering Employers' Federation (EEF) constructed the data on behalf of its federated engineering firms. It consists of detailed payroll statistics on wages and hours of two homogeneous blue-collar occupations in the engineering industry, skilled fitters and unskilled labourers. The statistics dichotomise each occupational group into timeworkers and pieceworkers.[1] The data are provided at a district-level of aggregation. They consist of hours and earnings totals based on samples of the four types of workers (i.e. two skill levels by two remuneration methods). These allow calculation of average weekly hours and average hourly earnings for each district. For the post-war period, the EEF additionally provide direct information on average standard hourly wages. Comparable data for the inter-war period involves an intermediate calculation but this results in accurate estimates. Two important features of the data are that workers' skill endowments and educational attainments are implicitly rigorously controlled.[2]

Use is made here of 28 of the EEF districts in England and Scotland, covering the pre-war period from 1926 to 1938 and the post-war period 1954 to 1966. The great majority of the local labour markets define travel-to-work areas and their choice is predicated on the fact that matching unemployment rates are available (Hart and MacKay, 1975). The pre-war and post-war periods provide contrasting observations

[1] Minimum national-level time rates of pay were determined for fitters and labourers. These formed the reference for establishing district-level wage differentials for these and other blue-collar occupations (turners, patternmakers, moulders, boilermakers, sheet metal workers, coppersmiths and 'others'). It should be noted, however, that individual firms had considerable discretion to vary wages above minimum rates.

[2] Skilled fitters followed an apprenticeship system with prescribed ranges and levels of skill acquisitions. Labourers required no training. Moreover, for workers in each occupation group, there would be little variation in the lengths and levels of pre-work education. This was especially true in the pre-war period, a time when virtually every worker, fitter or labourer, commenced work direct from elementary school. Occupational homogeneity is a marked comparative advantage of these data. Thus, for example, while the New Earnings Survey Panel allows us to differentiate rigorously between standard hourly wages and hourly earnings at the individual level, it does not permit detailed educational and human capital controls.

of inter-market hours' variations and, accordingly, a strong basis for measuring differential hours' impacts. During the Great Depression, hours of work and unemployment displayed extreme volatility and resulted in wide variations across labour markets (Hart, 2001). In the post-war period, hours and unemployment fluctuations were less extreme through time although wide cross-sectional district differences remained.

Evidence is provided that suggests that estimates of wage functions can be seriously misleading if standard hourly wage rates are not used as the basis of analysis. The use of average hourly wage earnings, which in part reflect changes in overtime working, precludes identification of *separate* wage rate and labour utilisation associations with unemployment. In times of high cross-sectional and time-wise hours' volatility during the inter-war period, a significant relationship between earnings and unemployment in fact hides a weaker association between the wage rate and unemployment. In the economically more stable 1950s and 1960s, the contrast between a strong earnings curve and a weak wage curve is found to be even starker.

2 Wage earnings decomposition

Suppose that an individual works h weekly hours, of which h_s are standard hours remunerated at the hourly standard wage, w. If $h > h_s$ then $(h - h_s)$ defines weekly overtime. Overtime hours are remunerated at a premium, k (where $k > 1$) so that the hourly overtime rate of pay is kw. If $h = h_s$ then the worker is employed for maximum standard hours, or for short-time hours, and all hours are compensated at w. Expressing an individual's average hourly earnings, e, as a geometric average, we have

$$e = w^{\theta}(kw)^{(1-\theta)} \qquad (1)$$

where $\theta = h_s/h$. Taking logs and re-arranging gives

$$\ln e = \ln w + (1-\theta)\ln k \ . \qquad (2)$$

Earnings decompose into the standard wage rate, the proportion of weekly hours devoted to overtime and the overtime premium. If no overtime is undertaken, so that $\theta = 1$, e and w are the same.[3]

The restriction is imposed that a constant overtime premium applies to all workers in the industry. In fact, in our data, ln k = ln (1.5) = 0.405 held for a high proportion of overtime hours throughout the industry for all occupations and through all time periods. Then, differentiating (2) with respect to time, we obtain

$$\frac{1}{e}\frac{de}{dt} = \frac{1}{w}\frac{dw}{dt} - (0.405)\frac{d\theta}{dt} \ . \qquad (3)$$

So, proportional rates of changes in wage earnings and the standard wage are the same if the ratio of standard to total hours is constant through time. In general, however, changes in both w and θ influence changes in e. In fact, *wage earnings can rise even if both the standard wage rate and the overtime premium remain constant*. Such a

[3] Suppose that expression (1) represents averages of wages payments and hours over a homogeneous group of workers in a firm or local labour market. How does the geometric mean hourly earnings, e, compare with the more commonly adopted arithmetic mean of hourly earnings? The latter may be expressed as $e^* = w\theta + wk(1 - \theta)$. We have $e = e^*$ when $\theta = 1$ and $\theta = 0$, otherwise $e < e^*$. The latter result is a general property pertaining to the relationship between geometric and arithmetic means (see, for example, Stuart and Ord, 1994, p.45). For the data in this paper, simulations show that inter-war and post-war estimates of e and e* - for respresentative values of $\theta = 0.8$ and $\theta = 0.9$ and using each year's national average earnings for each category of wage earner - are within 3 pence of one another.

rise can occur because a higher proportion of total working time per week consists of (more expensive) overtime hours.

Figure 1 shows industry-level changes through time in θ for the pre- and post-war periods.[4] Pre-war overtime fluctuations were considerably greater than those in the immediate post-war. In the former period, θ ranges from $0.93 \leq \theta \leq 1$ for fitters and $0.90 \leq \theta \leq 1$ for labourers. The value of $\theta = 1$ for both occupations in 1931 and 1932 represents the fact that, on average, short-time hours were worked in the industry.[5] In the post-war period, values of θ were in the narrower bands of $0.88 \leq \theta \leq 0.92$ for fitters and $0.84 \leq \theta \leq 0.88$ for labourers. These differences are unsurprising when set against the background of the unemployment experience in the two periods (see Table 1).

Figure 1 here

It is important to note, however, that annual cross sectional average weekly hours' variations were large in both periods. Details are shown in Table 1. In the case of fitters, the coefficient of variation averaged about 6 between 1929-1931 and then averaged about 4.4 between 1932 and 1938. This latter average corresponded almost exactly with that for the period from 1954 to 1966. In the case of labourers, hours' variation narrowed somewhat in the later period. As for standard hourly wages, Table

[4] More detailed statistics on local labour market movements in standard and overtime hours can be found in Hart and MacKay (1975) and Hart (2001).

[5] In fact, at this time, the gap between maximum weekly standard hours and actual standard hours was in excess of 3 hours for about one-third of local labour markets, mainly in the North of England and in Scotland. In several other markets, particularly in the relatively prosperous South of England, average overtime was positive even in the depth of the Depression.

1 reveals a slight increase in inter-district variations for fitters in the post-war period contrasting with small reductions for labourers.

Table 1 here

Wage rates and hours of overtime per worker are both related to the rate of unemployment. From the original contributions of Phillips (1958) and Lipsey (1960) onwards, many theoretical and empirical contributions have established a negative association between the rate of change of w and the rate of unemployment. In more recent times, theoretical developments of the wage curve have advanced a negative link between the *level* of wages and unemployment (Blanchflower and Oswald, 1994a). For example, it is shown that regional-level wage curves derive straightforwardly from the Shapiro and Stiglitz (1984) efficiency wage model. In order to prevent shirking, the firm pays a wage rate that is higher than the value of local unemployment. In regions of relatively high unemployment, the penalty for being caught shirking is also high because the probability of finding alternative employment is relatively low. Hence, the firm can meet its no-shirking constraint at a lower wage rate, *ceteris paribus*. The negative wage curve derives from the fact that firms in relatively low unemployment regions need to pay higher efficiency wages than their counterparts in high unemployment regions.

But what if wage earnings replace the wage rate so that the formulation in (1) represents the remuneration measure in the wage curve? In addition to the wage rate, the hours' dimension of earnings would also be expected to relate negatively to regional unemployment rates.[6] Suppose that quits are postulated to depend, in part,

[6] More formal developments of the arguments in this paragraph can be found in Hart (2001), as well as strong empirical evidence of a negatively sloped regional hours' curve in the inter-war period.

on the probability of finding alternative employment which, in turn, is inversely related to the rate of unemployment. The quit rate is positively related to the firm's fixed labour costs, such as resulting from hiring and training. A fall in unemployment is associated with increased quits and, therefore, rises in fixed employment costs. A cost minimising firm will offset the latter by substituting longer hours of existing workers for fewer workers since hours are independent of fixed costs. Hence, hours relate negatively to the rate of unemployment. Moreover, longer working hours will increase average hourly earnings if this implies that, on average, employees work higher ratios of overtime to total weekly hours.

3 Wage specifications

The EEF provide group-level data by geographical district from which it is possible to obtain average hourly standard wages and average hourly wage earnings. The four work groups are timeworking fitters, pieceworking fitters, timeworking labourers and pieceworking labourers. In the post-war period the two wage measures are provided by EEF, derived directly from district-level payrolls. For the inter-war period, an intermediate calculation is necessary.

How do we estimate average hourly earnings and standard wages in the inter-war period? First, maximum weekly standard hours were fixed throughout the industry by national agreement; they were set at 47 hours in all EEF federated firms between the wars. Second, the overtime premium, k, was fixed throughout the industry, with an overwhelmingly dominant rate of $k = 1.5$.[7] EEF data allow us to calculate average

[7] While fixed rates applied throughout the industry, there was some variation around $k = 1.5$. Workers were paid $k = 2$ for Sunday working. Up to 1931, $k = 1.5$ was paid for all other overtime hours. From 1931 to 1946, $k = 1.25$ applied to the first two weekly hours of overtime, thereafter $k = 1.5$.

weekly earnings E and average weekly hours h, and so average hourly earnings are e = E/h. The average standard hourly wage rate, w, can be calculated by the simple formulas[8]

$$w = e = \frac{E}{h} \qquad \text{if } h \le 47$$
$$w = \frac{E}{47 + (h - 47)1.5} \quad \text{if } h > 47\,. \tag{4}$$

The empirical approach is to estimate wage curves and Phillips curves using w and then to compare results when e (=E/h) replaces w.

For reference purposes, consider the following representation of the wage curve as related to the EEF data. For group i, in district r at time t we have

$$\ln w_{irt} = \alpha \ln u_{rt} + g_i + d_r + f_t + \nu_{irt} \tag{5}$$

where w is the average wage, u is the unemployment rate and ν is an error term and where $g_{i,}$ d_r and f_t are dummies for (respectively) worker groups, EEF districts and time periods.

Two related wage formulations are now considered. The first follows construction of Blanchflower and Oswald (1994b) and consists of augmenting (5) by adding the lagged dependent variable. Thus, we have

[8] Hart (2001) provides evidence in support of the fact that the formulas provide accurate estimates of standard hourly wages.

$$\ln w_{irt} = \alpha \ln u_{rt} + \beta \ln w_{irt-1} + g_i + d_r + f_t + \nu_{irt} \qquad (6)$$

Suppose that it is found that the parameter α is significantly negative. Then, Blanchflower and Oswald argue that a finding of $\beta = 0$ is supportive of a wage curve specification while $\beta = 1$ supports the Phillips curve.

Card (1995) and Card and Hyslop (1996) suggest an alternative specification that also provides a test of wage curve versus Phillips curve. First-differencing equation (5) eliminates group and district fixed effects, producing

$$\Delta \ln w_{irt} = \beta_1 \mathrm{lnu}_{rt} + \beta_2 \mathrm{lnu}_{rt-1} + h_t + \Delta \nu_{irt} \qquad (7)$$

If in (7) β_1 is found to be significant and β_2 insignificant then this provides empirical support for the Phillips curve. Alternatively, if estimates of β_1 and β_2 reveal equal sized parameters with opposite signs then the wage curve is supported. This is the preferred equation here. Apart from the in-built test of appropriate specification, equation (7) also has the marked advantage over (6) of removing the problems associated with incorporating a lagged dependent variable in panel estimation (Hsiao, 1986; Baltagi, 1995).

Note that in (6) and (7) the wage rate is defined over i (i = 1,..,4) work groups while in each year the unemployment rate is the same for each group (i.e. there is no 'i' subscript for u). It may be the case that groups in the same district are affected by a common set of unobserved district-level variables. If this is the case, ordinary least squares (OLS) coefficient estimates are unbiased but inefficient while standard errors are generally downwardly biased (Moulton, 1990). To counter this problem, use is made of the cluster option in STATA (Version 7), applied to the 28 districts. This relaxes the inter-group independence assumption and requires only that observations across clusters are independent. In most cases, this application produces small increases in standard errors on unemployment rates. As a further precaution, wage equations for individual work groups estimates were also undertaken. Group-level post-war estimates to equation (7) are shown in the Results Appendix.

4 Results

Average earnings and wage data in most EEF districts included in this study are derived from large samples of workers. As shown in Table A2 of the Data Appendix, the average district-level number of workers by occupation and payments method varied from 300 to 1250 in the inter-war period from 560 to 1920 in the post-war period. However, several districts are extremely small, with wage averages based on sample sizes of under-20 workers. Inevitably, these cases displayed several outlying estimates of average remuneration. The problem was most acute in the inter-war period and, especially, in the trough years of the Great Depression. Two estimation strategies were considered: (a) adopt weighted least squares (WLS) on all districts for which data are available or (b) confine the analysis to districts with cells based on sample sizes of at least 40 workers[9] in each and every time period and apply ordinary least squares (OLS). The analysis and discussion in Deaton (1997) tips the balance in

[9] This is slightly arbitrary. In the inter-war period, there are several cases of districts averaging between 20 and 50 workers, but with several years of critically low numbers. This choice eliminates these cases and ensures reasonable-sized minimum sample sizes. Problems of low numbers per cell are not nearly so prevalent in the post-war years. For consistency, the 'at-least-40' rule is applied to the post-war period, but in fact the post-war results are little affected if no restriction is imposed. Post-war results using the full data set (i.e. irrespective of sample sizes) are shown in the Results Appendix.

favour of option (b), the use of OLS.[10] The district work groups excluded by the choice of cell size under (b) are shown in Table A3 of the Results Appendix. It is shown that (i) there are far more district exclusions in the inter-war period and (ii) piece-rate fitters are the most affected group.

Table 2 here

Inter-war results to equations (6) and (7) are shown in Table 2. Columns (i) and (ii) contain, respectively, the wage rate and earnings rate regressions equivalent to equation (7). The wage rate results in column (i) are weak and offer no support for either a wage curve or a Phillips curve formulation. When earnings replace wage rates in column (ii), the results apparently give support to a wage curve specification. In fact, in terms of equation (3), the estimates owe far more to the relationship between θ and unemployment than between w and unemployment.

Results to the wage curve specification in equation (6) are presented in columns (iii) and (iv) in Table 2. The group intercepts (g_i in equation (6)) are captured by a dummy variable that takes is unity if the cells refer to piece-rate workers (zero if time-rate) and a dummy that is unity if the cells refer to skilled fitters (zero if labourers). The estimates indicate that pieceworkers earned higher wage rates than timeworkers, and skilled fitters earned higher wages than unskilled labourers. While acknowledging that extreme caution should be exercised over interpretation, the lagged wage coefficients suggest a slow wage adjustment speed. These latter results are in line

[10] In the earlier literature, for example, Blanchflower and Oswald (1994b) adopt OLS while Blanchard and Katz (1997) use WLS. On the assumption that the districts, or local labour markets, are homogeneous, Deaton shows that OLS is more efficient than WLS. If the markets are heterogeneous, there are econometric arguments for and against preference for one type of estimator over the other. WLS results for the inter-war period and based on the full samples are presented in Hart (2001). Question marks over econometric methodology apart, they serve to reinforce the differences between wage curves and earnings curves observed in the OLS estimates.

with the US findings of Blanchard and Katz (1997), although these authors find an even more sluggish wage adjustment process. They are at odds with the British findings of Blanchflower and Oswald (1994b) who do not obtain significant autoregression in their equivalent regional wage equations. The w-u and e-u elasticities are reasonably comparable with the respective column (i) and (ii) outcomes.

During the inter-war period in Britain, neither the Phillips curve nor the wage curve specifications are supported by our data. Almost certainly, these engineering industry-based results reflect wider national observations. In fact, close inspections of the original papers by Phillips (1958) and Lipsey (1960) show that the Phillips curve completely broke down over this period. This fundamental problem[11] was not brought to the foreground because the inter-war period was subsumed within much longer-term time series analyses by these authors. If average hourly earnings replace the standard wage then apparently stronger evidence for a wage curve emerges. But this derives from the fact that hours, not wages, accounted for the bulk of the action.[12]

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[11] 'Fundamental' because Phillips and Lipsey (and, subsequently, many others) argued that wage changes would be expected to relate to the state of (excess) demand for labour services. In fact, if this were true then the extremely pronounced unemployment cycle in the 1920s and 1930s should have been expected to produce strong supporting evidence. In fact, Lipsey observed that between 1922 and the Second World War "…times of falling unemployment were associated with lower [rates of change of wages] than times of rising unemployment". Hart (1983) provides an analysis of the breakdown of the Phillips curve that accommodates a wage and hours dimension to the problem.

[12] Interestingly, this latter observation is not confined to the British economy. In a study based on eight manufacturing industries, Bernanke and Powell (1986) found that US real wages were countercyclical between the wars. They also found that variations in hours contributed almost as much to the variation of total labour input as employment stock. See also Bernanke (1986) on the importance of US hours' adjustment in the inter-war period.

Is this difficulty over the interpretation of earnings-unemployment interaction merely the result of an unusual period of hours' volatility, especially in the late 1920s/early 1930s? From price change and unemployment perspectives, the 1950s and 1960s marked a more tranquil scene so that firms would not need to alter radically their labour inputs in the face of large and unexpected shocks. However, the influence of overtime is, if anything, more important in the latter period.

Post-war results to equations (6) and (7) are shown in Table 3 for the period 1954 to 1966. Results to equation (7) provide a clear reinforcement of the inter-war findings. A wage-curve formulation is accepted statistically only if wage earnings are used as the remuneration measure. In fact, the estimated e-u elasticities are three times larger than their w-u equivalents. Moreover, as shown in the Appendix Table A1, these relative findings hold for three of the individual worker groups. In the case of fitters working piece rates, there is support for a wage curve in this period. The equation (6) specification in Table 2 turns out to be very similar to the inter-war in respect of the payment and skill dummies, lagged adjustment and unemployment estimated coefficients.

Table 3 here

Why are the wage earnings effects even stronger in the less volatile 1950s and 1960s? One reason is that while inter-temporal changes in hours were less marked in the second period, inter-regional differences remained relatively quite large (see Table 1). A more important explanation is that many districts at the height of the Great Depression (i.e. during the years 1930-32) experienced short time working (see Hart,

2001) and so the overtime influence on wage earnings was far less significant during this time.

Apart from the paper by Black and FitzRoy (2000), it is hard to ascertain the extent to which these findings apply to other data sets. The reason for this is that very few researchers appear to have worried about the need to remove the influence of overtime working from the measure of the wage. A notable exception on the Phillips curve front is the US study of Taylor (1970) in which care is taken to incorporate standard wages. Two major factors make comparisons difficult between the results of that study and the present work. First, unlike here, Taylor attempts to account for the role of labour utilisation in the measurement of unemployment. Second, the local labour market dimension of the problem is not included in the earlier study.

As for the wage curve, Bellmann and Blien (2001) attempt to account for the role of overtime in their German establishment-level study. Using the first three waves of the IAB Establishment Panel, their measure of the average wage is the "computed sum of gross wages divided by the number of employees". In their wage curve regressions, they incorporate an overtime dummy to account for paid overtime. The dummy is significantly positive but appears to have no effect on their estimated wage-unemployment elasticities. These turn out to be in the region of -0.10, in line with Blanchflower and Oswald's findings and considerably higher than those obtained here. It is simply hard to judge the degree to which the dummy adequately captures the influence of overtime within earnings. For example, it is unclear how these authors deal with establishments in which a proportion (less than one) of the workforce works overtime. The incorporation of a dummy is not equivalent to obtaining direct measures of standard hourly wage rates. It should be added, however, that when these authors omit establishments that reported overtime working, they again found little effect on the estimated wage-unemployment elasticities. There is a compositional problem in studies that incorporate wages that are aggregate over a number of occupations. If different occupations within the same establishment (or region) are paid at different hourly standard rates *and work different numbers of weekly paid-for hours* then, as with overtime, relative time-wise movements and cross-sectional differences in hours across occupations could systematically affect the earnings measure. The use of individual or homogeneous occupational group data has clear advantages in this respect.

4 Conclusions

The Phillips curve still plays a prominent role in macroeconomic theory and associated empirical work. The wage curve has received more recent support as an alternative wage-unemployment specification. Many papers in the existing literature fail to document clearly how hourly wage rates are compiled. It is fairly safe to infer that most authors do not attempt to incorporate rates of pay that are independent of the influence of overtime working. This paper demonstrates that the dependent variable in Phillips curve and wage curve studies should be based on standard hourly wage rates. Using average hourly earnings can lead to seriously misleading outcomes.

The highlighted wage measurement problem may be particularly severe in the industry and occupations that make up the data set. Overtime working among fitters and labourers in engineering generally constituted an important part of the workweek. It would be interesting to discover the extent to which the problem pertains to other occupations in other industries. More generally, to the extent that a problem exists, it is certainly not confined to the estimation of Phillips curves and wage curves. It is a worthwhile exercise to check the implications of differentiating between hourly standard wages and hourly wage earnings in other types of wage models.

Results Appendix

Based on the preferred equation (7), Table A1 shows (a) aggregate post-war results based on the full sample of EEF districts (i.e. including cells with sample sizes less than 40 workers) and (b) the regressions by individual work group. The former reveal very similar outcomes to the results in Table 2 in the main text where the smallest sample-sized districts are excluded. The latter provide a direct means of tackling the aggregation problem highlighted by Moulton (1990). For one group - fitters working piece rates - the w-u and e-u coefficients are reasonably close and a wage curve is supported. Generally, however, the aggregate and individual group results are consistent. Moreover, the group-level results are little altered if district cell sizes of under 40 workers are excluded, as in Table 2.

Table A1 here

Data Appendix

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 Knowles and Hill, 1954, Appendix A, and Marsh, 1965, Appendix B). The average sample sizes of workers within each cell over the 28 EEF districts and their standard deviations are shown in Table A2.

Table A2 here

With less disaggregation than incorporated here, these data were originally described in Hart and MacKay (1975) and a detailed breakdown of districts 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, 1932-7, and 1965-66, March for 1929-31 and 1958, June for 1959-64, July for 1958, September for 1954-6. 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.

In the regressions in Tables 2 and 3, work groups with one or more critically low sample sizes were excluded. These exclusions are indicated in Table A3. Note that 10 districts had sample sizes in excess of 40 in all cases.

Table A3 here

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Figures and Tables

Figure 1 Pre- and post-war movements in θ

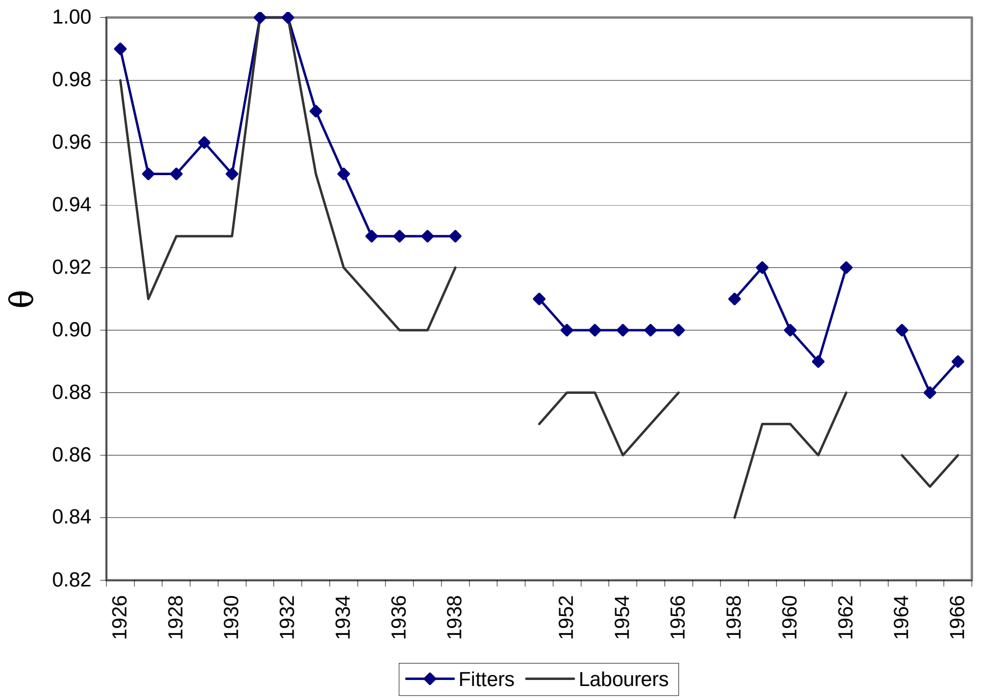

Table 1 Annual cross-sectional variations in hours and standard wages, British engineering 1926 - 1938 and 1951-1966

Year	Weekly Hours[1]		Standard Hourly Wages [1]		Mean Weighted Unemployment Rate[2]
Pre-war	**Fitters**	**Labourers**	**Fitters**	**Labourers**	
1926	5.82	6.92	13.56	13.79	13.6
1927	8.11	7.33	14.22	10.28	10.0
1928	7.82	8.24	12.19	9.28	12.0
1929	5.77	5.40	13.31	8.76	11.7
1930	5.95	6.03	13.80	9.61	14.9
1931	6.04	6.18	12.57	9.21	22.7
1932	5.04	7.04	10.75	8.29	25.3
1933	4.03	4.98	10.95	8.35	22.1
1934	4.59	3.80	13.02	9.66	18.8
1935	4.46	4.98	12.79	10.28	17.1
1936	4.58	4.66	12.51	10.25	13.7
1937	4.00	5.27	13.92	9.39	11.5
1938	4.18	4.97	13.54	7.85	12.9
Post-war					
1951	4.62	3.09	13.86	6.95	1.1
1952	4.01	3.02	13.91	7.31	1.7
1953	4.23	3.71	14.62	6.60	1.6
1954	3.77	2.42	14.28	6.56	1.2
1955	4.80	2.86	14.45	6.46	1.0
1956	4.06	6.01	13.41	10.39	1.3
1958	3.94	2.98	14.67	6.68	1.9
1959	4.08	2.68	16.82	7.29	2.3
1960	3.78	3.29	17.37	8.62	1.8
1961	4.19	2.95	16.29	8.38	1.7
1962	2.98	2.38	16.38	8.47	2.3
1964	4.12	5.22	16.57	13.96	1.9
1965	5.41	2.31	15.74	8.23	1.5
1966	7.13	2.57	15.97	7.83	2.1

Notes:

1. Statistics for hours and wages are coefficients of variation (× 100) weighted by the number of employees in each occupation recorded in the EEF returns.

2. Mean unemployment rates are calculated with respect to the 28 districts and weighted by the size of the insured labour force in each district (source Hart and MacKay, 1975).

Table 2 Inter-war hourly wage/earnings - unemployment relationships, British engineering 1926 - 1938 (OLS)

	Equation (7) estimates		Equation (6) estimates	
Independent Variables*	**Δln w_t** (i)	**Δln e_t** (ii)	**ln w_t** (iii)	**Ln e_t** (iv)
Unemployment (ln u_t)	-0.010 (0.008)	-0.018 (0.007)	-0.014 (0.006)	-0.021 (0.005)
Lagged unemployment (ln u_{t-1})	0.008 (0.008)	0.017 (0.007)	0.003 (0.011)	0.014 (0.009)
Lagged wage (ln w_{t-1} or ln e_{t-1})	-	-	0.659 (0.041)	0.661 (0.041)
Piecework dummy	-	-	0.047 (0.009)	0.043 (0.008)
Skilled fitter dummy	-	-	0.116 (0.015)	0.115 (0.015)
Labour market and time dummies	-	-	Yes	Yes
Time dummies	Yes	Yes	-	-

Notes: No. of observations = **912**.

Figures in parenthesis are robust standard errors incorporating STATA's cluster option on the district-id. Hourly wages (w) exclude overtime and hourly earnings (e) include overtime.

Table 3 Post-war hourly wage/earnings - unemployment relationships, British engineering 1954-1966* (OLS)

	Equation (7) estimates		Equation (6) estimates	
Independent Variables**	**Δln w_t** (i)	**Δln e_t** (ii)	**ln w_t** (iii)	**ln e_t** (iv)
Unemployment (ln u_t)	-0.007 (0.006)	-0.021 (0.007)	-0.016 (0.007)	-0.024 (0.007)
Lagged unemployment (ln u_{t-1})	0.007 (0.006)	0.023 (0.006)	-0.002 (0.007)	0.016 (0.006)
Lagged wage (ln w_{t-1} or ln e_{t-1})	-	-	0.679 (0.039)	0.706 (0.040)
Piecework dummy	-	-	0.039 (0.005)	0.031 (0.005)
Skilled fitter dummy	-	-	0.108 (0.012)	0.095 (0.011)
Labour market and time dummies	-	-	Yes	Yes
Time dummies	Yes	Yes	-	-

Notes: No. of observations = **672**.

Figures in parenthesis are robust standard errors incorporating STATA's cluster option on the district-id. Hourly wages (w) exclude overtime and hourly earnings (e) include overtime.
* There are no data for 1957 and 1963. Combined with the use of lagged variables, this meant that estimation was conducted for eight years: 1955, 1956, 1959, 1960, 1961, 1962, 1965 and 1966.
** Includes one dummy to account for an extreme outlying unemployment observation for Coventry in 1966. Due to exceptional structural and industrial relations problems in the automotive and aircraft industries, this city experienced a four-fold increase in unemployment - much of which was temporary unemployment - in this year compared to the previous year (4.1% compared to 1%).

Table A1 Post-war results to equation (7) by individual work groups (using all cell sizes), British engineering 1954-1966 *

	All work groups**		**Fitters (time rates)**		**Fitters (piece rates)**		**Labourers (time rates)**		**Labourers (piece rates)**	
	$\Delta\ln w_t$	$\Delta\ln e_t$	$\Delta\ln w_t$	$\Delta\ln e_t$	$\Delta\ln w_t$	$\Delta\ln e_t$	$\Delta\ln w_t$	$\Delta\ln e_t$	$\Delta\ln w_t$	$\Delta\ln e_t$
Unemployment (ln u)	-0.010 (0.007)	-0.023 (0.007)	-0.013 (0.014)	-0.028 (0.13)	-0.022 (0.013)	-0.028 (0.014)	0.0004 (0.009)	-0.022 (0.012)	-0.003 (0.020)	-0.015 (0.018)
Lagged unemployment (ln u_{t-1})	0.011 (0.007)	0.027 (0.006)	0.014 (0.012)	0.029 (0.011)	0.022 (0.013)	0.031 (0.014)	0.001 (0.009	0.022 (0.012)	0.005 (0.016)	0.022 (0.015)
	792	792	208	208	192	192	208	208	184	184

Notes: * In these results, cells with less than 40 workers are included. Where cells have no information provided, the whole work group is excluded for that particular district and for all years. This accounts for the differences in sample sizes across groups.

** See Notes to Table 2.

Table A2 Mean (standard deviation) numbers of workers in 28 EEF districts

	Fitters on time rates of pay	Fitters on piece rates of pay	Labourers on time rates of pay	Labourers on piece rates of pay
1926 - 1938	563.7 (80.2)	859.9 (177.9)	1249.1 (304.3)	305.8 (70.2)
1954 - 1966	999.4 (161.9)	1893.2 (213.1)	1914.5 (280.8)	566.7 (127.3)

Table A3 Excluded work groups in Tables 2 and 3

Inter-war

	Fitters		Labourers	
	Time	Piece	Time	Piece
Aberdeen	-	X	-	x
Barrow	x	-	-	-
Bedfordshire	x	-	-	x
Blackburn	-	-	-	x
Burnley	-	X	-	x
Burton	x	X	x	x
Derby	x	-	-	-
Dundee	-	X	-	x
Halifax	-	-	-	x
Hull	-	X	-	x
Lincoln	-	-	-	x
Liverpool	-	X	-	x
North Staffs	x	X	-	x
Nottingham	-	X	-	x
Oldham	-	-	-	x
Rochdale	-	-	-	x
St. Helens	x	-	x	x
Wigan	x	X	-	x

Post-war

	Fitters		Labourers	
	Time	Piece	Time	Piece
Aberdeen	-	-	-	x
Barrow	x	-	-	x
Bedfordshire	-	-	-	x
Burnley	x	-	-	x
Burton	x	-	-	x
Coventry	-	-	-	x
Dundee	-	-	-	x
Halifax	-	-	-	x
Hull	-	-	-	x
North Staffs	-	X	-	x
Oldham	-	-	-	x
Rochdale	-	-	-	x
St. Helens	x	X	x	x
Wigan	-	X	-	x

Notes: X denotes an excluded work group due to one or more cells with sample sizes less than 40 workers