



A paper looking at the changes made to the questionnaire and its impact was published on 31 October 2005 and can be found here <http://www.statistics.gov.uk/cci/article.asp?id=1294>. The purpose of this paper is to focus on the statistical work that was conducted in order to address the discontinuity that resulted from introducing an 'other pay' question.

### Analysis

A cognitive interview exercise was conducted during July and August of 2005 in an attempt to gain information from respondents about the way in which they had answered the basic pay and other pay questions. During the case studies it was found that some respondents were doing as we expected and splitting the basic pay into basic and other pay. However, other respondents were now reporting significant amounts of other pay that appeared to be missing in 2004. The cognitive interviews revealed that there was a wide range of allowances that were applicable to the other pay question on the 2005 ASHE questionnaire, reflecting the range of business environments that respondents work in. Whether the allowances were included in response to the basic pay question on 2004 NES depended on how respondents had interpreted the question. Around half of the respondents interviewed did include these allowances. It must be noted here that the numbers in the cognitive interviews were small and results should be treated with caution.

The second stage of the other pay discontinuity work was to analyse the respondent level data. This also showed that some respondents were splitting their basic pay into basic and other pay whilst other respondents were now reporting significant amounts of other pay. This becomes apparent when we compare the growth rate between basic pay in 2004 and basic pay in 2005.

**Chart 1 – Year on year growth of weekly earnings for all full time employees**

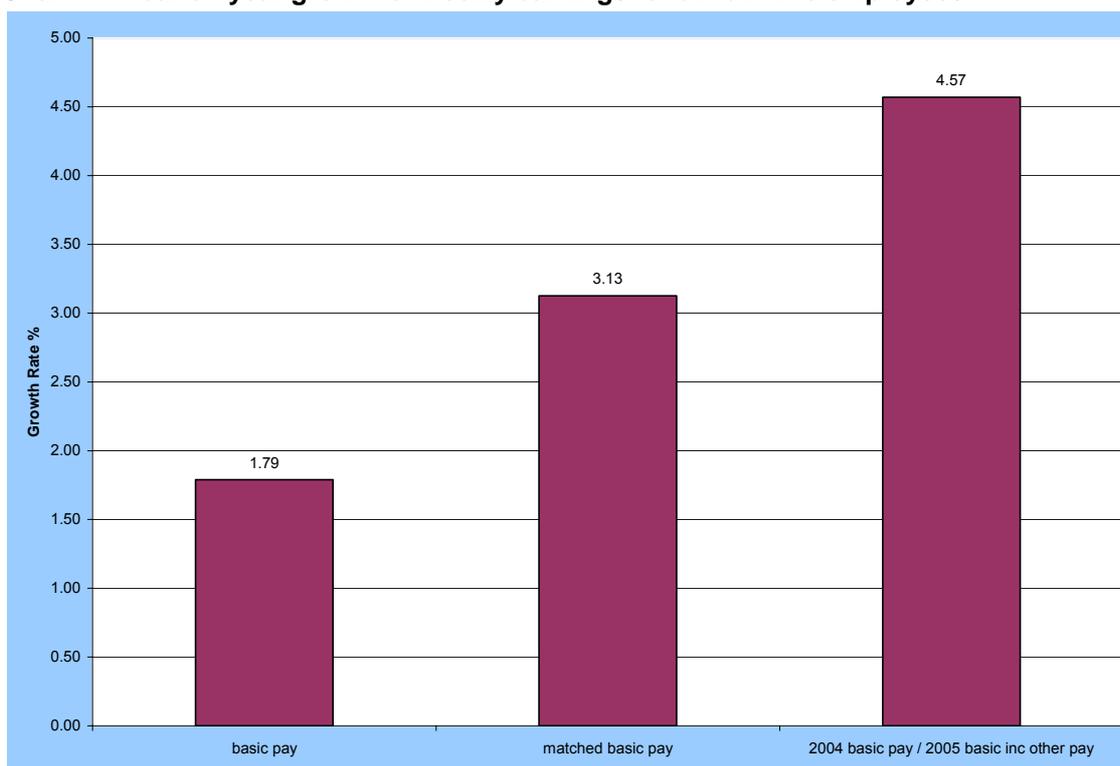
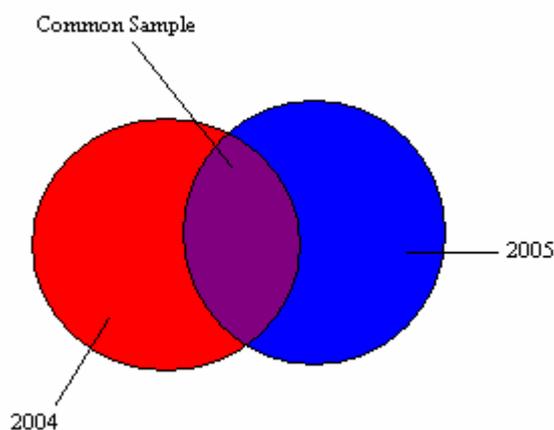


Chart 1 shows that the year on year growth for basic pay between 2004 and 2005 stands at 1.79%. Year on year growth for basic pay in 2004 and basic pay including other pay in 2005 is 4.57%. Basic pay growth on a matched sample basis indicates that underlying growth stands at 3.13%. The matched sample is those respondents who reported only basic pay in both years. This matched growth is only an indication of the growth in basic pay. This evidence suggested that some other pay was missing in 2004 as the basic pay on basic pay annual growth was low and annual growth of 2004 basic pay on 2005 basic including other pay was high.

## Methodology

Users require a consistent time-series to produce growth rate estimates each year. It was therefore decided that to produce a comparable time series and meet users needs a method would need to be developed to impute other pay in 2004. This focused on 'correcting' records and imputing for other pay in 2004.

There were two subsets of data which required different approaches. The first subset consisted of all records that responded in 2004 and 2005. In Chart 2 below these are represented by the purple section.



### Chart 2 – Diagram showing the make up of the ASHE 2004 and 2005 respondents

For those respondents that had reported basic pay in 2004 and 2005 and also reported other pay in 2005, it was assumed that other pay was missing in 2004 if the growth between basic pay 2004 and basic pay plus other pay 2005 was greater than 5%. A value for other pay 2004 was 'imputed' at the respondent level using the ratio of other pay to basic pay in 2005. This first stage resulted in almost 16,000 records out of 112,000 having an imputed value of other pay in 2004.

The second subset consisted of those records that only responded in 2004. These are represented by the red section in Chart 2. Some of these records will have missing other pay while others will either have no other pay or will have already included it in the basic pay figure. To correct these, a probabilistic model was developed that had two stages. The first stage was to estimate the probability that a record has missing other pay. A generalised linear model was used with candidate variables occupation, hourly rate excluding overtime, age band and sex to assess the probability of a record being incorrect and hence needing a value for other pay to be imputed. The model is illustrated algebraically below.

$$P_i = \alpha_1 A_i + \alpha_2 B_i + \alpha_3 C_i + \alpha_4 D_i + e_i$$

Where  $P_i$  – probability that unit  $i$  has missing 'other pay'

$A_i$  - one digit occupation

$B_i$  – Hourly earning excluding overtime

$C_i$  – Sex

$D_i$  – age band

$e_i$  – error term assume  $N(0, \sigma_1)$

These variables were used in fitting a model to the first subset to estimate value and significance of the  $\hat{\alpha}_1, \hat{\alpha}_2, \hat{\alpha}_3, \hat{\alpha}_4$ . The significant variables were one digit occupation and hourly earnings excluding overtime. This model enabled a prediction to be made for the probability that each record in the second subset required an imputed value for other pay. Using the responses to these variables each record could then be assessed as to whether it should be imputed or not according to these probabilities. A random number [uniform (0, 1)] was then generated for each member and an adjustment was made if this number was less than the probability that an adjustment be made.

The second stage was to estimate the size of the missing pay. Another generalised linear model was used to assess which variables were significant in the model used to estimate the levels of other pay. The model is illustrated algebraically below.

$$O_i = \beta_1 A_i + \beta_2 B_i + \beta_3 C_i + \beta_4 D_i + f_i$$

Where  $O_i$  – Other pay as a percentage of basic pay

$A_i$  - 1 digit occupation

$B_i$  – Hourly earning excluding overtime

$C_i$  – Sex

$D_i$  – age band

$f_i$  - error term assume  $N(0, \sigma_2)$

Again the significant variables were one digit occupation and hourly earnings excluding overtime. This model was applied with estimated parameters  $\hat{\beta}_1, \hat{\beta}_2$  to the records that had been identified at stage one to give an estimate for other pay.

The second stage resulted in almost 8,000 records out of 60,000 having an imputed value for other pay in 2004. Using this method a total of almost 24,000 records had an imputed value for other pay. The total un-weighted value of imputed other pay was £2.2 million. This is a measure of basic pay that was missing in 2004. The value of other pay in 2004 is greater than this as some respondents would have included it within basic pay.

### Results and conclusions

The two subsets were compared graphically to check the effect of the model. This showed that the percentage of other pay for those respondents in 2004 and 2005 is not statistically different from that for respondents only in 2004. The charts also show that imputing for other pay in 2004 will add around 0.8% growth to basic pay at the all employee level.

2004 records have had a value for other pay imputed to account for missing other pay. The tables below show the mean and median levels of basic pay with growth rates by sex and full/part time and 1 digit standard occupation code. The impact of correcting for other pay in 2004 was to produce an annual growth to 2005 that was 0.8 per cent lower than when compared with the growth based on 2004 basic pay alone, based on the all employee level. This result is consistent for All employees, Males, Females, Full time and part time.

**Table 1 –Level and year on year growth in mean weekly basic pay**

	2004 basic pay	2005 basic pay	2004 basic inc other pay	2005 basic inc other pay	% Growth 2004 basic pay/ 2005 basic pay	% Growth 2004 basic pay / 2005 basic inc other pay	% Growth 2004 basic inc other pay / 2005 basic inc other pay
All employees	383.4	386.6	386.5	397.2	0.8	3.6	2.8
Males	470.0	470.5	473.9	485.3	0.1	3.3	2.4
Females	292.9	300.5	295.2	306.8	2.6	4.7	3.9
Full time	462.5	470.8	466.2	483.7	1.8	4.6	3.7
Part time	147.6	148.9	148.9	153.1	0.8	3.7	2.8

**Chart 3 – Mean year on year growth of weekly pay for all full time employees**

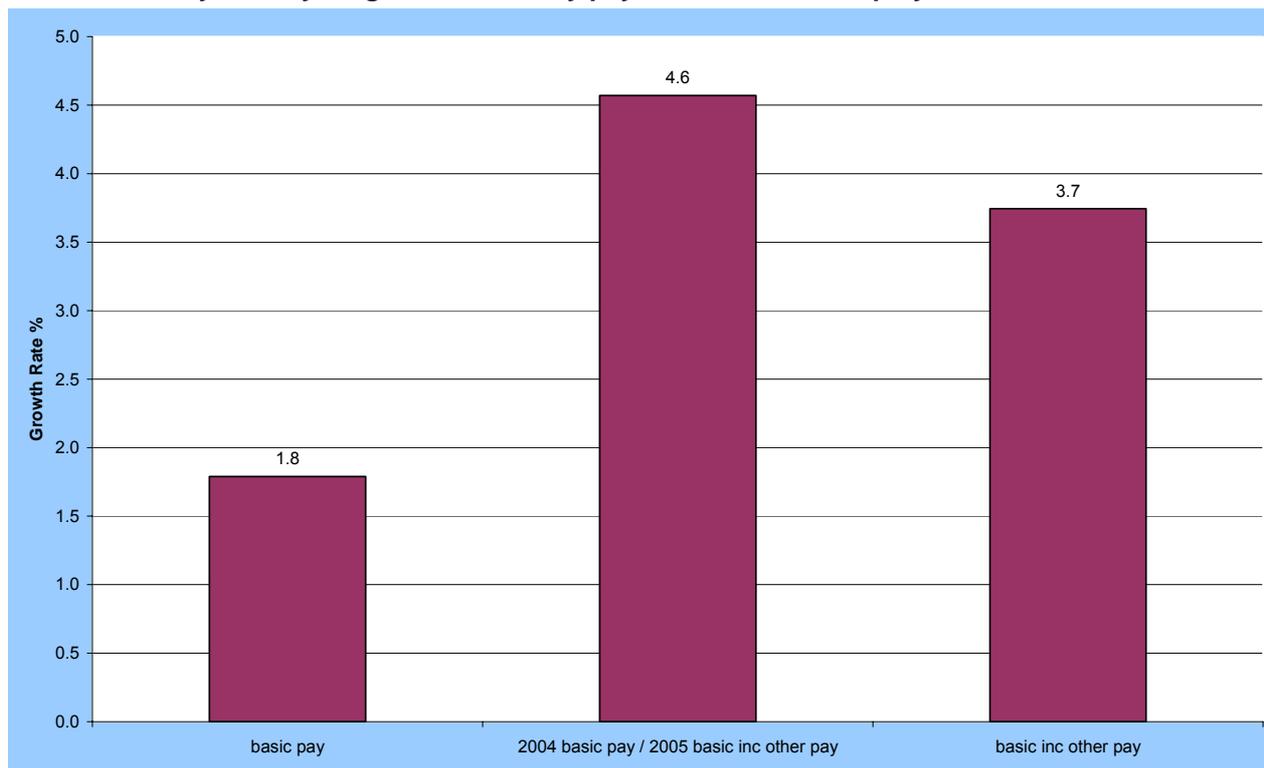


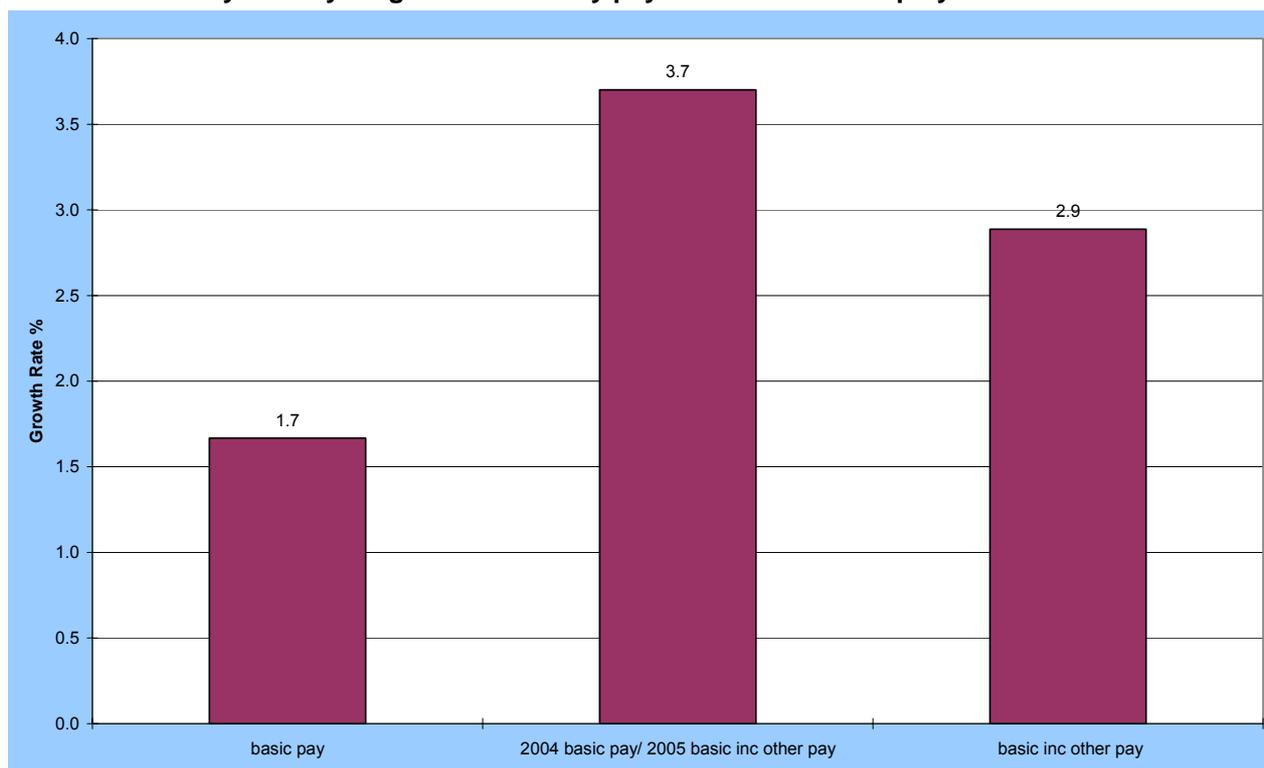
Chart 3 shows that the year on year growth for basic pay including other pay between 2004 and 2005 stands at 3.7 per cent. The results indicate that imputing for other pay has resulted in a consistent time-series between 2004 and 2005.

ASHE publication leads with the median value of earnings, the impact of other pay on the median estimates can be seen in Table 2 and Chart 4. Again the impact of other pay is to reduce annual growth in 2005 by 0.8 per cent. The impact on other pay is less on the median estimates this is due to other pay being associated with occupations at the lower end of the pay distribution.

**Table 2 – Level and year on year growth in median weekly basic pay**

	2004 basic pay	2005 basic pay	2004 basic inc other pay	2005 basic inc other pay	% Growth 2004 basic pay/ 2005 basic pay	% Growth 2004 basic pay / 2005 basic inc other pay	% Growth 2004 basic inc other pay / 2005 basic inc other pay
All employees	312.5	316.2	315.0	322.9	1.2	3.3	2.5
Males	380.0	381.1	382.8	388.9	0.3	2.3	1.6
Females	244.1	250.5	245.5	254.8	2.6	4.4	3.8
Full time	377.0	383.3	380.0	391.0	1.7	3.7	2.9
Part time	120.0	121.3	120.7	123.2	1.0	2.6	2.1

**Chart 4 – Median year on year growth of weekly pay for all full time employees**



If we look at the impact of other pay at the one digit Standard Occupation category then we can see that imputing for other pay has a different impact within occupation groups. This is because occupation was used in the GLM modelling to determine the likelihood of a record having missing other pay. Therefore the occupation group determined the amount of other pay imputed. For example, Personal Services in Table 3 shows that the impact of other pay is to reduce the mean annual growth by 1.2 per cent. There is a much lower impact Administrative and secretarial occupations where other pay reduces mean annual growth by 0.5 per cent.

**Table 3 –Level and year on year growth in mean weekly basic pay by 1 digit occupation**

	2004 basic pay	2005 basic pay	2004 basic inc other pay	2005 basic inc other pay	% Growth 2004 basic pay/ 2005 basic pay	% Growth 2004 basic pay / 2005 basic inc other pay	% Growth 2004 basic inc other pay / 2005 basic inc other pay
All employees	383.4	386.6	386.5	397.2	0.8	3.6	2.8
Managers and senior officials	680.8	693.9	686.1	716.1	1.9	5.2	4.4
Professionals	593.2	597.6	598.5	614.9	0.7	3.7	2.7
Associate professionals and Technical	444.4	446.7	448.3	459.5	0.5	3.4	2.5
Administrative and secretarial	276.4	278.3	277.6	281.8	0.7	2.0	1.5
Skilled trades	341.3	344.5	343.6	353.2	0.9	3.5	2.8
Personal Services	199.9	197.5	202.3	204.4	-1.2	2.2	1.0
Sales and customers services	163.1	165.6	164.0	167.9	1.6	3.0	2.3
Process plant and machine operatives	293.4	302.0	295.7	310.3	2.9	5.8	4.9
Elementary	184.2	185.2	186.1	190.7	0.6	3.5	2.5

**Table 4 –Level and year on year growth in median weekly basic pay by 1 digit occupation**

	2004 basic pay	2005 basic pay	2004 basic inc other pay	2005 basic inc other pay	% Growth 2004 basic pay/ 2005 basic pay	% Growth 2004 basic pay / 2005 basic inc other pay	% Growth 2004 basic inc other pay / 2005 basic inc other pay
All employees	312.5	316.2	315.0	322.9	1.2	3.3	2.5
Managers and senior officials	568.7	574.9	572.6	589.3	1.1	3.6	2.9
Professionals	557.9	574.2	562.9	582.5	2.9	4.4	3.5
Associate professionals and Technical	415.2	422.5	419.4	431.2	1.8	3.9	2.8
Administrative and secretarial	265.3	270.0	266.1	272.0	1.8	2.5	2.2
Skilled trades	331.5	338.1	333.0	344.7	2.0	4.0	3.5
Personal Services	190.4	192.5	193.0	196.0	1.1	2.9	1.5
Sales and customers services	142.8	145.6	143.5	147.8	2.0	3.5	3.0
Process plant and machine operatives	277.8	289.9	279.5	297.1	4.3	6.9	6.3
Elementary	183.6	186.8	185.0	189.2	1.8	3.0	2.2