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IZA DP No. 17959

The Rises and Falls of Piecework-Timework Pay Differentials. UK Engineering and Metal Working Industries, 1926-1965.

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ISSN: 2365-9793

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ABSTRACT

The Rises and Falls of Piecework-Timework Pay Differentials. UK Engineering and Metal Working Industries, 1926-1965.

Based on payroll data of blue-collar male workers in the UK's engineering and metal working industries between the mid-1920s and mid-1960s, this paper investigates piecework-timework pay differentials through time. The period covers several pre-Depression years, the Great Depression, the run up to WW2, the war itself, and the post war period. A major widening of the differentials occurred during the late 1920s and during the run-up to and the expansion of WW2 activities. In contrast, the Depression and the post-war years witnessed considerable narrowing of the differentials. Associated labour market topics include pieceworkers' compensating pay differentials and the transaction costs of pricing piecework output. The surge in women's employment in engineering and metal working in the early war years is shown to have contributed to changes in the male differentials.

JEL Classification: J31, J33, N64

Keywords: piecework, timework pay differentials, output fluctuations, piecework pricing

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INRODUCTION

From the late Nineteenth Century to the 1970s incentive pay in the form of piece-rates comprised an essential part of core manufacturing production in Europe and North America (Pencavel, 1977; Helper, Kleiner and Wang, 2010). This paper studies UK engineering and metal work industries between the 1920s and 1960s. Analysis is based on member firms of the Engineering Employers' Federation (EEF). The main focus concerns reasons for rises and falls of piecework-timework differentials among adult male blue-collar workers. Over our time frame, two-thirds of skilled and semi-skilled blue-collar workers in the EEF were paid piece rates. There are four important sub-periods – the Great Depression, the pre-war rearmament period, WWII, and the post-war industrial reconstruction. During this time span economic forces acted significantly to raise or to depress piece rates relative to time rates. A useful theoretical analysis of the core influences on piecework is provided by Lazear (1986).

Piecework-timework differentials peaked in the early years of WWII for two primary reasons. First, piece rates and other output-related bonuses were used by employers to incentivise productive war effort. Second, piece work rewarded ability and work application thereby helping firms to retain their best workers in an intensely competitive wartime labour market for skilled labour. On either side of the war years, there were two distinctly different periods during which the differentials narrowed. First, piece rates were cyclically more responsive than time rates to the Great Depression downturn due to their association with productive effort. Lower output demand penalised pieceworkers more than timeworkers. Second, in the post-war decades employers systematically reduced the differentials as piece rates began to lose their comparative payments-by-results advantages. One main cause of this trend centred

of the increasing costs of determining and negotiating piecework prices given new and expanding post-war output demands. While our EEF data extends to 1965, we report on the fact that piecework in our industries had virtually disappeared by the start of this Century.

The EEF annual payroll statistics, collected in October of each year, offer an unrivalled insight over a considerable time period into the pay and hours of pieceworkers and timeworkers in blue-collar occupations as well as differentiating between geographical locations and engineering sections. The EEF data cover Sections V to IX of the 1948 Standard Industrial Classification. The complete EEF employment, wages and hours statistics are available in the UK Data Archive (Hart and Roberts, 2006). During the study period from 1926 to 1965, the EEF represented between 1800 and 5000 engineering and metal working firms employing between 260 thousand and 1,120 thousand adult male manual workers and between 378 thousand and 1500 thousand junior males and females (Wigham, 1973, Appendix J). The data include a unique coverage of skilled and semi-skilled female blue- collar labour employed during the early war years.

Section I contains brief background details of engineering pay strucures of pieceworkers and timeworkers together with labour market cycles over the study period. For industry occupations and sections, estimated piecework-timework hourly pay differentials are estimated in Section II covering the complete time-period of the data. Section III concentrates on the volatile economic time period 1926 to 1939, with an investigation into evidence of compensating pay differentials in respect of workers on piece rates. Section IV studies the wartime effects on male pay differentials of, firstly, women's promotion to skilled work during the early war years and, secondly, the effects of semi-skilled women's demand for higher pay in the early war years.

The major post-war decline in the male piecework-timework differentials, which has continued to present times, is examined in Section V. Section VI concludes.

I. PAY STRUCTURES, AND LABOUR MARKET CYCLES

Table 1 here

Table 1 provides details of the EEF occupations, districts and sections covered here. The data consist of cell means that differentiate between employees depending on whether they are paid piece rates or time rates as well as by their occupation and their geographical work districts (largely travel-to-work areas). For a slightly shorter sub-period, 1930 to 1965, wages and working hours by occupation within engineering sections are provided. Section level data are not available by district. A unique aspect of the statistics is that for the years 1940-1942 we can separate female blue-collar workers into their official EEF categories of 'women doing men's work' (skilled workers) and 'women doing women's work' (largely semi-skilled workers). The considerable expansion of female blue-collar females in the early war years features in their associated effects on male piecework-timework differentials.

Figure 1 here

There were two main types of blue-collar remuneration, piece-rates and time-rates. Figure 1 shows that between 1926 and 1965 the percentage of pieceworkers in the EEF's total adult workforce (over the age of 21) remained above 55%, with a weighted average of 66%. It also indicates the start of the post-war decline of piece work.

A typical timeworker's basic pay consisted of an hourly rate combined with a National Bonus. Beyond this, total earnings included an overtime pay component and various supplementary payments. Supplementary payments became an increasingly important part of

pay during the war and in the post-war years. As a means of simplification, fitters and labourers basic time rates were agreed nationally and formed EEF guidelines for pay relativities among other occupations. Engineering firms, sections, and districts were free to deviate from these occupational guidelines. Pieceworkers' hourly pay also included a fixed element; they were guaranteed the equivalent of a timeworker's basic hourly rate and they were paid a slightly lower National Bonus. In contrast to time work, a pieceworker's remuneration importantly depended on productive effort per unit of time via agreed piece rates and time settings. Additionally, pieceworkers were also paid overtime premium rates and special supplementary payments.

Piece rates were determined in respect of a vast number of different products and processes. The EEF attempted to simplify matters through national agreements that established minimum percentage basic wage mark-ups above equivalent time rates that a pieceworker of average ability might be expected to attain. These were set at one-third of the appropriate basic time rate up to June 1931 and one-quarter of this rate thereafter. Firms, sections, and districts were not bound to these agreed targets.

Figure 2 here

The market demand for UK manufacturing products was especially volatile between 1926 and 1943. This contrasted with a 20-year immediate post-war period of relative stability, with steady growth in engineering and allied production. In Figure 2, differences in market conditions are shown in terms of unemployment rates. The national unemployment rate is calculated as the numbers unemployed as a percentage of the civilian working population (Feinstein, 1972, Table 57). The mean district unemployment rates, extracted from the Local Unemployment Index, cover all unemployed workers in the major EEF engineering districts, not

just engineering workers (see Table 1). The peaks of unemployment occur in the early 1930s. They declined during the military build-up in the mid- to late 1930s and then plummeted virtually to zero during the war and only once exceeded 2% up to 1965. The fact that the Great Depression especially damaged manufacturing employment is illustrated in Figure 2. In the EEF districts, where the main engineering and related activity took place, 1930s unemployment rates were considerably higher than national unemployment rates. By contrast, in the post-war period, the EEF district rates and national rates virtually coincided.

II. MALE PIECEWORK-TIMEWORK HOURLY PAY DIFFERENTIALS, 1926-1965

This section investigates hourly pay differentials between male pieceworkers and timeworkers over the period 1926 to 1965. Table 1 shows the EEF's blue collar occupations and their member firms' district locations. (There are no statistics for district-level data in 1943-1947, 1949, 1950, 1957, and 1963; for section-level data we have no data for 1926-1929, 1943-47, 1949/50, 1957, 1963 and 1965.)

For occupation *j* in district *d* at time *t*, we have

$$(1)\quad lnEP_{jdt} - lnET_{jdt} \equiv lnRE_{jdt} = Z_{jdt}\theta + e_{jdt}$$

where *lnEP* denotes the log of the hourly earnings of pieceworkers and *lnET* the log of the hourly earnings of timeworkers while *lnRE* expresses the log of the ratio of piecework and timework hourly earnings. Additionally, *Z* contains a set of controls consisting of occupation, district and time dummies.

We are also able to estimate the pay differentials in respect of engineering sections as opposed to districts (see Table 1 for the list of sections). EEF section data cover the period 1930-1965. Letting section be denoted by *s*, we have

$$(2)\ lnRE_{jst} = Z_{jst}\emptyset + e_{jst}$$

where the *Z* contains occupation, section, and time dummies.

Figures 3 and 4 here

Our district-based estimates of the percentage piecework-timework differentials are reported on the left column of Figure 3 and based on the estimated time dummies in (1) and (2). They are plotted against the national unemployment rate. Reported estimates are weighted by the number of workers in each occupation/district/year cell. Equivalent section-based differentials in Figure 4 are weighted by occupation/section/year numbers of workers.

Concentrating on the Figure 3 district data, given similar patterns in the Figure 4 section data, the period from 1926 to 1942 contains two substantial changes. First, from a highpoint of a 21% piecework premium in 1926 the differentials plummeted to 13% in 1932. This covered the principal part of the Great Depression cycle. Second, the piecework premium rose to 19% in 1942, covering the 1935-1938 rearmament period and the frenetic 1940-1942 war period (the peak year was in 1943). The substantial rise in the premium was in part due to loose piece rates in wartime engineering given rapid fluctuations in war demand that precluded full assessments of appropriate relative prices (Knowles and Robertson, 1951a).

Over the somewhat less volatile post-war years between 1948 and 1965 the district and section post-war piecework premiums averaged, respectively, 11% and 7%. By 1965, they had

fallen to 8% and 5%. In general, these estimates are in the ballpark of those obtained in earlier postwar studies. Pencavel (1977) finds a piecework premium of 7% based on 183 male punch press pieceworkers and timeworkers in Chicago. Seiler (1984) obtains a 14% premium for U.S. footwear and boys' suits and coats manufacture covering 100 thousand workers in 500 firms. In a study of 3000 workers in the Safelight Glass Corporation, Lazear (2000) estimates that a move to piece rates improves a worker's pay by about 10%.

III. COMPENSATING PAY DIFFERENTIALS AND MARKET VOLATILITY, 1927 - 1939

In the short run pieceworkers' pay is more dependent on hourly productive effort than timeworkers' pay. One argument supporting positive piecework-timework wage differentials is that a premium is paid to pieceworkers partly as a compensating differential for greater expected pay instability. This may result, for example, from exogenous fluctuations in the state of market demand. Exceptional falls in demand as experienced in the Great Depression would be expected to result in reductions in the levels of work intensity for many pieceworkers and, hence, in greater percentage falls in their hourly pay. The basic pay of timeworkers, in contrast, is fixed in the short run. This does not include additions to basic pay such as overtime payments and merit award and so does not preclude elements of pro-cyclical earnings flexibility in timeworkers earnings. For this reason, we include both basic pay and total earnings in the analysis that follows.

Pay responses for the period 1926-1939, a time of high economic instability, are investigated using both national and district unemployment rates to represent the state of the business cycle. It is clear from Figure 3 that district unemployment rates during the Great

Depression were higher than the national rate and so it is informative to include both rates. Occupations are included together with the full set of districts (see Table 1).

Estimating equations incorporating national unemployment are given by

$$(3)\ \Delta lnRB_{jdt} = a_0 + a_1 \Delta U_t + a_2 Year_t + Z_{jdt}\psi_1 + \Delta e_{jdt}$$

$$(4)\ \Delta lnRE_{jdt} = b_0 + b_1 \Delta U_t + b_2 Year_t + Z_{jdt}\psi_2 + \Delta e_{jdt}$$

where annual changes in piecework-timework basic pay and earnings differentials are regressed on the change in the national unemployment rate (ΔU_t), an annual time trend ($Year_t$), and where Z contains occupation and district dummies. Estimates $\hat{a}_1$ and $\hat{b}_1$ are semi-elasticities and obtained after clustering at the year level. Reported estimates are weighted by the number of total pieceworkers and timeworkers in each occupation/district/year/cell, with changes in the differentials as dependent variable.

For a sub-set of important engineering districts (shown in Table 1) we have matching district unemployment rates for the period 1926-1938, constructed to match travel to work geographical areas. These cover over 80% of the workforce in the full district samples. So, this allows estimation of semi-elasticities controlling for local labour market experiences. These alternative estimating equations are given by

$$(5)\ \Delta lnRB_{jdt} = c_0 + d_1 \Delta U_{dt} + Z_{jdt}\psi_1 + \Delta e_{jdt}$$

$$(6)\ \Delta lnRE_{jdt} = c_0 + d_2 \Delta U_{dt} + Z_{jdt}\psi_2 + \Delta e_{jdt}$$

where ΔU_{dt} is the change in the district unemployment rate and where, as well as occupation and district dummies, Z additionally includes time dummies. Since there are observations on up to

13 separate occupations per district over the period 1926 to 1939 (see Table 1), estimates $\hat{d}_1$ and $\hat{d}_2$ are obtained after clustering at the district/year level. Reported estimates are weighted by the number of pieceworkers or timeworkers in each occupation/district/year cell, with respective changes in real pay incorporated as dependent variable. The regression weights are the same as in equations (3) and (4).

Table 2 here

Table 2 shows results in relation to 6 dependent variables. They consist of the logs of the piecework-timework ratios of basic pay and earnings as well as the separate logs of basic pay and earnings of pieceworkers (P) and timeworkers (T). There are two equations differentiated by national and district unemployment rates. Semi-elasticities in respect of ΔU_t and ΔU_{dt} are listed alongside each equation. As well as unemployment rates, a further difference separates the two equations. The national unemployment equation includes a time trend while the district unemployment equation, based on equations (5) and (6), includes time dummies.

Results in respect of national and district unemployment rates are reported in Table 2. All pay differentials vary pro-cyclically. Estimated semi-elasticities indicate that a one-point increase in the national (district) rate of unemployment is associated with a 0.5% (0.2%) narrowing of the hourly basic pay differential. Using hourly earnings, the respective reduction is 0.4% (0.2%).

We also estimate equations (3) to (6) replacing the piecework-timework pay differentials with separate hourly basic real pay of pieceworkers (*ΔlnBP)* and time workers *(ΔlnBT)*. Basic real hourly piecework pay in respect of both measures of unemployment is significantly pro-cyclical while equivalent timework pay reacts insignificantly. We repeat this exercise for real

earnings, ie. $\Delta lnEP$ and $\Delta lnET$. In respect of national unemployment $\Delta lnEP$ is strongly pro-cyclical while $\Delta lnET$ is insignificant. However, in the district unemployment equations both real earnings of pieceworkers and timeworkers are significantly pro-cyclical. Clearly, however, the pro-cyclical effect for pieceworkers is considerably stronger than that of timeworkers. An explanation of the time-work result is the need for cutbacks in overtime working and/or merit awards. Taken together the overall results are consistent with the compensating pay differentials explanation of pieceworkers' cyclical earnings (see also Hart and Roberts, 2013a and b).

IV. WOMEN'S INFLUENCES ON MALE PAY DIFFERENTIALS, 1940-1942

In this section we examine two wartime implications for male piecework-timework differentials. They concern (i) semi-skilled women's promotion to skilled work, referred to in the EEF as 'women doing men's work' and (ii) semi-skilled women who comprised the large majority of new wartime recruits, and who were referred to as 'women doing women's work'. In the case of newly promoted skilled women our interest concerns the issue of equal pay for equal work. For semi-skilled women it concerns the problem of low pay. Inman (page 353) notes that women's pay rates in 1939 'were so low as to be unattractive to potential entrants.

Table 3 here

We make use of EEF's data for the years 1940 to 1942, based on 15 important EEF sections shown in Table 3. The proportion of women doing men's work to all workers grew from 0.01 to 11.6 from 1940 to 1942. The proportion promoted from all women workers grew from 0.04 to 0.2 over the same period. They were especially strongly represented in the wartime sections of aircraft manufacture, heavy and light engineering, electrical engineering, and motor manufacturing. Over the same period, the proportion of all women to total workers grew considerably from 0.31 in 1940 to 0.59 in 1942.

In May 1940 the EEF and the Amalgamated Engineering Union, undertook a set of agreements that enabled selected women to undertake skilled job tasks that traditionally had been the sole preserve of men who had served 5-to-7-years in craft apprenticeships. Similar agreements were undertaken by other private and public sector organizations. Women could be selected to undertake skilled work providing no skilled men were available. It was also agreed that on completion of war service men would be guaranteed their former civilian jobs. Women recruited for skilled work in EEF industries were required to undertake a 32-week training program. On successful completion, both government and union supported the view that a woman should earn equal pay to the man she replaced. An important stipulation was that equal pay was conditional on work undertaken in the absence of additional supervision and/or assistance. The government and unions also supported semi-skilled women in their calls for better pay. So how might these two sets of women workers influence men's pay differentials? We deal with each category in turn.

Women doing men's work

What would be the effect of women replacing skilled men if equal pay was universally adhered to? Then, *ceteris paribus*, we would observe little impact of piecework-timework relative pay of skilled men. Among a number of objections to equal pay for equal work perhaps the main critical question was how a woman could replace a man's work given that her work experience and skill set were considerably narrower than the man she replaced? What if employers decided to redefine job specifications that involved skilled women undertaking simpler job methodologies with skilled men re-directed to more demanding tasks that required high-level know-how and that commanded higher-level piece rates? For example, employers might explain this in terms of recent skilled women recruits needing more assistance and/or

supervision, thereby not breaking the terms of the union equal-pay agreements. In this event, male piecework-timework differentials would increase given the advantages of higher piece rates. We test for these possible outcomes in the regression that follows

Women doing women's work

A potential for semi-skilled women to influence the male piecework-timework ratios stemmed from their growing collective 'voice' with the main objective of increasing the low pay-rates. While engineering unions supported women's pay claims, they did not permit a major erosion of the differentials in respect of lower paid males. In effect, successes by women in achieving pay increases could also benefit the pay of time-rated male workers. Inman (1957, pp. 353/4) reports on the minimum basic time rates of women doing women's work from October 1939 to August 1944 in relation to comparable male time-rated workers. In May 1940, the time-rate for a woman over 21 for a standard workweek was 61% of that for a male labourer's time rate - 35 shillings compared to 57 shillings. By August 1944, following three incremental increases in pay the women's rate had improved to 74% of the male rate. The male pay increased from 57 shillings to 75s.6d. The pressure by women to improve rates of pay may well have helped to benefit the higher time rates of their semi-skilled male colleagues, albeit with a tightening of the differentials.

For any given engineering section, let *PFM* denote the proportion of women doing men's work to all workers. Also at section level, let the proportion of females to all workers, *PF*, act as a proxy for women's voice in respect of higher pay demands. Regressions are reported in Table 4 based on the EEF's Table 3 data. Our section-level regression specification for adult males for occupation *j* in section *s* at time *t* for the period 1940 to 1942 is given by

$$(7)\quad lnRE_{jst} = c_0 + c_1 PFM_{st} + c_2 PF_{st} + Z_{jst}\phi + e_{jst}$$

where *lnRE* expresses the log ratio of pieceworkers to time workers hourly earnings and Z contains occupation dummies, section dummies, and time dummies. We also estimate equation (7) by replacing the dependent variable differential hourly earnings (ie. *lnRE)* with the separate real hourly earnings of male pieceworkers and male timeworkers. Since our female variables are measured at section level while the earnings differentials refer to males by occupations within sections, estimates $\hat{c}_1$ and $\hat{c}_2$ are obtained after clustering at the section/year level. Reported estimates are weighted by the number of workers in each section. Results are shown in Table 4.

Table 4 here

Sectional proportions of women doing men's work, represented by the variable *PFM*, are found to be associated with larger piecework-timework hourly pay differentials among male workers. We hypothesised that due to much shorter periods of training and a lack of relevant work experience, the employment of skilled female workers necessitated reorganisations of working practices. This in turn would have improved the returns to male piecework because skilled men could concentrate their work effort on relatively high-value skilled job tasks. Separating piecework and timework real hourly earnings, it is found that both *lnEP* and *lnET* are negative, although significantly less so for pieceworkers. While nominal pay increases among pieceworkers exceed those of timeworkers, real wages of both groups declined due to high price inflation in the early war years. The annual percentage change in the consumer price index between 1938 and 1939 was 6.3%, rising to 16.6% between 1939 and 1940, before falling back to 10.8% in 1940-41, and 7.2% in 1941-42 (Feinstein, 1972, Table 61). The producer price index follows a very similar pattern.

Most newly hired women in 1939 onwards were employed at the start of the war in semi-skilled jobs. They were supported by both government and unions in their early demands for higher rates of pay. However, unions were also keen to preserve wage differentials among comparable lower-skilled males. From Table 4, we find that *PF*, the proportion of females within total sectional employment, is significantly negatively associated with male piecework-timework hourly earnings differentials. Basic time rates of males rose, at least in part, due to the effects of successes in female pay protests combined with union action to ensure positive male pay-gaps. Separating piecework and timework real hourly earnings reveals that *PF* had no impact on male piecework pay the former but was significantly positively correlated with the male timework pay.

V. POST-WAR PIECE RATE PRICING AND THE DEMISE OF PIECEWORK

Why did the male piecework-timework pay differentials narrow so appreciably in the post-war years? In the short run, the transition from wartime to peacetime production served to narrow the differentials (Knowles and Robertson, 1951b). First, unlike timework, piecework pay is importantly determined by productive effort per unit of time. The scale and urgency of war production, combined with a patriotic zeal within the workforce, gave rise to exceptional piecework effort and this was almost certainly not sustained in the period of post-war reconstruction. Second, positive wartime earnings drift in piecework resulted from loose pricing of piece rates due to employers' inability accurately to assess relative prices in the face of frenetic wartime demand. A tightening of piece-settings during the relative calm of the post-war years would have served to rein back rate inflation. Third, pieceworkers' efficiency is conditioned by the length of production runs of given products. The transition from wartime to peacetime production would have involved falls in returns to effort for many workers due to

unfamiliarity with new products and their related job task re-specifications. As summarized by Knowles and Hill (1954, p 293): '*..skilled pieceworkers, who had been asked for maximum production at virtually any price and benefited disproportionately from the long wartime runs, suffered the most when the conversion to peacetime needs entailed extensive recalculations of piecework prices and times."*

In the longer term it is clear from Figures 3 and 4 that the differentials continued to narrow well beyond the end-of-war transition phase. There were two drivers behind this trend. First, technological advances combined to give rise to employers' concerns that piece rates were increasing too strongly relative to comparable time rates. Second, the need to avoid excessive drift of piece rates away from time rates was not only a concern within national negotiations but also at district and firm levels. A further complication in the case of within-firm differentials was that significant numbers of firms employed *both* pieceworkers and timeworkers within the same occupation. For example, based on data in respect of 2555 EEF companies in 1952, Hill and Knowles (1956) found that 23% employed both piece- and time-rated fitters.

Evaluating piecework remuneration required constant changes in output pricing. The associated costs of evaluating and negotiating new rates involved issues similar to those considered by Coase (1937) concerning the implications of transaction costs of market exchange (Helper, Kleiner, and Wang, 2010). In Coase, an advantage of firm-level production is that entrepreneurs can organize internal factors of production to reduce transaction costs compared to those associated with full recourse to market transactions. Engineering employers sought to limit the number of piece rates and time revisions thereby alleviating associated costs of rate determination and related negotiation. For improvements in technology, as the marginal costs associated with setting piece-rates exceeded the marginal productive returns, it became attractive

to simplify remuneration decisions. With industrial relations concerns to the fore, this turned out to be the somewhat crude expediency of paying pieceworkers and timeworkers equal money wage increments (Knowles and Hill, 1954). This served considerably to narrow hourly earnings differentials because pieceworkers' percentage increases were smaller than their timeworker equivalents.

By 1965, piecework-timework pay differentials had reduced to one half or less of their 1926-1942 average. The increasing recourse by employers to equalise pay increases of pieceworkers and timeworkers was perhaps symptomatic of an increased blurring in the distinction between the two pay groups. One pointer to this was a very significant wartime and post-war growth of supplementary payments. Such payments were set outside of national agreements and consisted of various types of compensating differentials for adverse working conditions as well as incentive payments, bonuses, and merit awards. Pieceworkers gained relatively from these payments during the war when incentives to produce maximum output-related effort were to the fore. These relative advantages reduced in the post-war years. For example, from a peak representing 47% of standard weekly earnings in 1942, pieceworkers' supplementary payments had fallen back to 39% in 1953. The timeworkers' equivalent 1942 figure was 25% but this had increased to 33% by 1953 (Knowles and Hill, 1954). Timeworkers' productive effort was increasingly incentivised. One supplementary payment, the compensatory bonus, only applied to timeworkers. This rewarded workers whose work was deemed to be worth more than typical time rates but who were not entitled to payments by results.

Merit rates, another type of supplementary payment, perhaps most clearly signalled the future trend not only of piecework-timework earnings differentials but also in the incidence of piece work itself. As for low incidence, the British Labour Force Survey for 2001-2005 shows

that only 1% of process, plant and machine operatives – all highly relevant to the industries in this paper - received pay that included 'piecework payments or tips or gratuities'. In contrast, merit payments were used to reward both individual and group performances (Knowles and Hill, 1954). At individual level, they recognised quality of work performance as it related to ability, special aptitudes, work experience, time keeping, and length of tenure. At group level, awards reflected skill and work quality realised within departments or workshops of the firm. Combining improvements in technology with the special need to reward individual and team quality of output were not altogether conducive to piece work (Helper, Kleiner, and Wang, 2010).

Advances in precision and automated technologies enhance potential product quality and product variety. Where the attainment of product quality involves both observable task execution combined with harder to observe initiatives for process innovations – such as suggestions for improved task executions - then advantages of piece rates relative to fixed wages are not so apparent (Holmstrom and Milgrom, 1991). Enhanced product variety involves increases in the costs of piece rate pricing and associated negotiation. Output depending on interactive inputs among work groups is difficult to monitor and reward on an individual basis.

VI. CONLUDING REMARKS

Recent decades have witnessed declines in piece rate remuneration in manufacturing industry in both Europe and North America. Contributory factors include changes in production techniques such as just-in-time systems, the increased cost of piece rate setting amid technologies that permit quite rapid changes in product varieties and designs, and a stronger emphasis on jobs involving both observable and non-observable work inputs. Our post-war

observations of systematic declines in piecework-timework wage differentials in the British engineering industry during the first two post-war decades reflected several of these types of influence and signalled the eventual decline of piecework itself.

Yet, the recent period of economic history covered here reminds us that piecework played two important roles during times of extreme economic crisis. First, and in contrast to the prevailing Keynesian view of downward real hourly wage stickiness, piecework offered a degree of short-run hourly procyclical pay adjustment. This would have helped to preserve engineering jobs during the Great Depression. Such adjustment was especially noticeable in the modern manufacturing firms of the southern and midland districts of Britain, for example aircraft and vehicle manufacture. Second, a piece rate system that rewarded productive effort was well suited to meet the intense and urgent pressures of demand in war supply industries during the build up to, and execution of, a major military conflict.

REFERENCES

COASE, R. H. (1937). The nature of the firm. *Economica*, 3. 386-405.

FEINSTEIN, C. H. (1972). *National income, expenditure and output of the United Kingdom 1855-1965*. Cambridge, Cambridge University Press.

HART, R.A. and ROBERTS, J. E. (2006). *Employment, hours and wages in the Engineering Employers' Federation*, 1914-1968. UK Data Archive, Study 5569.

HART, R.A. and ROBERTS, J. E. (2013a). Real wage cyclicality and the Great Depression: evidence from British engineering and metal working firms. *Oxford Economic Papers* 65: 197-218.

HART, R.A. and ROBERTS, J. E. 2013(b). Industrial composition, methods of compensation, and real earnings in the Great Depression. *National Institute Economic Review*, No.226, R17 – R29.

HELPER, S. KLEINER, M. M. and Wang, Y. (2010). Analysing compensation methods in manufacturing: piece rates, time rates, or gain sharing? *NBER Working Paper Series*, #16540.

HILL, T.P. and KNOWLES, K.G.J.C. (1956). The variability of engineering earnings. *Bulletin of the Oxford University Institute of Statistics* 18: 97-139.

HOLMSTROM, B. and MILGROM, P. (1991) Incentive contracts, asset ownership, and job design, *Journal of Law, Economics, and Organization,* 7: 24 – 52 (Special Issue).

INMAN, P. (1957}. *Labour in the munitions industries*. London: HMSO.

KNOWLES, K.G.J.C. and HILL,T.P. (1954). The structure of engineering earnings. Bulletin of the *Oxford University Institute of Statistics* 16: 272-328.

KNOWLES, K.G.J.C and ROBERTSON, D.J. (1951a)). Earnings in engineering, 1926-1948. *Bulletin of the Oxford Institute of Statistics* 13: 179-200.

KNOWLES, K.G.J.C and ROBERTSON, D.J. (1951b) Some notes on engineering earnings. *Bulletin of the Oxford Institute of Statistics* 13: 223-228.

LAZEAR, E.P. (1986). Salaries and piece rates. *Journal of Business* 59: 405-431.

LAZEAR, E. P. (2000). Performance pay and productivity. *American Economic Review* 90: 1346 – 1361.

PENCAVEL, J. H. (1977). Work effort, on-the-job screening, and alternative methods of remuneration. *Research in Labour Economics* 1: 225-258.

SEILER, (1984). Piece rate vs. time rate: the effect of incentives on earnings. *Review of Economics and Statistics* 66: 363-376.

WIGHAM, E. (1973). The power to manage. *A history of the Engineering Employers' Federation.* London, the Macmillan Press.

Table 1

EEF INDUSTRIES, OCCUPATIONS, SECTIONS, AND DISTRICTS

Industrial activities of EEF member firms (Ministry of Labour classifications)	Heating and Ventilation Apparatus; Scientific & Photography; Motor Vehicles, Cycles & Aircraft; Metal; Industries not separately specified; Constructional Engineering; Iron & Steel Tubes; Stove, Grate, Pipe etc. & general Iron Founding; Explosives; Hand Tools, Cutlery, Saws, Files; Marine Engineering; Brass, Copper, Zinc, Tin, Lead etc.; General Engineering; Brass and Allied Metal Wares; Watches, Clocks, Plate, Jewellery etc.; Wire, Wire Netting, Wire Ropes; Steel Melting & Iron Puddling, Iron & Steel Rolling and Forging; Bolts, Nuts, Screws, Rivets, Nails etc.; Tin Plate; Carriages , carts etc.
Occupations[1]	**Fitters (skilled)**; **Fitters (other than skilled)**; **Toolroom fitters**; **Turners**; **Patternmakers**; **Moulders(loose pattern)**; **Platers, riveters and caulkers**; **Sheet metal workers; Coppersmiths**; Turners and machinemen (at or above fitter's rates); Turners and machinemen (below fitter's rates); **Machinemen (at or above fitter's rates)**; **Machinemen (below fitter's rates)**; Machine moulders (at or above fitter's rates); Machine moulders (below fitter's rates);Moulding machine operators; **Fitters**; Fitters skilled (not toolroom or other);Toolroom fitters & turners; Skilled maintenance electricians; Skilled maintenance fitters; Other skilled maintenance; Maintenance men; **Moulders**
Engineering Sections	Agricultural engineers; Aircraft manufacturers; Allied trades; Boilermakers, Brassfounders; Construction engineers; Coppersmiths; Drop forgers, Electrical engineers; Founders; Gas meter makers; General engineers (Heavy); General engineers (Light); Instrument makers; Lamp manufacturers, Lift manufacturers; Locomotive manufacturers; Machine tool makers, Marine engineers; Motors: cars, cycles; Motors: commercial; Scale, beam etc. makers; Sheet metal workers; Tank and gasholder makers; Telephone manufacturers; Textile machinery makers; Vehicle builders; Miscellaneous; Plastic moulders; Iron castings; Non-ferrous castings; Other metal manufacturing; Engineers' small tools; Mechanical handling equipment; Industrial plant steel workings; Other mechanical engineering; Scientific etc./ watches; Radio & telephone apparatus; Domestic electrical appliances; Other electrical goods; Motor vehicle manufacturing; Motors & pedal cycles; Metal goods n.e.s.
Engineering Districts[2]	**Aberdeen**; **Bedford**; Belfast Marine; **Birmingham**; **Blackburn**; **Bolton**; Border Counties; Bradford; **Burnley**; **Burton**; Cambridge; Chester; **Coventry**; **Derby**; Doncaster; Dublin; **Dundee**; East Anglia; East Scotland; Grantham; **Halifax**; Heavy Woollen; Huddersfield; **Hull**; Keighley; Kilmarnock; Leeds; **Leicester**; **Lincoln**; **Liverpool; London; Manchester; North East Coast; Northern Ireland; North Staffs**; **North West Scotland; Nottingham; Oldham**; Otley; Outer London; Peterborough; **Preston; Rochdale; St Helens; Sheffield**; Shropshire; South Wales; **West of England**; Wakefield; **Wigan**.

Note: 1 Bold denotes occupations classified in the period up to 1942.

2 Bold denotes districts for which we have matching unemployment rates.

TABLE 2

PIECEWORKERS' AND TIMEWORKERS' HOURLY PAY REACTIONS TO CYCLCAL UNEMPLOYMENT CHANGES

Dependent Variables	*ΔlnRB*	*ΔlnBP*	*ΔlnBT*	*ΔlnRE*	*ΔlnEP*	*ΔlnET*
	1927-1939 (national unemployment rate)					
Semi-elasticities, ΔU_t	-0.5000** (0.1778)	-0.2265* (0.0942)	0.2492 (0.2589)	-0.4054* (0.2265)	-0.4453** (0.1020)	-0.0550 (0.3083)
Occupation dummies, district dummies, and time trend	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2506	2506	2506	2506	2506	2506
	1927-1938 (district unemployment rates)					
Semi-elasticities, ΔU_{dt}	-0.2027* (0.0949)	-0.2980* (0.0818)	-0.0430 (0.0355)	-0.1624* (0.0824)	-0.3248** (0.0746)	-0.0996** (0.0313)
Occupation dummies, district dummies, and time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1637	1637	1637	1637	1637	1637

OLS estimates are obtained after weighted by numbers of workers represented in each cell. Robust standard errors in brackets with ** (*) indicating 0.01(0.05) significance on two-tail test. Final output price deflator using national unemployment rate is obtained from Feinstein (1972, Table 61). Price deflation using district and unemployment dummies in second set of regressions. Standard errors are obtained after clustering at the year level (national unemployment) and at district/year level (district unemployment).

TABLE 3

PROPORTIONS OF WOMEN IN EEF ENGINEERING SECTIONS, 1940-1942

		Proportion women doing men's work to all workers			**Proportion women to all workers**			**Proportion women doing men's work to all women workers**		
Sections	Section weights, in 1942	1940	1941	1942	1940	1941	1942	1940	1941	1942
Agricultural Engineering	0.01	0.0173	0.0599	0.2205	0.1034	0.2161	0.4396	0.1673	0.2773	0.5015
Aircraft Manufacture	0.25	0.0142	0.0982	0.1329	0.3064	0.5522	0.6803	0.0464	0.1778	0.1954
Motors (commercial)	0.03	0.0659	0.2317	0.3094	0.1032	0.2837	0.4744	0.6386	0.8165	0.6523
Construction Engineering	0.01	0.0217	0.1116	0.2978	0.0279	0.2089	0.4958	0.7778	0.5341	0.6007
Copper	0.003	0.0081	0.2543	0.3317	0.0121	0.3252	0.4880	0.6667	0.7820	0.6798
Electrical Engineering	0.12	0.0017	0.0112	0.0260	0.6050	0.6938	0.7428	0.0028	0.0161	0.0350
Founders	0.03	0.0044	0.0746	0.1380	0.1656	0.3608	0.4763	0.0268	0.2067	0.2896
General Engineering (heavy)	0.12	0.0140	0.0946	0.1981	0.1604	0.2991	0.4571	0.0870	0.3164	0.4333
General Engineering (light)	0.20	0.0159	0.0356	0.1088	0.2835	0.4055	0.5446	0.0563	0.0877	0.1998
Gas Meter Makers	0.005	0.0133	0.0293	0.1515	0.2869	0.4938	0.5827	0.0462	0.0594	0.2600
Instrument Makers	0.03	0.0001	0.0208	0.0168	0.5509	0.7063	0.7455	0.0003	0.0295	0.0225
Marine Engineering	0.03	0.0294	0.0715	0.1852	0.0322	0.0831	0.2041	0.9148	0.8613	0.9073
Motors, Cars, Cycles etc.	0.12	0.0007	0.0360	0.0407	0.4106	0.4954	0.6356	0.0018	0.0727	0.0640
Tank and Gasholder Makers	0.002	0.0000	0.0418	0.2758	0.0355	0.2965	0.4232	0.0000	0.1408	0.6518
Textile Machinery Makers	0.04	0.0086	0.0382	0.0711	0.1315	0.3003	0.5384	0.0653	0.1272	0.1320
Total (weighted averages)	1.00	0.0121	0.0622	0.1162	0.3100	0.4628	0.5944	0.0390	0.1344	0.1955

TABLE 4

MALE DIFFERENTIALS AND FEMALE WORK ACTIVITIES

Dependent Variables	*lnRE*	*lnEP*	*lnET*
	1940-1942: occupations[a] and sections[b]		
Proportion of Women Doing Men's Work in Section Adult Employment (*PFM*)	0.3228** (0.1042)	-0.1877** (0.0543)	-0.5106** (0.0500)
Proportion of Women in Section Adult Employment (*PF*)	-0.2331** (0.0774)	0.0090 (0.0991)	0.2421** (0.0218)
Occupation dummies, section dummies, and time dummies	Yes	Yes	Yes
Observations	179	179	179

Robust standard errors in brackets with ** (*) indicating 0.01(0.05) significance on two-tail test. Final output price deflator is obtained from Feinstein (1972, Table 61).

a. Moulders (loose pattern); Sheet Metal Workers; Turners and Machinemen (at or above fitters' rates); Turners and Machinemen (below fitters' rates).

b. Agricultural engineering; Aircraft manufacture; Construction engineering; Copper; Electrical engineering; Founders; Gas meter makers; General engineering (heavy); General engineering (light); Instrument makers; Marine engineering; Motors: cars, cycles etc.; Motors (commercial); Tank and gasholder makers; Textile machinery makers.

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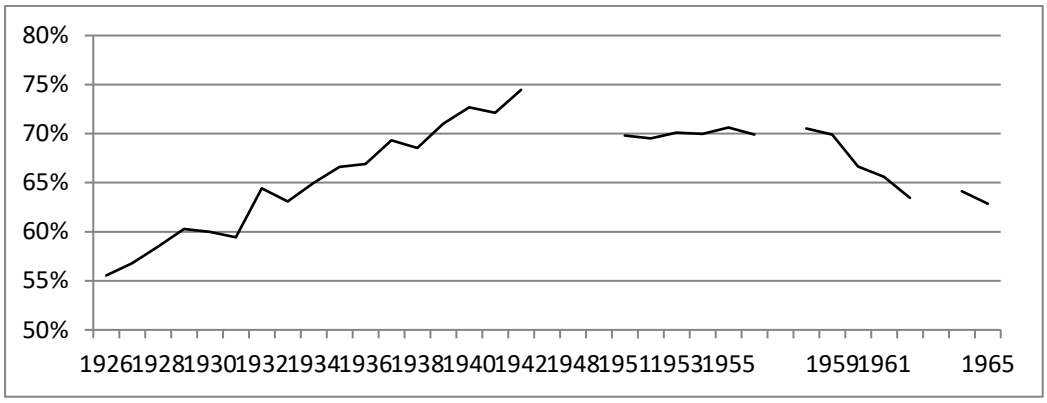

Figure 1. Percentage of pieceworkers in the total EEF workforce, 1926-1965

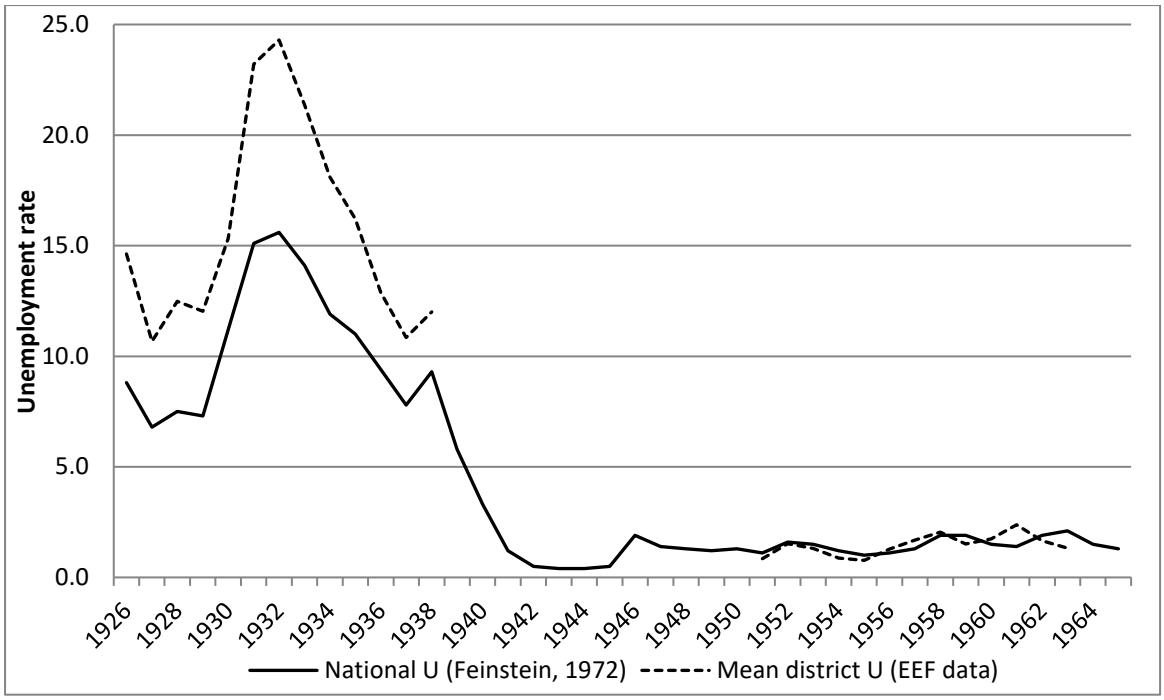

Figure 2. National and district unemployment rates, 1926 – 1965

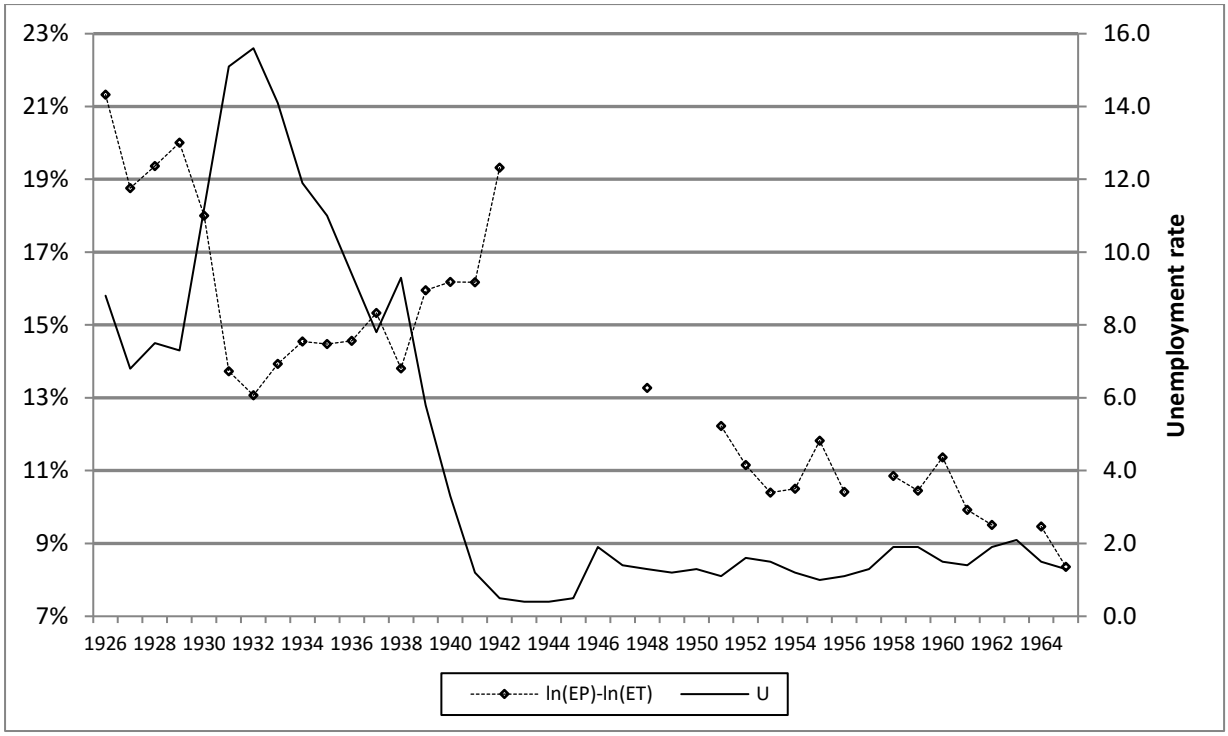

Figure 3. Male district hourly earnings differentials 1926-1965

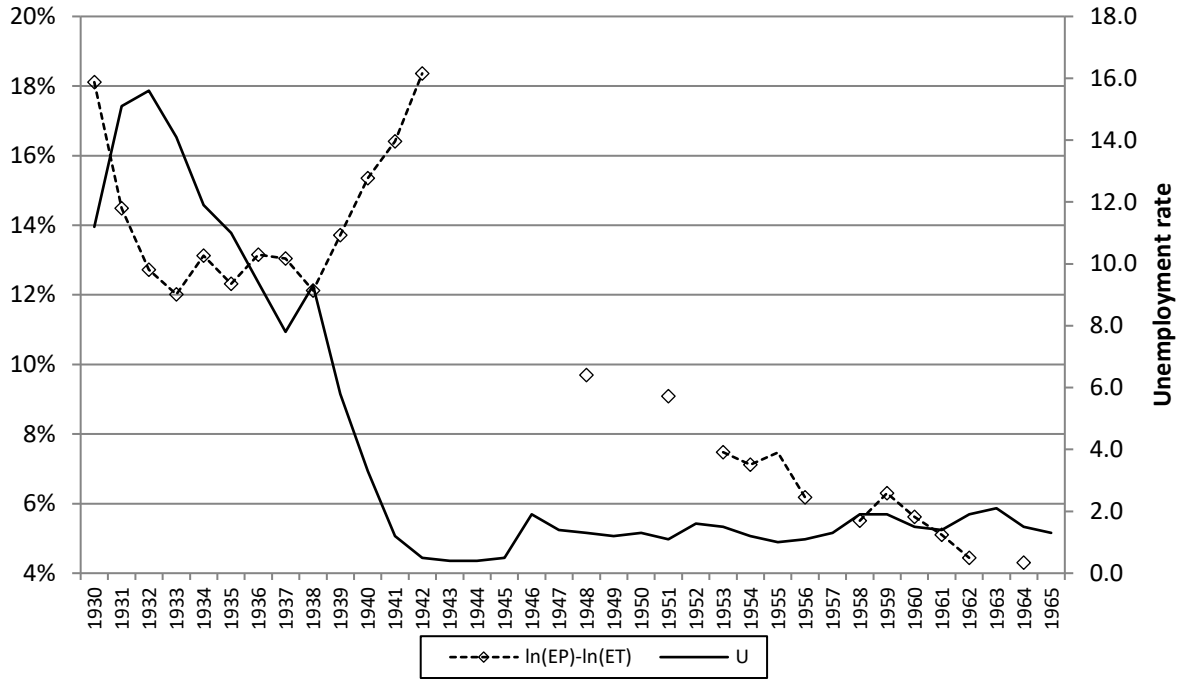

Figure 4 Male section hourly earnings distributions 1930-1965