Abstract

This paper investigates the impact on the wage distribution of the introduction, in April 1999, of the National Minimum Wage in the UK. Because of the structure of UK earnings statistics, it is not straightforward to investigate this and a number of different methods for adjusting the published statistics are discussed. The main conclusions are that the NMW does have a detectable effect on the wage distribution and that compliance with the NMW is widespread but the impact is limited because the NMW has been set at a level such that only 6-7% of workers are directly affected and the NMW has had virtually no impact on the pay of workers not directly affected. Furthermore, virtually all the changes occurred within two months of the introduction in April 1999 and its impact declined over time from April 1999 to May 2001 as the minimum wage was not up-rated in line with the increase in average earnings.

JEL Classification: J31
Keywords: minimum wage, wage inequality.

This paper was produced as part of the Centre's Labour Markets Programme

Acknowledgements

This paper was prepared for the Royal Statistical Society Conference on 'Explanations for Rising Economic Inequality'. We would like to thank participants at the RSS meeting and Mark Stewart for their comments.

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Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

ISBN 0 7530 1554 4

Individual copy price: £5

Has The National Minimum Wage Reduced UK Wage Inequality?

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June 2002

The Centre for Economic Performance is financed by the Economic and Social Research Council

Introduction

The UK has had a marked rise in wage inequality over the last 20 years. Figure 1 shows the evolution of inequality in the bottom half of the wage distribution using hourly earnings information from the New Earnings Survey 1975-99[1]. The most striking feature is the rapid rise in the $50^{th}/10^{th}$ hourly wage ratio in the 1980s. Trends in the 1990s are less marked but have not reversed the earlier rise. This is also confirmed by Figure 2. This figure presents the same measures of inequality between 1993 and 2001 using data from the source that will be used in this paper, the Quarterly Labour Force Survey.

In April 1999, a National Minimum Wage (NMW) was introduced into the UK, motivated at least in part by a desire to reverse this trend in wage inequality. Initially the rate was set at £3.60 per hour for those aged 22+ and £3.00 for those aged 18-21 inclusive. The adult rate was raised to £3.70 in October 2000 and to £4.10 in October 2001. This paper is about estimating the effect that the NMW has had on UK wage inequality among adults.

One reason why one might have been optimistic about the ability of the NMW to reduce wage inequality is that there is empirical evidence to suggest that the minimum wage in the United States has had a powerful influence on wage inequality in the bottom half of the earnings distribution, where trends in wage inequality have been somewhat similar to those in the UK (see diNardo, Fortin and Lemieux, 1996; Lee, 1999; Teulings, 2000). In the 1980s, when the federal minimum wage was kept at a fixed nominal level and consequently declined in relation to average earnings, wage inequality in the bottom half of the distribution rose dramatically. And, in the 1990s when the federal minimum was raised 3 times, this trend was stopped and even partially reversed.

In the UK, the changes in wage inequality in the past 20 years cannot plausibly be blamed on the minimum wage since the UK had no minimum wage prior to 1999 except for the rather ineffective Wages Councils, which set minimum wages for a number of low-paying sectors prior to their abolition in 1993.[2] However, other institutions may have been declining in their effectiveness to provide a floor to wages *e.g.* welfare benefits have been indexed to prices and not wages since 1983 and the fraction of workers who have their wages determined by collective bargaining is much lower than 20 years ago. It may be that the NMW is a substitute for these.

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[1] It is well-known that the NES under-samples part-time (and hence low-paid) workers but the trends in wage inequality in the NES are probably a fair reflection of what is happening in the economy as a whole.
[2] Note that a minimum wage does exist in the agricultural sector but this accounts for less than 1% of total employment.

The impact of the NMW on wage inequality will depend on the numbers of workers affected both directly and indirectly by the NMW, the level of the NMW and the initial level of wages. One might think that it would be relatively simple to answer the question 'what has been the impact of the NMW on UK wage inequality?' but weaknesses in UK data on hourly earnings make it harder than one might hope and this paper both illustrates these difficulties and tries to provide a solution. Others have considered this or related questions. The ONS (Stuttard and Jenkins, 2001) and the Low Pay Commission (2000) have presented estimates of the number of workers paid below or at the minimum wage but have not considered the wider effects on the wage distribution. These estimates are based on the work of Skinner and Beissel (2001) who estimate the distribution of hourly pay and the number of workers at the minimum wage using a donor method of imputation that is described in more detail below. Stewart and Swaffield (2001) have used another data set, the British Household Panel Survey, to evaluate the impact of the NMW. The contribution of this paper is to consider more broadly the impact of the NMW on wage inequality and investigate the sensitivity of results to alternative methods of estimating the wage distribution.

The plan of the paper is as follows. In the next section, we present evidence on the impact effect of the NMW on the wage distribution. Because of weaknesses in the available statistics, we discuss a number of ways in which the raw data might be 'adjusted' to get a better estimate of the true impact. The second section then considers the longer-run impact. Our main conclusions can be summarized as:

- the NMW has a detectable effect on the wage distribution
- compliance with the NMW seems widespread
- the NMW has been set at a low level such that only 6-7% of workers are directly affected
- the NMW has had virtually no impact on the pay of workers not directly affected
- virtually all the changes occurred within two months of the introduction in April 1999
- from April 1999 to May 2001 the minimum wage was not up-rated in line with the increase in average earnings so that its impact declined over time.

The bottom line is that one can see the impact of the NMW on the 5th percentile of the wage distribution, but there is no effect on the 10th percentile. This is consistent with the graphical evidence in Figures 1 and 2. For the most part, our conclusions reinforce those arrived at by others though we do point out that even the best available estimates probably over-state the impact of the NMW.

1. The Impact Effect of the NMW

The measure of hourly pay in the Labour Force Survey used in Figure 2 is derived by dividing a measure of weekly earnings by a measure of weekly hours: using ONS terminology we will refer to this as hourly pay. This measure has some serious problems that are discussed below but, for the moment, let us consider what the hourly pay data say about the impact of the NMW. Figure 3 presents some information on the bottom half of the distribution of hourly pay in March 1999 among adults (those aged 22+), just before the introduction of the NMW. Something like 7% of workers seem to be paid below the minimum, some on extremely low hourly wages. Figure 4 then shows the percentage increase in wages at each percentile of the wage distribution between March and May 1999. Although there is evidence for a greater increase in hourly wages for those at the bottom of the earnings distribution, the earnings increases for these workers fall a long way short of what would have been expected if all those initially paid below the minimum wage had had their wage raised to £3.60 – this is denoted by the compliance change line in Figure 4. Indeed between 5% and 6% of workers are still apparently paid below the minimum suggesting a serious problem with enforcement.

But, as is well-known, the hourly pay measure has serious problems. It is derived by dividing a measure of weekly earnings by a measure of weekly hours. But, the earnings period does not refer to the hours period or necessarily to the survey period, there are many proxy responses, and likely rounding in responses to both earnings and hours questions. All these mean that there is substantial measurement error in this measure of hourly wages.

In response to these concerns the ONS introduced, in Spring 1999, an alternative measure of hourly wages that, following their terminology, we shall call the hourly rate. Workers are asked if they are paid by the hour and, if so, what the rate is.

One can see the difference in the two measures in Figure 5, which plots the bottom half of the wage distribution for hourly pay and the hourly rate for those who respond to the hourly rate question (i.e. the samples are the same for the two distributions)[3]. One can clearly see that the hourly pay question has much more dispersion. It over-states the numbers of workers initially paid below the minimum and the size of the gap.

Figure 6 shows the percentage increase in wages at each percentile of the hourly rate distribution from March to May 1999 for those who report an hourly rate. The following features stand out. Only the bottom 1-2% now do not seem to comply, there is a large spike at the minimum wage and, to a first approximation the increase in wages seems to be confined to those initially paid below the minimum i.e. spill-over effects seem very small[4].

The problem with all these results that are based on reported hourly rates is that not all workers who report a measure of hourly pay report an hourly rate. In 1999 only 30% of workers report an hourly rate though in subsequent years (when the routing of the question was changed) this rises to 40%[5]. This does not matter if those who report an hourly rate are representative of the employed population as a whole but they are not. In particular, they tend to be lower-paid. This is confirmed in Table 1 where we report percentiles of the hourly pay distribution for those who do and do not report an hourly rate. For example, the 10th percentile of hourly pay for those who report an hourly rate is £3.50 per hour while it is £4.50 per hour for those who do not report an hourly rate. If we want some estimate of the impact of the NMW we need some way of imputing the hourly rate for those for whom it is missing.

Any method of doing this must make some identifying assumption. Perhaps the most common type of assumption in the 'missing data' literature is to assume that, conditional on some set of covariates, x, the distribution of the variable of interest is independent of whether it is observed or not. The variable of interest here is the hourly rate, which we will denote by w. Define a binary variable R that takes the value 1 if the hourly rate is observed and 0 if it is not. Hence, if f(.) is the density function, the identifying assumption is that:

$$f\left(w \middle| x, R=1\right) = f\left(w \middle| x, R=0\right) = f\left(w \middle| x\right) \qquad (1)$$

[3] Note that because hourly-paid workers tend to have lower wages, the impact of the minimum wage on this sub-sample is larger than in the population as a whole.
[4] It is likely that under-payment is a more serious problem among groups who are less likely to respond to the LFS in groups whose level of pay is very difficult to estimate.
[5] The US equivalent to the LFS, the CPS, has a similar structure for deriving hourly pay but a much higher fraction of workers report an hourly rate, something like 60%.

In the language of Rosenbaum and Rubin (1983), response is ignorable conditional on x. The conditioning variables are very important as the evidence above suggests very strongly that (1) does not hold if we do not have any covariates.

The methodology developed by the ONS (Stuttard and Jenkins, 2001) and based on the work of Skinner and Beissel (2001) derives a corrected distribution of the hourly rate using a variant of this approach. We are not going to provide a detailed description of the method used here but the most important features of it are as follows. A regression for the log of the hourly rate is estimated for a set of covariates and predicted values generated. Individuals without an hourly rate are then 'matched' with someone for whom an hourly rate is observed and who has a similar predicted hourly rate and they are then given the actual hourly rate of their 'match'. This type of procedure is sometimes known as "hot deck imputation within imputation classes". The implicit identifying assumption is stronger than that contained in (1) as the procedure assumes that the x variables only affect the mean of the log of w and do not affect the distribution in any other way.

The hot-deck imputation method is not the only choice that could be made. In the Appendix we show how one can estimate the overall distribution of w by re-weighting those observations for whom w is observed. The weights used are proportional to the inverse of the response propensity for someone with the same predicted hourly rate. The ONS procedure can be thought of one way of doing this re-weighting but not the only way. Here, we use a simpler method in which an individual who reports an hourly rate is given a weight inversely proportional to the fraction of those in a 10p band for the predicted rate that report an hourly rate.

Table 2 presents estimates of the impact effect of the introduction of the NMW using this methodology. We present estimates using a number of different choices for the 'x' covariates. The first column gives the raw distribution of the hourly rate which can be thought of as the estimate when no covariates are included. We then include controls for age, education, gender, race, temporary, part-time, public sector, month and employer size. As can be seen from the second column, this substantially reduces the measures of low pay. For example, the unweighted estimates suggest that 11.3% of workers were paid below £3.60 in March 1999 while introducing the covariates makes this fall to 7.1%. Similarly the unweighted estimates suggest 10.1% of workers paid within 2.5p of £3.60 in May 1999 while this falls to 6.8% in the second column.

We then investigate how sensitive these estimates are to the covariates used. Including industry and occupation dummies leads to a further fall in the estimates of the number of low-paid workers as does the inclusion of a dummy variable for a proxy response. The final column also includes the log of the observed hourly pay. Inclusion of this variable leads to a further substantial fall in the estimates of the extent of low pay and the impact of the NMW.

As described above, the ONS approach makes assumptions stronger than those implied by (1). In particular, it assumes that x is only a 'mean-shifter'. This is a testable assumption and the tests we have done indicated that it fails. For example the distribution of the 'residuals' from the hourly rate equation differs according to the level of the predicted hourly rate. An alternative approach that does not make the 'mean-shift' assumption is to just estimate a propensity model for reporting an hourly rate and to use the inverse of the propensity score to re-weight each observation for which the hourly rate is observed.

Table 3 presents estimates of the impact effect of the NMW using this methodology. In the specifications that have a smaller number of covariates the initial extent of low pay appears higher using this approach but the fraction paid the minimum wage in May appears somewhat lower. But, once the hourly pay is included as one of the covariates, the difference in the measure of the initial extent of low pay is very similar though the 'spike' at the minimum wage in May is 0.6 percentage points higher than for the estimates based on the propensity score.

A graphical way of comparing the two distributions is in Figure 7 which plots the unweighted, predicted wage and propensity score re-weighted wage distributions (using the specification with the most covariates). Both re-weighting methods lead to very different estimates of the wage distribution from the unweighted distribution but the two re-weighting methods are very similar to each other in the part of the wage distribution in which we are most interested: the bottom 25%[6].

Using the two re-weighting methods, Figures 8 and 9 present estimates of the change in the wage distribution from March to May 1999. Both methods give similar results. Between 6% and 7% of workers were initially paid below £3.60. This estimate is somewhat above the 4.6% quoted by Stewart and Swaffield (2001) as the percentage reporting in the BHPS that their pay rate had been affected by the introduction of the NMW. However, there are a number of reasons why their estimate might differ from that derived from the LFS.

[6] It is well known that these re-weighting methods can have the disadvantage that the sampling variation in the weights can be very large leading to large standard errors. This is not such a problem in the present application for the bottom end of the wage distribution as the propensity scores are all quite high in this region of the distribution. But, it does make more difference at the top end where relatively few workers report an hourly rate.

First, it is based on worker perception of whether their pay was increased. Secondly, the samples are different. But, the BHPS sample includes those aged 18-21: this will tend to produce a higher estimate of the proportions affected. Secondly, the BHPS sample is restricted to those who, at the interview date (typically in the autumn), were in jobs that had started before 1 April 1999: this excludes about 10% of workers. As the low-paid are more likely to be in jobs of short tenure this is likely to lead to a lower estimate of the numbers affected. Finally, the BHPS sample is restricted to those in the original BHPS sample: again, this is likely to lead to a lower estimate of the numbers affected since attrition is higher for low income individuals.

Figures 8 and 9 also suggest that almost all workers initially paid below the minimum wage had their wages raised to the new minimum by May 1999 and there is no evidence of spill-over effects further up the wage distribution. This should be compared with the BHPS estimate of 60% of workers initially paid below the minimum wage who had their pay raised to exactly the minimum (Stewart and Swaffield, 2001).

This conclusion that there is a detectable impact of the minimum wage on the 5^{th} percentile of the wage distribution but not at the 10^{th} is consistent with the graphical evidence presented in Figures 1 and 2 where the introduction of the minimum wage does appear to change the $50^{th}/5^{th}$ hourly wage ratio but not the $50^{th}/10^{th}$ wage ratio. The minimum wage has a modest effect on wage inequality because it is set so low and the spill-over effects seem so small.

However, there are reasons to think that even these estimates over-state the impact of the NMW. Even after controlling for all the other factors, the level of hourly pay remains a very significant predictor of whether an hourly rate is observed. It has a t-statistic of something like 23.4. This is troubling. The identifying assumption in (1) that, conditional on x, w and R are independent, can also be written as:

$$\Pr\left(R=1\middle|x,w\right)=\Pr\left(R=1\middle|x\right) \qquad (2)$$

i.e. conditional on x, the true hourly rate is of no value in predicting whether it is observed. But, how then does one interpret the significance of the hourly pay variable in explaining whether an hourly rate is observed or not? The hourly pay variable can be thought of as being made up of a part which is the hourly rate (which we would like to know) and some measurement error. It seems implausible to argue that it is the measurement error component that gives the explanatory power. It is more plausible to think it is an effect of the true hourly rate, that low-paid workers are simply more likely (even after controlling for many other factors) to report an hourly rate. But, if this is true, this violates the identifying assumptions in (1) and (2), meaning that neither of the above methodologies leads to consistent estimates of the true distribution of the hourly rate.

In fact, the 'bias' will be in a particular direction. If the low-paid are more likely to report an hourly rate and we ignore this fact, then we will over-estimate the extent of low pay in the economy. Hence, the estimates in Tables 1 and 2 should be thought of as upper bounds for the numbers affected by the introduction of the NMW. One can see in Tables 1 and 2 that introducing the hourly pay as a covariate results in a large drop in the measured extent of low pay and a 'better' measure of hourly pay is likely to result in an even larger drop. In current work we are considering what can be done about this: the approach is to make a different identifying assumption.

But, let us now consider longer-term changes.

2. Longer-Period Changes

The previous section showed that the impact effect of the NMW was to raise the wages of most but not quite all workers to the minimum and that spill-over effects were minimal. But, this only looks at the impact over a 2-month period. Over a longer period, it may be that the impact of the NMW reaches further up the distribution.

In fact, this does not seem to be the case. Figures 10 and 11 look at changes over a longer period using the predicted wage and propensity score re-weighting methods respectively.

We compare the change in the wage distribution from March to May 1999, from March 1999 to September 2000 (which was just before the adult rate was raised to £3.70) and from March 1999 to May 2001 (the last month for which we have data). Over this period there is nominal wage growth in the whole economy so, to abstract from this, we normalize the change in the median wage to zero.

The most striking feature of Figures 10 and 11 is that virtually all the change seems to have occurred by May 1999. There is no evidence of a 'slow-burn' effect of the NMW reaching further up the wage distribution. What has happened since is the slow erosion of the NMW in real terms as a result of nominal wage growth, something that the 10p rise in

October 2000 did little to reverse. Figures 10 and 11 suggest that, from May 1999 to May 2001 the lowest percentiles of the earnings distribution saw their earnings fall by 9% relative to the median. This is broadly consistent with a simple model in which the only increase in earnings the lowest percentiles have had is the 2.8% increase in the minimum wage in October 2000 and the ONS average earnings index has risen by 10% over the same period. However, Figures 10 and 11 do suggest a larger deterioration in earnings relative to the median for those in the bottom half of the distribution who are not affected by the NMW. The NMW has probably prevented this from being transmitted to the lowest-paid workers.

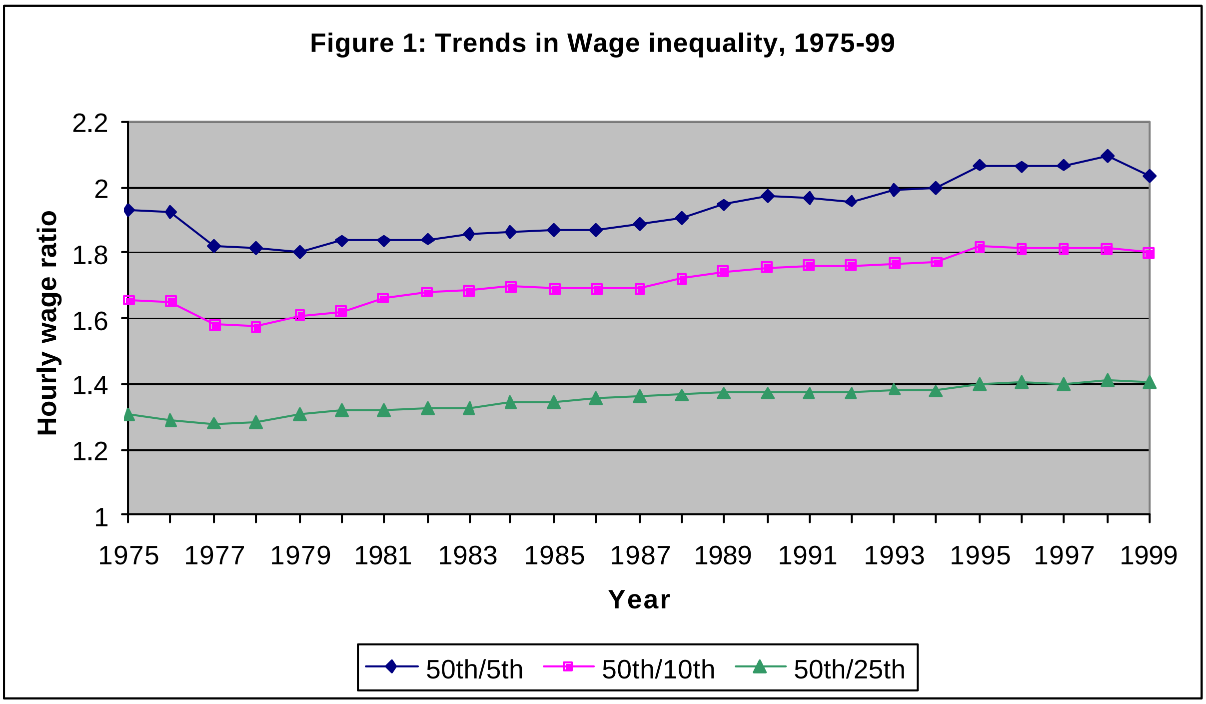
The rise to £4.10 that occurred in October 2001 is likely to have more than reversed the erosion of the impact of the NMW seen in Figures 10 and 11. Our estimates suggest that about 8-9% of employees are paid below £4.10 in May 2001. This can then be thought of as an upper bound on the proportion likely to be affected by the October 2001 increase.

3. Conclusion

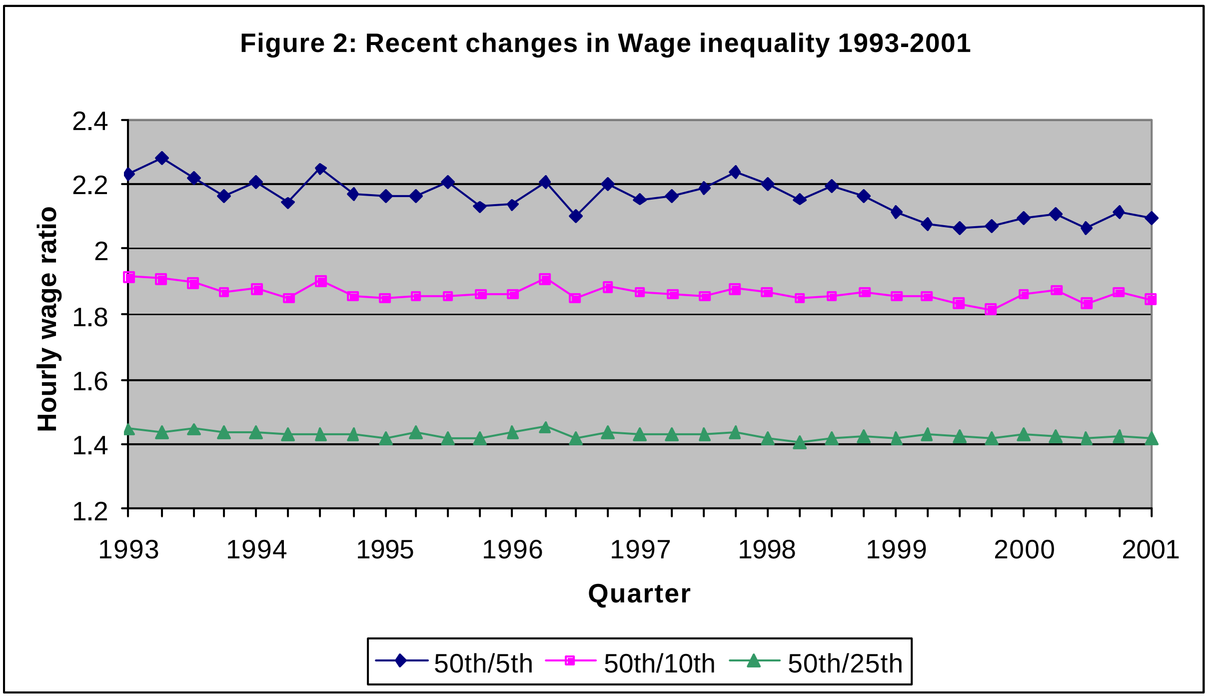
The NMW has been effective in raising the earnings of the lowest-paid workers. Less than 1% of adult workers fail to receive the minimum wage and some of these may not be illegal (e.g. there is a lower rate for those in the first 6 months of a job which provides accredited training and for those whose accommodation is provided by the employer). This is consistent with more qualitative evidence from the reports of the Low Pay Commission (Low Pay Commission, 2000).

But, the impact of the NMW on overall wage inequality is rather small, with no detectable impact on earnings at the 10th percentile even when the impact of the NMW was largest. There are two reasons for this: first, the minimum wage has been set at a low level, affecting less than 10% of workers. Secondly, the spill-over effect has been non-existent. This appears to be an important difference from the US where, for example, the results of Lee (1999) would suggest that spill-over effects are quite large. Why there should be this apparent difference is an interesting topic for further research.

Finally, there is good reason to think that the methodologies developed here over-state the impact of the NMW. There is evidence that the identifying assumptions used to estimate the numbers of low-paid workers are violated in the data. More work is needed to see how robust are alternative measures of the impact of the NMW to different identifying assumptions.

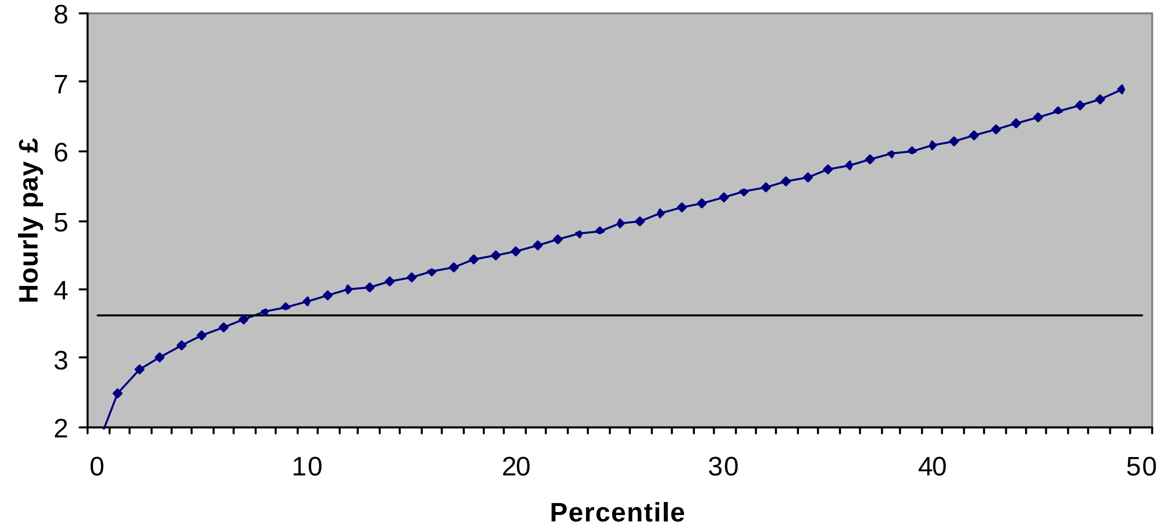


Notes: 1. New Earnings Survey Data. Real Hourly Wage.
2. Ratio of 50th/5th, 50th/10th and 50th/25th percentiles.



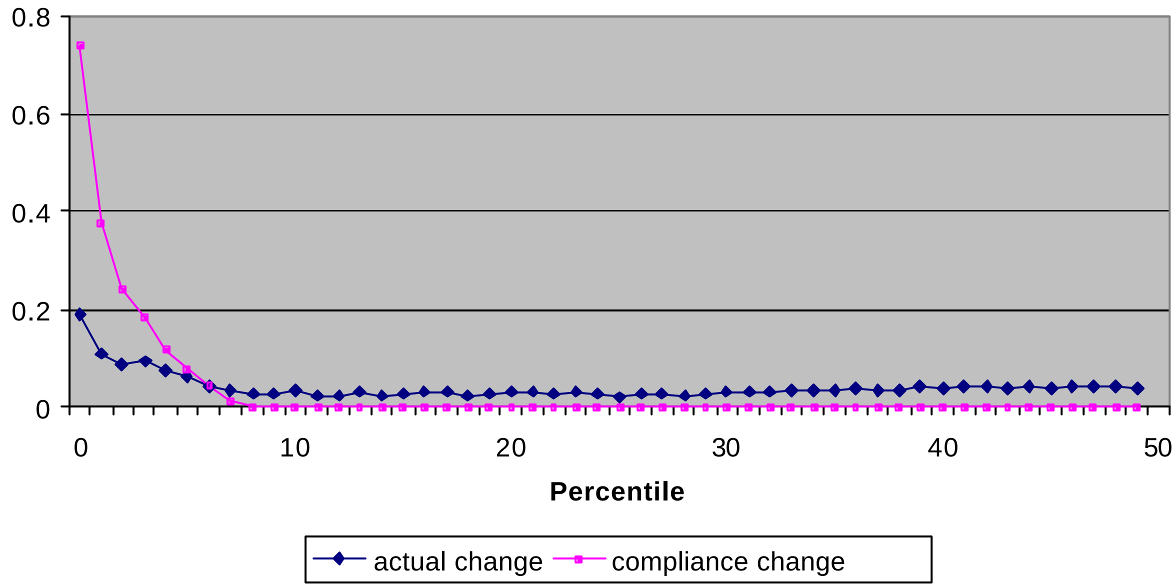
Notes: 1. Quarterly Labour Force Survey Data. Real Hourly Wage.
2. Ratio of 50th/5th, 50th/10th and 50th/25th percentiles.

Figure 3: Distribution of hourly pay just prior to introduction of the NMW

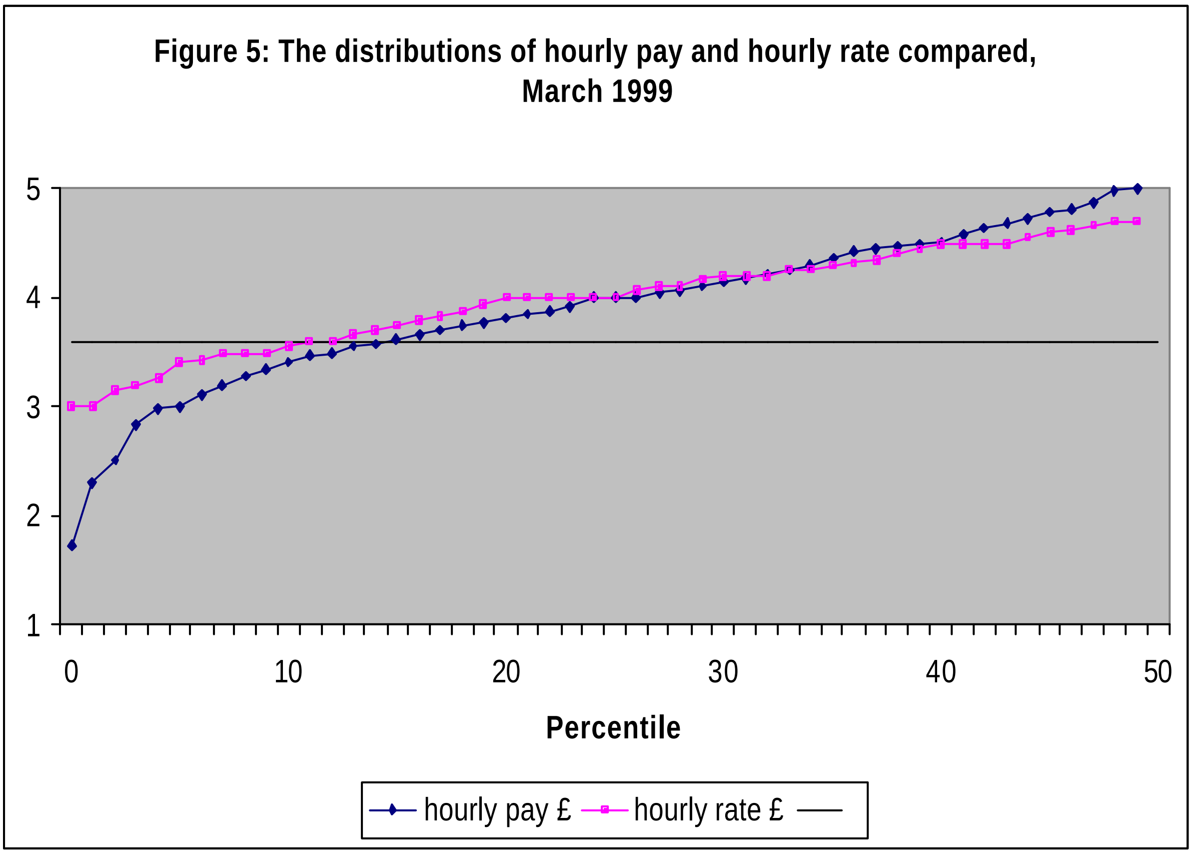


Notes: 1. Bottom half of the hourly pay distribution in March 1999.
2. All those aged 22+.
3. Horizontal line at £3.60 – where the NMW will come in.

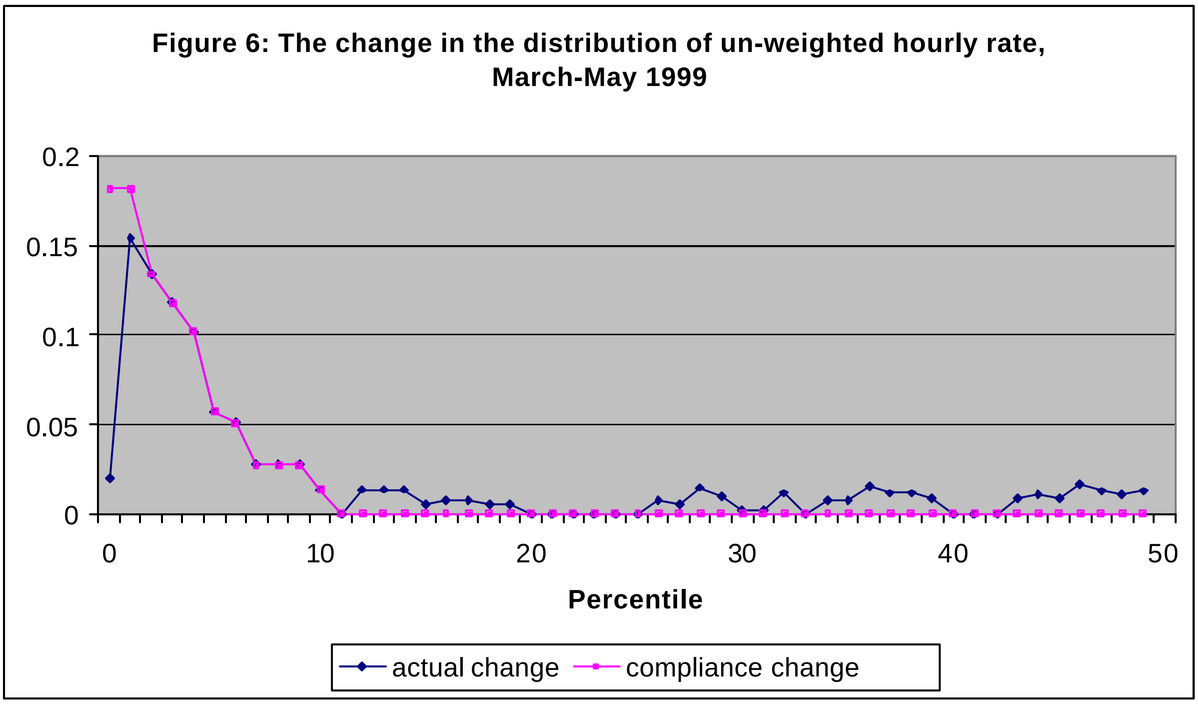
Figure 4: Change in the distribution of hourly pay, March-May 1999



Notes: 1. Change in the hourly pay distribution between March 1999 and May 1999.
2. The compliance change is the change in log hourly pay at each percentile necessary to comply with the NMW.

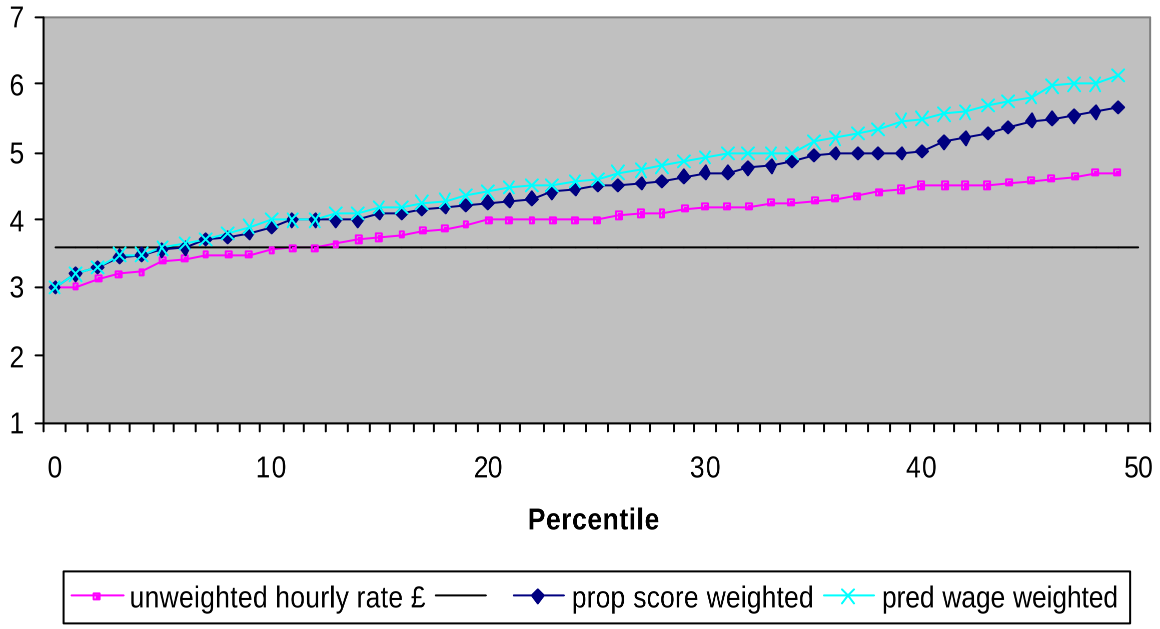


Note: The distribution of hourly pay here is for those that report and hourly rate, so the same individuals are represented in both lines. This differs from the distribution in Figure 3.



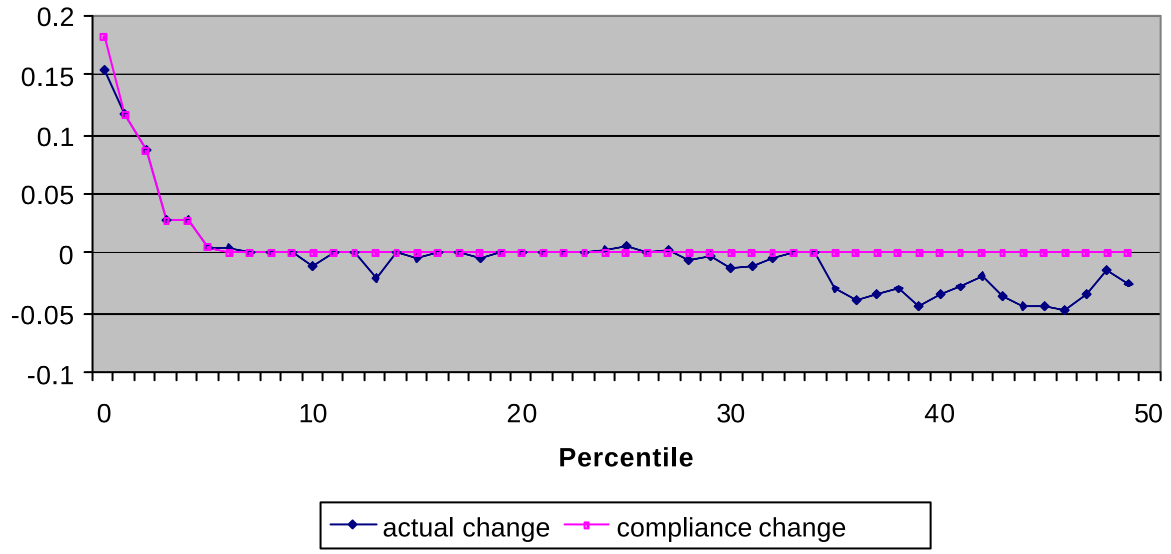
Notes: 1. Change in the hourly rate distribution between March 1999 and May 1999.
2. The compliance change is the change in log hourly pay at each percentile necessary to comply with the NMW.

Figure 7: The distributions of weighted and unweighted hourly rate compared, March 1999

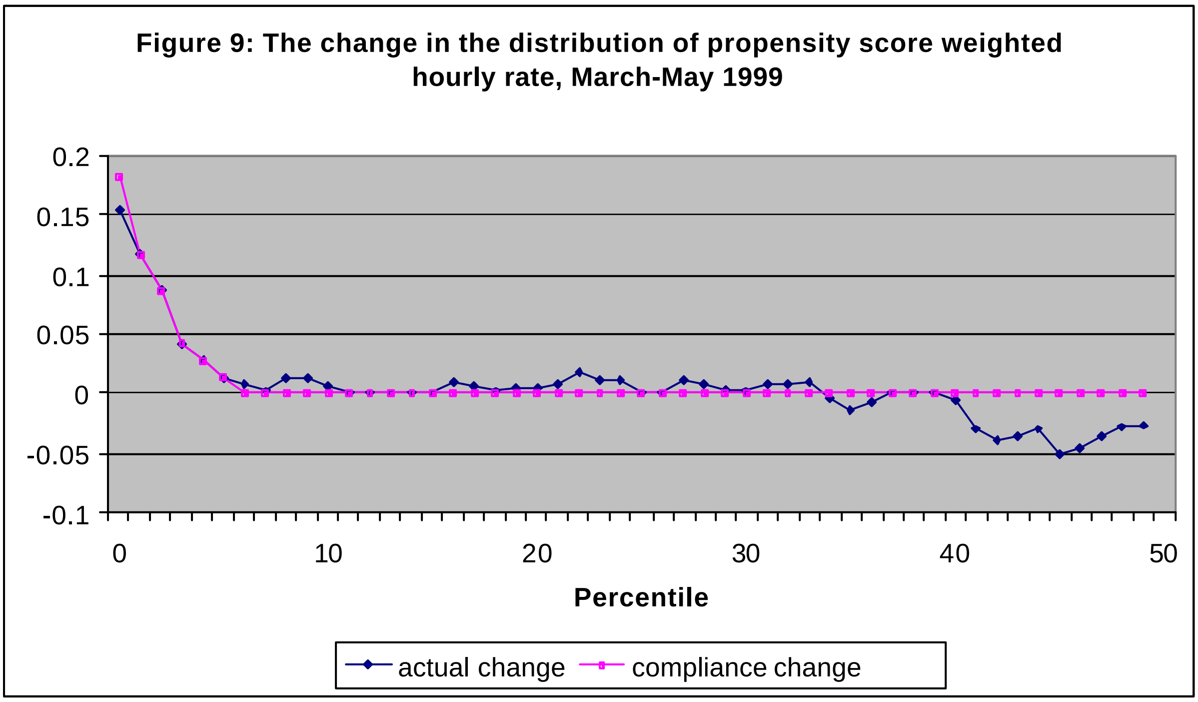


Notes: 1. Bottom half of distributions for the un-weighted hourly rate, the propensity score weighted and the predicted wage weighted hourly rate.
2. Horizontal line at £3.60 – where the NMW will come in.

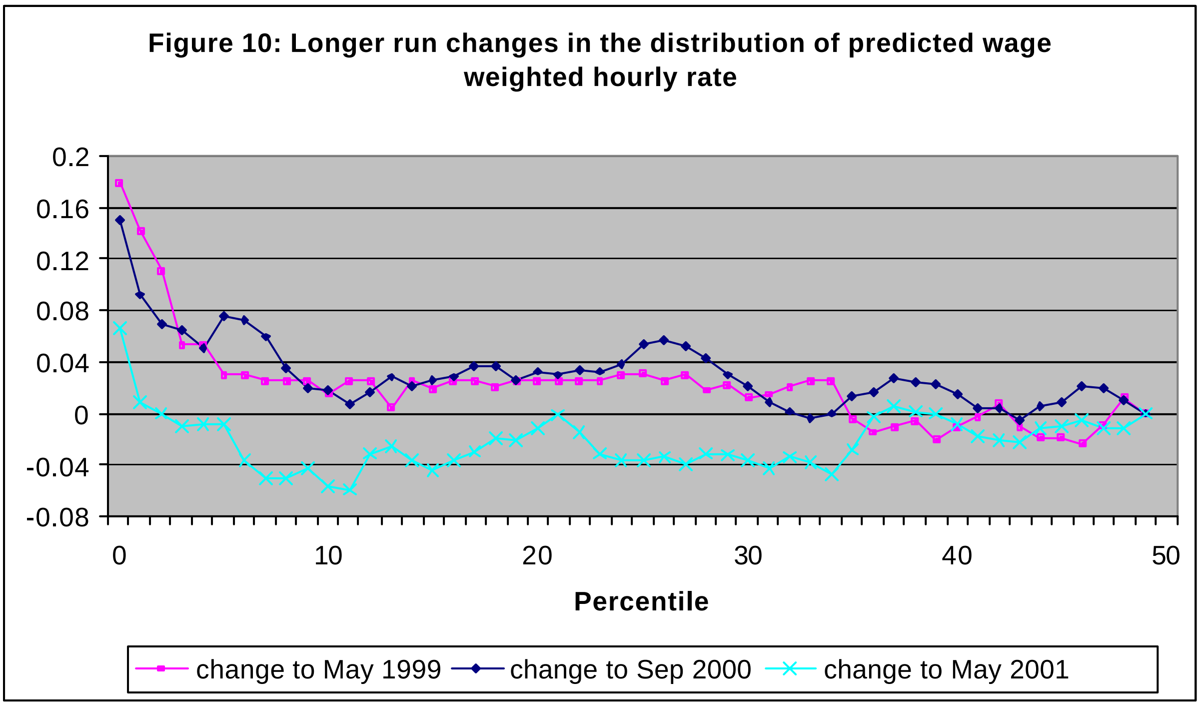
Figure 8: The change in the distribution of predicted wage weighted hourly rate, March-May 1999



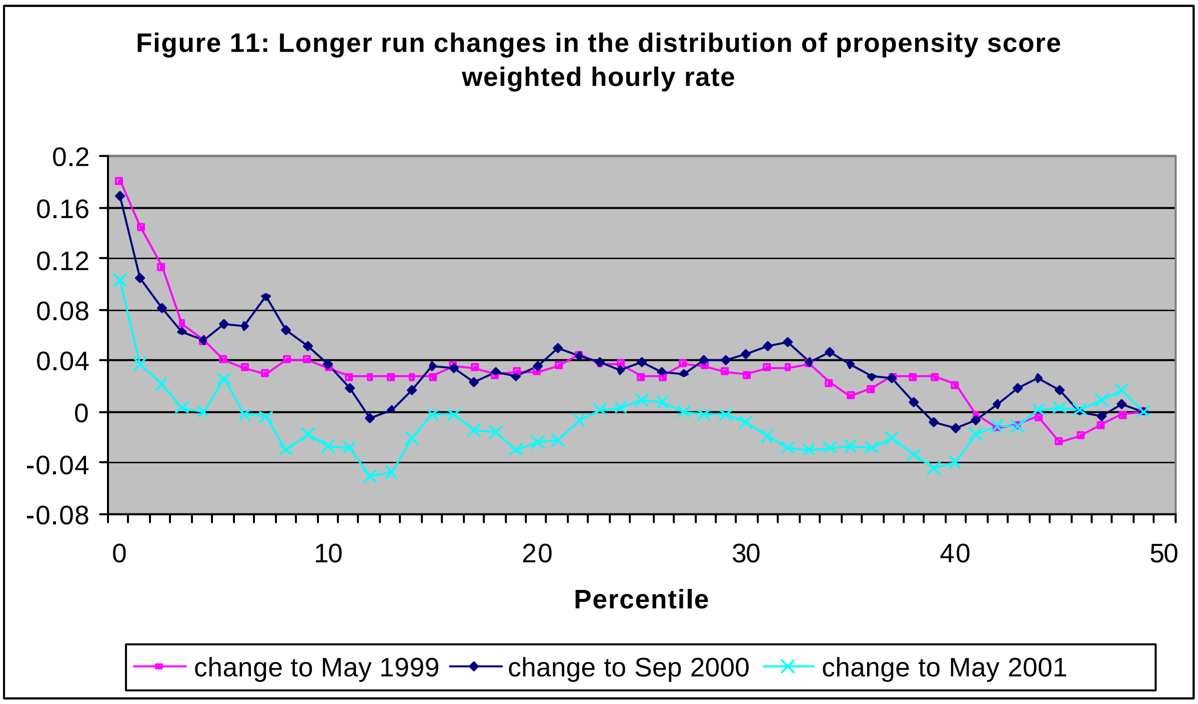
Note: 1. Change in the propensity score weighted hourly rate distribution between March 1999 and May 1999.



Note: Change in the propensity score weighted hourly rate distribution between March 1999 and May 1999.



Note: Wage changes are normalised to the predicted median wage change.



Note: Wage changes are normalised to the predicted median wage change.

Table 1: Distribution of derived hourly wage (hourpay) by whether or not an hourly rate reported

	For those who report an hourly rate - £	For those who don't report an hourly rate - £
Mar - 99		
5th percentile	3.0	3.8
10th percentile	3.5	4.5
25th percentile	4.1	6.0
50th percentile	5.3	8.3
75th percentile	7.4	12.0
90th percentile	10.4	16.5
95th percentile	12.5	20.2

Table 2: Estimates of the percentage of workers affected by the NMW

Predicted wage re-weighting

	Actual distribution	Basic specification	plus industry and occupation dummies	plus proxy measure	plus hourly pay
Mar-99					
% < £3.575	11.3	7.1	6.1	6.2	5.9
% £3.575-£3.625	2.1	1.4	1.2	1.2	0.9
% £3.625-£3.725	2.2	1.5	1.4	1.4	1.1
% > £3.725	84.4	90.1	91.3	91.2	92.0
May-99					
% < £3.575	2.2	1.5	1.3	1.3	1.2
% £3.575-£3.625	10.1	6.8	6.3	6.4	5.1
% £3.625-£3.725	2.5	1.6	1.3	1.4	1.7
% > £3.725	85.3	90.1	91.0	91.0	92.0

Table 3: Estimates of the percentage of workers affected by the NMW

Inverse propensity score re-weighting

	Actual distribution	Basic specification	plus industry and occupation dummies	plus proxy measure	plus hourly pay
Mar-99					
% < £3.575	11.3	7.4	6.9	6.7	6.0
% £3.575-£3.625	2.1	1.3	1.5	1.4	1.2
% £3.625-£3.725	2.2	1.4	1.4	1.3	1.3
% > £3.725	84.4	89.8	90.3	90.6	91.5
May-99					
% < £3.575	2.2	1.4	1.2	1.2	1.2
% £3.575-£3.625	10.1	6.1	5.7	5.9	5.7
% £3.625-£3.725	2.5	1.5	1.3	1.3	1.3
% > £3.725	85.3	90.9	91.8	91.7	91.9

Appendix

In this Appendix we show how the re-weighting estimates of the hourly rate distribution are derived. Use w to denote the hourly rate and x to represent covariates (which might include hourly pay).

Let us first consider the propensity score method. The unconditional distribution of w can be written as:

$$f(w) = \int f(w|x)g(x)dx \tag{3}$$

where g(x) is the marginal distribution of x. This can be written as:

$$f(w) = \int [f(w|x,R=1)p(x) + f(w|x,R=0)(1-p(x))]g(x)dx \tag{4}$$

where p(x) is the probability of R=1 given x, the propensity score. Using (1), (4) can be written as:

$$f(w) = \int f(w|x,R=1)g(x)dx \tag{5}$$

The important thing to note about (5) is that while the wage distribution conditional on x appears, the distribution of x is that for the whole population. This is not the same as the overall observed hourly rate distribution which is given by:

$$f(w|R=1) = \frac{\int f(w|x,R=1)p(x)g(x)dx}{\int p(x)g(x)dx} \tag{6}$$

The simplest way to compute the wage distribution in (5) is to re-weight each observation for whom the hourly rate is observed. The weight that we want to give each observation is given by:

$$j(x) = \frac{\int g(x')p(x')dx'}{p(x)} = \frac{p}{p(x)} \tag{7}$$

where p is the overall proportion of the sample for whom R=1. The weights to be used are the inverse of the response propensity: this is the response propensity weighting of Little (1988).

Now consider the ONS methodology. This assumes that for a given linear combination of x, $\hat{w} = b'x$, the distribution of w conditional on $(\hat{w}, x)$ is independent of x i.e. $\hat{w}$ is a sufficient statistic. They also assume that $\hat{w} = E\left(w|x\right)$ but that does not matter here. Now, if g(x) is the marginal density of x in the population and p(x) is the probability that someone with characteristics x reports an hourly wage, we will have:

$$f\left(w|\hat{w}, R=1\right) = \frac{\int_{b'x=\hat{w}} f\left(w|x, R=1\right) p(x)g(x)dx}{\int_{b'x=\hat{w}} p(x)g(x)dx} = \frac{\int_{b'x=\hat{w}} f\left(w|x\right)p(x)g(x)dx}{\int_{b'x=\hat{w}} p(x)g(x)dx} = f\left(w|\hat{w}\right) \quad (8)$$

where the first equality follows from (1) and the second from the assumption that $\hat{w}$ is a sufficient statistic.

Given the result in (8), one can simply apply the earlier result to show that one should re-weight the data using weights proportional to the inverse of the propensity score for a given predicted wage.

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