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DISCUSSION PAPER SERIES

IZA DP No. 13499

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ABSTRACT

How the Minimum Wage Affects Training among Apprentices

Previous studies have found mixed evidence regarding the effects of the minimum wage on training levels. This paper exploits a discontinuity in the minimum wage received by apprentices in the United Kingdom to examine this question. Workers aged 19-20 receive a substantial increase in the minimum wage after one year on an apprenticeship, whereas workers aged under 19 do not experience a change in the minimum wage at this point. Using data from the Apprenticeship Pay Survey, regression discontinuity design estimates suggest that the increase in the minimum wage has no overall effect on training among 19-20 year-olds. However, among firms that are compliant with the minimum wage legislation, the minimum wage reduces training by 11-23%. Since relatively few employers pay exactly the minimum wage, this implies a large elasticity of training with respect to the wage. Additional data from the Apprenticeship Evaluation Survey reveals that the overall effect of a 1% wage increase, including its effect on training, is a 0.1% reduction in a person's self-reported career prospects and a near-zero effect on his/her satisfaction with the apprenticeship.

JEL Classification: J24, J31

Keywords: minimum wages, training, apprentices

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1. Introduction

Economic theory suggests that in a competitive labour market, employers should respond to increases in the minimum wage by reducing training levels, because doing so allows them to at least partially offset the increased labour costs. If firms are able to substantially reduce training costs when the minimum wage rises, this may explain why many studies in the United States and most studies in Europe have found that there is little employment response to the minimum wage. Despite this, previous studies of the effect of minimum wages on training participation have reported mixed evidence, with some finding negative effects (Schiller 1994; Neumark and Wascher 2001) and others finding an insignificant relationship (Simpson 1984; Grossberg and Sicilian 1999; Acemoglu and Pischke 2003; Arulampalam *et al*. 2004; Fairris and Pedace 2004). These studies have been hampered by the difficulty of distinguishing between training that enhances a worker's productivity and training that is done for regulatory reasons (such as health and safety training), as well as the difficulty of measuring the amount of training received by an individual worker.

The objective of this paper is to provide causal evidence of the effects the minimum wage has on workplace training. It does this by focusing on apprentices in the United Kingdom, for whom training is an essential component of the work week. Apprentices who are aged 19 and over are subject to a lower rate of the minimum wage for their first year on an apprenticeship. This provides an ideal setting for a regression discontinuity design (RDD), where training levels are compared between apprentices on either side of the one-year threshold. Since apprentices aged under 19 are allowed to be paid the lower minimum wage rate for more than a year, they provide an additional control group.

Using data from the Apprenticeship Pay Survey from 2014, 2016 and 2018, sharp RDD estimates show that the increase in the minimum wage experienced by apprentices at the one-year mark results in an insignificant change in training across all apprentices, but an 11-23% reduction in the amount of training, once firms that pay less than they are legally required to are removed. Fuzzy RDD estimates provide evidence of how sensitive training is to the wage level. Because a high fraction of employers pay more than the minimum wage, the elasticity of training with respect to wages is found to be very high (around -1 or -2). An additional contribution of the paper is to examine the overall effects of training on an apprentice's wellbeing. Although a higher wage directly increases a person's satisfaction with his/her apprenticeship, this is almost exactly offset by the indirect negative effect of less training. The effect of a higher wage also has a significant negative effect on a person's self-assessed career prospects.

2. Background

In the UK, an apprenticeship is described by the government as a 'job with training' and refers to a structured programme of training, consisting of paid employment and learning, which allows a person to acquire knowledge and skills and gain a recognised qualification within a specific occupation or trade. Apprenticeships are ranked in terms of their academic level. Level 2 apprenticeships are equivalent to five GCSE passes; level 3 apprenticeships are equivalent to two A-level passes; level 4 and 5 apprenticeships are equivalent to a foundation degree or above; and level 6 and 7 are equivalent to bachelor's or master's degree. Each apprenticeship also follows a particular "framework", designed to provide entry to a particular occupation. Each is developed by a sector body, with the objective of allowing the apprentice to pass some competency-based qualification. Employers receive public funds to cover part of the cost of the apprenticeship. Since 2017, firms with payrolls over £3 million in England (but not other parts of the UK) are required to pay an Apprenticeship Levy, which is a dedicated account that may only be spent on apprentice training and expires after two years if unspent.

Training on an apprenticeship consists of informal on-the-job training, conducted while the apprentice performs his/her usual work tasks, and formal off-the-job training, conducted either at the apprentice's workplace or at some external training provider. To be eligible for government funding, at least 20% of an apprentice's normal working hours must be spent doing off-the-job training.

All employees in the UK, including apprentices, are subject to the National Minimum Wage. This comprises five separate rates, each applying to different groups of workers. There are four age-specific minimum wages, for workers aged under 18, 18-20, 21-24 and 25 and over.[1] In addition, the apprentice rate applies to apprentices who are either in the first year of their apprenticeship or are aged under 19. All rates are raised each year, on the recommendation of the independent Low Pay Commission. Since its introduction in 2010, the apprentice minimum wage has been set considerably lower than the other rates. As a result, many apprentices aged 19 and over get significant pay increases after they have been on their apprenticeship for a year. For example, in 2018, the minimum wage applying to a 19 year-old apprentice would have increased from £3.70 to £5.90 after one year. Figure 1 shows the evolution of the various minimum wage rates since their introduction in 1999.

[1] The 25 and over rate is referred to as the National Living Wage. However, it has no relationship to the Living Wage Foundation's 'Living Wage'.

The purpose of the apprentice rate is to allow employers to pay a lower hourly wage for workers who are likely to be less productive during their working hours than other workers and are also required to undertake more hours of off-the-job training. Employers are required to pay the minimum wage for all time spent training, including when it is undertaken away from the workplace. Therefore, the apprentice rate provides an hourly pay discount for employers, in return for them paying for time during which the apprentice is unproductive from the firm's perspective.

Since the explicit purpose of the apprentice rate is to allow employers to offset the cost of training, a simple way to think about the pay-training relationship in a competitive labour market is that an employer will retain an apprentice so long as the total amount they pay in wages is equal to the value of the marginal product produced by the apprentice. This requires:

$$wh = \theta(h - h_T), \tag{1}$$

where w is the hourly wage, h is the total number of hours the apprentice works or undertakes training for per week, h_T is the number of hours of training (on- or off-the-job) per week, and θ is the value of output produced by the worker per hour. This relationship implies that, if an apprentice is bound by the minimum wage, as the minimum wage increases the employer should reduce training hours according to the following relationship:

$$\frac{\partial h_T}{\partial w} = -\frac{h}{\theta}. \tag{2}$$

Hence, for a given increase in the minimum wage, training hours will be cut the most on jobs where apprentices work more hours in total (because the minimum wage will increase weekly pay by more in this case) and where apprentices are least productive during their hours on the job (because each extra hour of work time increases total revenue by less for these apprentices).

Three other employer responses are possible. If employers are unable to reduce training hours (for example, because they are already providing the minimum amount of off-the-job training and no on-the-job training), they may stop taking apprentices altogether. Evidence from Switzerland indicates that the number of apprenticeships in that country is sensitive to the presence of good substitutes, in the form of fully trained workers (Aepli and Kuhn 2019). Employers may also reduce the 'quality' of on-the-job training, e.g. by not providing supervision or requiring more learning by doing. Finally, employers may choose to ignore the minimum wage and pay less than they are required to.

3. Data

The analysis will primarily draw on data from the 2014, 2016 and 2018 waves of the Apprenticeship Pay Survey. This is a telephone survey of current apprentices in Great Britain. Its primary objective is to record levels of pay and hours among apprentices. After dropping respondents with extreme wage values (less than £2/hour or greater than £20/hour), the total sample size was 9,367 in 2014, 9,422 in 2016 and 9,582 in 2018. The respondents are contacted in advance and asked to have their most recent payslip at hand when they are called. Questions about pay and hours refer to the period covered by the payslip wherever possible.[2]

Although it is not a focus of the survey, the questionnaire includes two measures of training. Respondents are asked how many hours per week they spent training or on guided learning as part of their apprenticeship. The respondents are specifically instructed to consider the amount of time spent "attending college; on courses, workshops or training sessions at your employer's premises or held externally; learning at home; learning from workbooks; with your assessor, or filling in your portfolio".[3] In 2016 and 2018, respondents were also asked whether they received on average at least one day per week of formal training (the threshold for public funding set by government).

The survey records the level and framework of a person's apprenticeship. The available frameworks differ between England, Scotland and Wales and have changed over time, so the following consistent set of 14 framework groupings is used: Business and related; Children's learning and development and wellbeing; Construction and related; Customer service; Electrotechnical; Engineering, manufacturing technologies and related; Hairdressing; Health, social care and sport; Hospitality and catering; Management; Retail; Accounting; Care leadership and management; Other framework. The survey does not ask respondents how long their apprenticeship is expected to last. However, the apprenticeship start month and payslip month are recorded, so the number of months that have been spent on the apprenticeship can be calculated.[4]

[2] Respondents who do not have a payslip available are asked to answer questions with reference to their last full working week.

[3] Prior to this question, the respondents are asked to report how many hours per week they spent working and they are instructed not to include any training time that is already included in that amount. Therefore, the training hours measure may under-measure the total amount of training received, especially on-the-job training.

[4] For those respondents who did not have a payslip, the median payslip month among apprentices who had been on their apprenticeship for the same amount of time or less was used (among respondents from the same survey year who had completed/not completed 12 months on the apprenticeship).

For the first time in 2018 a portion of the APS was conducted jointly with the Apprenticeship Evaluation Survey (AEvS). The latter survey contains much richer information about an apprentice's training, including the average weekly hours spent on different types of training, including training at a college or external training provider, formal training sessions at the workplace from either the employer or a training provider, but away from the apprentice's usual work activities, and training at the workplace while the apprentice does his/her usual activities.[5] The AEvS also includes how satisfied a person is with his/her apprenticeship on a scale of 0-10 (where 0 is very dissatisfied and 10 is very satisfied) and whether the person agrees that the apprenticeship had improved his/her career prospects on a scale of 1-5 (where 1 is strongly disagree and 5 is strongly agree).

Figures 2-4 show the hourly wage distribution of apprentices, grouped by their age (16-18, 19-20, 21-24, or 25 and over) and how long they have been on their apprenticeship (less than one year or one year or more). In all cases, there appears to be a relatively high level of non-compliance, with many employers paying less than they are legally required to. One likely explanation for this is that firms do not pay workers for all the hours of training they have undertaken in a given pay period, due to confusion over the circumstances in which the minimum wage must be paid. Despite this, spikes are seen in the histograms at the levels of the various minimum wage rates. The modal pay for under-19s is the apprentice minimum wage, regardless of how long they have been employed, although a substantial faction of those in their second or higher year are paid either the 18-20 or 21-24 rate. 19-20 year-olds tend to be paid either the apprentice minimum wage rate or the 18-20 minimum wage rate in their first year, with most earning the 18-20 minimum wage after a year (as required by law). Those aged over 20 tend to earn the 25-and-over minimum wage rate from the start of their apprenticeships, with very few employers paying the apprentice rate in the first year, even though they are entitled to.

Table 1 presents means of the key variables for the APS regression sample, by age group and length of time on the apprenticeship. Both training and wages are higher among apprentices in their second year, relative to those in their first year. However, second-year apprentices are also more likely to be male, aged 19-20 and on higher-level apprenticeships, all of which are likely to predict higher wages in the absence of any minimum wage change.

[5] These questions referred to average training per week, not average training per week during the period covered by the payslip.

4. Results

Sharp RDD

The fact that apprentices experience a substantial increase in the minimum wage once they reach one year on their apprenticeship suggests the use of a regression discontinuity design. However, Figures 2-4 suggest that workers aged over 20 are unsuitable for this analysis, since so few of this age group earn the apprentice minimum wage rate, even in their first year. As a result, only workers aged under 21 will be included in the analysis. Since those aged under 19 do not receive a minimum wage increase at one year, they may be used as a control group, ensuring that any other factors that affect the wage at the one year point are controlled for. To begin with, the following sharp regression discontinuity specification will be estimated for person *i*:

$$TRAIN_i = \alpha_1 I(M_i \geq 12) + \alpha_2 I(M_i \geq 12) I(AGE_i \geq 19) + \alpha_3 I(AGE_i \geq 19) + \sum_{j=1}^{3} \alpha_{4j} (M_i - 12)^j + \sum_{j=1}^{3} \alpha_{5j} I(M_i \geq 12)(M_i - 12)^j + \mathbf{X}_i \boldsymbol{\gamma} + \varepsilon_i, \quad (3)$$

where *TRAIN* is a measure of the amount of training, *AGE* is the person's age, *M* is the number of months the person has been on his/her apprenticeship, $I(M \geq 12)$ is an indicator variable for whether the person has been on the apprenticeship for at least 12 months, $I(AGE \geq 19)$ is an indicator variable for whether the person is aged 19-20 (rather than under 19), **X** is a control vector of other determinants of training, which will include a full set of dummy variables for gender (2 categories), year (three categories), level (5 categories), framework (8 categories), country (3 categories). Only those who have been on their apprenticeship less than two years will be included in the sample, allowing for a bandwidth of 12 months on either side of the minimum wage threshold. The standard errors are clustered by *M* throughout, following the recommendation of Lee and Card (2008).

Table 2 presents estimates of equation 3. Two measures of training are used: a dummy variable for whether a person received at least one day per week of training and the number of hours of training per week the person received. The former was only asked in the 2016 and 2018 waves of the APS. In columns 1 and 3, only those aged 19-20 are included (so that $I(M \geq 12)AGE$ and *AGE* are excluded). For both training measures, a negative estimate of α_1 is found, although this is significant only using the one day training dummy.

These estimates will be biased if employers manipulate the length of the apprenticeships, to avoid paying the full rate of the minimum wage. A plot of the distribution of the observations

(the solid bars in Figure 5) indicates that there are relatively few observations with 12 months on the apprenticeship and the sample fails the McCrary density test, indicating evidence of a discontinuity in the density of time on the apprenticeship at the one year point. However, this does not necessarily indicate conscious manipulation on the part of employers, since one year is a common length for many apprenticeships.[6] Indeed, the distribution of the under-19 sample (the dashed bars in Figure 5) is almost identical to the distribution for the 19-20 sample, even though the former age group is not subject to a minimum wage increase after one year. Furthermore, a regression of a dummy for having spent more than a year on an apprenticeship on the interaction of the year dummies and the age group dummies shows that the probability of a 19-20 year-old having passed the one-year mark did not change from year to year, relative to a 16-18 year-old. This is consistent with a lack of adjustment to the minimum wage at the extensive margin and indicates that the under-19 group constitutes a suitable control group, which will capture baseline differences in the amount of training people receive at different lengths of time during an apprenticeship, unrelated to changes in the minimum wage.

When the under-19 group is added to the RDD sample (in columns 2 and 4 of Table 2), insignificant estimates of α_1 are found, indicating that there is no significant change in the amount of training received among under-19 year-olds after they reach one year on an apprenticeship. However, negative values of α_2 are found, indicating that, relative to the under 19s, the 19-20 year-olds receive a drop in training after one year. These RDD-difference-in-difference estimates imply that after one year the probability of receiving at least one day of training per week falls by 5.0 percentage points (equivalent to 8% at the mean level of training) and the amount of training per week falls by around 7 minutes (or 3% at the mean) among 19-20 year-olds, relative to the under-19s. However, once again, the effect is only significant when the one day dummy is used as the measure of training.

As noted in the last section (and seen in Figures 1-3), many employers appear to pay workers less than they are legally required to. Since these employers do not comply with the minimum wage in the first place, they are unlikely to respond in terms of training provision either. To examine how training is affected at workplaces that do comply with the law, workers who are paid less than 95% of the prevailing minimum wage are dropped from the sample in Table 3. Significant estimates of α_2 are now found for both training measures when the full 16-20 year-old sample is used (in columns 2 and 4). Passing one year on an apprenticeship is now

[6] Unlike the APS, the AEvS does record the planned length of the apprenticeship. In the combined APS-AEvS sample, 2% of apprenticeships were expected to last less than a year, 16% were expected to last exactly a year and 72% were expected to last more than a year.

found to lower the probability of receiving at least one day of training per week by 6.7 percentage points (or 11% at the mean) and to lower weekly training hours by 41 minutes (or 23% at the mean).

Figure 6 shows the predicted level of training over time on the apprenticeship, along with the average levels of training during each month on the apprenticeship, by age group. For the 19-20 age group, the probability of receiving at least one day of training per week is relatively stable over time on the apprenticeship, while the average hours of training falls during the first and last six months. Relative to this, the 19-20 year-olds consistently receive less training. However, the predicted probability of this group receiving at least one day of training per week and the predicted hours of training both drop sharply at the one-year mark.

Fuzzy RDD

The sharp RDD estimates in Tables 2 and 3 do not provide an indication of how sensitive training is to a given increase in the minimum wage. As seen in Figures 2-4, many employers choose to pay more than what they are legally required to. These employers are unlikely to respond to the increase in the minimum wage for their apprentices after one year, meaning that the negative training effects found in Tables 2 and 3 are attributable to a relatively small number of employers. Therefore, to examine how the level of training a person receives is affected by a given increase in his/her wage after one year due to the minimum wage a fuzzy RDD approach will be used. In this, the minimum wage applicable to a given worker (the "intention to treat") will be used as an instrument for his/her actual hourly wage. The following specification is estimated:

$$TRAIN_i = \beta_1 \ln w_i + \beta_2 I(M_i \geq 12) + \beta_3 I(AGE_i \geq 19) + \sum_{j=1}^{3} \beta_{4j} (M_i - 12)^j + \sum_{j=1}^{3} \beta_{5j} I(M_i \geq 12)(M_i - 12)^j + \mathbf{X}_i \boldsymbol{\gamma} + \nu_i, \quad (4)$$

where ln *w* is the log of the person's hourly wage. The log wage will be instrumented for by the interaction of $I(M \geq 12)$ and $I(AGE \geq 19)$.

Table 4 presents the results of estimating equation 4 for the two dependent variables. When the full sample of firms is used, the coefficient on the $I(M \geq 12)\ I(AGE \geq 19)$ interaction term is highly significant in the first stage when the one day of training dummy is used (in column 1), but is insignificant when weekly hours is used (in column 3), indicating the weak effect that

the minimum wage has overall. Furthermore, an insignificant estimate of β_1 is found using either training measure.

When the sample is restricted to compliant firms only, much larger first stage effects are found, indicating that 19-20 year-olds receive a sudden increase in their wage after one year on their apprenticeship, which is significantly more than what under-19s receive at that point. Furthermore, significant estimates of β_1 are found. The estimates are very large, reflecting the fact that the significant effects the apprentice rate has on training found in Table 3 arise despite the fact that many employers are unaffected by the policy, because they pay more than required. The results in column 2 of Table 4 imply that a 1% increase in a person's wage leads to a half percentage point reduction in the probability of receiving at least one day of training per week, equivalent to an elasticity of -0.82 at the mean. Column 4 indicates that a 1% increase in a person's wage leads to a 4-minute reduction in a person's weekly training hours, equivalent to an elasticity of -2.15.

The average weekly total hours spent on the apprenticeship, including both work and training time, is 39.3. If employers adjust training hours according the relationship in equation 2, the estimates in column 4 of Table 4 would then imply that the average apprentice has a marginal revenue product of £6.05 per hour. There is very little variation among apprentices in terms of total hours (90% work between 30 and 50 hours per week). However, there is likely to be considerable variation in productivity among apprentices. One proxy for this is the level of the apprenticeship, since higher-level apprenticeships typically require more prior education to enter. If the specification in column 4 of Table 4 is repeated on the sample of level 2 apprentices only, a training-wage elasticity of -2.40 is found, whereas when the sample of level 3 and higher apprentices is used, an elasticity of -1.74 is found. This suggests that the responsiveness of training to the minimum wage is highest for the least productive apprentices, consistent with equation 2.

A series of robustness tests are performed in Table 5, using the sample of compliant firms. First, the bandwidth around the one-year mark is reduced from 12 months to 10 months, in order to exclude the relatively sparsely populated first two months and last month of the sample (as seen in Figure 5). As seen in columns 1 and 4, this reduces the log wage coefficients slightly, but they remain significant. Next, a fourth-order (rather than third-order) polynomial in months on the apprenticeship is used to allow a more flexible time path or training. This makes little difference to the estimates (in columns 2 and 5). Finally, the sample is restricted to just those who had payslips available, for whom the wage information is likely to be more accurate. This reduces the sample sizes by more than half and the effect of the wage on the one day of training

dummy is no longer significant (in column 3). However, the effect on weekly training hours remains significant (in column 6).

Overall effects

Even if the minimum wage reduces an apprentice's training hours, the positive effects it has on his/her income might outweigh this. To get an idea of how much the minimum wage affects the overall value of an apprenticeship, data from the 2018 APS-AEvS were used. The following equation was estimated using OLS:

$$Y_i = \chi_1 \ln w_i + \chi_2 TRAIN_i + \mathbf{X}_i\boldsymbol{\lambda} + \psi_i, \quad (5)$$

where **X** includes age, gender, level and framework dummies and a quadratic in months on the course and *Y* is either a person's overall level of satisfaction with his/her apprenticeship (on a 0-10 scale) or whether a person agreed that his/her career prospects had improved since starting the apprenticeship (on a 1-5 scale). The results are shown in Table 6.

Both the wage and the amount of training raise satisfaction when the dummy for at least one day of formal training is used as the measure of training (as shown in column 1). Putting together the coefficients in Tables 4 and 6, it is seen that a 1% increase in a person's wage will lower his/her satisfaction by 0.0005 satisfaction points (or 0.007% at the mean), once training is taken into account. Both coefficients are insignificant when weekly training hours are used to measure training (as shown in column 2). In column 3 of Table 6, the weekly hours of each type of training are included as regressors. This reveals that an hour of off-the-job training at the workplace raises satisfaction the most, followed by an hour on-the-job training at the workplace, while off-the-job training at a college has no significant effect on satisfaction.

Columns 4 and 5 of Table 6 show that training raises a person's assessment of his/her career prospects, while the wage lowers it slightly. Taking into account the results in Table 4, the overall effect of a 1% wage increase on career prospects is -0.002 points (or -0.127% at the mean) if the one-day dummy is used and -0.002 points (or -0.119% at the mean) if weekly hours are used. Column 6 shows that the same types of training that raise satisfaction also raise career prospects.

Overall, the evidence in Table 6 suggests that the minimum wage has a sizable negative effect on an apprentice's career prospects, which roughly offsets the direct positive effects it has on his/her satisfaction with the apprenticeship. This implies that the existence of an apprentice rate of the minimum wage is effective at raising training and career prospects at those workplaces that comply with the law, even though the overall effect of the apprentice

rate is insignificant because of the large fraction of firms that appear to pay less than they should.

5. Conclusion

Previous studies of the link between minimum wages and workplace training have been hampered by a lack of high quality data on training. In response, this paper has examined training provision among apprentices in the UK, a group of workers for whom training is an integral part of the working week. Sharp RDD estimates reveal that 19-20 year-old apprentices at firms that are compliant with the minimum wage legislation receive an 11-23% drop in training after one year on the apprenticeship, at which point they are eligible for an increase in the minimum wage. This effect is found despite the fact that many employers pay their apprentices more than the relevant minimum wage. Accordingly, fuzzy RDD estimates find that training is very sensitive to wages, with elasticities larger than 1 in magnitude. Taking into account its effect on training, a 1% increase in wages is found to reduce an apprentice's self-assessed career prospects by 0.1% and a near-zero effect on his/her satisfaction with the apprenticeship. Taken together, this evidence suggests that the apprentice rate of the minimum wage has been successful in its stated aim of encouraging firms to employ apprentices and provide the necessary levels of training.

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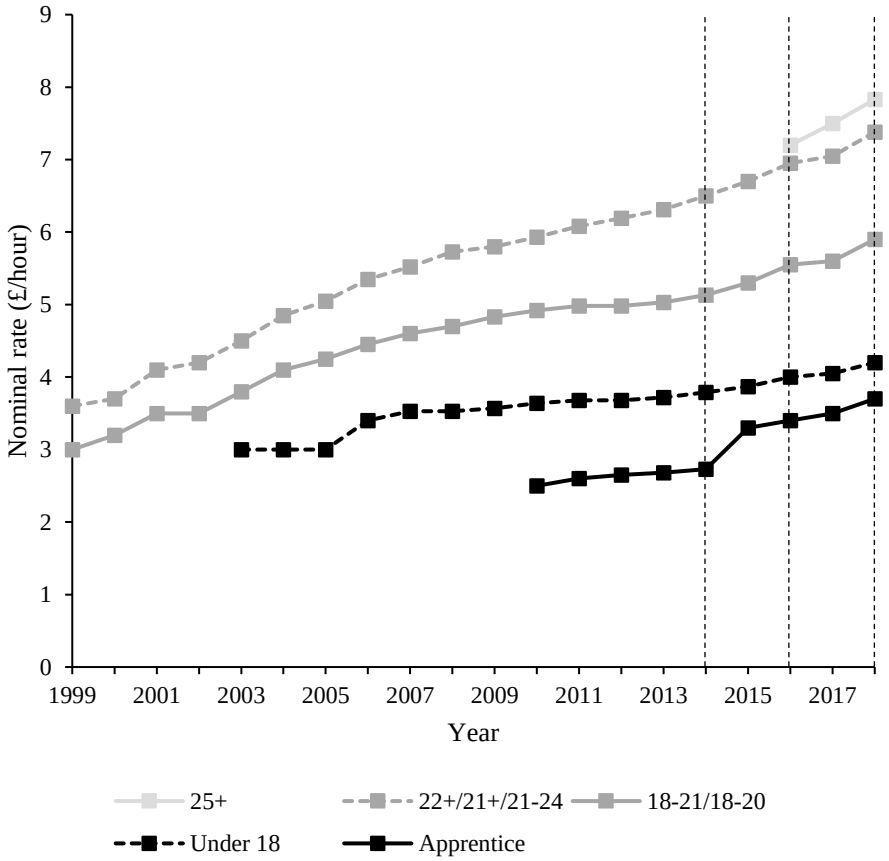
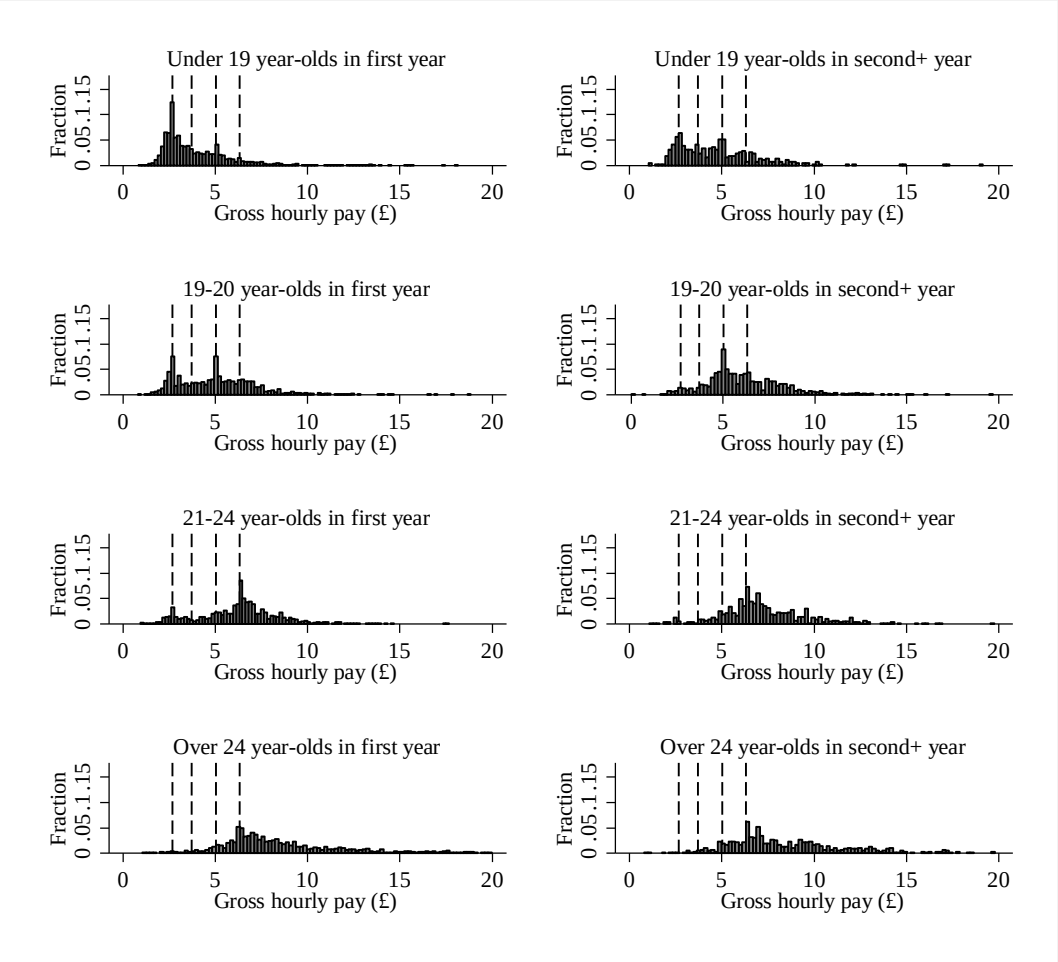
Figure 1: United Kingdom National Minimum Wage rates



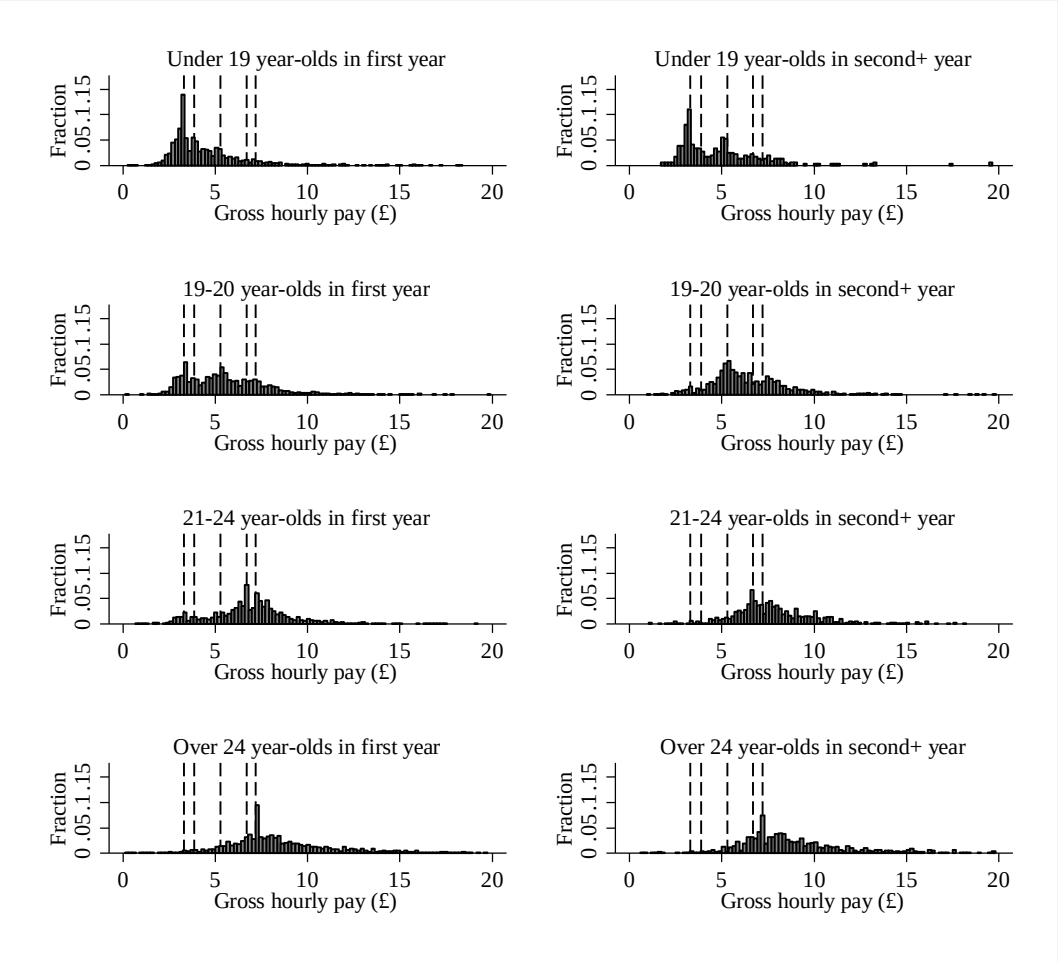
Notes: Eligibility for the adult rate of the minimum wage was lowered from 22 to 21 in 2010. The dashed vertical bars indicate the three years included in the APS sample.

Figure 2: Wage distribution in 2014



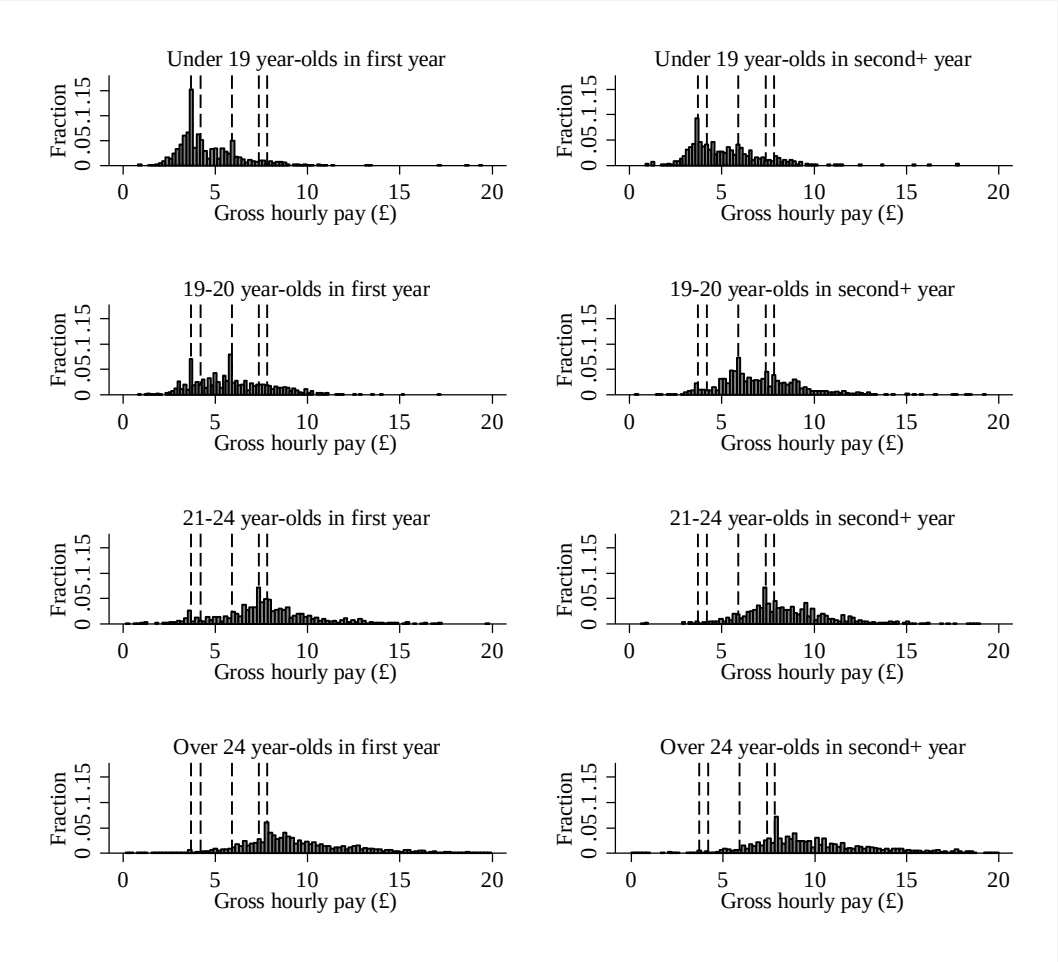
Notes: From left to right, the vertical lines represent the minimum wage rates for apprentices (£2.68), under-18 year-olds (£3.72), 18-20 year-olds (£5.03) and over-20 year-olds (£6.31), respectively.

Figure 3: Wage distribution in 2016



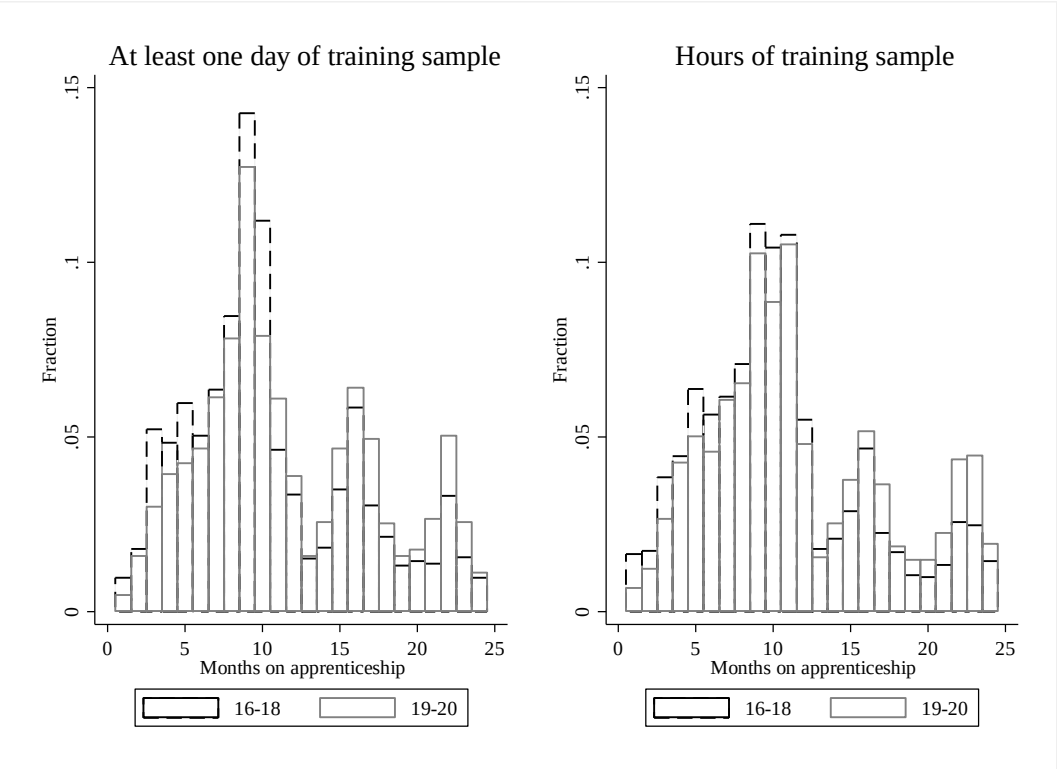
Notes: From left to right, the vertical lines represent the minimum wage rates for apprentices (£3.30), under-18 year-olds (£3.87), 18-20 year-olds (£5.30), 21-24 year-olds (£6.70) and over-24 year-olds (£7.20), respectively.

Figure 4: Wage distribution in 2018



Notes: From left to right, the vertical lines represent the minimum wage rates for apprentices (£3.70), under-18 year-olds (£4.20), 18-20 year-olds (£5.90), 21-24 year-olds (£7.38) and over-24 year-olds (£7.83), respectively.

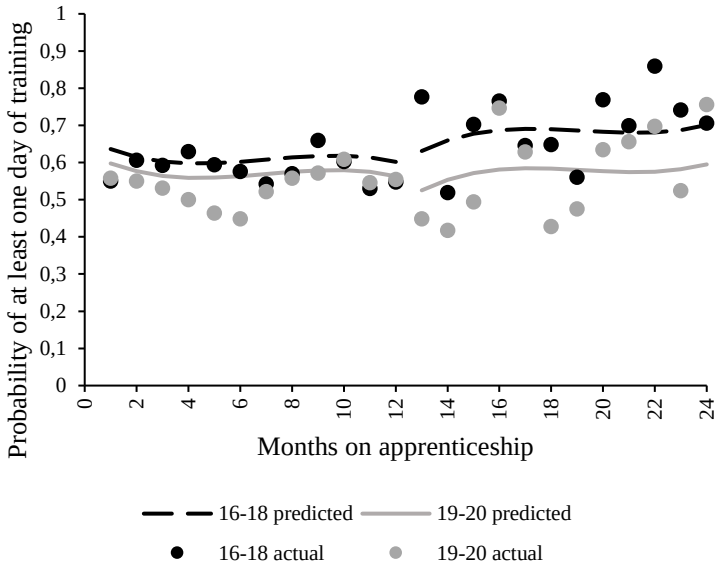
Figure 5: Distribution of observations by month on apprenticeship



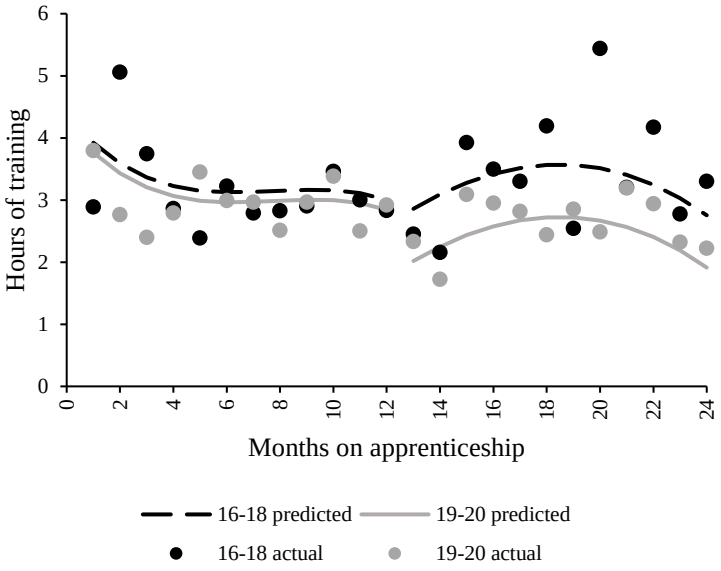
Notes: The samples are the ones used in columns 2 and 4 of Table 2.

Figure 6: Estimated wages and training

a. Predicted probability of receiving at least one day of training per week



b. Predicted hours of training per week



Notes: Predicted values are taken from the estimates in columns 2 (for panel a) and 4 (for panel b) of Table 3.

All control variables are set equal to their means.

Table 1: Means for the estimation sample

Variables	At least one day of training sample		Weekly training hours sample	
	A year or less	More than a year	A year or less	More than a year
At least one day of training	0.572	0.669		
Weekly training hours			2.977	3.105
Gross hourly wage (£)	5.509	6.377	5.285	6.187
Female	0.419	0.308	0.412	0.278
Male	0.581	0.692	0.588	0.722
Aged 16-18	0.533	0.583	0.494	0.541
Aged 19-20	0.467	0.417	0.506	0.459
Level 2	0.592	0.456	0.607	0.457
Level 3	0.384	0.501	0.375	0.511
Level 4	0.016	0.031	0.013	0.025
Level 5	0.001	0.004	0.001	0.003
Level 6/7	0.006	0.007	0.004	0.004
Wales	0.119	0.098	0.087	0.074
Scotland	0.115	0.281	0.098	0.209
England	0.766	0.621	0.816	0.718
Number of observations	3,418	1,543	5,902	2,319

Notes: The sample is restricted to the set of 16-20 year-olds used in Table 3.

Sampling weights are used. Observations are reweighted so that the total weight in each year is the same.

Table 2: Sharp regression discontinuity estimates

Variables	At least one day of training		Weekly training hours	
	19-20 year-olds	16-20 year-olds	19-20 year-olds	16-20 year-olds
Year plus on apprenticeship	-0.098*	0.077	-0.170	-0.074
	(0.050)	(0.050)	(0.417)	(0.351)
Year plus on apprenticeship × aged 19-20		-0.050*		-0.115
		(0.026)		(0.209)
2016			0.648***	0.442**
			(0.176)	(0.164)
2018	0.021	0.046***	0.611***	0.528***
	(0.026)	(0.016)	(0.194)	(0.172)
Male	0.097***	0.061**	-0.161	-0.018
	(0.030)	(0.028)	(0.125)	(0.167)
Aged 19-20		-0.027*		-0.303**
		(0.015)		(0.124)
Level 3	0.065***	0.041**	0.716***	0.726***
	(0.021)	(0.017)	(0.129)	(0.146)
Level 4	-0.104	-0.084	1.880**	1.778**
	(0.065)	(0.064)	(0.699)	(0.738)
Level 5	-0.108	-0.244**	2.640*	1.773
	(0.120)	(0.116)	(1.410)	(1.373)
Level 6/7	0.093	0.119*	2.202*	2.481**
	(0.078)	(0.062)	(1.101)	(0.891)
Scotland	-0.143***	-0.193**	-1.213***	-1.635***
	(0.034)	(0.030)	(0.219)	(0.293)
England	0.041	0.014	-0.051	-0.417**
	(0.030)	(0.029)	(0.240)	(0.186)
R-squared	0.125	0.139	0.042	0.041
Number of observations	3,195	6,088	5,146	9,902

Notes: All models also include a full set of framework dummies (14 categories), a third-order polynomial in the number of months relative to the one-year cut-off and the interaction of this polynomial with a dummy for having been on the apprenticeship for more than a year.

Standard errors are clustered by month on the apprenticeship and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Sampling weights are used. Observations are reweighted so that the total weight in each year is the same.

Table 3: Sharp regression discontinuity estimates using the compliant sample

Variables	At least one day of training		Weekly training hours	
	19-20 year-olds	16-20 year-olds	19-20 year-olds	16-20 year-olds
Year plus on apprenticeship	-0.116*	0.049	-0.386	0.038
	(0.064)	(0.056)	(0.549)	(0.405)
Year plus on apprenticeship × aged 19-20		-0.067**		-0.682***
		(0.031)		(0.226)
2016			0.375**	0.207
			(0.174)	(0.179)
2018	0.037	0.061***	0.459**	0.286**
	(0.029)	(0.018)	(0.185)	(0.138)
Male	0.086***	0.050*	-0.141	0.018
	(0.029)	(0.029)	(0.128)	(0.174)
Aged 19-20		-0.039***		-0.160
		(0.011)		(0.145)
Level 3	0.084***	0.054***	0.756***	0.742***
	(0.022)	(0.017)	(0.142)	(0.125)
Level 4	-0.094	-0.090	2.362***	2.067***
	(0.072)	(0.075)	(0.688)	(0.725)
Level 5	-0.095	-0.248*	2.885*	2.054
	(0.117)	(0.129)	(1.421)	(1.412)
Level 6/7	0.111	0.119*	1.702**	2.361***
	(0.080)	(0.063)	(0.820)	(0.779)
Scotland	-0.141***	-0.196***	-1.382***	-1.717***
	(0.039)	(0.033)	(0.258)	(0.294)
England	0.039	0.022	-0.127	-0.382*
	(0.036)	(0.031)	(0.226)	(0.195)
R-squared	0.132	0.139	0.047	0.041
Number of observations	2,671	4,961	4,361	8,221

Notes: All models also include a full set of framework dummies (14 categories), a third-order polynomial in the number of months relative to the one-year cut-off and the interaction of this polynomial with a dummy for having been on the apprenticeship for more than a year.

Standard errors are clustered by month on the apprenticeship and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Sampling weights are used. Observations are reweighted so that the total weight in each year is the same.

Table 4: Fuzzy regression discontinuity estimates

Variables	At least one day of training		Weekly training hours	
	Full sample	Compliant	Full sample	Compliant
Log gross hourly wage	-0.933	-0.498*	-7.160	-6.498***
	(0.716)	(0.256)	(13.791)	(2.258)
Year plus on apprenticeship	0.035	0.019	0.077	-0.144
	(0.054)	(0.034)	(0.761)	(0.552)
2016			1.070	0.900***
			(1.211)	(0.296)
2018	0.142*	0.104***	1.798	1.444***
	(0.073)	(0.022)	(2.456)	(0.411)
Male	0.081*	0.057*	0.045	0.072
	(0.044)	(0.032)	(0.200)	(0.175)
Aged 19-20	0.090	0.010		0.675*
	(0.098)	(0.031)		(0.375)
Level 3	0.150*	0.096***	1.624	1.374***
	(0.090)	(0.028)	(1.777)	(0.256)
Level 4	0.345	0.069	5.169	4.293***
	(0.359)	(0.140)	(6.676)	(1.075)
Level 5	0.157	-0.111	4.955	4.024**
	(0.375)	(0.191)	(6.696)	(1.757)
Level 6/7	0.515	0.265***	5.780	4.572***
	(0.318)	(0.094)	(6.310)	(1.166)
Scotland	-0.191***	-0.210***	-1.555***	-1.846***
	(0.023)	(0.030)	(0.297)	(0.303)
England	-0.015	0.007	-0.650	-0.615***
	(0.045)	(0.034)	(0.442)	(0.158)
First stage coefficient	0.053**	0.135***	0.016	0.105***
	(0.025)	(0.024)	(0.018)	(0.018)
R-squared	0.139	0.139	0.041	0.041
Number of observations	6,088	4,961	9,902	8,221

Notes: All models also include a full set of framework dummies (14 categories), a third-order polynomial in the number of months relative to the one-year cut-off and the interaction of this polynomial with a dummy for having been on the apprenticeship for more than a year.

The log wage is instrumented for by the interaction of a dummy for having been on the apprenticeship for more than a year and a dummy for being aged 19-20.

Standard errors are clustered by month on the apprenticeship and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Sampling weights are used. Observations are reweighted so that the total weight in each year is the same.

Table 5: Robustness tests with the fuzzy regression discontinuity estimates

Variables	At least one day of training			Weekly training hours		
	10-month bandwidth	Add quartic	Payslips only	10-month bandwidth	Add quartic	Payslips only
Log gross hourly wage	-0.455*	-0.511*	-0.258	-6.319***	-6.556***	-7.738**
	(0.254)	(0.263)	(0.281)	(2.318)	(2.269)	(3,641)
First stage coefficient	0.139***	0.132***	0.144***	0.111***	0.104***	0.100***
	(0.025)	(0.023)	(0.028)	(0.019)	(0.018)	(0.023)
R-squared	0.139	0.140	0.150	0.044	0.041	0.047
Number of observations	4,695	4,961	3,086	7,579	8,221	4,669

Notes: All models also include the same set of controls as in Table 4.

The log wage is instrumented for by the interaction of dummy for having been on the apprenticeship for more than a year and a dummy for being aged 19-20.

Standard errors are clustered by month on the apprenticeship and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Sampling weights are used. Observations are reweighted so that the total weight in each year is the same.

Table 6: Estimates of effects on satisfaction and career prospects

Variables	Satisfaction			Career prospects		
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Log gross hourly wage	0.263**	-0.002	0.219*	-0.069*	-0.105*	-0.049
	(0.128)	(0.015)	(0.113)	(0.042)	(0.058)	(0.043)
At least one day of training	0.635***			0.279***		
	(0.146)			(0.056)		
Weekly training hours		0.182			0.014*	
		(0.132)			(0.008)	
Weekly training hours at college			0.005			0.010*
			(0.016)			(0.006)
Weekly formal training hours at workplace			0.056***			0.022***
			(0.013)			(0.005)
Weekly informal training hours at workplace			0.025***			0.010***
			(0.006)			(0.003)
Male	-0.245	-0.144	-0.244	-0.106	0.035	-0.096
	(0.160)	(0.176)	(0.164)	(0.075)	(0.080)	(0.078)
Aged 19-20	0.023	-0.020	-0.059	0.221***	0.189***	0.180*
	(0.163)	(0.181)	(0.166)	(0.070)	(0.073)	(0.071)
Aged 21-24	-0.325	-0.280	-0.384*	0.196**	0.169*	0.158*
	(0.203)	(0.220)	(0.206)	(0.080)	(0.088)	(0.082)
Aged 25 or older	-0.383*	-0.276	-0.457**	-0.178**	-0.170*	-0.216**
	(0.198)	(0.214)	(0.198)	(0.086)	(0.098)	(0.089)
Level 3	-0.167	-0.131	-0.125	-0.049	0.025	-0.049
	(0.140)	(0.147)	(0.142)	(0.063)	(0.068)	(0.066)
Months on course	0.002	0.028	0.004	-0.004	-0.006	-0.001
	(0.028)	(0.029)	(0.028)	(0.011)	(0.012)	(0.012)
Months on course squared	-0.000	-0.001	-0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
R-squared	0.054	0.033	0.072	0.091	0.074	0.105
Number of observations	1,357	1,220	1,282	1,366	1,228	1,292

Notes: All models also include a full set of framework dummies (14 categories).

Standard errors are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Sampling weights are used.