REAL WAGES AND UNEMPLOYMENT IN THE BIG SQUEEZE

Short Title: Real Wages and Unemployment[*]

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UK real wage growth has slowed down, stagnated and recently turned sharply negative. We document the nature of real wage changes across the wage distribution over the last three decades, showing that recent patterns represent a distinct break of trend that pre-dates the onset of recession. We explore whether unemployment has become a stronger moderating influence on real wage growth and report, using aggregate economy-wide and regional panel data, that real wage-unemployment sensitivities have become stronger in the period from 2003 onwards. Finally, we offer some assessment of possible drivers of this increased sensitivity of real wages to unemployment.

1. Introduction

In the years following the financial crash and economic downturn of 2008-09, the UK labour market has responded differently to previous recent recessions. Output has remained below peak for much longer, with no sustained recovery apparent at least five years on from the start of the crisis. In contrast to the recessions of the 1980s and 1990s, real wages have fallen quite sharply

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rather than simply levelling off for a short period as, relative to the magnitude of the economic contraction, unemployment has risen by less than expected.

While real wage trends are affected by a number of economic factors, these two (at first glance) surprising outcomes are likely to be connected. However painful falling wages may be for individual workers, it is important to note that they may have been instrumental in preventing a much larger increase in unemployment. At the same time, the relatively benign picture for employment coupled with stagnant output has, as discussed in detail by Pessoa and Van Reenen (2014), led to an extremely poor productivity performance. This said, the factors driving these unusual (in historical terms) trends remain unclear. Set against this backdrop, gaining a better understanding of the extent to which there has been a shift in the relationship between real wages and unemployment becomes an important research venture. It is also one that has implications for real wage growth during any future period of economic recovery.

To show that this recent pattern of poor real wage performance is in stark contrast to what happened in the past, Figure 1 plots real wage growth at the 10^{th}, 50^{th} and 90^{th} percentiles of the wage distribution between 1979 and 2012. The Figure shows a general picture of steady real wage growth in the UK labour market through the 1980s and 1990s. Though wage inequality rose rapidly in this period – driven by faster growth in wages at the top (90^{th} percentile) as compared to the middle (50^{th} percentile), and in turn faster growth at the middle compared to the bottom (10^{th} percentile) this was (mostly) in the form of differential positive trends in real wage growth, and not through periods of real wage falls in any particular part of the distribution.[1] Since then, however, real wages have stagnated and then fallen right across the wage distribution.

With these developments in mind, this paper seeks to do two main things. First, we carefully document what has happened to real wage growth over time and describe how there has been different behaviour relative to the past. Second, we empirically model the way that

[1] See Machin (2011) for more detail on trends in wage inequality in the UK over the last forty years.

unemployment holds back real wages, asking whether there has been any change in the real wage-unemployment relationship in the period of poor real wage performance that has recently characterised the UK labour market. To do so we look at changes over time at both the national and regional level.

Our analysis highlights the recent period of stagnant and falling real wage growth just described that represents a distinct break of trend that started somewhere in the early 2000s and, importantly, which pre-dates the onset of recession. For example, since 2003 median real wages fell by around 1.4 per cent a year on average (flat-lining in the first part of this period and falling following the onset of recession).

At the same time, we also find an increased sensitivity of real wages to unemployment in the period from 2003. The increased correlation between the two is strong: in our empirical analysis the (negative) real wage-unemployment elasticity rises by around 5 to 6 percent (for a doubling of the unemployment rate) in the period between 2003 and 2012 as compared to 1986 to 2002. More precisely, this shift means that for the increase in the unemployment rate that took place between its low in 2005 (4.7 per cent) and its peak in late-2011 (8.4 per cent) someone working full-time at the median rate of pay earned around £1040-1240 less in annual earnings (in 2012 prices) compared to what would have occurred in earlier decades.[2]

The rest of the paper is structured as follows. In Section 2, we first briefly document what has happened to real wages and to unemployment over time in the UK, before turning to consider the connection between real wages and unemployment and a discussion of the modelling approach we adopt. Section 3 describes the data we use. In Section 4, we focus in more detail on the nature of real wage changes in the move from the period of positive real wage growth to the period of flat or falling real wage growth. In Section 5, we report our empirical findings on the

[2] The unemployment rate increased by 79 percent so, as the real wage-unemployment elasticity rose by 5 to 6 percent, this corresponds to 3.95 to 4.74 percent of 2012 median full-time earnings of £26,462, which amounts to £1037 to £1244.

changing sensitivity of real wages to unemployment and present a first exploration of possible explanations as to why such a shift has occurred. Finally, in Section 6 we offer some conclusions.

2. Real Wages and Unemployment

2.1 Trends in Real Wages

For the first time since the Great Depression, real wages in the UK are experiencing sustained falls in the absence of direct government wage controls. Even in the 1980s and 1990s recessions, real wage growth paused rather than going into reverse and a general picture of a steady real wage growth dominated the UK labour market through the 1980s and 1990s. The recent turnaround in real wage growth and the slowdown that has ensued as compared to the previous two decades is shown in Figure 1.

The Figure shows real weekly wage growth since 1979 for all workers aged 16-65 from the most reliable series, the New Earnings Survey (NES)/Annual Survey of Hours and Earnings (ASHE) employer reported data that covers around 1 percent of the population. The Figure shows that at some point in the early 2000s - beginning around about 2003 - the picture of rising real wages, coupled with rising wage inequality through faster real wage growth higher up the wage distribution, ended. It is interesting that real wage growth stalled well before the onset of the deep recession of 2008/9, when the UK experienced the tightest labour market we have had since the 1970s and with reasonable economic and productivity growth. That said, the Figure also makes it clear that falls in real wages occurred across the wage distribution with the onset of recession.

The Figure uses the Retail Price Index (RPI) to adjust for inflation as this is the only series that covers the entire period. The more widely used measure currently is the Consumer Price Inflation CPI series which generally shows a lower degree of inflation through this period. This then suggests that median real wage growth continued albeit at a slow rate until 2007 and shows a slightly less marked fall since. Thus the CPI based measure suggests that the recent fall in real

wages is of the order of 9 percent which has taken wages back to the levels seen in the early 2000s rather than the 11.5 percent or so represented in Figure 1. Even so such a fall is unprecedented since WWII.

2.2 Trends in Unemployment

As with the real wage trends, labour market performance in the recent past in the UK has evolved rather differently to what has happened in previous recessions. Typically, in periods of recession output falls and employment tends to fall to a similar or slightly greater degree, leaving productivity broadly stable and in turn real wages broadly stable as for the early 1990s recessionary period in Figure 1. As unemployment then falls back during recovery, growth feeds into wages to a greater degree than employment. This is the normal pattern that we had got accustomed to. Hence in the UK, as in other developed countries, the cyclical volatility of unemployment has been large relative to that of real wages, which has long puzzled economists (see Pissarides, 2009, or Kudlyak, 2010).

These patterns have looked different in the last decade, however. By historical standards, Britain has been experiencing not just a severe recession, but what some commentators refer to as a 'Great Recession'. Indeed, the fall in economic output in the recent recession was almost as large as the 1930s, but the recovery has been markedly slower. Output was nearly 4 percent below peak levels four years on from the start of the recession. By the same stage, the 1930s economy was in a sustained recovery.

One possible reason why things may not feel like a Depression is that the loss of employment has been relatively modest, with a fall in employment of just over 2 per cent of jobs compared to around 6 per cent in the previous two recessions. Indeed, a jobs recovery started as soon as the economy showed some growth in late 2009 and has held up well in the long period of economic stagnation that started in the second half of 2010. Figure 2 shows the ILO unemployment rate between 1979 and 2012. It shows very clearly how much unemployment

came down before the early 2000s, dropping from 10.6 per cent in 1993 to 5 per cent by 2003. The sharp increase in the late 2000s recession, with a rise from around just under 5 to a little over 8 percent, is also evident but flattens off relatively quickly after the recession ended and at significantly lower levels than after the two preceding milder recessions.

Putting these patterns of output and employment/unemployment change together makes it clear that productivity growth has stalled since 2006, which in historical terms is a remarkably sustained period (see the discussion by Pessoa and Van Reenen, 2014). The UK thus has output about 6 per cent below that recorded in previous recoveries of this maturity, but employment is 4 percent higher – this 10 percent productivity differential of producing less with more people is huge (see Blundell et al., 2014, and Wadsworth, 2013). Moreover, with cuts in employment resulting in 'productivity improvements' in the public sector, the gap appears to be concentrated in the private sector.

2.3 Real Wages and Unemployment

The recognition that unemployment can act to restrain wages dates back to the classical economists (for example, Marx's discussion of the reserve army of labour). In modern economics, the Phillips Curve (Phillips, 1958) had suggested a stable relationship existed between unemployment levels and wage growth, with higher unemployment restraining nominal (not adjusted for inflation) wage changes. This empirical relationship lacked any theoretical foundations except the plausible principle that 'when demand for labour is high and there are very few unemployed we should expect employers to bid wage rates up quite rapidly'.

However, this relationship broke down in the period of high inflation in the 1970s and newer theoretical and empirical evidence moved to suggest that unemployment regulates the rate of real wage growth, the mark up of wage growth over inflation, rather than nominal wage changes. Thus low unemployment was associated with not just higher wage growth, but a situation where wage growth exceeded productivity could lead to a slow but steadily upward

wage-price spiral. In this setting, the level of unemployment that holds wage growth and inflation steady was called the Non-Accelerating Inflation Rate of Unemployment or NAIRU (Layard, Nickell and Jackman, 1991) or the sustainable rate of unemployment by politicians. More recently, this real wage-unemployment debate has been revisited with Gali (2011) suggesting that the Phillips Curve has re-emerged in the US at least and arguing that, with wage setting rigidities the Phillips Curve relationship where unemployment restrains nominal rather than real wage growth, does have plausible theoretical underpinning.

Other empirical work has studied the relationship between the level of wages and local unemployment, via the existence of the so-called 'wage curve' (see Blanchflower and Oswald, 1994, 1995; and the meta-study of Nijkamp and Poot, 2005). Sargan (1964) also noted that the steady state (long run) solution to the Phillips' curve specifies that the level of wages depends on the level of unemployment. Moreover, in US work, Hines, Hoynes and Krueger (2001) argue that a relationship between the levels of unemployment and (real) wage levels both fits the data better and has a better justified theoretical justification to show how unemployment can restrain wages.

Higher unemployment acts to restrain the level of real wages in three potential ways. First, in times of high unemployment workers have a reduced scope to push for higher wages because of the lower availability of better alternative offers from other employers. Secondly, because workers fear job loss more when there are so many more people to compete against to get a replacement job, they may cede wages to hold on to a job. Finally, new job openings are flooded with applicants and firms can secure well qualified labour at lower wages than in better times.

Evidence suggests, however, that the unemployed and employed workers are not close competitors. Workers losing their jobs are disproportionately drawn from the ranks of the lower paid (Gregg et al., 2012). Even then on return to work, wages are substantially lower than prior to job loss (Nickell, Quintini and Jones, 2002), especially for longer periods of unemployment, and part of these wage losses persist for long periods. Those suffering from longer periods of

unemployment also struggle to maintain stable employment, suffering further periods of unemployment even 15 or more years later (Gregg, 2001). Part of the permanent loss of earnings stems from this instability of later employment or repeat job loss (Gregg and Tominey, 2005). This all suggests that many unemployed struggle on the margins of the labour market rather than acting as close substitutes for those in stable work. The more concentrated unemployment is on individuals (via long-term unemployment), regions or skill groups is likely to reduce this competition effect and reduce the downward pressure on wages (Nickell and Bell, 1995). Hence the unemployment sensitivity of real wages for workers already in employment, especially for higher paid or more educated workers, has regularly been found to be lower than for the unskilled for whom the elasticity of the wage curve is larger.

Of course, the recent evidence of slower real wage growth described in Section 2 does not necessarily mean that wage setting has become any more sensitive to unemployment. The pay restraints imposed by government in the 1970s are widely thought to have led to a build of wage pressure that was released after 1979, just as unemployment was rising and trade union influence began to decline, which is again widely thought to have led to reduced wage pressure. Hence, this period saw quite rapid wage growth among middle to high earners, despite high unemployment, and thus rising wage inequality (Machin, 1996, 2011).

Possibly more pertinent to the current period is the large scale migration from A8 countries from 2004, which could also have placed extra downward pressure on wages. Note that such migration would be focused on areas of high job demand and hence low unemployment. So this would tend to dampen the sensitivity of wages to local variations in unemployment as labour is arrives into these areas from overseas. So wage pressure in an economy may increase or decrease without any changed particular sensitivity to unemployment levels or indeed may actually go the other way and generate reduced sensitivity to local unemployment conditions through increased labour supply.

Thus, it is hard to assess whether this period of constrained real wage growth since 2003 reflects an increased sensitivity to unemployment from looking at aggregate data. It may simply reflect an aggregate slowdown in wage pressure for reasons unconnected to prevailing levels of unemployment. So to explore this question of wages have become more sensitive to unemployment, we begin by looking at the macroeconomic picture, and then move on to study regions over time. We wish to assess the sensitivity of wages to local unemployment to study whether this relationship appears to have strengthened and therefore resulted in poor real wage growth and thereby increased the importance of low unemployment for delivering real wage growth. If this is the case, we also need to consider whether such effects are more or less pronounced in different parts of the wage distribution.

Modelling Approach

We begin by running exploratory time series regressions at the economy wide level of the form:

$$\text{Log}(W_t) = \alpha_1 + \delta_1 \text{Log}(U_{t-1}) + \lambda_1 t + u_t \qquad (1)$$

where W is the real wage, U the unemployment rate, t a time trend and u is a random error.

Equation (1) relates the log real wage in period t solely to the log unemployment rate in period (t-1) and a trend. The key unemployment level term is lagged one period to reduce the potential for current prevailing economic conditions to be both driving unemployment and wage movements. However, we also respecify the formulation to allow for possible changes in unemployment to affect real wages as follows:

$$\text{Log}(W_t) = \alpha_2 + \beta_2 \Delta\text{Log}(U_t) + \delta_2 \text{Log}(U_{t-1}) + \lambda_2 t + v_t \qquad (2)$$

where the particular functional form adopted for the unemployment rate allows for short run effect (measured by the coefficient β_2) of changes in log unemployment to affect log real wages.[3]

[3] This is, of course, a particular functional form including t and (t-1) dated log unemployment as independent variables. We prefer to specify this way so as to obtain estimates of the δ's.

Estimating (1) and (2) for the whole period and two sub-periods before and after 2003 with annual data means that the sample size is low and therefore we very much think of this as an initial exploratory analysis of the wage sensitivity of unemployment. As such it is not feasible to isolate the role of unemployment from any other cyclical economic performance measures.

Pooled regional–time series panel data, sometimes referred to as meso-level analysis lying in between macro-aggregate and micro-individual level, offers a way forward. We consider two variants of the more general equation (2) within this approach at the regional level r:

$$\text{Log}(W_{rt}) = \alpha_r + \beta_3 \Delta \text{Log}(U_{rt}) + \delta_3 \text{Log}(U_{r,t-1}) + \lambda_3 t + \theta_3 X_{rt} + u_{rt} \quad (3)$$

$$\text{Log}(W_{rt}) = \alpha_r + \beta_4 \Delta \text{Log}(U_{rt}) + \delta_4 \text{Log}(U_{r,t-1}) + T_t + \theta_4 X_{rt} + v_{rt} \quad (4)$$

The models in (3) and (4) differ from the aggregate model first by the inclusion of regional fixed effects (α_r) and second because in some specifications we add regional controls X_{rt} to control for composition changes.[4] The latter include regional proportions of the workforce by age, education (proportion with a degree), gender and race.

Equations (3) and (4) differ in their modelling of common macroeconomic effects. The first model includes a time trend to do so, whilst the second includes a full set of year dummies T_t. Thus our main parameter of interest in the first equation, δ_3, captures an aggregate economic cycle in terms of (detrended) unemployment changes and regional specific deviations from this aggregate cycle. The inclusion of year dummies in the second equation conditions out the aggregate economic cycle and the parameter of interest, δ_4, captures an effect identified solely off of the regional deviations from the aggregate cycle.

In our main models, we consider the median log real wage as the dependent variable of interest. However, we also present results at decile intervals across the wage distribution so as to assess how widespread any shift in real wage formation, both in terms of underlying trend wage growth and sensitivity to unemployment, has been across the wage distribution. We also present

[4] See Blundell et al (2014) for study of the role of compositional change in the labour market during the recession.

a range of robustness tests, looking at models incorporating wage dynamics (as Blanchflower and Oswald, 1995, or Bell et al., 2002), using different price deflators to define the real wage, excluding London from the analysis and replacing the unemployment rate with its employment counterpart.

3. Data

We use employer reported wages data from the New Earnings Survey/Annual Survey of Hours and Earnings (NES/ASHE). This is an approximately 1 percent sample of all workers based on the last two digits of their National Insurance number. The data is drawn from firms' administrative pay records on a common reporting basis and represents the most accurate UK wage data. From 1979 to 2003, this was called the New Earnings Survey (NES) and from 2004 onwards the Annual Survey of Hours and Earnings (ASHE).[5]

For most of our analysis, we consider weekly wages (in 2012 prices, deflating by the retail price index, RPI) at different decile points of the wage distribution. Our initial analysis considers log real wages at the median, or 50^{th} percentile, of the distribution (i.e. for the worker exactly halfway up - or down - the wage distribution). We also study wages at different points in the overall distribution, looking at workers at intervals for each tenth of the working population (the 10^{th}, 20^{th}…… up to the 90^{th} percentiles of the distribution). The pay records on men and women are included for all those aged 16 to 65. The pay includes reported bonuses and overtime, but not in kind payments such as share options.

We have put together a regional panel of data on wages from the NES/ASHE data and unemployment rates from the Labour Force Survey for the standard regions of Britain: North East; North West; Yorkshire and Humberside; East Midlands; West Midlands; East Anglia;

[5] It is worth noting that there are some aspects of the sampling and data collection structure that could cause some changes in NES/ASHE series over time. These include the introduction of weights, changed definitions of incentive/bonus pay (in 2005) and occupational coding changes that affect weights (in 2007 and 2011). We use unweighted data and so only the 2005 change is of any relevance, and since we perform our analysis at regional or aggregate level, any impact should be minimal. See the online Data Appendix for more detail.

London; South East; South West; Wales; and Scotland. The sample we use covers these eleven regions for the years 1986 through 2012.[6] More details are given in the on-line Data Appendix.

4. Changes in Real Wages

Figure 1 is suggestive of a temporal break in real wage growth across the wage distribution that occurred in the early 2000s. This pattern of growing wage inequality and a recent slowdown in wage growth is also shown in Table 1 where the greater magnitudes of the trends in the real wage growth higher up the distribution can be seen. Panel A of table 1 shows that over the period 1979 to 2002 real wages grew by 0.65 percent per annum for workers at the 10th percentile of the wage distribution, by 1.41 percent per annum at the median and by 2.15 percent per annum at the 90th percentile.

Since 2003, however, a break in trend occurs.[7] The final column of the Table shows the picture from 2003. For low wage workers, at the 10th percentile of the distribution, falling real wages post-2003 more than totally offsets the previous growth for low paid workers from 1979 up to then. This partly reflects the rise of part-time working over this period, as its weekly wages that are reported here and also the use of the RPI deflator which is discussed below. However, even at the median the faster rate of earnings growth of the 1979-2002 period is matched on a per annum basis by falls after 2002 with negative real wage growth again of -1.39 percent per year. At the 90th percentile the shift is to slightly lesser falls in wages of -0.99 percent per annum. Panel B of Table 1 repeats the picture but starting in 1986, the period over which our estimation of the sensitivity of real wages to unemployment is undertaken in the analysis that follows. The patterns are very similar.

[6] The start year of 1986 is dictated to us as it is the first year when we can use the ILO definition of unemployment from the Labour Force Survey.

[7] In an earlier version of this paper, we presented Figures showing trend predicted wages for the whole period and up to 2003 alone. These confirmed the existence of a break around 2003, but showing them does not add substantively to the discussion of the numbers in Table 1 (results available on request from the authors).

Thus, the labour market experienced a shift away from positive real wage growth that started around 2003. So far the real wages numbers we have discussed deflated by the RPI, which is the only series of consumer price inflation available over the full period we consider. It is, however, well known though that the RPI produces higher price inflation than now routinely used Consumer Price Index (CPI). The differences are partly due to the fact that the CPI does not include housing costs for owner occupiers (reflecting mortgage costs and house prices), but also has a different calculation method which leads to a lower estimated increase in prices (see Office for National Statistics, 2012, for detailed discussion of alternative price measures). The CPI, however, is only available from 1988. Producer price inflation as captured by the GDP deflator suggests an even lower rate of price increases. More recently the Office for National Statistics have released a revised RPI series (RPIJ) which uses the same basket of goods as in the RPI, but the methodology is more similar to the CPI. This is only available back to 1998.

Figure 3 shows the time series evolutions of these four price indexes, for the time periods for which they are available (and set to 100 in 2012). It confirms that there are differences over time in the levels of price inflation that they depict. In panel C of Table 1 we thus repeat the median wage growth exercise using these alternative price deflators (on shorter time periods). Using these deflators does show higher real wage growth at the median over the whole 1988 to 2012 time period, and real wage falls since 2003, but at a rate that is just over one half of a percent lower per annum than when the RPI deflator is used. This then makes a material difference to the picture of real wage movements over data period but the slowdown in wage growth and recent falls are still very much apparent. In the recent post-2002 period the GDP deflator shows a distinctly slower rate of growth than even the CPI suggesting a modest wedge between real wages from the perspective of producers and consumer wages over this period. Thus, in the next Section where we move on to report results from estimating real wage-unemployment sensitivities from economy wide and regional real wage equations between 1986

and 2012, we also discuss what happens when different price deflators are used to define wages in real terms.

5. Estimates of Changing Real Wage-Unemployment Sensitivities

5.1 Economy Wide Median Real Wage Equations

Table 2 shows real wage-unemployment sensitivities estimated from aggregate equations (equations (1) and (2) from Section 2 above). The upper panel of the Table shows estimates from a specification relating the (log of the median) real wage to the (log) unemployment rate and a linear trend that picks up the underlying growth rate of real wages. The lower panel additionally includes the change in the (log) unemployment rate. In each panel results are shown in columns (1) and (2) for the whole 1986-2012 period, with column (1) specifying a linear trend and in column (2) this is split for periods before and after 2003 (1986-2002 and 2003-2012).

In the specifications reported in both columns, the first thing to note is that there is a significant wage restraining impact of lagged unemployment on median real wages. In column (2) of Table 2 we report an estimated elasticity for the full period of -0.102 in the upper panel and -0.088 in the lower panel. The column (1) specification, which does not allow for a shift in trend real wage growth, displays a far higher elasticity (of -0.175 in the upper panel and -0.179 in the lower panel). In both specifications of the lower panel estimates, the current period change in unemployment is poorly determined suggesting that we are not picking up effects of the economic cycle on wages other than through the lagged effect of higher unemployment.

Considering the magnitudes of these estimates, it is worth noting that in the first year of our sample (1986) unemployment was high and nearly halved by 2002. Of course it has also risen sharply in the recent downturn: as we described in the Introduction, the trough to peak rise from 2003 to 2012 was 79 percent. The column (2) estimates of the trend coefficients suggest that wages were growing at an underlying rate of 0.8 percent per annum before 2003, but were also

boosted by the halving of unemployment. From 2003 onwards, they grew at an underlying rate of -0.5 percent in the upper panel equations (from the difference in the trend coefficients, 0.008 - 0.013), and by -0.6 percent in the lower panel equations. Over and above this, flat or falling real wage growth occurred as a consequence of the wage dampening effects of rising unemployment.

However, these first estimates do not explore whether there is variation in both the unemployment sensitivity for the sub-periods 1986-2002 and 2003-2012. This is shown in the columns (3) and (4) where we allow differential effects for both trend wage growth and unemployment for each period. The unemployment restraining effect rises sharply, between the two time periods, in the upper panel going from -0.062 to -0.184, or a change of -0.122, and in the lower panel going from -0.056 to -0.151, corresponding to a change of -0.095. Hence, the wage dampening unemployment effect is far greater post-2003 (although the change reported in the final column of Table 2 for the lower panel models is not very precisely estimated owing to the small sample sizes).

The estimates also suggest underlying wage growth was a little bit higher in both periods than when we do not allow for a shift in the impact of unemployment (annual rises of 0.9 percent pre-2003 in upper and lower panels and falls of 0.2 percent for the upper panel and 0.4 percent for the lower panel after). So compared to the raw slowdown in real wage growth of 2.7 percent (panel B Table 1), conditional on unemployment and the increasing sensitivity of wages to unemployment this becomes a more modest 1.0 percent (upper panel) and 1.3 percent (lower panel). Thus, it does seem from the macroeconomic time series estimates, that wages are sensitive to unemployment levels and in the period when real wages ceased their trend growth, they became more sensitive to unemployment.

Regional Median Real Wage Equations

The aggregate economy wide data we have used so far has two potential drawbacks. First, the second post-2003 time period we consider constitutes only ten annual data points which is

very short to isolate a statistically precise increase in the effects of unemployment on real wages and any underlying slowdown in real wage growth. Second, the only measure of the economic cycle we have modelled is unemployment and anything else that is happening at the same time, such as changes in firm profitability or shifts in aggregate demand, could show up as an unemployment effect. To address these issues, we therefore also estimated results from the regional panel on real wages and unemployment.

Table 3 reports estimated elasticities of the regional median real weekly wage with respect to the regional unemployment rate from the previous year (from the regional wage curve specifications described in equation (3) of Section 2). The upper panel reports results from the same model specification as the lower panel of Table 2 (i.e. the more general model with a time trend) but here the sensitivity of real wages to unemployment in each region is considered, increasing the amount of information available. The estimated sensitivity of wages to unemployment now reflects the aggregate cycle seen in Table 2 and the local deviation from that national picture.

As before we start in column (1) with a single equation model not allowing for any temporal shifts in parameters over the time period considered. Column (2) introduces a set of region and time varying labour market characteristics. The latter variables are designed to pick up compositional shifts in the workforce such as the increasing share of the workforce that is women as well as cyclical composition shifts that might occur with the less skilled/educated dropping out of the workforce in a downturn. The controls capture education level (the proportion with a degree), age, gender and ethnicity. From the reported specification, it seems that from comparing the trend coefficient in column (2) to column (1) that composition adjusted underlying wage growth was a little slower than without these controls, mainly due to increasing education levels in the workforce.

Focusing now on the models which split the sample period, reported in columns (4) and (5) of Table 3, there is again a marked increased sensitivity of real wages to unemployment in the post-2002 period.[8] The wage equations include regional fixed effects and so the estimated elasticities can be interpreted in terms of changes in levels. As shown in the final column, the magnitude of the increased sensitivity of wages to local unemployment conditions is -0.062 (going from -0.059 to -0.121), which is strongly significant. Underlying wage growth, conditional on shifts in unemployment is slightly negative at 0.5 percent per annum after 2002, whereas it was around 1.1 percent per annum prior to this point.

The specifications in the second panel of Table 4 include a full set of year effects in place of the trend. This is a more general specification where any year to year movements in wages arising from any other source than unemployment will be captured, including the aggregate economic cycle, by the year dummies. Thus, the estimated effect of regional unemployment only reflects the year to year movements in regional unemployment that differ from the national picture. In some ways, this is a tough ask of the data as the general aggregate rise and fall in unemployment with the economic cycle is discounted and as the measure of unemployment is from a survey (the Labour Force Survey), year to year deviations from national patterns will include movements due to sampling variability which could lead to attenuation bias. Interestingly, however, in terms of changes through time, we see the same pattern of results as for the economy wide analysis and the regional analysis incorporating trends alone.

Column (4) in panel B of Table 3 shows that the estimated regional real wage-unemployment sensitivities show no significant relationship in the 1986-2002 time period, which

[8] One pertinent question, already alluded to at times earlier in the paper, is whether 2003 is the year where a structural break occurs. We conducted a Chow test for the existence of a break in the trend of real wages for years 2002, 2003 and 2004 and concluded that in statistical terms the structural break does occur then. With a trend being the only explanatory variable, the F-statistic for a structural break in the year 2002 is 331.23, in the year 2003 is 344.98 and in the year 2004 is 342.85. However, with a trend and lagged unemployment as explanatory variables the F-statistic for 2002 is 288.81, for 2003 is 326.27 and for 2004 is 315.94. Adding a lagged wage to the trend and lagged unemployment regressors, the F-statistics become 1044.00, 1122.97 and 1017.50 for 2002, 2003 and 2004, respectively.

says that there was no independent regional effect above the economy wide cycle. However, in column (5) there is a significant negative relationship in the recent 2003-12 time period (i.e. showing a 5.4 percent fall in wages when unemployment doubles, or a 3.8 percent fall for the 79 percent trough to peak rise in the unemployment rate in the 2003 to 2012 time period). Thus, real wages became significantly more sensitive to unemployment at the regional level in this latter period and the estimates are broadly in line with the greater sensitivity to the aggregate cycle seen in the macro-time series and pooled regional-time series models. The change is strongly significant in statistical terms.

Overall, the regional results are suggestive of a general slowdown in real wage growth combined with growing sensitivity to local unemployment.[9] We can retrieve the year dummies from the models in panel B and relate these to macro-level unemployment conditions in the same way as in Table 2.[10] The results from carrying out this exercise are shown in Table A1 of the Appendix and they suggest a somewhat lower sensitivity of wages to unemployment than seen in the unadjusted macroeconomic results of Table 2, but again in terms of numerical magnitudes the shift in the sensitivity (of -0.038) is broadly similar in magnitude to that seen in panels A and B of Table 3 (where the wage curves become more elastic through shifts of -0.062 and -0.050 respectively).

5.2 Regional Real Wage Equations Across the Distribution

Table 4 repeats the empirical exercise in panel B of Table 3, but considering different percentiles of the wage distribution in the regional panel. Estimates of decile specific real wage-unemployment elasticities for 1986-2002 and 2003-10 are reported, along with the change in these elasticities across the two sub-periods.

[9] We also estimated specifications where the dependent variable was the full-time weekly wage or the hourly wage and if the employment rate, rather than the unemployment rate, was entered on the right hand side of the estimating equation. These all produced qualitatively similar findings, which are available from the authors on request.

[10] In doing so, the retrieved dummies reflect an average of the regions rather than the raw national average as they have been adjusted for shifts in regional workforce composition.

The results in the Table show real wages to be far more sensitive to unemployment for the lower paid. However, at almost all deciles local unemployment becomes more important in the second period – the 10th percentile being the exception – so that the real wage-unemployment elasticities became bigger (in absolute magnitude) in the second time period. The different behaviour at the 10th percentile is most likely because the minimum wage propped up wages in the 2000s after its introduction in 1999. In the regional context, this will be likely to have boosted wages most in low wage and mostly high unemployment areas, thus lowering the relationship between wages and local unemployment. However, for the rest of the distribution, one sees unemployment restraining real wages by more in the 2003-12 time period. For higher wage workers the picture that is important for wage setting was more the national than the regional one and hence when we take out the economy wide cycle the sensitivity to just local conditions in the earlier time period was low to non-existent. Yet the estimates suggest that the sensitivity to local conditions has become increasingly important. This would be consistent with a decline in national pay setting and union bargaining toward more localised pay setting. This pattern was also identified by Nickell and Faggio (2005), and we return to this in our general discussion below.

5.3 Tests of Robustness

Table 5 reports some robustness checks. Panel A reports results from a model where we include regional wage dynamics through a lagged dependent variable (see for example, Blanchflower and Oswald, 1994, and Bell et al., 2002). It also includes the current rather than lagged unemployment rate as per the wage curve analysis of Blanchflower and Oswald (1994). Of course, this automatically adds extra difficulties as the coefficient on the lag is now biased and needs to be instrumented. Likewise current unemployment is likely to be correlated with other cyclical variables and likewise instrumentation is a sensible response.

A specification that enters the current (dated t) log unemployment rate in the dynamic wage equation and instruments using lags of wages and the unemployment rate produces

qualitatively similar effects to our main analysis. The wage-sensitivity of unemployment falls from -0.005 to -0.069, thus changing by 0.064 (as compared to the Table 3 change of 0.050). The wage dynamics appear unchanged however, suggesting that the fall in real wages is not driven by faster wage adjustment to unemployment shocks but rather by greater magnitudes of these effects. This model also supports the representation as a levels on levels model since the estimated coefficient on the lagged dependent variable is significantly below unity, which would have implied that the level of unemployment was regulated the rate of real wage growth.

A second robustness check, reported in Panel B, shows what happens if we use the GDP deflator, rather than the RPI which noted earlier produces a higher estimate of price inflation. The results remain robust, with the coefficient on the lagged unemployment rate showing a change of -0.050. We also re-estimated the upper panel Table 3 models for the slightly shorter period (1988 onwards) where three alternative inflation measures (the RPI, CPI and the GDP deflator) are available – these results are given in Appendix Table A2, with a significant strengthening of the real wage-unemployment sensitivity occurring (to slightly different degrees) for all measures.[11]

A third robustness check that we undertook was to exclude London from the regional panel, on the grounds that the economic structure of London is rather different (e.g. with the City of London financial centre and higher house prices than in other parts of the country). This made little difference to the reported results, as is shown in the results reported in panel C of Table 5.

Finally, we explored replacing the regional unemployment rate with the employment rate. This directly represents the availability of employment in the region without possible confounding effects of changes in labour supply. The estimates show a qualitatively similar pattern, in terms of a significant strengthening of the real wage-employment sensitivity in the 2003-12 time period. Note here that changes in the employment rate are much smaller in

[11] Of course, the inclusion of year dummies in the lower panel means it does not matter which price index we use as we get the same results since the dummies wash out the aggregate variation.

proportionate terms (since we adopt a log-log formulation) when compared to the unemployment rate and hence the coefficients are ten times larger.

5.4 Discussion and Interpretation

The evidence of an increase in the sensitivity of real wages to (local) unemployment conditions appears strong and robust to a number of alternative representations. Our analysis so far does not, however, shed any light on why this may have occurred. In this sub-section we offer an initial exploratory assessment of some of the more obvious potential explanations.

The regressions reported so far have been based on weekly pay and so an obvious starting point might be to assess whether hours of work have become more cyclical. The very rapid growth of under-employment - when people report they are in part-time jobs because they are not able to find full-time work - through the recession might be evidence for this. The numbers reporting under-employment rose from 600,000 to 1.4 million between 2008 and 2012 and are yet to fall back. Yet in the 1990s recession the peak was around just 800,000. There has also been much media discussion of the rise of zero hours contracts. In a similar vein, it may be the case that pay contingent of firm performance, such as bonuses and incentive pay systems, have become more prevalent raising the sensitivity to the economic cycle.

The results in panel A and B of Table 6 enable some assessment of these possibilities. Gregg and Wadsworth (2011) report that hours were not unusually volatile through this recession compared to previous ones and the results in panel A shows that switching to using an hourly pay measure shows no material difference in the results. Thus, the rise in unmet demand for full-time work appears to reflect people seeking to work more hours as falls in real wages bite than it does an unusual increase in part-time working. Panel B reports estimates based on 'Basic Pay', that is excluding overtime and all bonuses/incentive payments. There is a definitional change concerning incentive payments in our data in 2004 (this is discussed fully in the on-line Data Appendix) but this does not seem to affect the key result that basic pay has become more sensitive to

unemployment by as much as total pay has. Thus the results of panels A and B of Table 6 does not seem to suggest that changing patterns of hours of work and the composition of types of pay are driving our main result.

The sizable uptick in net immigration that followed the accession of eight eastern European countries to the EU in 2004 is broadly coincident in time with the apparent slowdown in wage growth in our data. However, migrants are likely to flow to locations with strong networks and job opportunities. So with likely exception of London they are likely to head for low unemployment areas and regions and as such are more likely, if anything, to be pushing wages down in lower unemployment regions and thus are unlikely to be driving our main result. We explore this by including a variable at the regional level measuring the proportion of UK citizens. As shown in panel C of Table 6, this variable does not attract a significant coefficient in either time period, nor does it affect the changing unemployment sensitivity by much, which remains statistically significant at -0.046.

Finally, collective wage agreements in Britain have been declining for the last thirty years or so. According to data from the Workplace Industrial/Employee Relations Surveys, the proportion of workplaces with 25 or more employees which had recognised trade unions fell from 64 percent in 1980 to 53 percent by 1990, 38 percent by 2004 and to 37 percent by 2011.[12] The proportion in the private sector with union recognition is only 17 percent by 2011 in workplaces with 25 or more employees, and even lower at 11 percent for those with 5 or more employees.[13] Thus union decline in Britain has been occurring over a long period and the unionization rate has fallen to become very low in historical terms.[14]

In the ASHE data we use, there is some information on this through details of five categories of wage setting within the workplaces where our sample are employed. These

[12] The 1980 to 2004 numbers come from Brown, Bryson and Forth (2009). We thank Alex Bryson for supplying us with the consistently defined number for 2011.
[13] These numbers from the 2011 WERS are from van Wanrooy et al (2013).
[14] See also Machin (2000).

categories do not discuss trade union presence, but rather whether wages are set according to national/industry agreements or organisation wide pay structures from 2004 onwards. Even this less restrictive measure (i.e. union and non-union) of the presence of organisation wide agreements shows a decline, falling from covering 43 percent of workers in 2004 to 38 percent in 2012.

This decline in national organisational pay setting and longer-term decline in unionization and union bargaining may well be contributing to the growing sensitivity to local unemployment. This was also identified as a potential suspect of changing wage-unemployment relations in earlier work by Nickell and Faggio (2005) who suggest that the early declines in collective agreements had increased the sensitivity wages to unemployment already in the 1980s. Table 7 thus shows results where we look at the wage sensitivity to unemployment for those covered and uncovered by some form of collective agreement. As noted above, the definition of covered and uncovered differs irreconcilably between the pre-2004 measures, which comprise a list of major national collective bargain agreements with trade unions, and that from 2004, which is based on indicators of pay setting systems operated by companies. Hence the aim here cannot be to compare across time periods, but across covered and uncovered sectors.

The results of Table 7 show that in the uncovered sectors wages are significantly more sensitive to regional unemployment movements that for those where some form of national pay setting occurs at the industry or company level. Therefore, in line with Nickell and Faggio (2005), the decline of such pay setting structures is likely to have raised the sensitivity of wages to unemployment. However, this is likely to be reflecting a general longer term shift, not least since sustained union decline has been happening since the late 1970s, rather than being something particular to the more recent period. As such, whilst it is likely to have been a contributing factor, this is probably only partial at best.

The last obvious possibility, which is hard to test empirically, is welfare reform. From 1996 successive governments have progressively increased the extent of required activity undertaken by those receiving welfare payments. This is described as the increase in 'welfare conditionality' and breaches are associated with sanctions, reductions in cash payments, which in turn have become more severe. Starting with the unemployed, this conditionality has been extended to lone parents and most recently to those with less severe health and disability issues. Claimants are thus required to undertake and provide evidence of activity, principally job search. At the same time has occurred the development of a system of tax credits which supplement low wages mainly for those with children. The increased pressure to take low waged work and compensation for doing so may have increased the willingness of workers to trade lower wages for employment, and also their substitutability for low wage workers. However, this argument feels more apposite for the lower third of wage distribution, roughly the main portion for coverage of tax credits, whereas we see the increased unemployment sensitivity across the wage distribution.

6. Conclusions

In this paper, we document and study the fact that real wage growth has stagnated in the UK since around 2003 and has, unlike in past recessionary periods, turned negative since 2009. We ask whether this can be related to high unemployment holding back wages, that was either not present, or was less marked, in the period of real wage growth that came before. We highlight that since 2003, the slowdown, stagnation and recent real wage falls have occurred across the wage distribution.

From an analysis of economy-wide data and of regional panel on real wages and unemployment, we find the same pattern of results. We document the nature of real wage changes across the wage distribution over the last three decades, showing that the recent period of stagnant real wage growth represents a break of trend that pre-dates the onset of recession. Our statistical

analysis that shows that an increased sensitivity of real wages to unemployment appears to have been an important factor in this slowdown of real wage growth, with real wage-unemployment sensitivities becoming more marked in the period of poor real wage growth. This is strongly the case, with a doubling of unemployment driving down real wages by around 5 to 6 percent more in the 2003-12 time period than earlier (including the 1990s recession).

Thinking about what this means in monetary terms, the increase in unemployment that took place between its low in 2005 (4.6 per cent) and its peak in late-2011 (8.3 per cent) would be associated with a reduction of around £1040-1240 in the annual earnings of someone working full-time at the median rate of pay in the more recent period compared to what would have occurred in earlier decades.

On the one hand, this increased sensitivity has driven down real wage levels compared to what would otherwise have been the case. On the other, this may well have limited the extent of job losses in the recent deep recession. Of course, while we show that unemployment has been a factor, it is not the only variable driving real wage stagnation post 2003. There has still been a slowdown in underlying trend in real wage growth from around 1.5 percent per annum to stagnation. On top of this stagnation of wages increased unemployment has been pressing down on wages with a heavier weight than before, turning this stagnation into falling real wages.

We remain less clear on precisely why the unemployment sensitivity has increased but what we have been able to do in terms of possible explanations suggests it may, at least in part in the longer term, be a consequence of the weakening of labour market institutions such as the coverage of trade unions and nationwide organisational pay scales. More recently, it may also reflect the impact of active welfare policies that have made the unemployed closer substitutes for those in work and tax credits which partially maintain incomes in the face of lower wages. Both of these fit into the idea that the presence of more elastic wage curves in recent times have come about as a result of greater labour market flexibility.

Finally, our findings open up a number of relevant research questions that need to be studied in more detail. The first is to compare changing patterns of real wage growth with other data sources. The second is to start to try and more fully understand what have been the proximate causes of the real wage slowdown, and why the level of unemployment is more strongly related to real wages in this recent period of poor real wage growth performance than it was before. A third, given our robust regional findings, is to consider the potential importance of differential degrees of labour market flexibility in different local labour markets. Hopefully, research in these areas will enable us to gain a better understanding of why real wage stagnation and falls have occurred and the extent to which increased real wage-unemployment sensitivities are more recently reflecting an impact of greater flexibility in the UK labour market.

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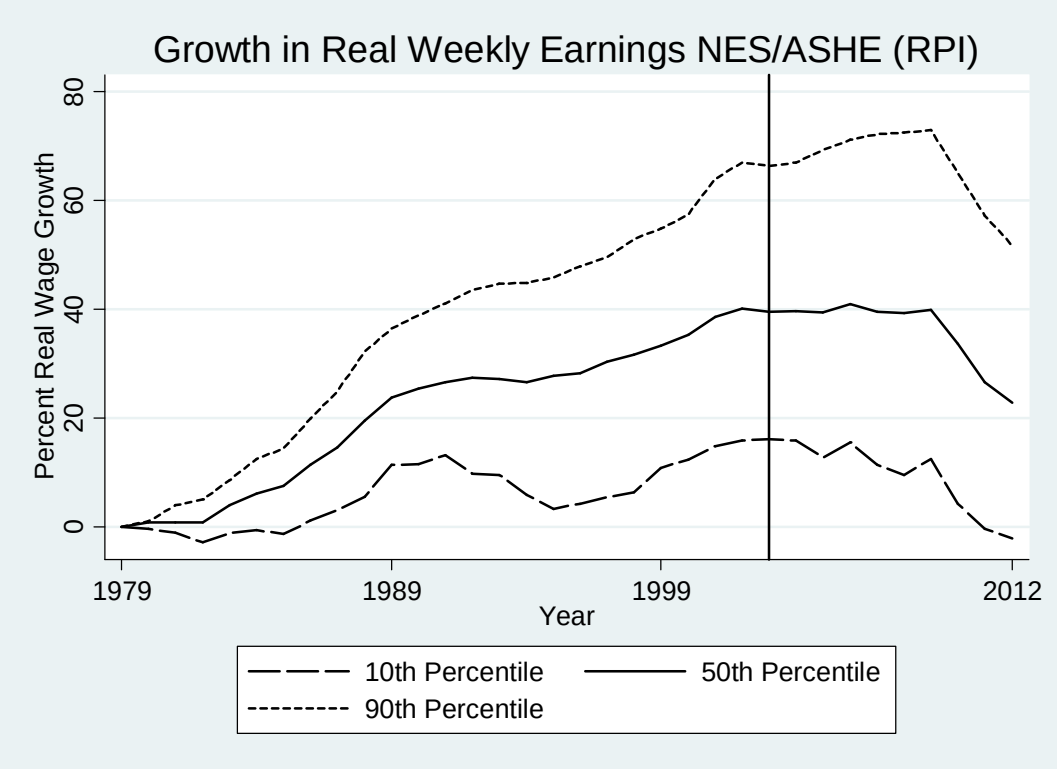
Fig. 1. Real Wage Growth at the 10th, 50th and 90th Percentiles, Weekly Wages, 1979-2012

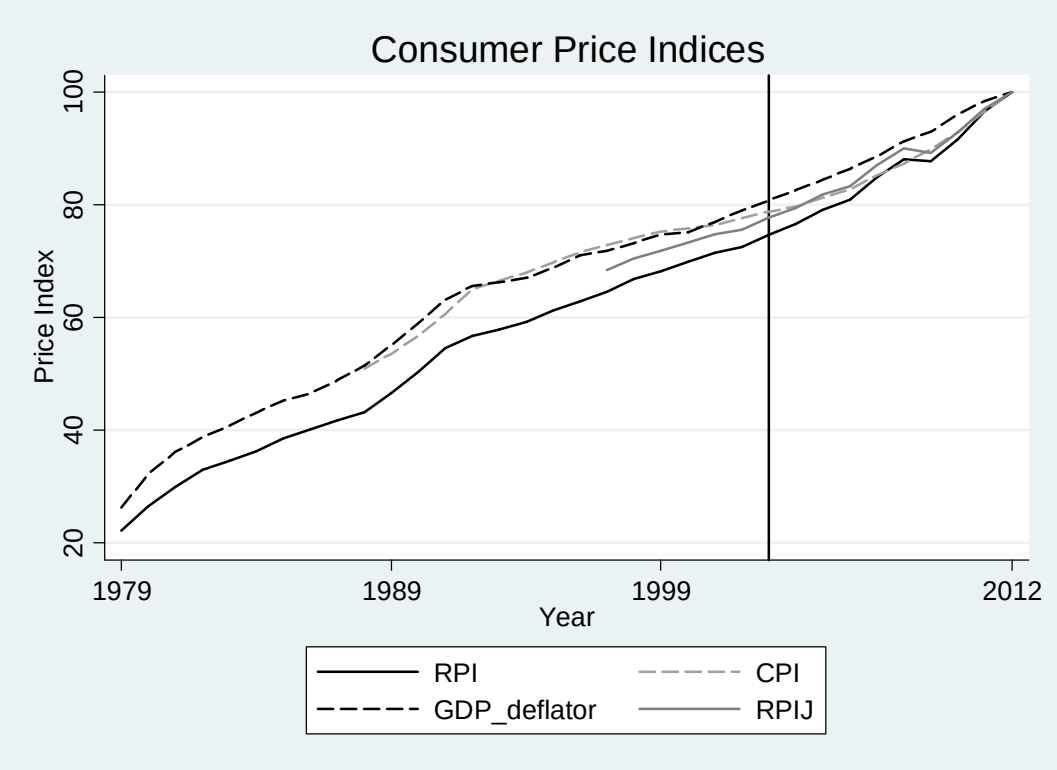


Notes: From New Earnings Survey/Annual Survey of Hours and Earnings. Weekly earnings deflated by RPI. The vertical line denotes 2003.

Fig.2. ILO Unemployment Rates, 1979-2012

Notes: Quarterly data from ONS. ILO Unemployment Rates for 16+ (seasonally adjusted). Vertical dashed lines show recession quarters.

Fig. 3. Consumer Price Indices: A Comparison



Notes: From ONS – see ONS (2012) for discussion of alternative price measures.

Table 1: Average Annual Percentage Real Wage Growth and Price Inflation

A. Real Wage Growth, Full Time Period 1979-2012	1979-2012	1979-2002	2003-2012
10th Percentile	-0.03	0.65	-1.83
50th Percentile	0.65	1.41	-1.39
90th Percentile	1.30	2.15	-0.99
B. Real Wage Growth, Sample Period 1986-2012	1986-2012	1986-2002	2003-2012
10th Percentile	-0.08	0.84	-1.83
50th Percentile	0.40	1.34	-1.39
90th Percentile	0.94	1.96	-0.99
C. Median Real Wage Growth, Different Indexes, 1988 to 2012	1988-2012	1988-2002	2003-2012
50th Percentile, RPI	0.13	1.04	-1.39
50th Percentile, CPI	0.77	1.69	-0.75
50th Percentile, GDP Deflator	0.80	1.58	-0.49
50th Percentile, RPIJ	.	.	-0.90

Notes: Numbers in panel A and B from NES/ASHE deflated by RPI, 2012 prices based on March each year. Numbers in panel C from NES/ASHE deflated by different price indexes, 2012 prices, either March or quarter one values.

Table 2: Aggregate Median Real Weekly Wages and Unemployment, 1986-2012

	Dependent Variable: Log(Median Real Weekly Wage)				
	(1)	(2)	(3)	(4)	(4) – (3)
	1986-2012	1986-2012	1986-2002	2003-2012	Change Between 1986-2002 and 2003-2012
A. Estimates of Equation (1)					
Log(Unemployment Rate[t-1])	-0.175	-0.102	-0.062	-0.184	-0.122
	(0.031)	(0.023)	(0.021)	(0.059)	(0.060)
Trend	0.001	0.008	0.009	-0.002	-0.010
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)
Post-2002 Trend		-0.013			
		(0.003)			
R-Squared	0.818	0.901	0.911	0.819	0.916
Sample Size	27	27	17	10	27
B. Estimates of Equation (2)					
ΔLog(Unemployment Rate[t])	-0.041	0.041	0.020	0.041	0.021
	(0.034)	(0.035)	(0.043)	(0.069)	(0.078)
Log(Unemployment Rate[t-1])	-0.176	-0.088	-0.056	-0.151	-0.095
	(0.032)	(0.025)	(0.027)	(0.101)	(0.097)
Trend	0.002	0.008	0.009	-0.004	-0.013
	(0.001)	(0.002)	(0.002)	(0.006)	(0.006)
Post-2002 Trend		-0.014			
		(0.004)			
R-Squared	0.826	0.907	0.911	0.828	
Sample Size	27	27	17	10	

Notes: Robust standard errors in parentheses.

Table 3: Regional Median Real Weekly Wages and Unemployment, 1986-2012

	Dependent Variable: Log(Regional Median Real Weekly Wage)					
	(1)	(2)	(3)	(4)	(5)	(5)-(4)
	1986-2012	1986-2012	1986-2012	1986-2002	2003-2012	Change Between 1986-2002 and 2003-2012
A. Trend Specification						
ΔLog(Unemployment Rate [t])	-0.054	-0.069	-0.000	-0.022	0.011	0.033
	(0.011)	(0.013)	(0.011)	(0.010)	(0.018)	(0.020)
Log(Unemployment Rate [t-1])	-0.145	-0.158	-0.082	-0.059	-0.121	-0.062
	(0.010)	(0.009)	(0.010)	(0.009)	(0.019)	(0.021)
Trend	0.003	-0.003	0.007	0.011	-0.005	-0.015
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)
Post 2002 Trend			-0.016			
			(0.002)			
Region Dummies	Yes	Yes	Yes	Yes	Yes	
Regional Controls	No	Yes	Yes	Yes	Yes	
R-Squared	0.927	0.951	0.966	0.980	0.970	
Sample Size	297	297	297	187	110	
B. Year Dummies Specification						
ΔLog(Unemployment Rate [t])	-0.002	-0.005		-0.007	-0.015	-0.008
	(0.012)	(0.010)		(0.010)	(0.013)	(0.016)
Log(Unemployment Rate [t-1])	0.005	-0.013		-0.004	-0.054	-0.050
	(0.015)	(0.010)		(0.010)	(0.013)	(0.016)
Region Dummies	Yes	Yes		Yes	Yes	
Year Dummies	Yes	Yes		Yes	Yes	
Regional Controls	No	Yes		Yes	Yes	
R-Squared	0.983	0.988		0.992	0.994	
Sample Size	297	297		187	110	

Notes: Robust standard errors in parentheses. The time varying regional controls are from the Labour Force Survey and are the proportion with a degree, female, young and white in the regional workforce.

Table 4: Regional Estimates Across the Wage Distribution

		Dependent Variable: Log(ith Percentile Real Weekly Wage)		
		(1)	(2)	(2)-(1)
		1986-2002	2003-2012	Change Between 1986-2002 and 2003-2012
10th Percentile	ΔLog(Unemployment Rate[t])	-0.036(0.033)	-0.050(0.034)	-0.014(0.047)
	Log(Unemployment Rate[t-1])	-0.119(0.031)	-0.075(0.042)	0.044(0.052)
20th Percentile	ΔLog(Unemployment Rate[t])	-0.015(0.019)	-0.040(0.026)	-0.024(0.032)
	Log(Unemployment Rate[t-1])	-0.038(0.018)	-0.077(0.029)	-0.039(0.034)
30th Percentile	ΔLog(Unemployment Rate[t])	-0.009(0.013)	-0.012(0.016)	-0.003(0.021)
	Log(Unemployment Rate[t-1])	-0.015(0.012)	-0.056(0.018)	-0.041(0.021)
40th Percentile	ΔLog(Unemployment Rate[t])	-0.012(0.010)	-0.009(0.014)	0.003(0.017)
	Log(Unemployment Rate[t-1])	-0.007(0.010)	-0.048(0.015)	-0.041(0.018)
50th Percentile	ΔLog(Unemployment Rate[t])	-0.007(0.010)	-0.015(0.013)	-0.008(0.016)
	Log(Unemployment Rate[t-1])	-0.004(0.010)	-0.054(0.013)	-0.050(0.016)
60th Percentile	ΔLog(Unemployment Rate[t])	-0.004(0.010)	-0.029(0.013)	-0.024(0.016)
	Log(Unemployment Rate[t-1])	0.003(0.009)	-0.050(0.012)	-0.054(0.015)
70th Percentile	ΔLog(Unemployment Rate[t])	-0.005(0.009)	-0.038(0.012)	-0.034(0.015)
	Log(Unemployment Rate[t-1])	0.003(0.009)	-0.051(0.012)	-0.054(0.015)
80th Percentile	ΔLog(Unemployment Rate[t])	0.004(0.010)	-0.020(0.012)	-0.024(0.016)
	Log(Unemployment Rate[t-1])	-0.002(0.008)	-0.034(0.013)	-0.032(0.016)
90th Percentile	ΔLog(Unemployment Rate[t])	0.006(0.013)	-0.013(0.013)	-0.020(0.018)
	Log(Unemployment Rate[t-1])	0.003(0.011)	-0.038(0.015)	-0.041(0.019)

Notes: Robust standard errors in parentheses. From year dummies specification, comparable to lower panel of Table 3.

Table 5: Robustness Checks

	Dependent Variable: Log(Regional Median Real Weekly Wage)		
	(1)	(2)	(2)-(1)
	1986-2002	2003-2012	Change Between 1986-2002 and 2003-2012
A. Wage Dynamics - Instrumented			
Log(Unemployment Rate[t])	-0.005 (0.011)	-0.069 (0.036)	-0.064 (0.038)
Log(Real Wage[t-1])	0.646 (0.102)	0.616 (0.117)	-0.030 (0.155)
Region Dummies	Yes	Yes	
Year Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.995	0.995	
Sample Size	176	110	
B. GDP Deflator			
ΔLog(Unemployment Rate[t])	-0.007 (0.010)	-0.015 (0.103)	-0.008 (0.016)
Log(Unemployment Rate [t-1])	-0.004 (0.010)	-0.054 (0.013)	-0.050 (0.016)
Region Dummies	Yes	Yes	
Year Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.993	0.993	
Sample Size	187	110	
C. Exclude London			
ΔLog(Unemployment Rate[t])	-0.017 (0.010)	-0.013 (0.014)	0.004 (0.017)
Log(Unemployment Rate [t-1])	-0.020 (0.009)	-0.060 (0.013)	-0.040 (0.016)
Region Dummies	Yes	Yes	
Year Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.979	0.979	
Sample Size	170	100	
D. Regional Wage and Employment			
ΔLog(Employment Rate[t])	-0.022	0.362	0.384
	(0.080)	(0.093)	(0.122)
Log(Employment Rate[t-1])	-0.118	0.541	0.659
	(0.086)	(0.118)	(0.144)
Region Dummies	Yes	Yes	
Year Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.992	0.994	
Sample Size	187	110	

Notes: Robust standard errors in parentheses. Year dummies regional specification comparable to lower panel of Table 3 in all panels. Instruments used in panel A are first and second lags of wages and unemployment.

Table 6: Exploration of Possible Reasons for Increased Unemployment Sensitivity

	(1)	(2)	(2)-(1)
	1986-2002	2003-2012	Change Between 1986-2002 and 2003-2012
A. Hourly Wages - Dependent Variable: Log(Regional Median Real Hourly Wage)			
ΔLog(Unemployment Rate[t])	0.010 (0.009)	-0.011 (0.012)	-0.021 (0.015)
Log(Unemployment Rate [t-1])	0.012 (0.010)	-0.050 (0.012)	-0.062 (0.016)
Region Dummies	Yes	Yes	
Year Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.994	0.995	
Sample Size	187	110	
B. Basic Weekly Pay - Dependent Variable: Log(Regional Median Real Weekly Wage Excluding Overtime Pay and Bonuses)			
ΔLog(Unemployment Rate[t])	0.007 (0.009)	-0.011 (0.013)	-0.009 (0.012)
Log(Unemployment Rate [t-1])	0.011 (0.009)	-0.043 (0.017)	-0.049 (0.015)
Region Dummies	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes
Regional Controls	Yes	Yes	Yes
R-Squared	0.994	0.996	0.996
Sample Size	187	88	88
C. Include Migration Control			
ΔLog(Unemployment Rate[t])	-0.007 (0.010)	-0.011 (0.013)	-0.003 (0.016)
Log(Unemployment Rate [t-1])	-0.004 (0.010)	-0.050 (0.013)	-0.046 (0.016)
Proportion UK Citizens	-0.069 (0.161)	-0.220 (0.170)	-0.151 (0.233)
Region Dummies	Yes	Yes	
Year Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.992	0.994	
Sample Size	187	110	

Notes: Robust standard errors in parentheses. Year dummies regional specification comparable to lower panel of Table 3 in all panels. Basic Weekly Pay changed definition in 2004 so the dependent variables in the first two columns of panel B and years 2003 and 2004 are excluded. The last column in panel B therefore reports the change for the period 2005 to 2012.

Table 7: Variations by Collective Bargaining Coverage

	Sample Split Based on Coverage of National Collective Agreements (1986-2004) or National Collective Agreements or National Company Pay Structures (2005-2012)			
	1986-2004		2005-2012	
	Covered	Uncovered	Covered	Uncovered
ΔLog(Unemployment Rate[t])	0.009 (0.015)	0.001 (0.018)	0.016 (0.017)	-0.030 (0.020)
Log(Unemployment Rate [t-1])	0.024 (0.016)	-0.021 (0.016)	-0.006 (0.015)	-0.075 (0.024)
Region Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Regional Controls	Yes	Yes	Yes	Yes
R-Squared	0.973	0.984	0.991	0.994
Sample Size	209	209	88	88

Notes: Robust standard errors in parentheses. Year dummies regional specification comparable to lower panel of Table 3.

Appendix – Additional Tables

Table A1: Time Dummies and Aggregate Unemployment, 1986-2012

	Dependent Variable: Averaged Time Dummies From Regional Estimates				
	(1)	(2)	(3)	(4)	(4) – (3)
	1986-2012	1986-2012	1986-2002	2003-2012	Change Between 1986-2002 and 2003-2012
ΔLog(Unemployment Rate[t])	-0.047	0.055	0.017	0.067	0.051
	(0.039)	(0.038)	(0.038)	(0.061)	(0.069)
Log(Unemployment Rate[t-1])	-0.166	-0.056	-0.049	-0.088	-0.038
	(0.035)	(0.024)	(0.023)	(0.092)	(0.088)
Trend	-0.003	0.006	0.005	-0.004	-0.008
	(0.001)	(0.002)	(0.002)	(0.006)	(0.006)
Post-2002 Trend		-0.018			
		(0.004)			
R-Squared	0.596	0.828	0.818	0.733	
Sample Size	27	27	17	10	

Notes: Robust standard errors in parentheses. The dependent variable is the values of the retrieved year dummies from Panel B in Table 3.

Table A2: The Impact of Using Different Price Deflators - Trend Specification

	Dependent Variable: Log(Regional Median Real Weekly Wage)		
	(1)	(2)	(2) - (1)
	1988-2002	2003-2012	Change Between 1988-2002 and 2003-2012
A. CPI			
ΔLog(Unemployment Rate [t])	0.005	-0.012	-0.018
	(0.011)	(0.018)	(0.021)
Log(Unemployment Rate [t-1])	-0.077	-0.124	-0.047
	(0.010)	(0.019)	(0.021)
Trend	0.007	0.003	-0.005
	(0.002)	(0.002)	(0.003)
Region Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.985	0.970	
Sample Size	165	110	
B. GDP Deflator			
ΔLog(Unemployment Rate [t])	-0.011	0.004	0.015
	(0.008)	(0.012)	(0.014)
Log(Unemployment Rate [t-1])	-0.021	-0.079	-0.058
	(0.007)	(0.013)	(0.014)
Trend	0.010	0.002	-0.008
	(0.001)	(0.001)	(0.002)
Region Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.993	0.986	
Sample Size	165	110	
C. RPI			
ΔLog(Unemployment Rate [t])	0.002	0.011	0.010
	(0.008)	(0.018)	(0.020)
Log(Unemployment Rate [t-1])	-0.046	-0.121	-0.075
	(0.008)	(0.019)	(0.020)
Trend	0.005	-0.005	-0.009
	(0.001)	(0.002)	(0.002)
Region Dummies	Yes	Yes	
Regional Controls	Yes	Yes	
R-Squared	0.989	0.970	
Sample Size	165	110	

Notes: Robust standard errors in parentheses. The time varying regional controls are from the Labour Force Survey and are the proportion with a degree, female, young and white. From trend specification, comparable to median model in panel A of Table 3.

Data Appendix – For Online Publication

A. New Earnings Survey/Annual Survey of Hours and Earnings

We use employer reported wages data from the New Earnings Survey/Annual Survey of Hours and Earnings (NES/ASHE). This is an approximately 1 percent sample of all workers based on the last two digits of their National Insurance number. The data is drawn from firms' administrative pay records on a common reporting basis and represents the most accurate UK wage data. From 1979 to 2003, this was called the New Earnings Survey (NES) and from 2004 onwards the Annual Survey of Hours and Earnings (ASHE).

More specifically, the employer reported wages dataset used for the analysis is a panel of individuals extracted from NES/ASHE called New Earnings Survey Panel Data (NESPD)/ Annual Survey of Hours and Earnings Panel Data (ASHEPD). The NESPD/ASHEPD panel contains a reduced set of variables from NES/ASHE for years 1979 to 2012.

We extracted gross weekly wages and hourly wages for all workers aged 16 to 65. These were computed at national and regional level (see B. below) at the 10^{th}, 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th} and 90^{th} percentiles). Most of our analysis focusses on the median.

There are some discontinuities in the gross weekly wage series due to changes in the pay definitions and in the sample selection from NES to ASHE and other data issues we encountered:

i) Earnings Definitions Across Time

A new questionnaire introduced for the 2005 ASHE generates a discontinuity in the gross weekly earnings series used for most of our analysis. Gross weekly earnings include basic pay, bonuses (incentive pay and premium pay), overtime payments and other pay. With the introduction of the new questionnaire there were changes to the survey on questions related to incentive pay and other payments.

NES has two different questions on incentive pay and bonuses ("payments made in every pay period" and "payments made less often than every pay period") whereas ASHE from 2005 onwards simplifies those two questions to only collect "incentive pay paid and earned in the pay period". Comparing responses for years 2004 and 2005, ONS concludes that the NES question "where payments are made in every period" is comparable to responses to the 2005 question. Therefore, such a change in definition lowers incentive payments reported and, consequently, gross weekly pay. According to ONS, removing "less often incentive pay" in 2004 decreases pay at an aggregate level by 1 percent. In 2003, 6.7 percent of the16 to 65 year-old employees in NES report having received incentive payments outside of the period with a median pay of £27.73 a week.

NES does not contain a specific question on other payments as the respondents were asked to include other payments together with basic pay. From 2005 onwards, however, ASHE includes an extra question on "pay for other reasons" and excludes the reference to other payments from the basic pay question. By comparing the responses of a restricted sample of individuals to both

questionnaires, ONS concludes that half of the respondents included other pay together with basic pay in 2004 and split basic pay into basic pay and other pay in 2005. However, the other half of the respondents reported other pay in 2005 that they missed in 2004. The extra question in ASHE increases overall gross weekly pay by 1 percent in aggregate levels and thus offsets the effect of the incentive pay question and should not be a worry when calculating aggregate figures.[15] In 2005, 19.5 percent of employees in our sample received other payments with a median value of £23.71 a week.

The measure of basic pay we consider in panel B of Table 6 has been generated using NES and ASHE cross-sections because NESPD and ASHEPD do not contain a measure of basic pay. From 1986 to 2003, basic pay includes other payments (NES definition) while from 2005 onwards other payments are excluded (ASHE definition). [16] This small definitional shift is unlikely to affect the sensitivities to unemployment reported in Panel B of Table 6.

ii) Changes in Sample Selection

From 2004 onwards, ASHE includes employees who changed jobs or entered the job market between the sample selection date and the survey reference period. Although the wage series used for our analysis includes that supplementary sample of individuals, excluding them from year 2004 to 2012 does not significantly change our results. In addition, ONS collected earning's information on companies registered for VAT but not PAYE in 2004 and 2005 but stop collecting them in 2006 because the characteristics of the employees were similar to those registered in PAYE. These individuals are excluded from the NESPD/ASHEPD sample.

In 2007 and 2008 the sample size was reduced by 20 percent and subsequently restored in 2009. The cut targeted the industries with the least variation in earning patterns so that the impact on aggregate figures should be small. However, the reduction did not have a homogeneous effect across industries and, for instance, organisations that provided information electronically were not affected by the cut. The wage series released by ONS aimed at solving the potential non-randomness of the cut by adjusting the weights. Given that we do not use weights for our analysis we have imputed the wage change from ONS published data series for regional weekly wages from 2007 to 2012 as a robustness check and the results remain consistent with the main results reported in Table 3.[17]

Finally, in 2010, a new PAYE system was introduced leading to an ASHE sample 35 percent higher than expected. Previous system represented employers' accounts and the new system PAYE represents pay and tax details of individuals. According to the ONS, quality-assurance demonstrated that the final dataset of responses were similarly distributed across age, sex, industry and business size-band.

iii) Earnings Under the National Insurance Lower Earning Limit

[15] ONS (2005).

[16] Although the questionnaire was introduced in 2005, the wage measures included in the panel for year 2004 aim at replicating the "2005 onwards" measure of gross weekly wages (i.e. other pay was imputed and incentive "payments made less often than every pay period" excluded) so that we have excluded year 2004 from the basic pay analysis.

[17] Our wage series excludes weighting so our wage estimates are slightly lower than those published by the ONS for recent years. The ONS data is unweighted from 1979 to 1996 but weights were developed from 1997. Weights are based on LFS estimates and were introduced with ASHE although back figures were generated from 1997.

Although there should not be any individual earning less than the National Insurance lower earnings limit (LEL), there is an increasing number of individuals in the panel earning below that quantity, from 4 percent in 1979 to 7 percent in 2012. The increase in the proportion of part-time workers explains such an increase as they account for virtually all of the individuals earning under LEL and the proportion of part-time workers in the panel increases from 14 percent in 1979 to 28 percent in 2012. Hence the rise of workers with wages below the NI LEL was proportionate to the overall rise in part-time working suggesting no shift in the propensity of low waged workers to be in the sample.

iv) Duplicates in Panel

Both NES and ASHE questionnaires record the information for the main and secondary job of an individual. The general rule applied to generate the NESPD/ASHEPD panel is to keep just one job for each individual. However, from year 2001, more than one job for some individuals appears in the panel. These duplicates correspond to jobs coded as non-main jobs that have a higher pay than the main jobs. In order to generate a panel with one observation per person we have kept the higher paid job for those individuals that appear to have more than one job in the panel. The highest proportion of duplicates are observed in years 2001 to 2003 and they represent less than 0.3 percent of individuals.

v) Collective Agreements

The information on collective agreements in NESPD/ASHEPD differs across time. From 1986 to 2004, respondents whose pay was set with reference to a pay agreement were classified into one of the major national collective agreements. From 1986 to 1996, 141 national agreements were reported and from 1997 to 2004 they were restricted to 44. From 2005 onwards, ONS simplified the types of agreements to 5: national agreement; sub-national agreement; organisational agreement; workplace agreement; and national or industry supplemented by a subnational, organisational or workplace agreement.

In Table 7, an individual is defined as covered from year 1986 to 2004 if it is classified in one of the major national collective agreements; it is defined as uncovered otherwise. From 2005 onwards, covered individuals are those that are classified as being in a national, sub-national, organisational or national or industry supplemented by a subnational, organisational or workplace agreement. Uncovered individuals from 2005 onwards also include those that report being in a workplace agreement.

B. Price Indices

Most of our analysis uses the Retail Price Index (RPI). We also compare with the Consumer Price Index (CPI), the GDP price deflator and the newer revised RPI series (RPIJ) which uses the same basket of goods as in the RPI, but the methodology is more similar to the CPI. This is only available from 1998. The data are from ONS and more detail on their definitions and availability is given in Gooding (2011) and ONS (2012).

C. Unemployment Rates

National ILO unemployment rates were obtained from ONS. Regional ILO unemployment rates were calculated from Labour Force Survey (LFS) microdata.

D. Regional Panel

The regional panel is put together for the old definition of the standard regions of Britain: : North East; North West; Yorkshire and Humberside; East Midlands; West Midlands; East Anglia; London; South East; South West; Wales; and Scotland. This had to be done because this is the only definition in LFS going back as far as 1986 (the LFS variable URESMC), the start year of our statistical analysis. NES/ASHE data was configured using detailed area data to match.

E. Labour Force Survey Variables

The regional control variables were calculated from LFS microdata. For the main specifications these are the regional proportions of 16-65 year olds over time with a degree, female, young and white. In addition, for the panel C of Table 6 results the proportion of UK citizens was calculated from LFS microdata at the region-time level.

Additional References

Gooding, P. (2011) Consumer Prices Indices, History of and differences between the CPI and RPI?, ONS:http://www.ons.gov.uk/ons/rel/cpi/consumer-price-indices/history-of-and-differences-between-the-consumer-prices-index-and-retail-prices-index/index.html

ONS (2005) ASHE Methodology-Measurement of Basic Pay and Other Pay.