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ABSTRACT

Labour Productivity during the Great Depression and the Great Recession in UK Engineering and Metal Manufacture

This paper compares labour productivity during the Great Depression (GD) and the Great Recession (GR) in engineering, metal working and allied industries. Throughout, it distinguishes between output per worker and output per hour. From the peak-to-trough of the GD cycle, hourly labour productivity was countercyclical, remaining above its 1929 starting point. In the GR peak-to-trough period, hourly productivity was procyclical, falling below its 2007/08 starting point. While employment and average weekly hours reductions were much more pronounced in the GD compared to the GR, the GD recovery was both stronger and more sustained. The discussion of the different experiences in the two eras concentrates on employment and hours flexibility, the comparative lengths of weekly hours, the behaviour of real wages, and human capital aspects of labour inputs.

JEL Classification: E32, J23, J24

Keywords: labour productivity, Great Depression, Great Recession

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1 Introduction

This paper examines the effects of the Great Depression (GD) and the Great Recession (GR) on labour productivity in UK engineering, metal working and allied industries. Vehicle and aircraft manufacture predominate within allied industries. These manufacturing sectors experienced peak-to-trough reductions in real output of about 24% in both eras. The 2007/2008 downturn was associated with a 20% fall in hourly labour productivity. In sharp contrast, hourly labour productivity in the 1929 downturn remained above its starting level. For most of the sectors in the GR period, labour productivity recovery beyond the initial trough was very tenuous with sustained periods during which it fell below its immediate pre-recessionary level. Recovery following the GD trough was both strong and sustained.

Labour productivity is measured here in two well-known ways. These are (i) productivity per worker, i.e. real output divided by employment (Q/E), and (ii) hourly productivity, i.e. real output divided by labour hours (Q/H with H = E.h and h = average actual weekly hours). The principal UK industrial data constraint for the interwar years concerns a limited coverage of actual weekly working hours. Fortunately, it is possible to obtain this information for the industries included here. Not only are they of central importance to manufacturing as a whole but, in both eras, they were especially impacted by the economic downturns. For the GD period, productivity estimates are based on annual measures covering all engineering, metal working and allied industries (forthwith EMA industries). For the GR period, a reasonably strong match is obtained using quarterly data for three sectoral clusters - Basic Metals and Metal Products, Machinery and Equipment, and Transport Equipment.

There are four major observed differences in the behaviour of labour productivity between these two recessions. First, hourly productivity (Q/H) during the 1929-32 peak-to-trough of the GD business cycle was countercyclical, remaining above its 1929 starting point throughout. The comparable labour productivity paths during the GR were strongly procyclical from the outset of the 2007/8 financial crisis. Second, the percentages of employees laid-off during the GD were much higher than during the GR. Relatedly, falls in productivity per worker (Q/E) were considerably less severe in the GD compared with the GR. Third, changes in the average actual weekly hours component of Q/H was a major contributory factor to the countercyclicality of hourly productivity during the GD downturn. Actual weekly hours played a far less significant role in influencing the shape of the GR productivity cycles. Fourth, after the initial GD cyclical downturn there was a persistent growth path in hourly productivity, rising to 15% above its 1929 level by 1937. In contrast, for two of the three manufacturing sectors in the GR, long-term hourly productivities remained below their 2007/8 starting levels.

Section 2 discusses countercyclical and procyclical labour productivity with an emphasis on employment and working time. Cyclical productivity measurement and data are discussed in Section 3. Section 4 reports on the shapes of the Q/E and Q/H cycles in each era. Factors influencing cyclical productivity paths in the two eras are discussed in Section 5. This concentrates on the flexibilities and changes in average products of employment and hours as well as on the roles of real wage changes and worker skills. Section 6 notes several parallels with the GD – GR experiences when comparing hourly productivity paths in the US with those of prominent European economies following the 2007/08 financial crisis. Section 7 concludes.

2 Countercyclical versus procyclical labour productivity

Up to the 1960s, modelling assumptions behind the constructs of technical production functions were consistent with expectations of countercyclical movements in labour productivity. Yet contemporary empirical investigations were by no means fully supportive.

For example, US hourly labour productivity was found to be procyclical in some industries and countercyclical in others (Bordo and Evans, 1993). From the 1960s, findings of procyclical labour productivity dominated empirical work in the remaining post-war decades of the last century (Hart and Malley, 1999). In more recent times, signs of labour countercyclicality have re-emerged, especially in the US literature (Biddle, 2014).

Countercyclical labour productivity is dependent on two important labour market requirements. First, that labour is a freely variable factor input. Second, that the average product of labour exhibits decreasing short-run returns. Where labour is represented on both the extensive and intensive margins of production - that is in relation to employment and average weekly hours - factor variability and decreasing returns might express on one or both margins.

Consider a cost-minimising firm facing an unexpected short-term product demand fall. Assume a short-run period during which the capital stock is fixed. Initially, let h also be fixed. E is treated as a variable input factor that exhibits decreasing returns. In this case, Q/E suffices to measure short-run labour productivity. In the demand downturn, the firm reduces its workforce size sufficient to minimise the labour costs of meeting its falling output requirements. Decreasing returns serve to increase Q/E. As Q and E subsequently recover in the cyclical upturn, Q/E will decease. Short-run worker productivity is countercyclical. Now, let h also be treated as a variable input factor that also exhibits decreasing returns. The firm can meet falling output by an optimal reduced combination of workers and hours. Decreasing returns in both factor inputs would ensure that Q/H is countercyclical.

Mitchell (1913) pinpointed three potentially important driving-forces behind an expected outcome of decreasing returns. These cover both labour margins.

(1) On the labour demand side, during the peak-to-trough period of the cycle, employers are likely to dismiss their least efficient workers thereby enhancing average productivity

across the surviving workforce. During the post-trough recovery period, as output and employment expands, average productivity would be expected to fall due to the need to hire or re-hire workers with lower average productive potential.

(2) On the labour supply side, given higher transaction costs of finding equivalently paid employment as the the recession deepens, workers in general may be encouraged to attempt to improve their work performances in order to avoid dismissal. During subsequent market expansion, the probabilities of finding suitable alternative employment are increased and fear of job loss reduced.

(3) Cuts in total weekly hours during the peak-to-trough period may serve to enhance hourly worker productivity through easing the negative impacts of long daily/weekly hours on work concentration and effort. During the upturn these negative work pressures will be re-established as weekly hours increase.

These possibilities in relation to the EMA industries in the two eras are discussed in Section 5. In terms of (1), there are reasons for expecting that in both the GD and GR business contractions employers controls over layoff decisions strengthened due to contractions of union membership and market power. As for (2), the threats of employment dismissal and subsequent prolonged unemployment spells were especially serious in the GD compared to the GR given far higher rates of unemployment and higher propensities to fire workers. In the case of (3), significant cuts in long workweeks during the GD may well have helped to improve workers' average hourly performance. In contrast, it is unlikely that cuts in the relatively short workweeks of the GR period would have entailed comparable impacts.

Despite the fact that countercyclical influences on labour productivity were undoubtedly present during the inter-war years, what explained the growing post war evidence of a prevalent incidence of procyclical labour productivity? A dominant line of reasoning emerged in labour market economics in support of the view that in important instances labour should not be treated as a variable input factor. The arguments tended to refer more to the employment stock rather than its rate of utilisation. The dominant paradigm was the labour hoarding hypothesis (see Fay and Medoff, 1985 and Biddle, 2014 for background). During economic downturns, contractual employment agreements, firing costs, and costs of writing-off specific training investments[1] might be expected to result in degrees of employment retention in excess of that required to meet short-term output requirements.

Again suppose that real output falls unexpectedly with h assumed fixed. Hoarding labour in the downturn phase of the cycle results in a fall in Q/E. In effect, this results from a reduction in a 'hidden' variable, average work effort per period. Immediately following the cyclical trough, Q/E rises due to the increasing returns of dishoarding. In the longer term, as new employees are hired, decreasing returns may set in. Cyclical employment productivity is predominantly procyclical.[2] If h is allowed to vary in the hoarding firm, the peak-to-trough observed fall in Q/E would overestimate the 'true' productivity reduction by failing to account for the fall in labour input due to shorter working hours. In the graphs of labour productivity with respect to time, Q/H would lie above Q/E during the peak-to-trough period. In the upturn of the cycle, the dishoarding effect of improved effort per hour would enhance the upward trajectories of both Q/E and Q/H. Thereafter, the relative tracks of these two

[1] The greater the specificity of workers' acquired skills, the stronger the employer/worker interests in sharing training costs in order to achieve longer expected employment spells and lower labour turnover. The mutual benefits of sharing costs might involve a post-training wage premium to the worker that is greater than the alternative wage while the firm gains a longer expected period of employment tenure thereby providing more time to amortize the fixed employment cost. This would serve to encourage a degree of labour retention during economic downturns (Oi, 1962).

[2] Essentially, the hoarding hypothesis predicts procyclical fluctuations in average work effort. But it was recognised that short-run increasing returns could occur without such effort variations. During economic downturns a higher proportion of per-period effort might be directed less towards producing current output and more towards fulfilling post-recession goals in respect of productive performance. This may include more time devoted to equipment maintenance and to task-related training programmes.

variables will depend of the comparative sizes of the decreasing returns to workers and to hours of work.

A special case of countercyclical-versus-procyclical labour productivity outcomes is pertinent to the GD aspects of this paper and provides a strong motivation for distinguishing between Q/E and Q/H. During the downturn of the cycle, Q/E might exhibit mild procyclicality due perhaps to a relatively modest average hoarding effect. While traditional EMA industries in northern districts of the UK experienced considerable falls in employment and company closures, the more modern industries of vehicle and aircraft manufacture and electrical engineering, predominantly located in midland and southern districts, were far less prone to laying off workers. Nationwide, the combined employment experiences produced a modest net peak-to-trough fall in Q/E. Reductions in peak-to-trough average weekly hours in the northern districts were considerable but somwhat less severe in the midland/southern districts. Overall, in the peak-to-trough period countercyclical effects of reductions in average weekly hours more than offset the procyclical output per worker resulting in net countercyclical changes in hourly labour productivity.

3 Coverage, measurement and data

Measuring Q/H requires knowledge of average actual weekly hours and this determines why work here concentrates on EMA industries. The only available source of information for the UK during the interwar period covers these industries.[3] The GD data are annual and the GR data are quarterly.

[3] Actual weekly hours at a more macro level were not available in the UK until the 1940s (see Hart and MacKay, 1975 and Mitchell, 1988, p. 96). De Jong and Woltjers (2011, Table 1) do attempt to obtain UK estimates of Q/H for total manufacturing in the GD. It appears that they used EEF weekly hours in their calculation based on EMA industries for one or two occupations. This is unlikely to produce an accurate total manufacturing estimate. This is certainly the case for the UK during the GR as can be seen by comparing Figures 4 and 6 below.

Table 1 Engineering and Metal Working Industrial Coverage

<table>
<tr><td colspan="2" align="center">Great Depression</td></tr>
<tr><td>* Engineering, Metal Working and Allied Industries (SIC, 1948)</td><td>Agricultural engineering; aircraft manufacture; allied trades; boilermakers; brassfounders; construction engineering; coppersmiths; drop forgers; electrical engineering; founders; gas meter makers; general engineering (heavy); general engineering (light); instrument makers; lamp manufacture; lift manufacture; locomotive manufacture; machine tool makers; marine engineering; motors: cars, cycles etc.; motors (commercial); scale, beam etc. makers; sheet metal workers; tank and gasholder makers; telephone manufacture; textile machinery makers; vehicle builders.</td></tr>
<tr><td colspan="2" align="center">Great Recession</td></tr>
<tr><td>** Basic Metals and Metal Products (Codes 24-25)</td><td>Basic iron, steel and ferro-alloy; tubes, pipes etc., other products of first processing steel; precious and other non-ferrous metals; metal casting; structural metal products; tanks, reservoirs, containers; steam generators; weapons and ammunition; forging, pressing, stamping etc.; coating of metals; machining; cutlery, tools, hardware; other fabricated metal products.</td></tr>
<tr><td>** Machinery and Equipment (Code 28)</td><td>General purpose machinery; agriculture and forestry machinery, metal forming machinery and machine tools; other special purpose machinery.</td></tr>
<tr><td>** Transport Equipment, Codes (29 and 30)</td><td>Motor vehicle and trailers; bodies for motor vehicles; parts and accessories for motor vehicles; ships and boat building; railway locomotives and rolling stock; air and spacecraft etc. machinery; military fighting vehicles; transport equipment nes.</td></tr>
<tr><td colspan="2">* Based on Engineering Employers' Federation breakdowns

** From a total of 930 thousand jobs, the respective percentage employment shares of the three GR sectors in 2008Q1 are (in descending order above) 46%, 23% and 31%.</td></tr>
</table>

Sources: **Great Depression:** correspond to Orders V to IX of the 1948 Industrial Classification.
Great Recession: Office for National Statistics: for fuller details of Codes' coverage see https://www.ons.gov.uk/file?uri=/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007/sic2007summaryofstructurtcm6.xls

Full details of data, productivity constructions and graphs in respect of the GD cycle are given in Hart (2019) and so it will suffice to provide a brief outline here. The EMA industries covered annually for the GD period are listed in Table 1. They comprise the 1948

Standard Industrial Classification (SIC) Orders V (metal manufacture) and Orders VI-IX (engineering and allied industries) (Central Statistical Office, 1948). Data on actual weekly hours of work are provided each October from the payroll records compiled by Engineering Employers' Federation (EEF), a Federation whose member firms cover these SIC orders (see Knowles and Hill, 1954, Appendix A).[4] This allows construction of an aggregate average actual weekly hours time series for timeworkers based on fourteen high, medium and low-skilled blue-collar occupations within member firms delineated by 51 geographical engineering districts throughout the UK.[5] It is combined with annual real output indices for the same SIC Orders provided by Feinstein (1972, Table 51) which cover gross domestic product at factor cost (1913= 100) and based on the Index of Industrial Production. Feinstein (1972, Table 59) also provides matching data from the Ministry of Labour that provides employment indices. These cover employment in iron and steel, electrical goods, mechanical engineering and shipbuilding, vehicles and other metal industries.

For the GR cycle, quarterly and seasonally adjusted indices of Q/E and Q/H are provided by the UK Office for National Statistics (ONS) (2016=100).[6] Output is the Chained Volume GVA.[7] To achieve the best overlap with the GD data, three sectors of manufacturing industry are included in the analysis – Basic Metals and Metal Products, Machinery and

[4] The complete EEF data set is available in the UK Data Archive: http//www.esds/ac.uk/finding/Data/snDescription.asp?sn==5569.

[5] Piecework was common place in engineering and metal working during the interwar period. It is shown in Hart (2019) that accounting for both time workers and pieceworkers makes virtually no difference to the shapes of the labour productivity cycles shown here.

[6] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/datasets/labourproductivitytables110andr1

[7] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/datasets/annualbreakdownofcontributionswholeeconomyandsectors

Equipment, and Transport Equipment. Table 1 lists the main product headings for each sector together with their relative workforce sizes at the start of the GR.

Table 2 Peak-to-trough percentage changes real output, employment and total hours

Industries	Peak	Trough	% Change
Great Depression			
Engineering and Metal Working			
Real output (Q)	1929	1932	-24.3
Employment (E)	1929	1932	-19.8
Labour hours (H=E.h)	1929	1932	-25.8
Great Recession			
Basic Metals and Metal Products			
Real output (Q)	2007 Q3	2009 Q3	-23.8
Employment (E)	2008 Q2	2010 Q3	-15.5
Labour hours (H=E.h)	2008 Q1	2011 Q1	-15.0
Machinery and Equipment			
Real output (Q)	2007 Q4	2009 Q3	-24.6
Employment (E)	2008 Q3	2010 Q2	-12.5
Labour hours (H=E.h)	2008Q3	2009 Q2	-12.9
Transport Equipment			
Real output (Q)	2008 Q1	2009 Q1	-24.1
Employment (E)	2008 Q1	2011 Q2	-8.6
Labour hours (H=E.h)	2008 Q1	2009 Q1	-9.3
Total Manufacturing			
Real output (Q)	2008 Q1	2009 Q3	-12.6
Employment (E)	2007 Q2	2010 Q1	-11.6
Labour hours (H=E.h)	2008 Q1	2009 Q4	-10.4

In order to gain some initial comparative perspective on magnitudes of changes in the variables comprising the labour productivity measures- i.e. real output, employment and total hours - Table 2 shows their peak-to-tough percentage declines during the GD and GR eras. Given the more comprehensive industrial coverage for the GR, total manufacturing is also included for this period.

Among the EMA industries, there is one striking similarity between the GD and GR cycles. The peak-to-trough fall in real output is virtually the same for each and every sector of manufacturing, at about 24%[8], so we can measure relative labour productivity outcomes with respect to equal severities of output reductions. There are two important differences between the two eras. First, the employment fall during the GD was more severe than that in the GR. A fall of 19.8% in the earlier period compares with falls ranging from 15.5% to 8.6% in the more recent period. Second, during the GD, labour hours (H) fell significantly more than employment (E) (25.8% compared to 19.8%). The equivalent H-falls in the GR sectors, as well as in total manufacturing, differed little from their equivalent E falls.[9]

4. Labour productivity over the Great Depression and Great Recession cycles

(a) The GD cycle

The Great Depression in the UK started in the second half of 1929.[10] This year marked the peak of a 3-year boom period in respect of both total manufacturing in general and the industries studied here (Feinstein, 1972, Table 51). Accordingly, I set 1929 as the starting point of the GD cycle. Figure 1 shows the Q/E and Q/H labour productivity cycles from 1929 to 1935, with 1929=100. From Table 2 we see that from 1929 peak to 1932 trough, Q fell by 24.3% and E fell by 19.8%, with Q/E in Figure 1 showing a modest 5.4% reduction. However, labour hours H fell by 25.8% and during the cyclical downturn from 1929 to 1932 Q/H was countercyclical. At the trough in 1932 Q/H was 2.1% higher than its starting level in 1929.

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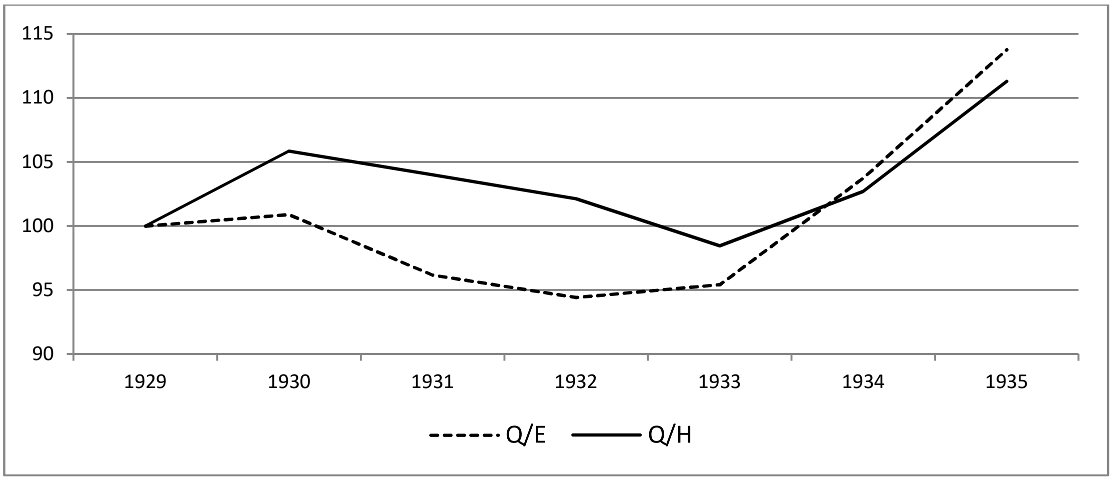
[8] Starting periods of the cycles are more finely tuned for the three GR sectors because they are based on quarterly data.

[9] As shown in Table 2, the percentage output falls among the three GR sets of industries were twice that of manufacturing industry as a whole. Employment in total manufacturing fell by 11.6% and labour hours fell by 10.6%.

[10] Burns and Mitchell's (1946) work on measuring business cycles gives 1929 Quarter 3 as the British pre-depression peak and 1932 Quarter 3 as the trough of the cycle.

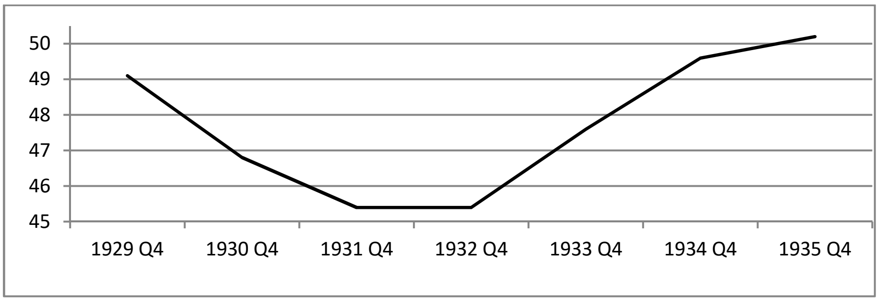
Figure 1 Output per worker and output per hour in UK engineering and metal working 1929-1935 (1929=100)



Source: Hart (2019)

Two US studies obtain similar findings. Bordo and Evans (1993) find that Q/H in US manufacturing industry was countercyclical between 1929Q3 and 1933Q1. They also find countercyclical labour productivity in the petroleum, leather and paper/pulp industries.[11] Bernanke and Powell (1962) calculate trough-to-peak ratios (1933Q1 compared to 1929Q3) for eight US industries. They find that for three manufacturing industries – paper, leather and lumber – the ratios are greater than 1. Manufacturing in total has a ratio of 0.89.

Figure 2 Average actual weekly hours GD engineering/metal sectors



Source: Engineering Employers' Federation company payroll statistics

[11] These authors undertake their work using quarterly data taken from the interwar study of Bernanke and Parkinson (1991).

Figure 3 Gap between the indices of Q/H and Q/E in Figure 1

The incorporation of average actual weekly hours, h, defines the difference between Q/H and Q/E. Figure 2 shows average actual weekly hours in the UK EMA sectors of the Engineering Employers' Federation, 1929 to 1935. Workers averaged just over 49 weekly work hours in 1929, falling to just over 45 weekly hours in 1932, followed by a steep climb back to reach the starting level by 1934. The important countercyclical influence of introducing average weekly hours into the definition of labour input is best revealed by graphing the gap between Q/E and Q/H in Figure 1. This is shown in Figure 3 and closely approximates the inversion of Figure 2.[12]

(b) The GR cycles

Figure 4 shows the equivalent GR labour productivity graphs of Q/E and Q/H for the EMA sectors in Table 1. Comparing the cycles in Figures 1 and 4, there are three major differences between the two eras. First, the GR peak-to-trough falls in the Q/E measure of productivity – averaging around 20% - are about 4-times greater than the equivalent GD fall in Figure 1. This represents propensities to retain employees that are in excess of those needed to meet output requirements. Second, there is little difference between the Q/E and Q/H cyclical

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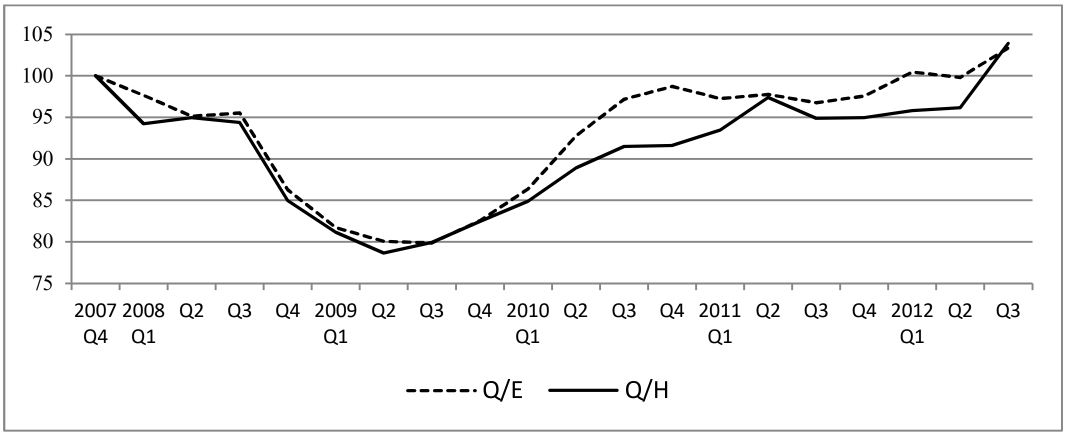
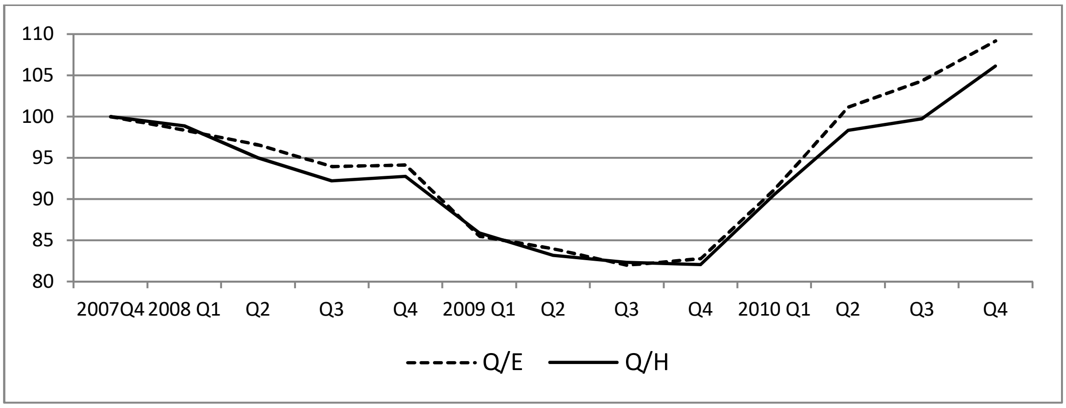
[12] It holds precisely in terms of proportionate (or log) rates of change. Let P_1 = Q/E and P_2 = Q/H. The proportionate changes are $\Delta P_1 = \Delta Q - \Delta E$ and $\Delta P_2 = \Delta Q - \Delta E - \Delta h$. So $\Delta P_2 - \Delta P_1 = -\Delta h$, or the negative of the proportionate change in average per worker weekly hours.

Figure 4 Indices of Q/E and Q/H for three sets of GR industries

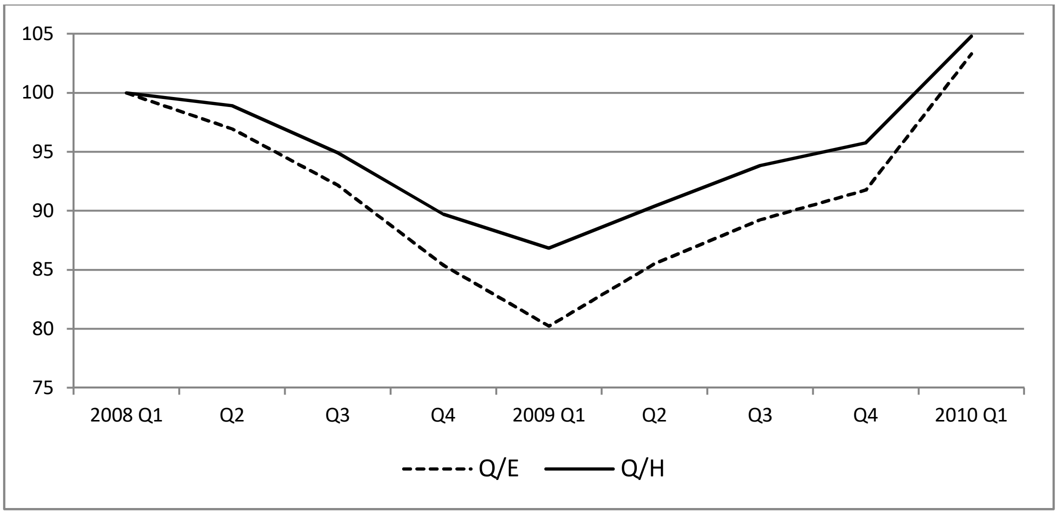
(a) Basic Metals and Metal Products (2007 Q4 = 100)



(b) Machinery and Equipment (2007 Q4 = 100)

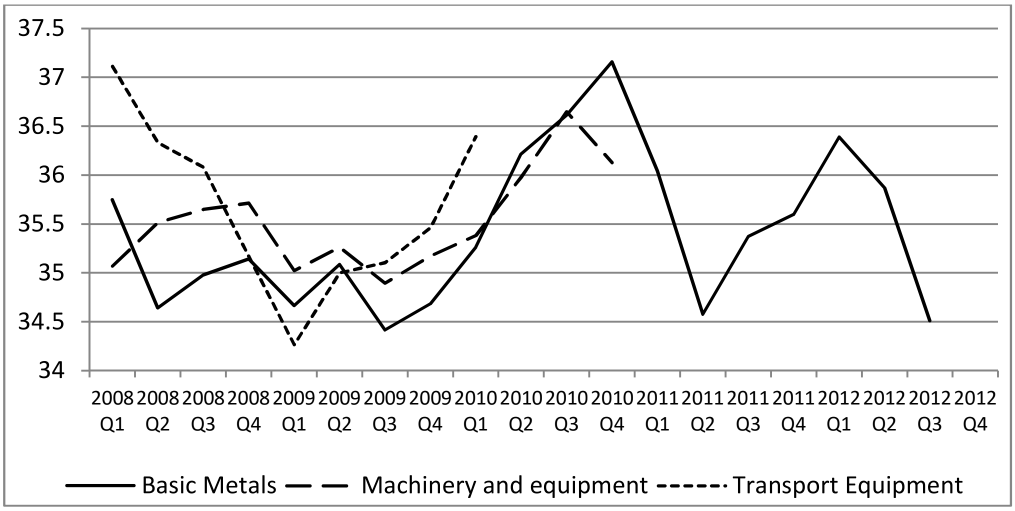


(c) ***Transport Equipment (2008Q1=100)***



Source: Source: Office for National Statistics productivity plots over the cycles in two of the three GR sectors, comprising about 70% of the GR EMA industries. This contrasts strongly with the clear divergences in comparison with the Q/E and Q/H averages over all GD EMA industries. Third, both Q/E and Q/H graphs display marked procyclical productivity movements compared with the respective procyclical and countercyclical movements in the GD period.

Figure 5 Average actual weekly hours in the Great Recession



Source: Office for National Statistics

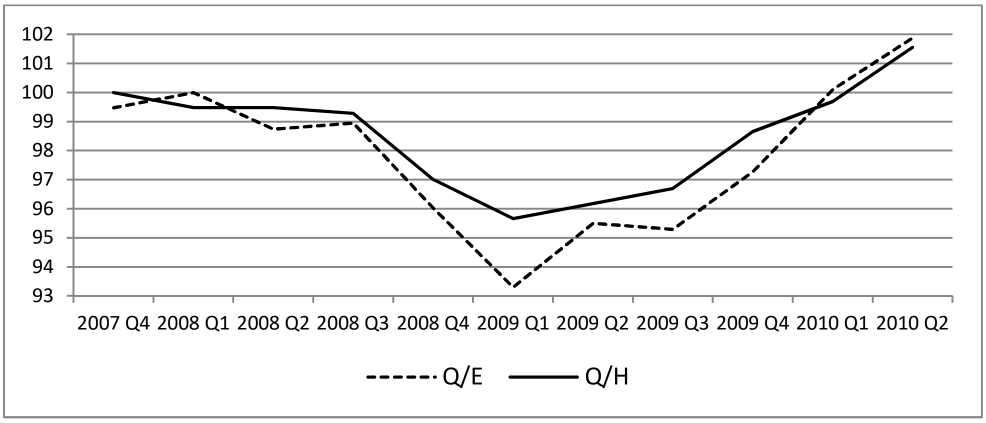
Comparing the Q/E and Q/H graphs of the Basic Metals and Metal Products and the Machinery and Equipment sectors, it is useful to differentiate among distinct time-intervals. First, the graphs of Q/E and Q/H in each sector more or less coincide during the peak-to-trough phases of the cycles. Figure 5 shows the graphs of average actual weekly hours (h) in the GR sectors over the periods corresponding to their respective cycles in Figure 4. For these two sectors, changes in average weekly hours are relatively modest, and quite erratic between 2008Q1 to 2009Q3. So, Q/H deviates little from Q/E during the initial downturn phase of the cycle. Immediately following the troughs, in the second phase, both sectors reveal relatively steep increases weekly hours. From Figure 4, there they also display sharp rises in both Q/E and Q/H. These observations are consistent with the proposition that output increases more than proportionately to employment and labour hours due to increased effort per hour (or dishoarding). In the third phase, employment and total hours continue to rise at somewhat lower rates of increase. The tendency for Q/E to lie above Q/H suggests that decreasing returns to hours are dominating decreasing returns to employment.

It seems hard to avoid the conclusion that, in contrast to their GD engineering/metal working counterparts, employers operating in Basic Metals/Metal Products and Machinery/Equipment maintained a workforce above the needs of output requirements during the peak-trough period. First, respective percentage falls in employment of 15.5% and 12.5% compare with falls in real output of 23.8% and 24.6% (Table 2). Second, there was limited attempt to offset excess employment stocks by systematically cutting weekly hours.

The lengths of the productivity cycles for the Transport Equipment sector are both shorter and better defined than in the foregoing two sectors. Recall from Table 2 that this sector displays the highest employment retention of all three sectors: the percentage employment reduction was one-third that of output. From Figure 5, we see that the sector experienced a clearly defined sharp drop in average actual weekly hours in the peak-to trough period. This is consistent with the observation that the rate of decline of Q/E exceeds that of Q/H during the downturn. The subsequent upward trajectories of both Q/E and Q/H are consistent with pronounced dishoarding effects. This sector was growing strongly before the recession set in and showed vigorous long-term growth after its upturn in 2009Q1. It seems likely that the pre-recessionary growth produced business expectations compatible with a desire to retain excess labour during the recessionary downturn.

The 20% falls in peak-to trough labour productivity in the three highlighted sectors contrast markedly with the respective 6.4% and 4.3% falls of Q/E and Q/H for total manufacturing shown in Figure 6. The shape of the total manufacturing labour productivity graphs are most reflective of the Transport Equipment sector.

Figure 6 Indices of Q/E and Q/H for GR total manufacturing



Source: Office for National Statistics

(iii) Summary of key GD/GR cyclical comparisons

(a) Real output in both the GD and GR periods fell by about 24% in EMA industries.

(b) Peak-to trough percentage falls in both employment and total hours were considerably greater in the GD compared to the GR (see Table 2).

(c) The percentage peak-to-trough fall in H exceeded that of E by 6% during the GD. In contrast, the percentage peak-to-trough falls in H differed little from E in the three GR sectors.

(d) The length of the average workweek in the two eras was in the order of 10 to 13 hours longer in the GD cycle than in its GR equivalents (see Figures 2 and 5).

(e) Actual weekly hours during the peak-to-trough period contracted by an average of 3.7 hours in the GD compared to GR falls of 2.8 hours in the Transport Equipment sector and little systematic variation in Basic Metals/Metal Products and Machinery/Equipment sectors.

(f) The Q/H measure of labour productivity rose by 5.8% in the first year of the GD cycle and remained above its starting level during the peak-to-trough years. Q/H fell immediately below its peak starting point in the three GR sectors, with falls of between 17% and 21% at their cyclical troughs.

5 What accounted for the labour productivity differences in the two eras?

This section extends the discussion of the differing labour productivity experiences in the GD and the GR. It highlights the contributions of real wages, employment, worker skills, and working time. It also focuses on somewhat longer time spans, covering several years before and after the main GD and GR cycles.

(a) The Great Depression

Starting in 1929 there was a period of severe price deflation in the UK. Between 1929 and 1934, the real value of workers' hourly consumption wages rose by 11% due to a deflation of the prices of consumer goods and services (Feldstein, 1972, Table 61). Over the same period, the real value of employers' real hourly product wages, measured in terms of workers' output, rose by 13% due to a deflation of output prices. Figure 7 shows the graphs of real hourly and weekly product wages over the period 1927 to 1937.[13] Starting in 1929, the impact of the deflation is shown clearly in relation to the marked increases in real hourly wages (excluding overtime), and real hourly earnings (including overtime).[14] Unlike the two hourly pay indices, there is a sharp dip in the index of real average weekly earnings (real AWE) in 1929. Employers offset the rise in real hourly wage costs of employment by reducing the length of average weekly hours and hence the weekly wage bill.

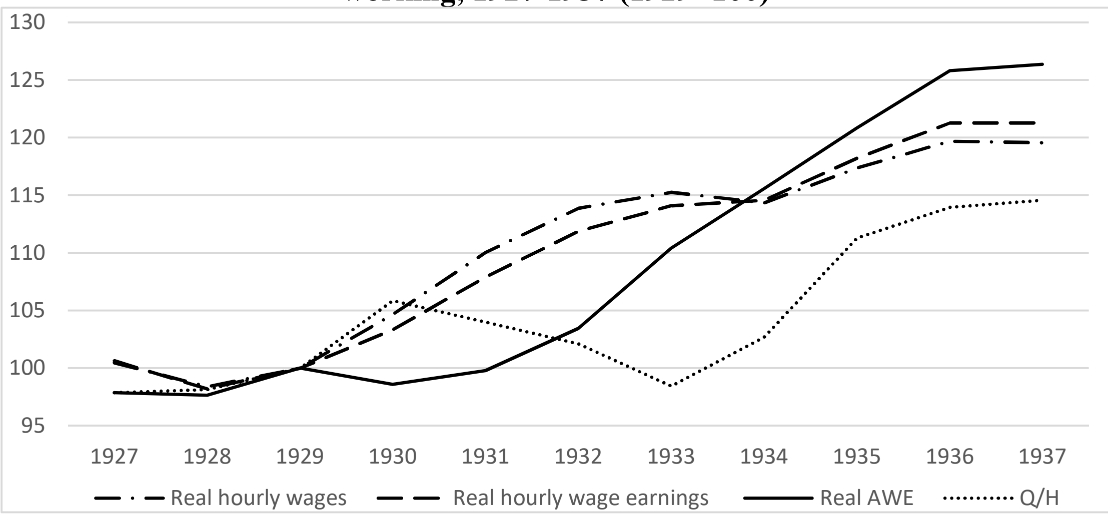
Figure 7 includes the graph of hourly productivity Q/H. The effect of cutting weekly hours at the start of the cycle served to reduce the gap between hourly productivity and real

[13] The respective graphs of consumption wages are very similar.

[14] The hourly earnings index lies below the hourly wage index due to a major decline in the share of overtime working in total work hours and in related overtime premium pay. Overtime rates applied to weekly overtime hours in excess of the standard 47-hour workweek. Hart and MacKay (1975, Tables A3 and A4) show that, for most engineering districts in the UK, overtime working among fitters and labourers in EEF member firms was eliminated by 1932.

AWE over the complete cycle. We would expect that these two variables would correlate positively (Taylor, Jowett and Hardie, 2014). Interestingly, however, they moved in opposite directions between 1929 and 1932. Initially, Q/H rose sharply while real AWE declined. Thereafter, as the 1932 depression's trough approached, Q/H declined steadily, real AWEs increased steadily, but the index of the former remained below that of the latter.

Figure 7 Product wages and hourly productivity in engineering and metal working, 1927-1937 (1929=100)



Sources: EEF company payroll statistics and Feldstein (1972)

Bordo and Evans (1993) rule out labour hoarding in respect of their similar GD finding of US countercyclical hourly labour productivity: they argue that "the length and severity of the Great Depression (1929-1933) suggests that the costs of adjusting employment and honoring implicit long-term employment contracts were second-order relative to the losses that many firms and industries experienced". Certainly, UK labour inputs on both extensive and intensive margins behaved very flexibly in both downturn and upturn phases of the GD. As shown in Figure 8, employment fell by 6.5% in 1929-30 and by a further 5.5% the following year. In the recovery stage, employment rose by 5.1% in 1932-33 and by a further 5.5% the following year. Average weekly hours declined by 4.7% between 1929 and 1930 followed by a further 3% decline the following year. So, on firms' intensive margins, cuts in working time were both speedy and large.[15] At the start of the recovery in 1932-33, average weekly hours increased by 4.8% and by a further 4.2% the following year. Figure 8 clearly reveals that rates of decreases and increases in total weekly hours, H, were significantly enhanced by the changes of both component parts of labour input.

Figure 8 Annual percentage rates of change of employment, weekly hours and total hours over the GD cycle

The post-1932 recoveries in employment, hours and labour productivity were strongly enhanced in 1935. This year marked the start of a series of major rearmament programmes. EMA industries were essential to what was to become the core of the manufacturing war-effort. Parker (1981) provides a valuable discussion of the fiscal policy and collective bargaining aspects of this activity

A preponderance of general skills among engineering and metal workers was undoubtedly linked to a low propensities to hoard labour during the GD. The highest skilled workers, so-called journeymen, were fully apprenticed blue collar workers. An

[15] Falls in average weekly hours resulted both from a reduction or elimination of overtime working and, more significantly, by the introduction of short work weeks. Both reactions were especially strong in the northern engineering districts of England as well as in Scotland and North Ireland where older and more traditional metal working and engineering firms predominated (see Hart and MacKay, 1975).

apprenticeship lasted for between 5 to 7 years. Most apprentices had no pre-work school qualifications since their employment starting ages were below 16, the age when qualifications were available by examination in selective secondary schools. Their apprenticeship training was typically confined to a single trade – e.g. fitters, turners, boilermakers, patternmakers, iron moulders. Their acquired skills were equally valuable to competing firms. The net costs of training were modest.[16] A low incidence of firm-specific training reduced firms' incentives to retain workers whose marginal product fell below the going wage rate.[17]

Were the productivity effects of significant job losses during the GD enhanced by employers laying off their least productive workers? Post-1929, unions were weakened through large losses of membership and the potential for unilateral decision making by employers was enhanced.[18] Certainly, there were ample opportunities to improve the average

[16] In the first year an apprentice typically earned about one-sixth of a journeyman's hourly pay rate and in the final year somewhat less than one-half (Hart, 2005). For much of their time, on-the-job training consisted of learning-by-doing alongside fully apprenticed journeymen. In the final year of their apprenticeship they commonly performed unsupervised job tasks equivalent to those of a journeyman in the same occupation. Such pay differentials and work activity are compatible with Becker's (1962) human capital proposition that workers cover all the training costs related to general skill acquisition.

[17] There was strong procyclical adjustment in the employment of journeymen in EMA industries between 1929 and 1938. A significant procyclical response among journeymen is captured by the current annual change in unemployment with an insignificant influence of the lagged rate. In contrast, apprentices' procyclical responses exhibited a delay, indicated by a significant one-year lag in the change of unemployment. These findings combined with direct documentary evidence supports the contention that apprentices provided substitute labour for more expensive older journeymen during the GD cycle (Hart, 2005).

[18] A major example of this occurred on a large scale in relation to EEF employers' attempts to cut labour costs at the start of the GR. They sought to cut overtime premium payments, nightshift rates and piecework prices (Knowles and Hill, 1954; Wigham, 1973). Eventually, in July 1931, the unions agreed fully to the proposed cuts after the threat by employers of unilateral action.

productivty of the employment stock in EMA industries in the GD 'as many firms had been rationalised or merged or put out of business by the slump' (Wigham, p. 134).[19]

Another explanation of improved productivity is that workers' awareness of rapidly growing layoffs and unemployment in their local engineering labour markets may have encouraged greater work application and effort in order to reduce their own layoff probabilities. Between 1929 and 1932, average unemployment rates in the UK rose from 11.7% to 25.3% across 28 EEF districts (Hart and MacKay (1975, Table A.5).[20]

Not only were the lengths of weekly hours flexible during the GD but there are strong reasons for supposing that they enhanced labour productivity reponses due to diminishing returns. Long weekly hours were the norm in the EMA industries covered here. Pencavel (2015 and 2018) produces micro evidence of diminishing returns to long average weekly hours based on British and US micro datasets. In his study of British munitions workers in WW1, diminishing returns are observed in respect of weekly hours in excess of 44.[21] Based on an augmented Cobb-Douglas production function that allows the elasticity of output with respect to weekly hours to vary with hours and on a standard Cobb-Douglas function subdivided into short-hours and long-hours regimes, Pencavel (2018, see Figure 7 and Table 4.5) finds that weekly hours above 44 are statistically consistent with diminishing returns. As shown in Figure 2, peak-to-trough falls in average weekly hours in GD engineering and metal working clearly fall in this range of working time. For workers prone to stress and fatigue due

[19] Margo (1992, pp.3/4) reports on somewhat indirect evidence of layoffs among the least efficient workers in US firms during the GD and also reports on the closure of inefficient plants in the US automotive industries (p 13).

[20] These rates are reasonably close to the UK administrative unemployment rates provided by Denman and McDonald (1996). These range from 10.4% to 22.1% between 1929 and1932.

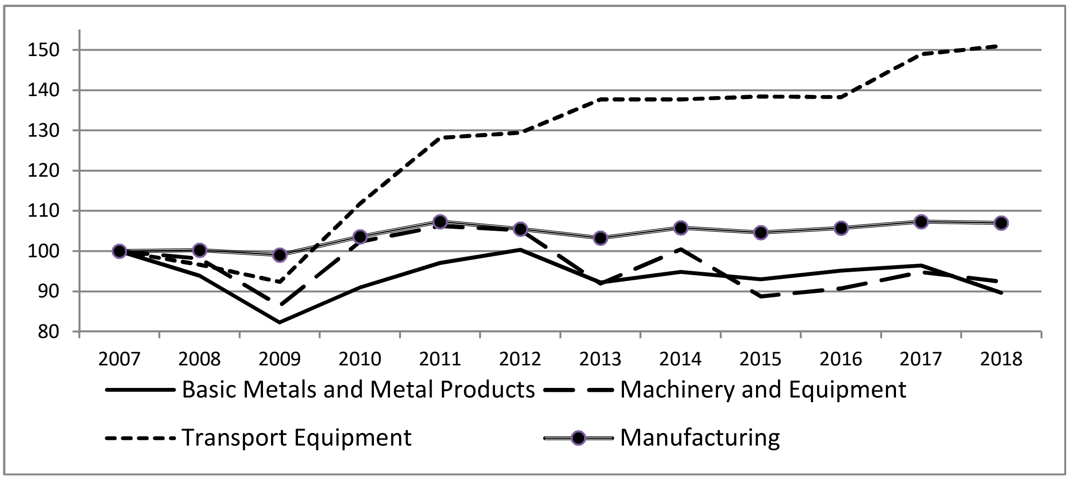
[21] Munitions production was undertaken in some EEF member firms, an activity that was to become especially important in the run-up to and during WW2.

to long work hours, significant reductions in weekly hours may have helped to improve labour productivity through improvements in work performance.

As outlined in Section 2, Mitchell's (1913) three factors leading to decreasing labour productivity returns – laying off the least productive workers together with the effects of the threat of unemployment and the introduction of shorter weekly hours on work performances – are all likely to have played significant roles within EMA industries during the GD.

(b) The Great Recession

Figure 9 Q/H in the GR, 2007 to 2018 (annual data, 2007 = 100)

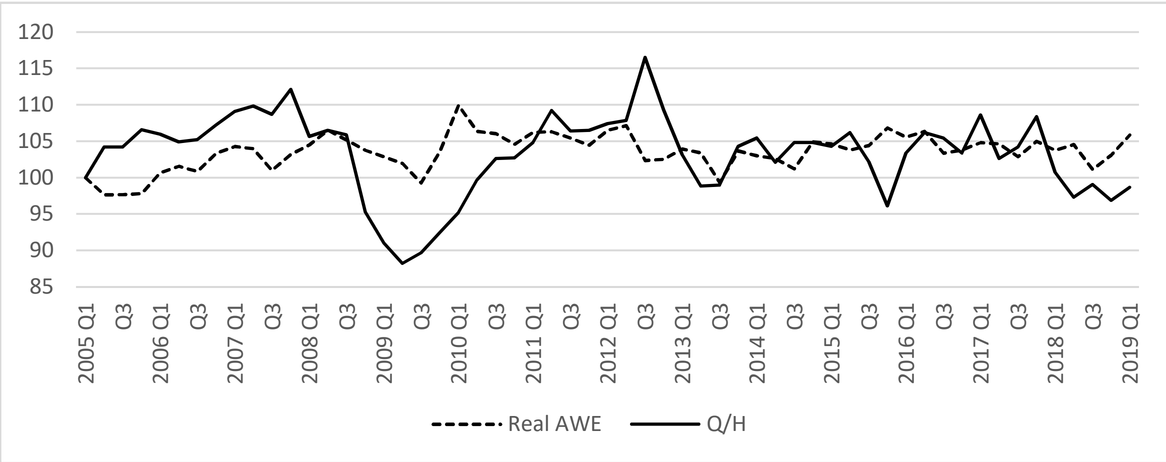


(c) Source: Office for National Statistics

Figure 9 shows the annual progressions of Q/H over the years 2007 to 2018 for the three EMA sectors together with that of total manufacturing. With the exception of a prolonged increase in hourly productivity in the Transport Equipment sector after 2009,[22] the remaining manufacturing picture is one of either low productivity growth or productivity contraction. Total manufacturing underwent a very modest recovery while both Basic Metals and Metal Products and Machinery and Equipment sectors have displayed sustained periods of hourly productivity reductions since the 2007 starting point.

[22] As shown by the UK Commission of Employment and Skills (2014, Table 1.2), Transport Equipment was one of the top UK output growth sectors between 2005 and 2012.

Figure 10 Indices of real AWE and Q/H: Basic Metals and Metal Products (2005 Q1 = 100)



Source: Office for National Statistics

Figure 10 shows the real AWE (deflated by GDP) and hourly labour productivity Q/H for the largest of the three GR sectors (see Table 1), Basic Metals and Metal Products, over the period 2005 Q1 to 2019 Q1. Peak Q/H at the start of the recession occurred during 2007 Q4 (see also Figure 4). Prior to that quarter, both Q/H and real AWE had been rising strongly since 2005. This period not only marked strong productive performance in the economy as a whole but also solid company business positions in terms of cash flows and returns on capital employed (Martin and Rowthorn, 2012, pp. 26-28). The consequent healthy financial positions of many firms at the start of the recession may have strengthened their ability and willingness to retain excess labour over the ensuing downturn (Coulter, 2016).

From its peak in 2007Q4, Q/H fell over 20% to its trough in 2009Q2. It then rose to a new peak in 2012Q3. The peak-to-trough movements of real AWE, displaying a somewhat lagged response, were far less severe. Starting in 2008Q2, real weekly pay fell back by 7% to 2009Q3 before rising by 10% to 2010 Q1. Thereafter, real AWE reduced gradually over a prolonged period: by 2013Q4 it had fallen to its 2005Q1 starting level. Then it more or less kept in line with productivity performance until 2018.

The weak reaction of real AWE to Q/H falls at the start of the GR is in sharp contrast to the equivalent reaction in the GD. One important reason for this was that, unlike the GD, average weekly hours' changes during the peak-to-trough GR period did not provide a strong contribution towards reducing AWE. As shown in Figure 5, the early phase of the GR was marked by average weekly hours in Basic Metals and Metal Products moving up and down within a narrow one-hour band between 35.5 and 34.5 hours. When recovery set-in after 2009Q3, hours increases did play an important role, rising by 2.8 weekly hours to 2010Q4 (see Figure 5).

In contrast to the upward pressure on real hourly product wages due to the 1929-34 output price deflation, the prolonged decline in real AWE from 2010 to 2014 in relation to the Basic Metals and Metal Product sector was symptomatic of the whole economy in respect of real hourly and real weekly wages (see Taylor, Jowett and Hardie, 2014, Figure 4). It has been suggested that the decline in real AWE during the GR may provide a reason for the relatively mild decline in employment relative to output (as detailed here in Table 2) and hence to a fall in labour productivity (Coulter, 2016). But this begs the question of why, on the labour supply side, workers would appear to have acquiesced to such serious falls in pay.

One reason for the reduction in real AWE between 2010 and 2014 may have been related to the long-term decline in the bargaining power of workers due to reductions in union coverage and firm-level collective bargaining. This trend commenced in the 1980s and continued to present times (Brown, Bryson and Forth, 2008; Bell and Hart, 2020). An associated advantage in respect of labour productivity is that employers may have been in a relatively strong position to lay off the least productive workers following the financial crisis. Support for this supposition for the UK workforce is provide Blundell, Crawford and Jin (2013) via an Oaxaca wage decomposition equation based on the Labour Force Survey from 2007 to 2012. They estimate that mean log wages would have been expected to rise by 3.3%

due to improved compositional changes in respect of worker job characteristics. Yet, overall, mean log wages are found to have fallen by 5.3%. The strong net negative wage outcomes are argued to have occurred among those who remained in work through this time. First, continuing declines in bargaining power of labour might have been strong enough to reduce wages despite the favourable worforce compositional effects on average productivity. Second, wages may have been depressed due to a rise in labour supply, for example following a sustained period of significant net inward migration. Third, reductions in household wealth may have led to more workers being keen to retain their existing jobs in the face of increased competition on the jobs market. On the labour demand side, Pessoa and Van Reenen (2016) argue that falls in real wages have been accompanied by increases in capital costs resulting in a fall in the capital-to-labour ratio. This is consistent with labour productivity falling more than that of total factor productivity.

It was argued in relation to the GD that employment flexibility was helped by the fact that metal working and engineering skills were largely general in nature. General skill acquisition has been relatively less important in the current era. A major reason for this is that many repetitive job tasks traditionally associated with general skills of both timeworkers and pieceworkers in the 1930s have been effectively automated. As examples, automation now features prominantly in drilling, milling, fitting, press operating, riveting, welding, and tool making. Further, the advent of computer aided design and manufacture (CAD/CAM) and computer numerical control (CNC) machining has enabled firms to achieve a far greater degree of production flexibility and diversification thereby enabling high degrees of bespoke specialisation in metal and engineering manufacture. Accordingly, there has been a greater emphasis on firm specific knowhow and skills. Associated with this, there has also been a greater demand by employers for pre-work educational qualifications, both at school and at college levels. School qualifications for most applicants are gained at around age 16 and, for many of these, higher qualifications at schools and colleges are achieved in later years. College courses are available for the basic skill requirements in metal and engineering jobs, such as a CNC machinist or a CAD technician.

Workers who obtain relevant pre-work qualifications and who are subsequenly trained in firm-specific applications are likely to be of long-term value to employers. Lambert (2010) notes that in UK manufacturing following the 2007/8 downturn, and in comparison with earlier recessions, there has been a greater reluctance among employers to lay-off workers and a stronger willingness to accept temporary productivity reductions among skilled workers. It is also pointed out that since the early 1990s to the start of the GR there was a rise from a fifth to a third in the proportion of working age employees who had completed higher education and that in the ten years before the GR most of the million jobs that had disappeared in the manufacturing sector involved less skilled process workers.

Unemployment rates during the GR[23] rose from 5.3% in 2007 to 7.6% in 2009 to a peak of 8.1% in 2011 before entering a long and substantial decline to 3.8% in 2019. So, for example, the GD peak rate in 1932 was in the region of 2.5 to 3 times higher than the GR peak. In fact, as proxied by unemployment, the UK labor market in the GR fared much better than most European countries (Herz and Van Rens, 2020). It is likely, therefore, that the threat of job loss during the GR was a less potent means of encouraging work effort for the typical EMA employee.

As for weekly hours reductions, it was earlier noted that in relation to his study of WW1 munitions workers, Pencavel (2018) found diminshing returns for weekly hours in excess of 44. In contrast, weekly hours between 43 and 33 were found to be statistically consistent with the hypothesis that hours vary proportionately with output. These differences

[23] Referring here to individuals aged 16 and over (Office for National Statistics).

between relatively long and short weekly hours regimes are consistent with the divergent hourly productivity behaviours in the peak-to-trough periods of the GD and the GR.

It is likely that in both the GD and GR downturns, employers were able in part to layoff their least efficient workers due to a decline in unions' collective bargaining power. The unemployment and working time differences between the GD and the GR would point to the likelihood that positive productivity effects on work application and effort due to threats of job loss and to hours' reductions would have been more potent in the GD.

6 A parallel scenario in recent comparative US and European labour productivity experiences

Table 3 Changes in GDP, Employment and Labour Hours in the Great Recession

	UK			Germany			US		
	Peak	Trough	Change (%)	Peak	Trough	Change (%)	Peak	Trough	Change (%)
Real GDP	2008 Q1	2009 Q2	-6.1	2008 Q1	2009 Q1	-6.6	2007 Q4	2009 Q2	-4.1
E	2008 Q2	2010 Q1	-2.3	2008 Q4	2009 Q2	-0.5	2008 Q1	2009 Q4	-5.6
H	2008 Q1	2009 Q3	-4.3	2008 Q2	2009 Q2	-3.4	2007 Q4	2009 Q4	-7.6

Sources**:** Germany and US percentages, Burda and Hunt (2011, Table 1). UK real GDP data from Office for National Statistics (ONS); E and H from Labour Force Survey (LFS).

Both employment and labour hours responses to falls in real output experienced by EMA industries were far more pronounced during the cyclical downturn in 1929 compared to that of 2007/8. Looking at the GR in an international context, the US exhibited much larger employment and labour hours responses than did European countries. As shown in Table 3, the US fall in real GDP was large, though somewhat less than experienced in the UK and Germany. But US relative employment and total hours reductions were considerably greater.

Pessoa and Van Reenen (2014, Figure 4) compare the paths of hourly labour productivity from 2008Q1 to 2012Q1for the three countries in Table 3 together with France and Italy. The European countries display hourly labour productivity changes similar to those shown in respect of the UK's three EMA sectors in Figure 9. In contrast, hourly productivity in the US follows a pattern that more closely reflects that shown in Figure 1 for the GD coverage here. In 2008 US Q/H rose countercyclically, then fells back slightly for one quarter before rising far more strongly and consistently than in the European economies. Moreover, in similar fashion to the GD wage observations for the UK, but contrary to the those of the GR, real product wages rose during the US recession. Mulligan (2011) provides and interesting analysis of US rises in hourly labour productivity and real product wages over the 2008-9 period.

7 Conclusion

The level of hourly labour productivity in EMA industries at the start of the GD in 1929 was exceeded during the peak-to-trough years before rising strongly from 1933 onwards. For roughly 70% of the EMA industries in the GR, the productivity performance was far less satisfactory. Commencing in 2007/8, hourly labour productivity fell considerably in the peak-to-trough years, recovered by 2012 before falling back for a prolonged period to levels below those recorded at the outset of the recession.

The respective costs to workers associated with these two productivity trajectories ran in the opposite directions. Higher proportions of workers lost their jobs in the 1930s and there were considerably larger cutbacks in average weekly paid-for working hours. In large part, the GD labour flexibility that was vital to average hourly productive performance was achieved at the price of reduced workforce economic welfare. In contrast, far higher proportions of workers retained their jobs and experiencd less severe cutbacks in weekly working hours during the GR, despite equally serious demand falls in EMA industrial output. Moreover, for those workers who lost their jobs in the recent recession, state social welfare support was more comprehensive and generous than in the 1930s.

But there were two important cost features that served to reduce these apparent comparative welfare gaps. First, for those who retained their jobs during the GR, the severity of the falls in average weekly hours was considerably mitigated by real increases in hourly pay resulting from major falls in consumer prices between 1929 and 1934. Second, the recovery from the GD cyclical trough turned out to be strong and sustained, resulting in industrial expansion, real weekly and hourly wage growth, and improved productive performance. None of these three positive outcomes was experienced for most EMA sectors in the longer-term GR period.

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