

# The Minimum Wage and Human Capital Accumulation of Young Low-paid Workers in a Recession

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## Executive Summary

The report examines the effect of the introduction of the minimum wage in 1999 (and its subsequent annual up-rating) on: school enrolment, participation in further and/or higher education, and educational achievement. In particular, we examine the effect of the national minimum wage on the incidence of training among employees and on the participation in apprenticeship schemes. In light of the current economic climate, our models account for the regional unemployment rate in order to investigate further the role of the minimum wage over the business cycle, as this acts as a measure of changes in economic activity over time and over different regions in the country.

This study uses evidence drawn from the repeated cross sections of the Labour Force Survey (LFS) from 1984 until 2009 (annually until 1992 and quarterly thereafter), and from the annual cross sections of the Annual Survey of Hours and Earnings (ASHE) since 1997. The LFS allows us to measure over time the enrolment in school and further/higher education, achievement in terms of the highest qualification obtained, the unemployment rates in the population of all economically active individuals aged above 16, and, since 1994, employees' hourly wage rates. The ASHE on the other hand measures more precisely hourly wage rates among employees. Hence at the cohort level we are able to match the information extracted from the LFS with the corresponding information drawn from the ASHE.

This approach allows us to measure the proportion of individuals of a given cohort enrolled in further education as they age from 16 to 25, as well as the proportion of individuals of a given cohort indicating a general qualification or an apprenticeship as their highest qualification. We construct this data at the broad regional level, for gender groups, and for each year of observation. In the case of the incidence of the minimum wage on training we construct similar datasets at the sectoral level rather than at the regional level.

The empirical methodology allows us to measure the effect of the national minimum wage (NMW) bite (as measured by the ratio of the minimum wage to the cohort specific median wage) on each of the proportions of interest.

We measure the effect of a policy or environmental variable (i.e. the NMW bite or the regional unemployment rate) on an outcome (e.g. a proportion of individuals in a given group achieving an A-level as the highest qualification) using elasticities. An elasticity measures the proportional change of an outcome relative to the proportional change in the policy variable. An elasticity of 0.1 would suggest that in response to a change of 1% in the policy variable, the outcome of interest changed by 0.1%. Instead an elasticity of -0.1 would have suggested that the response to a 1% change in the policy variable lead to a decrease of 0.1% in the outcome of interest.

We find the following:

- The national minimum wage had a small insignificant effect on cohort specific school enrolment. Using evidence from 1997-2009 from matched LFS-ASHE information, the elasticity at the sample average of the proportion of a cohort enrolled in school with respect to the NMW bite specific to each age group ranges from 0.10 to 0.15. The effect of the cohort specific unemployment rate is small and its sign is not robust across sub-periods of the sample and specifications. For the most recent sample period, using the matched LFS-ASHE information, the elasticity at the sample average ranges from -0.07 to 0.024. **This means that the NMW has no discernable effect on school enrolment.**
- The national minimum wage and the cohort specific unemployment rate have a small yet significant effect on cohort specific further and higher education enrolment (i.e. enrolment in education beyond school). For the most recent sample period, using the matched LFS-ASHE information, the elasticity at the sample average with respect to the NMW bite ranges from 0 to 0.23, while the average elasticity with respect to the unemployment rate ranges from 0 to -0.075. So that a 1% increase of the NMW bite is associated with at most a 0.23% increase in further and higher education enrolment; a 1% increase in the unemployment rate decreases enrolment by at most 0.075%. This rather counterintuitive finding may potentially stem from two, possibly interacting, factors. (1) it may be the result of a generous unemployment insurance system, which reduces the opportunity cost of being unemployed and (2) it may be because of the increased cost of higher/further education (tuition fees, living expenses), which increases the opportunity cost of being in education. **This means that the NMW as well as the local unemployment rate have a small effect on further and higher education enrolment.**
- The minimum wage and the cohort specific unemployment rate do not have any consistently significant effect on cohort specific education achievement (as measured by the within cohort proportion with a given qualification as their highest qualification achieved by age 23). There is an indication that the completion of an apprenticeship by age 23 depends significantly on the size of the bite at age 18. In this case, however, the size and sign of the elasticity of the proportion with respect to the NMW bite at age 18 depends on whether or not we include the complete history of the NMW bite and the unemployment rates from age 18 to age 23. Depending on the specification, the elasticity of the proportion of completing an apprenticeship by age 23 with respect to the NMW bite ranges from 0.069 to -0.721. **This means that, excluding apprenticeships, the NMW and the unemployment rate have no effect on education achievement.**

- When we study the effect of the minimum wage and the cohort specific unemployment rate on the ratio of the proportion completing an apprenticeship by age 23 relative to the proportion completing an alternative qualification obtained by age 23, we find that the elasticity of the proportion with respect to the national minimum wage is consistently measured between -0.14 and -0.34 depending on the alternative qualification considered. This suggests that the national minimum wage has a negative effect on the completion of apprenticeships (relative to other qualification choices). The history of the unemployment rate from age 18 to age 23 is a significant determinant of the relative completion when we compare the proportion completing an apprenticeship relative to the proportion obtaining a Btec or at least one A-level by age 23. **This means that the NMW has a negative effect on the completion of apprenticeships by age 23 relative to the completion of other qualifications.**
- Within sectors, the effects of the national minimum wage, and of the unemployment rate on the proportion of employees involved in training are significant in particular if we focus on the more recent period (1997-2009) using the matched LFS-ASHE sample. In this case the elasticity of the training proportion with respect to the bite of the national minimum wage is precisely measured at -0.243 among young employees. This means that younger workers receive or participate in less training as the minimum wage bite increases, potentially reflecting the reluctance or inability of employers to absorb the higher wage costs. Among older workers the corresponding estimated elasticity figure is not significantly different from zero. Changes in the unemployment rate do not appear to significantly affect the proportion of workers, of either age group, receiving training. **This means that the NMW has a negative effect on the incidence of training among young employees.**

Overall all our findings suggest that the minimum wage and economic activity may not have any significant and consistent effect on education enrolment and achievement, except in the case of apprenticeship. Moreover we cannot detect any consistent effect of the minimum wage and economic activity on the incidence of training among employees in broad sectors.

## Introduction

The report examines the effect of the introduction of the minimum wage in 1999 (and its subsequent annual up-rating) on: school enrolment, participation in further and/or higher education, and educational achievement. In particular, we examine the effect of the national minimum wage on the incidence of training among employees and on the participation in apprenticeship schemes. In light of the concurrent economic climate, we incorporate the regional unemployment rate in our models as this acts as a measure of changes in business activity over time and over different regions in the country. Hence we study whether the effect of the national minimum wage bite depends on the level of business activity as measured by age group specific regional unemployment rates.

Over the last 25 years, Britain experienced two recessions, of differing intensity – one in the early 1990s and the most recent one which began in early 2008. The early 1990s recession was the result of a downturn which began in the US in October 1987. At the time the Dow Jones Industrial Average lost 22%, the stock market recovered fairly quickly but it also initiated the savings and loans crisis that led to a sharp decline in output, which again was offset by a remarkable rise in consumer spending. The first Gulf War in 1990, and the resulting increase in oil prices, undercut the recovery and the US experienced a “double dip recession” which it overcame by 1992.

Despite the links of the British economy with that of the US, the British Economy did not slow down until the third quarter of 1990, when it almost doubled its unemployment figure (claimant counts) from 1.6 million to 3 million (Pissarides, 2003), making that recession comparable in severity to that of the late 1970s-early 1980s downturn. The recession lasted for 5 quarters (GDP change -2.5%) and the economy regained its pre-recession level of GDP by 1993<sup>1</sup>. Over the next years, average GDP growth was around 3% below the pre-recession levels of 4%. During the following 15 years the UK economy experienced an uninterrupted period of growth which terminated in the late 2000s when the financial crisis that begun in the US spread and brought most of the world into recession. Britain was severely hit by these events and government intervention (Lenza et al., 2010) was promptly designed to avert a deep and prolonged period of recession.

In April 1999, minimum wage laws applied once again to the British labour market. Since then the level of the national minimum wage has been reviewed regularly and its rates have been updated annually. The effects of a minimum wage on young workers’ employability and human capital investments in particular when those workers enter the labour market during an economic downturn has, to the best of our knowledge, received limited attention in the UK literature to date. Nevertheless, recent interest in the labour market outcomes of

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<sup>1</sup> See <http://www.statistics.gov.uk/cci/nugget.asp?id=2294>

college graduates entering the labour market during a recession, for example Oreopoulos et al. (2005) using Canadian data, and Kahn(2009) using US data, find that the effects of a recession on recent graduates are substantial and long lasting.

In a recessionary period, we expect significant outflows from employment into unemployment as the industrial structure readjusts to match the new financial structure. The extent of these flows depends in general on the length of the recession and varies between different age groups. The US experience shows that the young suffer the highest outflows from work and the lowest inflows. Older workers are less likely to exit the labour force but substantially fewer enter it (Blanchard and Diamond, 1990). Depending on the strength of a country's employment protection legislation the literature suggests that the young (i.e. 25 and below) would be relatively more severely hit by an economic downturn.

However, the effect of a recession on workers' human capital accumulation is not determined a priori. The reduced opportunity cost of education during a downturn may provide workers (and employers) with incentives to invest in acquiring new skills. However, since participation in training is higher among young workers and since it is the employment of the young that is most likely to reduce (at least initially) when demand contracts (Gielen and van Ours, 2005), training opportunities are likely to fall.

Furthermore, the severity of the recession and the duration of the training program are both contributing factors to the overall effect on training. A relatively short recession is most likely to affect short training spells, since the benefits of long training programmes, such as apprenticeships, are expected to materialise when the economy has recovered (or is recovering). In contrast, a lasting recession will affect both short and long-term training programmes with more lasting effects.

In most relevant contexts, when market imperfections are likely (as at the start of a recession, for example when financial institutions limit the flow of loans to firms or to individuals), the theoretical effect of a recession on training is difficult to assess a-priori. As far as this report is concerned, we attempt to measure empirically the effect of the minimum wage laws on the human capital accumulation of young, low paid workers during a period of economic hardship.

In this study we follow the cohort analysis advocated by the recent literature, and apply it to information derived from the Labour Force Survey between 1984 to date and supplemented by data from the Annual Survey of Hours and Earnings, to measure the impact of the minimum wage on the one hand and the impact of the economic environment on the other hand on education and training choices.

This choice of sample period has the advantage of including both the 2008 and the early 1990s (the latest substantial recession before the current one)

recessions. Although the LFS does not allow us to measure all aspects of interest over the sample period (the measurement of earned income is not possible prior to 1994) it will provide the required information about the effects of a severe recession on many variables of interest, in particular the incidence of training, education and apprenticeship training.

The next section reviews the literature. We then present the econometric methodology and present and describe the source of data we use. The following section presents the empirical findings and discusses their implications. Finally we conclude.

## Literature Review

A large part of the literature focuses on the evolution of the number of apprentices trained and how this number evolves over the business cycle and responds to economic incentives. From a theoretical standpoint one cannot conclusively comment a priori on the impact of recessions on apprenticeship training. There are two main theoretical approaches to the issue, Steven's (1994) investment model and models analysing the substitutability of skilled labour with apprentices (see Lindley, 1975).

In Steven's (1994) model, demand for apprentices is an investment for future production. In this two-period model, the firm can either offer no training in the first period and hire skilled labour when demand increases at period two or train young unskilled workers in period one in expectation of higher production in the second period. The choice depends on relative costs and benefits. If we accept the perfect substitutability of skilled labour and apprentices, future benefits are the same but costs may not be. There are training costs for apprentices – such as apprentices' wages, net of productive contributions, training materials and instructors' fees – and recruitment costs for skilled labour.

If the supply of skilled labour is high and there are no (or very low) search and hiring costs, firms will choose not to supply any training unless the worker (or the government) bears the full cost. If, on the other hand, these costs are substantial, firms will prefer to equip workers with the skills they require at a lower cost than when demand rises and thus offer more apprenticeship contracts in the current period (Ryan, 2009).

Suppose that the economy is going into a recession and apprenticeship contracts last more than one period. If the negative shock is deemed as temporary, future costs and benefits of both recruiting skilled labour and training young workers remain unaffected. Should apprentices' wages stay at the same level, there may be two effects at play. Current productivity decreases thus raising training costs but, if training is conducted by incumbent workers, the cost of their lower productivity is partially offset by the fact that they contribute to the training of apprentices who will be more productive at a lower cost when demands picks up again.

If demand is expected to return to previous levels in a relatively short time period, and there are no (or very low) labour adjustment costs, the incentive to train disappears. In this case, the firm sheds workforce, both skilled and unskilled, and even though apprenticeships in absolute numbers may fall, the ratio of apprentices to employees may in fact rise.

If, on the other hand, firing and hiring costs are high, the firm may choose to sustain the current level of employment, hence, halting recruitment of both

skilled labour and apprentices. In this case the ratio of apprentices to employees may fall, which will give rise to the empirical observation of the pro-cyclicality of apprenticeship training.

When the recession is expected to extend to at least a second reference period, and cover the period which is required for apprentices to complete their training, one should consider two additional factors that influence the firm's decisions. Firstly, the recruitment of skilled labour in period two (or beyond) will be cheaper, and secondly, with lower demand, the firm needs fewer workers whether they have been training in-house or not. Therefore, a prolonged decline in economic activity is likely to result in a reduction of apprenticeship contracts. Furthermore, it would be unprofitable for the firm to maintain the workforce in anticipation of higher future production and redundancies will occur affecting both terms of the apprentices to employees ratio.

An alternative to the investment model, the substitution model claims that demand for apprentices is a function of both the economic climate and the apprentices' wages. In the case of a temporary shock, and assuming that relative wages are not impacted upon, the model predicts a reduction of staff (both skilled and unskilled). With high labour adjustment costs, however, firms may choose to retain a portion of permanent skilled labour and adjust to market needs by utilising relatively cheaper and more flexible contract workers (including apprenticeships).

Moreover, during economic downswings, training of employees becomes cheaper in terms of foregone production. In such instances, firms may opt to (re)train their employees in expectation of higher productivity when demand recovers. That results in fewer apprenticeship contracts being offered but more on- and off-the-job training for current employees. Additionally, in recessionary times, individuals with no liquidity constraints, shift their efforts to the production of human capital in light of lower opportunity costs.

Standard analysis of human capital formation as postulated by Becker (1964) and extended by Hashimoto (1982) suggests that the firm will only provide training of a general nature if the worker finances it themselves. Since it cannot legally bind the worker to the firm in the post-training period and thus extract rents through paying wages below the worker's marginal productivity. On-the-job training in this setting raises the worker's future productivity and earnings and is subject to current direct as well as indirect costs. The only way a profit maximising firm will agree to provide general training is by paying the worker lower wages during training – in effect the worker will pay for their training but it can be a convenient alternative in the presence of liquidity constraints. In the presence of legally guaranteed compensation for young workers, the amount by which the firm can lower the wage is reduced and thus training costs increased (and they will rise with corresponding increases in the level of the minimum

wage). With substantial training costs, the amount of training provided by firms is expected to decline.

In imperfectly competitive labour markets such as those described by Acemoglu and Pischke (1999) with frictions that compress the distribution of wages, firms can extract higher rents and have thus more incentives to provide general training. This wage compression also means that the firm extracts higher rents from the skilled than the unskilled, since the productivity of the former is higher, particularly when minimum wages are in operation (and/or when the cost of unemployment is larger for the skilled). Therefore, training increases even when wages increase since firms only need to increase the level of training and thus the surplus accruing to them. .

As long as minimum wage legislation and associated increases in the rate of the minimum wage act as a premium on the training costs, we would expect that their operation in the labour market will exacerbate the negative recruitment effect of the recession. The extent of the effect becomes an empirical question and will depend on the level of the rate, the sector and the depth of the economic cycle.

We have already mentioned that the firm has a choice following a negative demand shock to either train workers in expectation of high future demand, when labour adjustment costs are high, or reduce its workforce and hire skilled labour at a later date when the economy recovers provided adjustment costs are low. Minimum wages in this case raise the training costs of young workers during a period of slow growth and depending on the rate of the minimum wage the firm may not be able to offset the cost by utilising skilled permanent staff. In this case, training offers are expected to decline manifesting a negative effect of minimum wages on training that would reinforce the pro-cyclical observation of apprenticeship recruitment.

With a prolonged spell of contracting demand, apprenticeship recruitment is expected to be reduced even further than the instance of a temporary spell since firms do not expect demand to recover while, or before, apprenticeships are completed and hence it would be easier and more profitable to cut the wage bill through shedding young employees on flexible contracts, particularly in countries with high employment protection and rigid labour market rules.

Even when apprentices and skilled workers are seen as perfect substitutes, when the firm adjusts to demand fluctuations, a higher apprentices' wage translates to either fewer being recruited by hiring temporary staff to complement the permanent workforce, when high labour adjustment costs are assumed, or equally, fewer being recruited when no adjustment costs are present and the supply of skilled workers during recovery is abundant.

On the other hand, the decline in apprenticeship contracts offered by firms will reduce the opportunity cost of schooling and/or human capital accumulation thus

driving more young people either to remain or return to school and/or further and formal education. Hence we expect to observe an increase in the numbers admitted to schools, colleges and universities. Cohorts graduating in following years when the economy would have recovered would be in possession of higher skills and firms may perceive incentives to offer even more training, creating thus a virtuous cycle of human capital accumulation.

Britain has a long history of Apprenticeships. In 1804, a law abolished the seven-year duration requirement for an apprenticeship and made one of the first legal references that factory apprentices had to be taught 'basic' skills i.e. reading, writing and arithmetic. By the end of that century, apprenticeship training had spread from the artisan trades to the then growing sectors of engineering and shipbuilding and later to trades such as plumbing and electrical work.

By the mid 1960s there were around a quarter of a million apprentices in the UK but there were growing concerns about the effectiveness of what was believed to be a supply-led Apprenticeship system to provide trainees with skills valued in an economy shifting the bulk of production away from manufacturing and into new and expanding occupations and industries. In the 1980s, Apprenticeship training lost vital government support and was subverted by the cheaper, yet less valued, Youth Training Scheme and Youth Training Programme. The early 1980s recession further burdened the struggling Apprenticeship system with employers cutting apprentices' recruitment considerably. At the start of the 1980s, when Industrial Training Boards were abolished, numbers had dropped to just over fifty thousand trainees.

Following the recognition of a shortage of intermediate vocational skills in the UK, in 1993, the (Conservative) government put a new emphasis on Apprenticeships and developed the policy of new Modern Apprenticeships at Level 3 and Modern Traineeships at Level 2. These were designed to improve employers' and potential trainees' perceptions about the system and work-based learning in general. Employers would contribute to the design of the training through the National Training Organisations (replaced by the Sector Skills Councils) and apprentices would be equipped with industry-valued skills thus increasing their employability upon completion. The new scheme was designed in the following year and became fully operational from 1995 on.

Following the redesign of the system and the significant investment from government, apprenticeship training witnessed a rise in both numbers and completion rates. There were 240,000 Apprenticeship starts in 2008/09 with a completion rate of 71% for the same period compared to 37% in 2004/05<sup>2</sup>. Work-based learning has again become a prominent feature of human capital accumulation.

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<sup>2</sup> <http://www.apprenticeships.org.uk/About-Us/History-of-Apprenticeships.aspx>

The impact of Modern Apprenticeships on participants in the UK has received limited attention in the literature and the few empirical studies that discuss the impact of apprenticeships do so as part of broader studies of transitions to work from school and/or the impact of various vocational qualifications. In addition, the evidence presented generally covers all apprenticeships, not just Modern Apprenticeships (McIntosh, 2007). An exception to this is the study by McIntosh (2004) where the author uses UK Labour Force Survey (LFS) data for the period 1996-2002 to estimate the wage returns of completing an apprenticeship for both men and women. Controlling for other qualifications held and personal characteristics, he finds a wage premium of around 5-7% for men who have completed an apprenticeship but no wage returns for women. Moreover, this wage return to apprenticeship is further increased, to twice as much, if the apprentice holds a Level 3 NVQ (or above). Most importantly, this study confirms that the apprenticeship is of great value to male school leavers with no qualifications. The returns for the latter group are higher than those leaving full time education with GCSEs – they need to reach Level 3 NVQ to increase their earning power.

Ryan (2001) also suggests positive wage returns for male apprentices in the UK and no returns for women while reviewing existing literature across countries. In the US, apprenticeships are associated with substantial increases in wages for males but the very low participation rate of women does not allow for confident conclusions about the impact on women's wages. In France, the positive impact on earnings appears to be temporary and fades away after a five-year period upon entry into employment. He also reports that apprenticeships increase the likelihood of being in employment, more so for those individuals with low or no other qualifications.

In contrast to studies confirming a positive impact on wages for apprenticeships, Dearden et al. (2002), in their study of returns to academic and vocational qualifications, find no statistically significant effects on wages for individuals with apprenticeships. However, in their estimations they use apprentices with no other qualifications – once an individual obtains a higher (or other) qualification, they are included in a different qualifications group.

More empirical work has been conducted for countries where apprenticeship training is more common. For Germany, where around 4% of the workforce is on apprenticeship training, Clark and Fahr (2002) find the wage return of a year of apprenticeship training, on average, to be 8.2%. The authors comment on the close proximity of this number to the return on an extra year of general education in the country.

Cooke (2003) finds very similar starting wages for those with and without apprenticeship training in Germany but considerably higher wage growth rates for former apprentices in the period from 1984 to 1997. These results are independent of the type of schooling each individual received.

The result that qualifications already held do not influence the returns to apprenticeships is confirmed by Bougheas and Georgellis (2004) who use data from the German Socio-Economic Panel for the period 1984 to 2000 to assess differences in wages among those who have completed an apprenticeship. The authors only consider people who have completed an apprenticeship in their sample and thus do not comment on the value of the apprenticeship as such. They find that men earn more than women and that there is a wage premium for apprentices with larger (more than 2000 employees) firms. If an individual completes their training with a large firm and remains in employment with the firm afterwards, they will receive almost 9% more than if they had completed the apprenticeship with a small firm. Even if they move to a new employer, they will still receive around 6.4% more for having done an apprenticeship with a large organisation. Interestingly, the authors suggest that individuals who move firms enjoy greater wage growth with years on the job but individuals who stay with the firm earn more upon completion.

Similar results to those of Bougheas and Georgellis (2004) are reported by Euwals and Winkelmann (2004) who find that in Germany, large firms offer higher wages after completion of an apprenticeship. The duration of training is also found to have a positive impact on the post-apprenticeship wage. The authors proxy the quality of training by the wage paid during training and include it in their model as an explanatory variable together with controlling for firm size. Their results suggest that there is little disparity between the wages of individuals who remain with the training firm and those individuals who leave. Euwals and Winkelmann interpret this finding as evidence of the general nature and transferability of apprenticeship training across employers in Germany.

In a comparison study of the US and Germany, Winkelmann (1997) finds that the benefits of apprenticeships are similar in the two countries despite the greater popularity of this form of training in Germany. In the US, 12% of the workforce has undergone some form of formal company training while in Germany the figure is in excess of 70%. The author estimates returns in both countries in the range of 4.4% to 11%.

Hofer and Leitz (2004) consider the case of Austria, where apprenticeship training is as common as in Germany. They compare workers who have completed an apprenticeship with high school graduates and unskilled workers. They find that the likelihood of being in employment of a worker who has completed apprenticeship training is higher than that of an unskilled worker but lower than that of a high school graduate. In terms of wages, completing an apprenticeship will earn the worker around 12% higher wages than the unskilled and equivalent wages upon entry into the labour market to high school graduates. The latter group, however, will experience higher wage growth in later years.

As mentioned above, statistical work on the benefits of Modern Apprenticeships in the UK is very limited. McIntosh (2007) is a first attempt at detailed analysis to the costs and benefits of Modern Apprenticeships. The author uses LFS data from the 2004 and 2005 surveys and even though the results are likely to suffer from unobserved heterogeneity and selection bias, they seem to suggest a great value of apprenticeship training to individuals. More specifically, the author reports a 8% wage return for all recognised apprenticeships for men but no statistically significant returns for women. Apprenticeship returns are higher in the manufacturing industries with metal manufacture, manufacture of machinery and construction found to have statistically significant returns of 17%, 13% and 11% respectively. In the sales and hospitality industries, however, the only statistically significant return was in the sale of motor vehicles with 11% while for Other Services, only transportation (9%), telecommunications (10%) and public administration (4%) were found to have a significant impact. When Modern Apprenticeships are considered the results change dramatically. A man who completes an Advanced Modern Apprenticeship earns on average 22% more than one with a Level 2 qualification. For a man who completes a Foundation Modern Apprenticeship the wage return is 20%, on average, in comparison to a man educated at Level 1 or 2. For women the corresponding figures are 14% at the Advanced level and 4% at the Foundation level.

McIntosh (2007) also considers the case of young people i.e. those under 26 years of age. For this group, a return of 8% to all recognised apprenticeships is reported for women and a return of 23% for men. This is the first instance in the literature where positive returns to all apprenticeships are reported for women. Given that in this age group the likelihood is that a woman would have completed a Modern Apprenticeship, the result suggests a change in the impact of apprenticeship training for women. Furthermore, a Level 3 Modern Apprenticeship is found to raise men's wages by 23% and women's wages by 22%. At Level 2, however, while men's wages are raised by 22%, there are no returns for women. In terms of employment effects, this study suggests that for men, the probability of being in full time employment is higher for recognised apprenticeships by 15 percentage points, for Advanced Modern Apprenticeships by 18 percentage points and for Foundation Modern Apprenticeships by 13 percentage points. The corresponding figures for women are 17 for recognised apprenticeships, 19 for Advanced Modern Apprenticeships and 9 for Foundation Modern Apprenticeships.

Available empirical evidence on the behaviour of apprenticeships during the economic cycle is limited to a few developed countries and primarily involves the estimation of the relationship between workplace training and business cycle indicators.

Stevens (1994) using data from the British engineering industry for the period 1967 to 1988, estimates an investment model of training. Apprentice numbers fell considerably following the first oil shock of the early 1970s and again during

the wake of the next decade. Stevens (1994) looks at the ratio, in logs, of apprentices to all employees. In relation to the economic cycle, she finds a positive relationship between this ratio and the cycle, suggesting the pro-cyclical behaviour of apprenticeship training and recruitment.

For the British engineering industry, Hart (2005), looks at how apprentices' recruitment adjusted during the Great Depression thus covering the decade 1928 to 1938. Using district unemployment figures for 27 districts as indicators of the business cycle, he estimates dynamic employment equations for apprentices. Like Stevens (1994), he finds that apprenticeship recruitment moves with the cycle. Hart also comments on the role of employers' perceptions as to the length and depth of the recession in their decisions to cut apprentice numbers in comparison to other types of employees. He argues that a decline in economic activity that is seen as temporary and/or mild may not necessarily result in a drop in apprentices, labour cost savings could come from the firing of more 'expensive' employees with relatively rigid wages. Experienced apprentices could perform almost all duties at a lower cost.

In a study looking at the early 1990s recession, Felstead and Green (1996), report that apprentices witnessed a 15% decline in the three years between 1989 and 1992 (in absolute terms, from 367,000 in the spring of 1989 to 312,000 at the same time in 1992). The authors also report a pro-cyclical pattern of apprentice recruitment for that period, in line with previous studies. In their study, only 25% of employers indicated that they cut back training and 27% reported no change in their training expenditures; thus suggesting a small negative effect of a relatively severe recession on training.

In the US, apprenticeships are not as popular as they are in continental Europe or even Britain and most occur in the construction industry where they last between three to four years. Bilginsoy (2003) uses data on apprentices collected from the Bureau of Apprenticeship training from the period 1989 to 1995. His competing risk model includes two hazards, one for cancellation and one for completion of the training. He finds that both move with the business cycle. Cancellations are fewer during a period of contracting demand since trainees find it difficult to obtain semi-skilled employment in the labour market and thus quit the programme. Successful completions also fall due to the decline in training jobs. Unlike the Stevens (1994) study in which the decision of the level of recruitment and retention of apprentices during a downturn lies with the firm, in Bilginsoy's (2003) study, the trainee is given the choice (to an extent) to continue and complete or quit.

Germany ranks at the top of countries with a widespread apprenticeship programme both in terms of quality and numbers recruited. Other German-speaking countries, namely Austria and Switzerland, and the Nordic countries enjoy very similar apprenticeship training programmes to that of Germany and have thus also attracted attention in the literature.

Wagner (1998) provides a descriptive account of the effects of the early 1990s recession. She compares the ratio of apprentices to employees in 1990 and in 1995. She reports that the share of firms offering apprenticeship contracts fell from 28.3% to 23.7% during that time and finds a drop in the ratio of apprentices to employees from 7 in 1990 to 5.5 in 1995 for the economy as a whole, from 10.9 to 8 among micro/small firms (1 to 9 employees) and from 5.2 to 4.3 among large firms (>500 employees). The descriptive nature of the study does not allow for solid conclusions as the decline in apprentice numbers could be attributed to a number of factors such as a changing industrial composition and not to the recession exclusively. On the other hand, Jaconebbinghaus, Mohrenweiser and Zwick (2008) find that during the early 2000 slowdown of the economy, the percentage of apprenticeships remained relatively unchanged, suggesting to the authors the commitment of German businesses to train workers even in a bad economy.

Askilden and Nilsen (2005) study the case of Norway using data on the manufacturing and construction industries for the period 1990-1996. They model the demand for apprentices and adult workers using a trans-log cost function. They assume that it is quantities that determine the cyclical variation of cost shares and not wages and estimate the relationship of these shares with the current and future (four quarters) unemployment rate. They present evidence that firms hire more adult workers during economic downturns when supply increases and that the number of apprentices follows the business cycle and increases as both the current and future unemployment rate subsides. This finding reinforces the belief of severe wage rigidities among adult workers and the increased flexibility of apprentices as a segment of the labour force. Their results are in line with other studies in the area reporting the pro-cyclical behaviour of apprenticeship recruitment.

For Switzerland, Schweri and Mueller (2008), using Swiss firm data for the years 1995, 1998, 2001 and 2005, find a positive correlation between average three-year GDP growth and the percentage of firms offering training. The authors also graph the share of 16 year old apprentices and the rate of GDP growth and they conclude that the former is indeed pro-cyclical. A similar result is reported for Denmark by Westergaard-Nielsen and Rasmussen (1999) who use data on apprentices covering the years 1980 to 1991. The probability of taking on an apprentice is positively correlated to the rate of newly recruited workers and negatively correlated to the rate of redundancies/quits. The few empirical studies dealing with the issue of the behaviour of apprenticeships during an economic downturn seem to suggest that there is a clear negative effect of the recession on craft training, with numbers falling as GDP contracts and increasing during recovery and subsequent peaks.

In summary, most studies, across countries, report positive wage returns for apprenticeships ranging from around 8% to 15%, mainly for male apprentices. For women, the reported results are either very low or statistically insignificant

but this may be due to the relatively low female participation rates in such schemes especially in the past decades. Moreover, most studies assessing the impact of recessions on apprentices' recruitment report that firms respond by cutting the numbers of apprentices during contracting demand times with the exception of firms in Germany that seem to sustain pre-recession apprentices' recruitment levels even during the downturn of the business cycle.

## General Methodology

The objective of this section is to introduce the general empirical strategy we use to analyse the data at hand. In the case of the measurement of education/qualification achievement these data take the form of cohort proportions at different education/qualification levels for various regions and by gender and at different ages. We therefore use a modelling framework which is appropriate for this kind of data.

It is possible to relate our data of cohort aggregates to a "simple" model of individual schooling/education choice. Assume that at time  $t$  each individual in cohort  $c$  in a particular region, decides on their education status (i.e. whether or not to attend full-time education) by comparing their expected reward if they terminate their education in the current year relative to the expected rewards if they remain in full time education an additional year. Denote  $w_{c,t}^{med}$  as the median wage applying to cohort  $c$  at time  $t$  (this in principle can be estimated from observed data). Assume that the expected reward in work, for a member of this cohort at time  $t$ , takes the form:

$$w_{i,t}^{wk} = (\delta_{0.50}^{wk} + \sigma_{c,t} \varepsilon_{i,t}^{wk}) w_{c,t}^{0.50} + \delta_{min}^{wk} w_{c,t}^{min} \text{ for all } i \text{ in cohort } c \text{ at time } t,$$

while the reward expected while remaining in education one additional year is:

$$w_{i,t}^{ed} = (\delta_{0.50}^{ed} + \sigma_{c,t} \varepsilon_{i,t}^{ed}) w_{c,t}^{0.50} + \delta_{min}^{ed} w_{c,t}^{min} \text{ for all } i \text{ in cohort } c \text{ at time } t.$$

This specification for the expected rewards in each case assumes that individuals believe that the scale of the uncertainty they are exposed to is proportional to the median wage for the cohort at the time, i.e.  $\sigma_{c,t} w_{c,t}^{0.50}$ . The parameter for the minimum wage term captures the sensitivity of pupils' beliefs about their future rewards to the current level of the minimum wage, if either  $\delta_{min}^{wk}$  or  $\delta_{min}^{ed}$  is "large enough" the minimum wage has a significant role in determining the schooling decision for individuals in the cohort. If we assume for convenience (i.e. to obtain closed form expressions for the cohort proportions still in full time education) that the individual unobserved components  $\varepsilon_{i,t}^{wk}$  and  $\varepsilon_{i,t}^{ed}$  are distributed as random variables following independently an extreme value distribution, then the proportion of individuals in education in the region for the particular cohort  $c$  at time  $t$  can be expressed as a probability in the logit form:

$$\begin{aligned}
\Pr[\text{in full time education in time } t \mid c, t] &= \Pr[w_{i,t}^{sd} > w_{i,t}^{wk} \mid c, t] \\
&= \Pr\left[\left(\delta_{0.50}^{sd} + \sigma_{c,t} \varepsilon_{i,t}^{sd}\right) w_{c,t}^{0.50} + \delta_{\min}^{sd} w_{c,t}^{\min} \right. \\
&\quad \left. > \left(\delta_{0.50}^{wk} + \sigma_{c,t} \varepsilon_{i,t}^{wk}\right) w_{c,t}^{0.50} + \delta_{\min}^{wk} w_{c,t}^{\min} \mid c, t\right] \\
&= \Pr\left[\left(\left(\delta_{0.50}^{sd} + \delta_{0.50}^{wk}\right) w_{c,t}^{0.50} + \left(\delta_{\min}^{sd} - \delta_{\min}^{wk}\right) w_{c,t}^{\min} > \sigma_{c,t} w_{c,t}^{0.50} \left(\varepsilon_{i,t}^{wk} - \varepsilon_{i,t}^{sd}\right) \mid c, t\right)\right] \\
&= \Pr\left[\theta_{c,t}^0 + \theta_{c,t}^{bite} \frac{w_{c,t}^{\min}}{w_{c,t}^{0.50}} > \left(\varepsilon_{i,t}^{wk} - \varepsilon_{i,t}^{sd}\right) \mid c, t\right] \\
&= \frac{1}{1 + \exp\left(-\theta_{c,t}^0 - \theta_{c,t}^{bite} \frac{w_{c,t}^{\min}}{w_{c,t}^{0.50}}\right)}.
\end{aligned}$$

For this class of models the parameters are directly proportional to the elasticity of the cohort proportion with respect to a change in the minimum wage, indeed we have:

$$\begin{aligned}
e_{Pr/bite} &= \frac{\% \Delta \Pr[\text{in full time education at time } t \mid c, t]}{\% \Delta bite} \\
&= \theta_{c,t}^{bite} \frac{w_{c,t}^{\min}}{w_{c,t}^{0.50}} (1 - \Pr[\text{in full time education at time } t \mid c, t])
\end{aligned}$$

Therefore assuming that the bite is always less than 1 the parameter  $\theta_{c,t}^{bite}$  is always an upper bound to the elasticity of interest.

The closed form expression for this probability suggests that we consider the following log-odds transformation of the cohort-regional proportion:

$$\ln\left(\frac{\Pr[w_{i,t}^{sd} > w_{i,t}^{wk} \mid c, t]}{1 - \Pr[w_{i,t}^{sd} > w_{i,t}^{wk} \mid c, t]}\right) = \theta_{c,t}^0 + \theta_{c,t}^{bite} \frac{w_{c,t}^{\min}}{w_{c,t}^{0.50}}.$$

The object of such a transformation is to allow us to apply simple estimation techniques using least squares and allow for the introduction of cohort and regional specific effects which can be easily dealt with using within-like estimators. The left hand side can be measured directly from the proportion derived from the LFS data while the variables of interest on the right hand side can be constructed either directly from the LFS or matched to the LFS from ASHE.

We can further expand on the theoretical specification we propose above, by introducing the regional cohort specific unemployment rate and cohort and time specific effects. For example, the expected reward in work could take the form:

$$w_{i,t}^{wk} = (\delta_{0.50}^{wk} + \delta_{0.50,unemp}^{wk} Urate_{c,t} + \eta_c + \xi_t + \sigma_{c,t} \varepsilon_{i,t}^{wk}) w_{c,t}^{0.50} + (\delta_{min}^{wk} + \delta_{unemp}^{wk} Urate_{c,t}) w_{c,t}^{min}$$

and the theoretical group proportion would be such that:

$$\ln \frac{\Pr[w_{i,t}^{sd} > w_{i,t}^{wk} | c, t]}{1 - \Pr[w_{i,t}^{sd} > w_{i,t}^{wk} | c, t]} = \epsilon_{c,t}^0 + \theta_{c,t}^{bits} \frac{w_{c,t}^{min}}{w_{c,t}^{0.50}} + \theta_{c,t}^{Urate} Urate_{c,t} + \theta_{c,t}^{inter} Urate_{c,t} \frac{w_{c,t}^{min}}{w_{c,t}^{0.50}} + \eta_c + \xi_t$$

In this case the formula for elasticities we gave earlier must be modified to account for the interaction with the unemployment rate.

We can preserve the spirit of the analysis on education achievement when turning to the evolution of apprenticeship or firm training in different sectors by comparing the proportion of new apprentices in a given sector to the population of employees in that sector with an alternative education level at the same age. In this setting the specification of the model in terms of the log odds ratio appears as the natural choice and thus a logit model can be applied. Consider first the case of education achievement, for each cohort (c) of a given kind (which corresponds roughly to region x, gender k) at a given time (t), we assume that the proportion achieving the education j takes the logit form:

$$q[Ed = j | x_1, \dots, x_j] = \frac{\exp(x_j \beta)}{\sum_{i=1}^J \exp(x_i \beta)}$$

where the index  $x_j \beta$  summarises the effect of the vector of co-variates  $x_j$  (observed or unobserved) on the proportion of the specific cohort achieving level j. The consequence of this specification is that the log of the relative risk ratio (i.e. the log of the ratio of the proportions achieving two different levels) is linear in the co-variates and in the parameters. We have

$$\ln \frac{q[Ed=j | x_2, \dots, x_j]}{q[Ed=\bar{j} | x_2, \dots, x_j]} = (x_j - x_{\bar{j}}) \beta$$

This last expression can be adapted to allow for cohort, time, and group specific effects which would capture the specific contribution of each factor. An additional advantage of this empirical specification is to limit the effect of differences in cohort sizes as they change over time. Note, however, that perverse compositional effects may still have a notable effect (for example, if industrial composition varies significantly over time or between regions). Furthermore by specifying a reference category (here denoted  $\bar{j}$ ) all the findings can be interpreted relative to a fixed (and hopefully well controlled) benchmark.

To summarise our specification of choice, when we study the effect of the minimum wage on education achievement, measures the effect of co-variables on the logarithm of odds ratios of the form:

$$\ln \frac{q[Ed = j|x_1, \dots, x_T]}{q[Ed = \bar{j}|x_1, \dots, x_T]} = \tilde{x}_{c,t}\beta + z_{c,t}(NMW)\delta + \eta_c + \eta_t + \varepsilon_{c,t},$$

where  $\tilde{x}$  collects the observed co-variables controlling for differences between the two education groups,  $z(NMW)$  collects the measures of the effect of the National Minimum Wage (after its introduction),  $\eta_c$  and  $\eta_t$  are the cohort (group) specific and time specific effects (if required) which capture the average cohort or time effects while  $\varepsilon_{c,t}$  represents the unobserved transitory components (i.e. the unobserved components of  $x_j\beta$ ). Hence our analysis can be understood as a difference in difference approach when the “treatment” group is the subpopulation at education level  $j$  and the “control” group is the subpopulation at the reference education level  $\bar{j}$ . Identification of the effect of the minimum wage is obtained from two sources: the comparison of early cohorts which did not experience the minimum wage with later cohorts which experienced it, and the comparison between cohorts where the National Minimum Wage takes different values.

Our estimates rely on estimates of cohort specific proportions. These estimates are affected by sampling error (i.e. variability caused by the sampling process). In our case the dependent variable is in fact a transformation of the estimated proportions: the log-odds ratio. A Taylor-type expansion around the population proportion suggests that the variability of the estimated log-odds ratio is affected by the size of the sample cohort. Indeed we find:

$$\ln \left( \frac{\hat{q}_{j,m}}{\hat{q}_{j',m}} \right) - \ln \left( \frac{q_{j,m}^0}{q_{j',m}^0} \right) \simeq \frac{1}{q_{j,m}^0} (\hat{q}_{j,m} - q_{j,m}^0) - \frac{1}{q_{j',m}^0} (\hat{q}_{j',m} - q_{j',m}^0),$$

hence we can evaluate approximately the variance of the estimated log-odds ratio as

$$\begin{aligned} \text{Var} \left[ \ln \left( \frac{\hat{q}_{j,m}}{\hat{q}_{j',m}} \right) \right] &\simeq \frac{1}{(q_j^0)^2} \text{Var}[\hat{q}_{j,m}] + \frac{1}{(q_{j'}^0)^2} \text{Var}[\hat{q}_{j',m}] - 2 \frac{1}{q_j^0 q_{j'}^0} \text{Covar}[\hat{q}_{j,m}, \hat{q}_{j',m}] \\ &\simeq \frac{1}{(q_j^0)^2} \frac{q_j^0(1-q_j^0)}{n} + \frac{1}{(q_{j'}^0)^2} \frac{q_{j'}^0(1-q_{j'}^0)}{n} + 2 \frac{1}{q_j^0 q_{j'}^0} \frac{q_j^0 q_{j'}^0}{n} \\ &\simeq \frac{1-q_j^0}{n q_j^0} + \frac{1-q_{j'}^0}{n q_{j'}^0} + \frac{2}{n} = \frac{1}{n} \frac{q_j^0 + q_{j'}^0}{q_j^0 q_{j'}^0} \end{aligned}$$

which suggests that in general we would expect regressions involving log-odds ratios to exhibit heteroscedasticity: i) the variance of the log-odds ratio for different statistical units depend on population quantities for each different unit, and ii) because of sampling the estimated log-odds ratios will depend on the size of each cohort. In the case of the logarithm of the ratio between the proportion choosing a particular alternative and the proportion not taking this alternative, the formula above simplifies. We find:

$$\text{Var} \left[ \ln \left( \frac{\hat{q}_{j,n}}{\hat{q}_{j',n}} \right) \right] \approx \frac{1}{n} \frac{1}{q_j^0 q_{j'}^0}.$$

Hence in all our regressions involving log-odds ratios we report heteroscedastic robust precision for our estimates. Furthermore we weight each cohort observation by its sampling weight.

## **Data construction Labour Force Survey and Annual Survey of Hours and Earnings**

The data we use are extracted and compiled from two distinct sources: from the time series of Labour Force Surveys (April-June quarter) from 1984 to 2009, and from the annual time series of the Annual Survey of Hours and Earnings from 1997 to 2009. The former contains a wide (but variable) range of observations on potentially active individuals in the UK aged 16 and above, while the latter contains information on employed individuals in the UK aged 16 and above. In particular, because the information from the latter is collected directly from employers, ASHE contains good quality information on hourly pay, weekly hours, age of the worker and sector of employment as well as some information on the training received by the workers. The LFS contains information collected from individuals directly such as age, (ILO) labour market status, education level (attainment and/or current enrolment), location (general government regions), sector of activity when employed and so on. Both surveys are sampled in such a way that a sampling weight can be attached to each observation.

We use both surveys to construct cohortxgroup averages of various characteristics using these sampling weights (pwt03 and pwt07 for the LFS, and calwght from ASHE).

Depending on the focus of our analysis the exact definition of the cohortxgroup varies but is made clear in the relevant sections. The outcome of this intermediate step is the construction of a pseudo panel of observations where we are able to follow cohortxgroup as they age during the period 1984 (1997 for the matched data with the ASHE) to 2009.

## **Data Description**

In this section we describe aspects of the data on which we will estimate our empirical models. We first present, Figure 1, the evolution of the proportion of

individuals aged between 16 and 19 going to school for each cohort between 1968 and 1990 and the proportion of individuals aged 16 to 25 involved in full time education (excluding school), Figure 2. Each figure shows the contribution of each of the cohortxgroup as calculated from the LFS. In Figures 1 and 2 the relative size of each group is represented by the size of the circles centred around the group estimate of each proportion. Moreover we show the evolution of the median proportion (the bold line) against age on the horizontal axis. We observe that the pattern of overall attachment to school has not changed qualitatively for the cohorts the data cover. The proportion of individuals involved in full time education shows more variation over time (if only to reflect the increased availability of further and higher education study programmes over the last 20 years). Although it varies between regions and gender (the source of variation around the average) the proportion of individuals in full time education (post school) reaches a maximum of around 40% at age 18 or 19. The transition takes place between the early cohort where the maximum was below 20% and the cohorts born in the late 1970s where the maximum and the pattern of evolution is more or less the one we observe for the later cohort.

**Figure 1: Proportion of cohort still in school by cohort year of birth (LFS)**

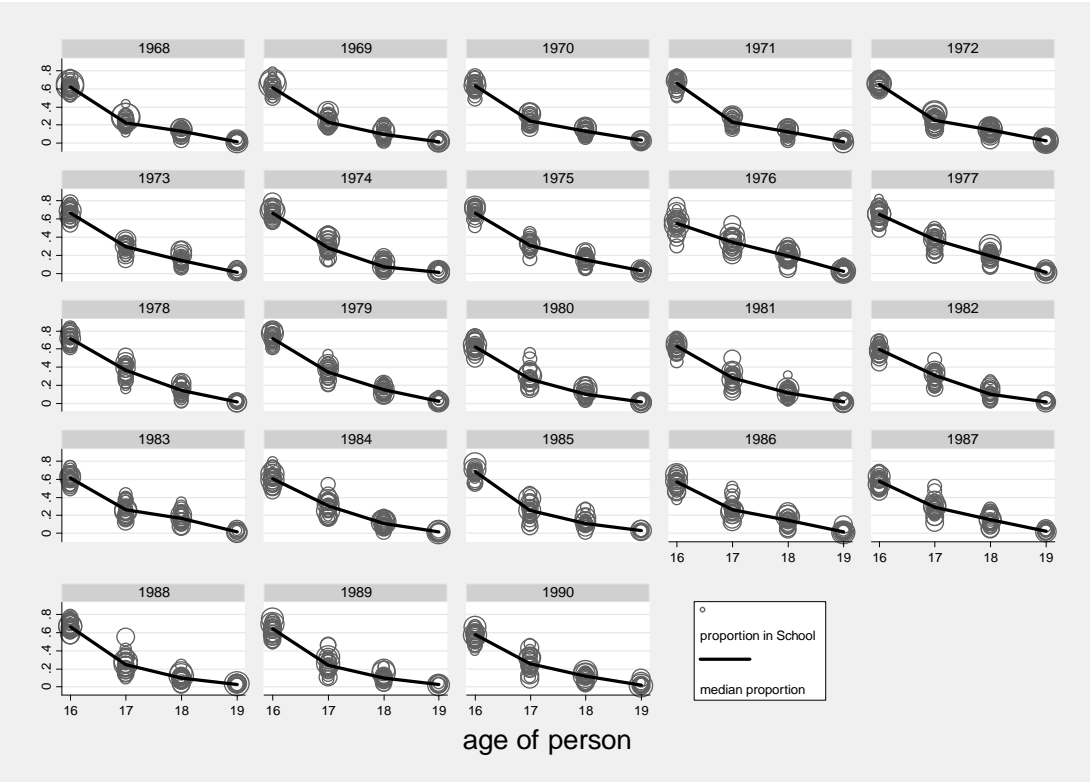


Figure 2: Proportion in Full time education (after school) by cohort (LFS).

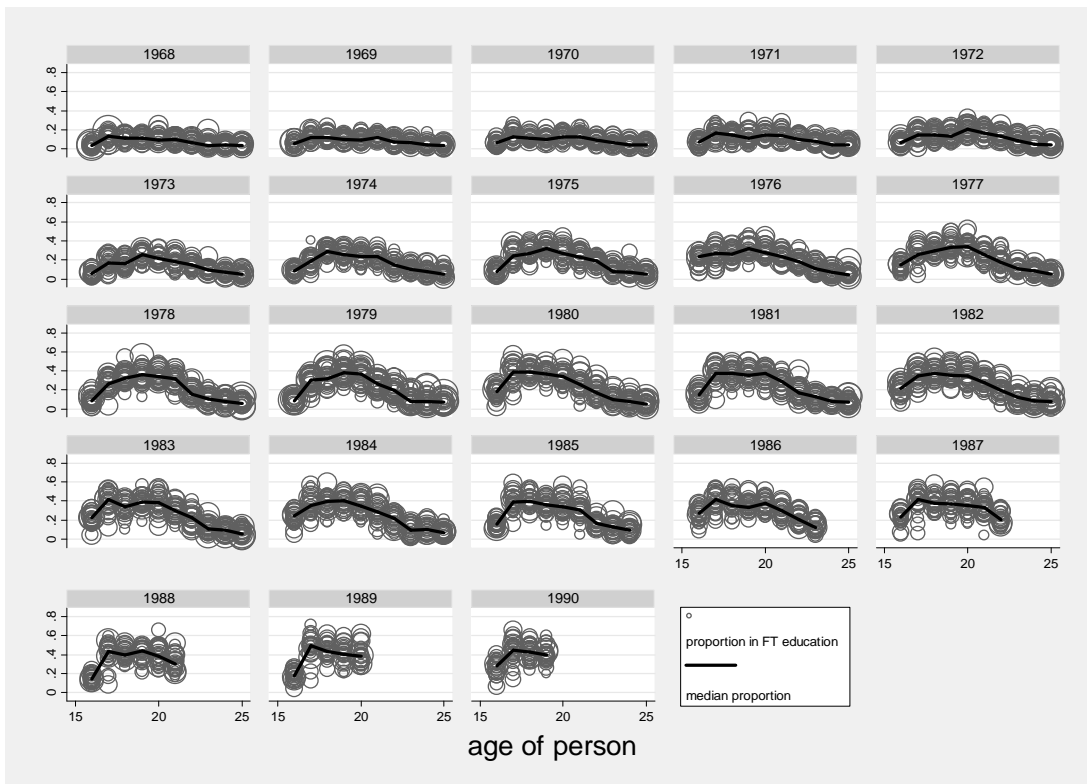
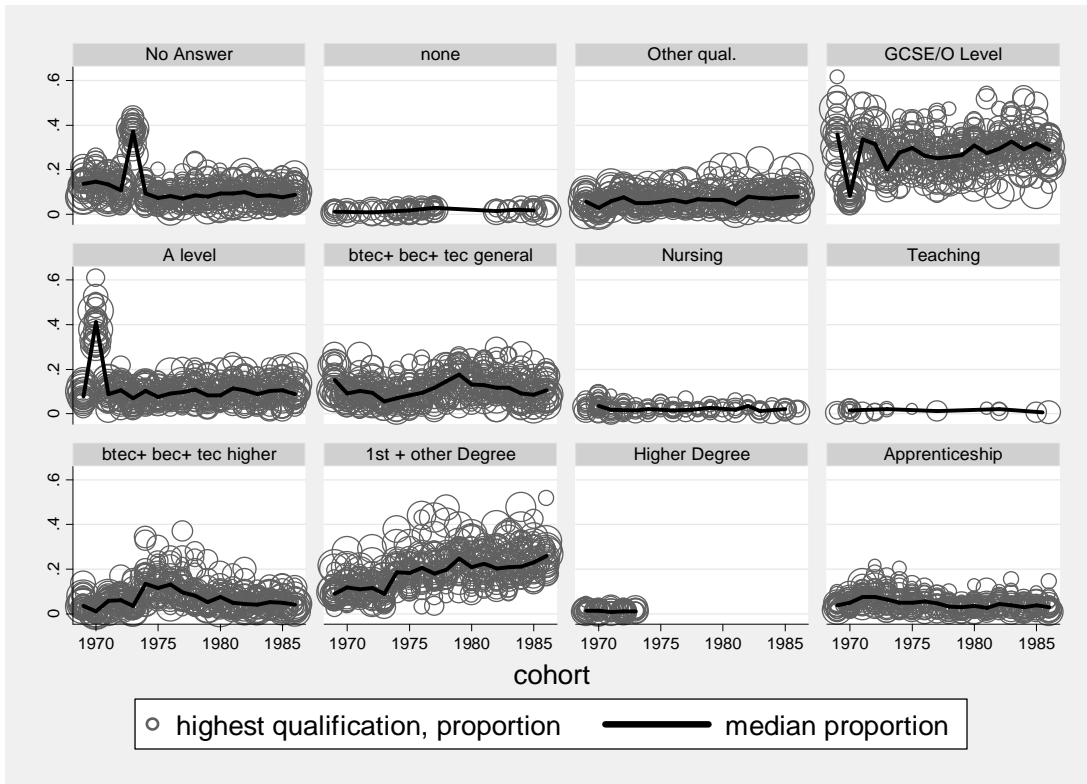


Figure 3 illustrates the evolution of the highest qualification reported at age 23 by cohort. The main observation concerns the increase for the younger cohorts of the number of individuals reporting a first degree or equivalent as well as the apparent decrease in the number reporting completed Apprenticeships. Furthermore, Btec (or equivalent qualification) at the higher level seems to have become less popular among recent cohorts while the proportion of individuals reporting Btec (or equivalent) general qualifications has remained broadly constant. Note that for the early periods the proportions of for the "No Answer", "GCSE/O level" and "A level" show substantial isolated variations. As far as we can tell this is not due to miscoding of the information in the LFS.

Figure 3: Highest qualification reported at age 23 over time (LFS)



Figures 4 and 5 show the regional evolution of the average unemployment rate for the young and the older individuals (i.e. between the age of 25 and 65) respectively. We observe an increase in the unemployment rate in the early nineties, while overall there is a downward trend that starts off from the early eighties (15% overall) and extends until 2007, where it seems to reach a minimum below 10% uniformly. In several regions (for example North West, Yorkshire & Humberside, East and West Midlands) we detect a clear change after 2006, i.e. the unemployment rate of the young starts to increase significantly. We observe a similar phenomenon among older individuals from a lower starting point below 10% overall in the early eighties and reaching a minimum about or below 4% in the early 2000s. In particular, there is a sharp increase in the unemployment rate in 2009.

Figure 4 : age group unemployment rates over time per regions (15<age<26)



Figure 5 : age group unemployment rates over time per regions (25<age<66)



We now turn to the comparison of the measurement of the hourly wage rate and the National Minimum wage bite between the Labour Force Survey and the Annual Survey of Hours and Earnings. Table 1 reports the results of several regressions of the bite measure in the LFS (using the information given in variable HOURPAY since 1994) against the same ASHE bite measure (using the variable HE). We report weighted regression estimates of bite at the same cohortxregionxyearxage group level in both cases. The figure of interest is reported in the first row where we would expect a value close to 1. The first column, column [1], reports the parameter estimate for the younger groups of the regression model without any control and reports a parameter close (larger than) to 1. The estimate for older individuals (column [2]) is further away (below) from one. Controlling for year, region, gender, age dummies, in column [3] and [4], suggests that the differences in the bite measures between the LFS and ASHE depend on the groups' definition. We obtain the same qualitative result when we account instead for cohortxgroup specific effect (column [5] and [6]). Furthermore, if we believe that the measurement in ASHE is closer to the "true" NMW bite, we conclude that the LFS measure is less reliable when the ASHE reports larger measures of the NMW bite for both young and older individuals. Recall that the bite is small when the particular group median wage is large relative to the NMW, while the bite is large when the group median wage is comparable to the NMW. The LFS measure of the NMW bite appears to be an underestimate of the ASHE measure for cohortxgroup where the NMW is close to the median.

**Table 1: Regression NMW bite measured in LFS on NMW bite measured in ASHE**  
(per cohort x region x gender x year)

Estimation Method	OLS	OLS	OLS & Dummy	OLS & Dummy	FE	FE
Age band	(16,26)	(25,60)	(16,26)	(25,60)	(16,26)	(25,60)
Column	[1]	[2]	[3]	[4]	[5]	[6]
Bite(ASHE)	1.0717***	0.8596***	0.7582***	0.6421***	0.4898***	0.4144***
N	5259	14600	5259	14600	5259	14600
dof	1	1	30	56	1	1
r2_a	0.2376	0.4222	0.3344	0.4971	0.2863	0.512
F	1062	3640	77.88	141.1	41.71	182

legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

Figure 6, for the young, and Figure 7 for older workers attempt to illustrate some aspects of the differences between the LFS and the ASHE measurements of the bite. We present the overlaid histograms for the NMW bite from the two

sources of information. Note that the distribution of the ASHE measurement is consistently more concentrated than the distribution of the LFS measurement. Furthermore the distribution of the LFS measurement is clearly more spread for the young.

Figure 6: NMW Bite in ASHE vs LFS (15<age<26)  
(per cohort x region x gender x year)

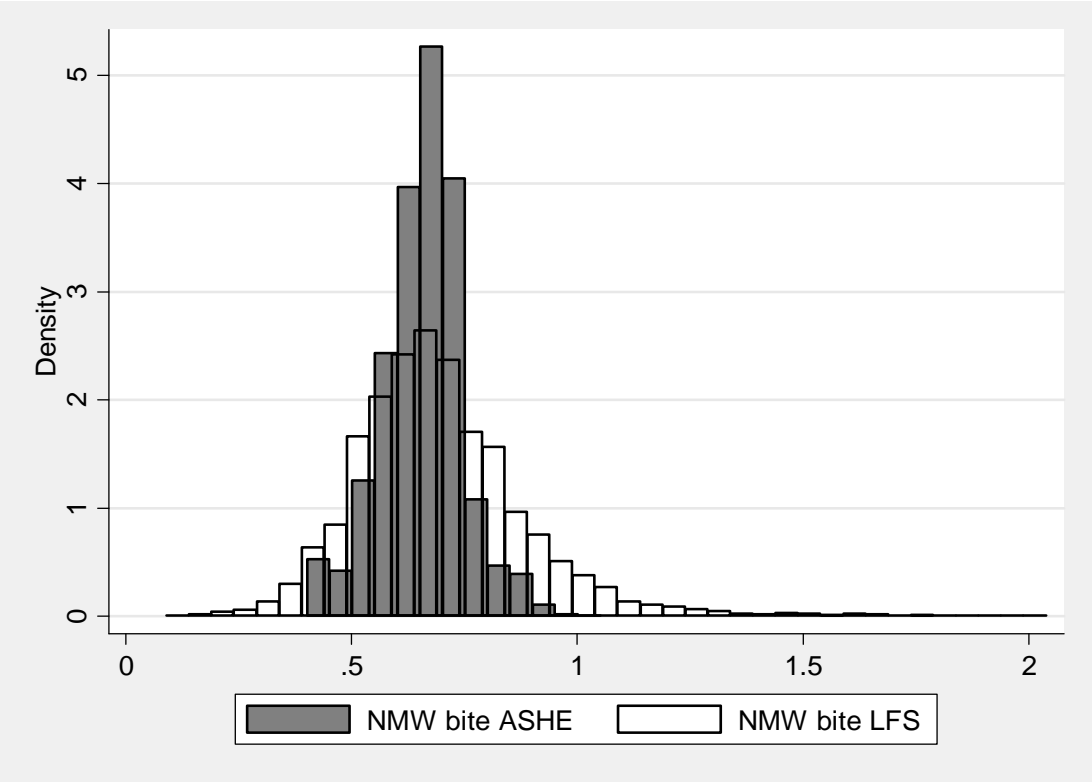
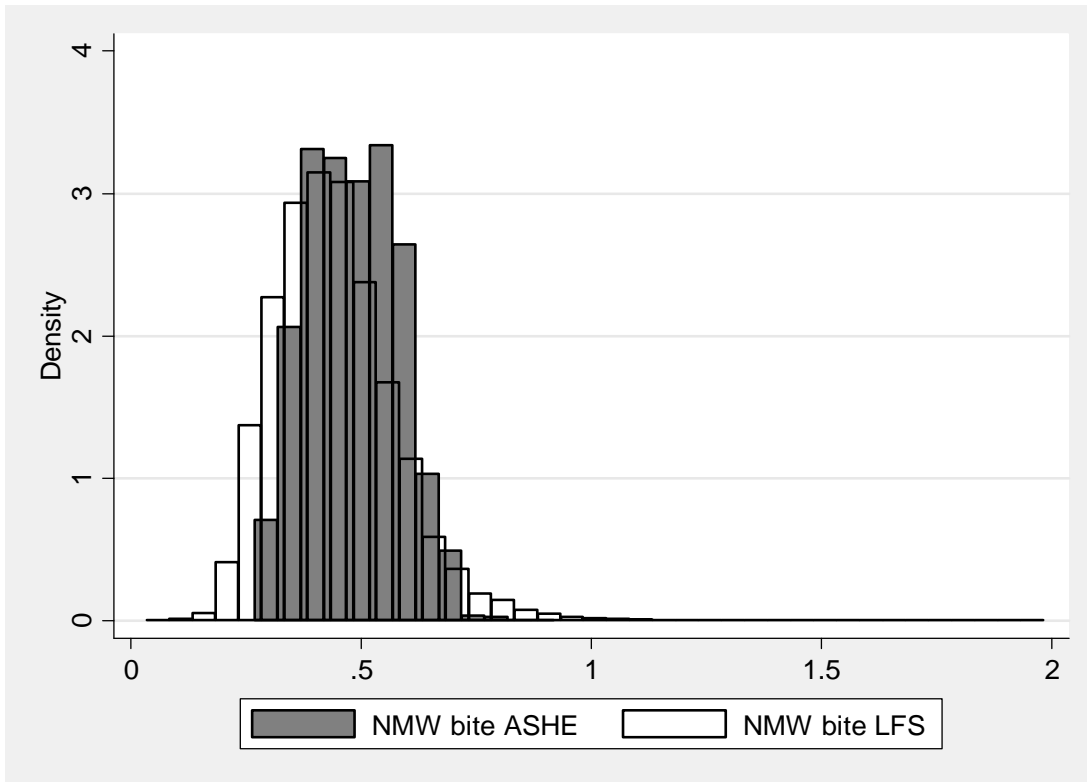


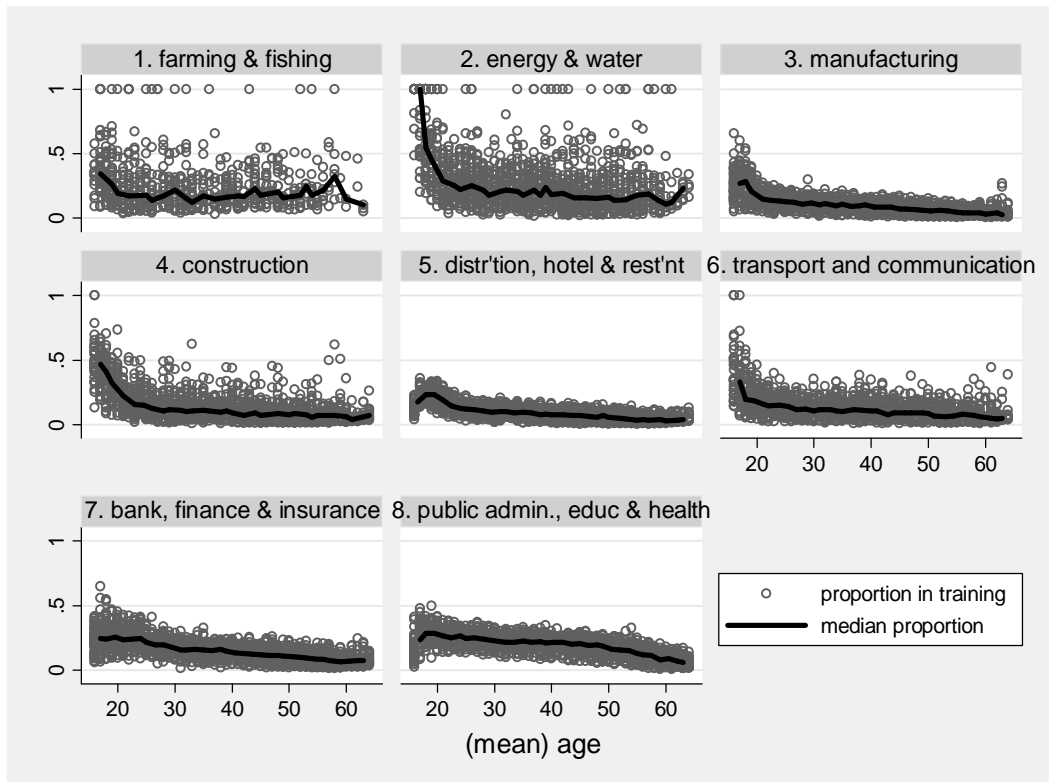
Figure 7: NMW Bite in ASHE vs LFS (25<age<66)

(per cohort x region x gender x year)



Finally figure 8 illustrates the incidence of training by sector in the population of employed workers as measured by the Labour Force Survey (ASHE only measures employees on a “junior” rate). Figure 8 describes the distribution of “training rates” across sectors for employees at different ages (between 16 and 65). The bold line indicates the position of the median proportion for each age. We observe that the proportion of employees receiving training varies substantially across sectors and between age groups. In particular proportions of those receiving training are largest for younger workers, decrease substantially for workers between 22 and 25 and remain stable for older (above 25) age groups. The absolute levels of the proportions of workers engaging in training differ between sectors but the pattern described above among age groups persists across sectors. The energy and water sector as well as construction are the two sectors which stand out for the incidence of training among young employees. The occurrence of training episodes in the service sectors (banking and public administration) among younger employees is significantly smaller.

Figure 8: Proportion receiving Training, per sector, 15<age<66



## Empirical analysis and discussion

### A. Current Education Status and the NMW

We first apply our methodology to the case of “current education status”. We attempt to assess the effect of the minimum wage and the variation in economic activity on current education status. In terms of quasi experimental design, we observe an intervention (the introduction of the minimum wage and its annual up-rating) and variations in economic conditions for different cohorts (variations in the regional cohort specific unemployment rate). The difficulty arises because of the limited availability of clear control groups given the universal applicability of the national minimum wage legislation. The quasi experimental design used to study outcomes of the introduction of the minimum wage (say Stewart, 2004) works well because it is possible to argue that age groups are almost identical in terms of labour market prospects at the time of the introduction but are treated differently (soon) before and (soon) after the introduction of the minimum wage. However as the observations move away (forward in time) from the introduction of the NMW all the data is in principle “treated”, if only indirectly, by the treatment. Even in the case of exemptions, this is unlikely to result from “random” or “ignorable” assignment but from clear choices (i.e. comparisons of alternatives, with potentially dependent outcomes).

Differences between cohorts in different regions arise because of variations in regional economic conditions (which we measure by the region cohort specific unemployment rate). In principle, everything else constant, this allows us to compare cohorts in different regions, before and after the minimum wage is introduced, experiencing the same level of regional unemployment, or cohorts in different regions exposed to the same NMW status (in operation or not) experiencing different levels of unemployment rates. In this context, the former thought experiment identifies the effect of the minimum wage, while the latter identifies the effect of unemployment on education choices.

We provide evidence for two types of information concerning current education status: first, the proportion of individuals still attending school and second, the proportion of individuals still involved in full time education (after school). We compare the findings based on a) the LFS for the whole sample period (1984-2009), b) the LFS for the latter part of the sample period (1997-2009) and finally c) for the matched LFS and ASHE over the more recent sample period (1997-2009).

We comment on the various tables of estimates in turn. We focus first on the effect of the national minimum wage and of the regional unemployment rate on the current education status of youth between 16 and 25. Table 2 reports our findings. The unit of observation used are groups in terms of cohort, gender, region and age for cohorts born between 1968 and 1994. The upper part of the table (a) reports results based on the LFS data from 1994 to 2009, the middle part (b) of the table reports results on the LFS data from 1997 to 2009, while the lower part (c) of the table report results where estimates of the bite obtained from the ASHE are used. Columns 1 and 2 report on the estimation results concerning the current attachment to school. Columns 3 and 4 report on the results for the full time education status (post school).

We only report estimates based on at least 150 cohortxgroup observations (and such that each cohortxgroup is observed at least twice)<sup>3</sup>. Each table reports on “fixed effects” regression where each cohortxgroup observation is weighted by the sum of the sampling weights of each original sample observation used to create it. The standard errors therefore account for the data construction step (i.e. the creation of the cohort groups) as well as the potential heteroscedasticity between groups over time and region.

We further test several joint hypotheses: the direct effect of the unemployment rate and the interaction effect between the unemployment rate and the bite of the minimum wage are zero (see line F1(p;)) where we report the p-value for the

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<sup>3</sup> From the individual data in the LFS (say), we construct the average or median value for the dependent and the explanatory variables for each cohort\*gender\*region group. As time passes we can follow the same cohort\*gender\*region group as it ages, hence we will observe the same group several times (but at different ages). To be able to account for the cohort\*gender\*region group specific effects we need at least two observations for each such group. Furthermore we make sure that we have at least 150 such cohort\*gender\*region group observations. To construct the averages we use the survey sampling weights and we further calculate the overall weight of the cohort\*gender\*region group averages for each LFS cross section and use these as observation weights for the calculation of the regression results.

test), the sectoral composition of the regional workforce is unimportant (see line F2(p;) where we report the p-value for the test). We also report the conventional F-test for the overall significance of the regressions i.e. including the cohortxgroup specific effects and age dummies. In the case of school enrolment, we only consider enrolment between age 16 and age 20. While in the case of full time education enrolment we include age dummies up to age 25. Finally we report the elasticities of the cohortxregion proportions with respect to changes in the unemployment rate, and the elasticity of the cohortxregion proportions with respect to changes in the value of the NMW bite.

We measure the local unemployment rate<sup>4</sup> in two alternative ways: in the first instance (columns 1 and 3) we use the regional and gender specific age group unemployment rate (i.e. independent of the education level; Age Unp'Rate). In the second case (columns 2 and 4) we use the regional, gender specific and education specific age group unemployment rate (Cohort Unp'Rate). The latter is obviously directly associated with current education status, since the higher the proportion of individuals still engaged in full time education the lower the unemployment rate. The former is less directly associated with the proportion of individuals enrolled in full time education.

The parameter estimates vary in ways that are difficult to compare across specifications. To that effect we calculate the implied elasticities evaluated at the average of the dependent variables for each group. We note that only the elasticities relative to the age group unemployment rate lead to consistently significant results across sample periods and data sources. Furthermore, whenever they are significant, the elasticities with respect to the unemployment rate are of similar signs and magnitude around -0.07. The minimum wage bite is only positive and significant in the case of full time education for the sample period 1997-2009 when we use the information on the bite measured using the ASHE. In this case the elasticity of the bite is 0.229, which implies that a 1% increase in the bite leads to an increase in full time education attachment of about 0.23%. Nevertheless, we do not believe that this estimate is reliable; in particular since its corresponding estimate using the information from the LFS (part b) in table 2) takes a different value and is not significant.

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<sup>4</sup> Here the unemployment rate is the proportion of a cohortxgroup which is classified as unemployed by the LFS economic activity variable (see the appendix for details of the definition).

**Table 2: Proportion of individuals in School and Enrolment in Full Time Education (post school)**

a) LFS 1994-2009	1	2	3	4
Variable	School	School	FT course	FT course
Bite	-0.0564	0.0407	-0.0292	-0.0119
Log median wage	-0.0260	-0.0038	0.0325	0.0312
Age Unp'Rate	-1.6470		-1.2463**	
Age Unp'Rate*Bite	0.1880		0.3457	
Cohort Unp'Rate		1.2191		-0.2315
Co't Unp'Rate*Bite		-1.0473		0.1706
Elasticity % wrt Unp'Rate	-0.1189*	0.0201	-0.0743***	-0.0057
Elasticity % wrt Bite	-0.0144	-0.0032	0.0016	-0.0008
N	840	840	2097	2097
Groups	409	409	548	548
# Explanatory Variables	15	15	21	21
R <sup>2</sup> (adjusted)	0.912	0.911	0.800	0.798
F	222.8	216.9	130.9	122.2
F1(2;)	0.05	0.34	0	0.13
F2(7;)	0.68	0.60	0.57	0.50

Legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

b) LFS from 1997 to 2009	School	School	FT course	FT course
Bite	0.0528	-0.0526	-0.0362	-0.0107
Log mediab wage	-0.0929	-0.0793	0.0286	0.0347
Unp'Rate	-0.2518		-1.2721**	
Age Unp'Rate*Bite	-1.2055		0.3279	
Cohort Unp'Rate		0.9043		-0.0752
Co't Unp'Rate*Bite		-0.2817		0.0845
Elasticity % wrt Unp'Rate	-0.0860	0.0235	-0.0698***	-0.0007
Elasticity % wrt Bite	-0.0395	-0.0334	-0.0036	-0.0030
N	676	676	1802	1802
Groups	342	342	482	482
# Explanatory Variables	15	15	21	21
R <sup>2</sup> (adjusted)	0.907	0.907	0.802	0.800
F	161.7	156	105.3	100.2
F1(2;)	0.16	0.43	0.00**	0.50
F2(7;)	0.89	0.78	0.52	0.800

legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

c) ASHE-LFS from 1997 to 2009	School	School	FT course	FT course
Bite	0.6443	0.2361	0.4988*	0.6217**
Log mediab wage	1.1816	1.0243	1.0268***	1.0982**
Unp'Rate	0.7732		-1.3352*	
Age Unp'Rate*Bite	-2.7148		0.3823	
Cohort Unp'Rate		0.6829		0.3464
Co't Unp'Rate*Bite		0.0838		-0.6675
Elasticity % wrt Unp'Rate	-0.0699*	0.0245*	-0.0750**	-0.0007
Elasticity % wrt Bite	0.1543	0.1057	0.2295*	-0.0031
N	894	894	2563	2563
Groups	342	342	482	482
# Explanatory Variables	21	21	27	27
R <sup>2</sup> (adjusted)	0.907	0.907	0.802	0.800
F	290	286	198.4	197.7
F1(2;)	0.03*	0.08	0.00	0.50
F2(7;)	0.51	0.43	0.70	0.01*

legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

## B. Highest Qualification and the NMW

We now turn to the effect of the NMW and the state of the labour market on the highest qualification obtained as it is recorded in the LFS. Our approach follows the statistical methodology used in the previous section. While the approach could be given a more structural interpretation in the previous section, this is not easily done here (because of the interaction between the timing of multiple education choices and the state of the “economy” at the time the decisions are taken): the model we estimate here is therefore a reduced form of the “true” structural form.

Since the highest qualification records a “stock” rather than a “flow” we fix our point at a given age (here 23) and we condition on the history of the cohortxgroup specific national minimum wage bite and of the cohortxgroup specific unemployment rate. Hence, our objective here is to describe whether the proportion within a cohort obtaining a given highest qualification depends on the past history of the national minimum wage and its effect on the cohortxgroup wage distribution, as well as its interaction with the group specific unemployment rate.

In practice we recreate for each observation the history the group faced between age 18 and age 23; this implies that we condition on the NMW bite, the group unemployment rate and their interactions, at all ages from 18 to 23. We can further understand our estimates as providing evidence as to the “long run” effects of the introduction of the minimum wage and its interaction with the local unemployment rate.

Since the longest history of the hourly wage (as measured by the “hourpay” variable) available in the LFS starts in 1994 we are in effect only using cohorts born between 1976 and 1986. This explains why the number of observations (at most 242 depending on data availability) is reduced relative to the numbers we observe in the previous section.

To obtain a consistent measure over time, we have coded the highest qualification recorded in the LFS variable HIQUAL into 10 groups including, “Degree Level”, “Btec (higher)”, “Btec (general)”, “A-level”, “Apprenticeship” as well as “Teacher and Nurse Training”, “O-level, GCSE”, “Other qualification”. We include estimates for a highest qualification at “degree level” as a test of the approach: we have the strong prior that the history of the bite or of the unemployment rate at age 18 to 23 should not have any effect on the proportion of a cohortxgroup reaching a degree level qualification (since their reservation wage is likely to be significantly higher than the national minimum wage), whereas for other qualification levels the strength and significance of the effect of the bite and of the unemployment rate is debatable ex-ante.

**Table 3: Proportion achieving highest qualification at age 23. (1968<cohort<1987)**

	Apprenticeship		First Degree		Btec, bec, tec (higher)		Btec, bec, tec (general)		A-level		GCSE/O-level		Other qualification	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Elasticity % wrt Unp'Rate age 23	0.446	-	-0.134	-	-0.14	-	0.034	-	-0.062	-	0.164	-	0.188	-
Elasticity % wrt Bite age 23	-0.576	-	-0.001	-	-0.392	-	-0.533	-	0.866*	-	-0.013	-	-0.425	-
Elasticity % wrt Unp'Rate age 22	0.201	-	0.017	-	-0.499**	-	0.290*	-	0.063	-	0.024	-	0.057	-
Elasticity % wrt Bite age 22	-0.148	-	0.191	-	-0.119	-	0.239	-	0.088	-	-0.037	-	-0.075	-
Elasticity % wrt Unp'Rate age 21	-0.055	-	0.002	-	-0.008	-	-0.245	-	0.159	-	0.126	-	-0.317	-
Elasticity % wrt Bite age 21	-0.334	-	0.202	-	-0.247	-	0.186	-	0.195	-	-0.177	-	0.771*	-
Elasticity % wrt Unp'Rate age 20	0.287	-	-0.001	-	-0.321	-	-0.0853	-	-0.224	-	0.036	-	-0.05	-
Elasticity % wrt Bite age 20	0.568	-	-0.082	-	0.049	-	0.159	-	0.016	-	0.254	-	-0.305	-
Elasticity % wrt Unp'Rate age 19	-0.209	-	-0.046	-	-0.015	-	0.038	-	0.109	-	-0.126	-	0.013	-
Elasticity % wrt Bite age 19	0.069	-	0.088	-	-0.604	-	0.441	-	-0.019	-	0.044	-	-0.318	-
Elasticity % wrt Unp'Rate age 18	0.091	0.063	-0.009	-0.04	-0.071	-0.199	-0.059	-0.023	0.093	0.01	-0.11	-0.062	0.315	0.2
Elasticity % wrt Bite age 18	0.069*	-0.721*	0.255	0.346	0.179	0.002	0.077	0.491*	-0.028	-0.112	-0.008	-0.012	-0.003	0.014
N	164	164	241	241	211	211	237	237	223	223	242	242	200	200
# Explanatory Variables	46	46	47	47	46	46	46	46	46	46	46	46	46	46
R2*	0.407	0.434	0.329	0.352	0.505	0.502	0.4	0.392	0.028	0.024	0.32	0.339	0.262	0.254
F	-	-	4.455	5.815	7.976	9.575	-	-	1.569	1.558	5.735	6.05	-	-
F-test Bite	0.2	-	0.52	-	0.57	-	0	-	0	-	0.58	-	0.18	-
F-test Unemployment Rate	0.32	-	0.94	-	0.16	-	0	-	0	-	0.24	-	0.75	-
F-test Unp'Rate*Bite	0.56	-	0.7	-	0.52	-	0.7	-	0.7	-	0.49	-	0.79	-
F-test Sector	0.04*	0.00**	0.96	0.96	0.24	0.08	0.7	0.17	0.7	0.71	0.79	0.63	0.17	0.1

legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

Table 3 presents the derived elasticities from the parameter estimates for each qualification (the parameter estimates are available on request from the authors) evaluated at the sample average of the bite and the unemployment rate. Each set of results is obtained from a linear regression model on the relevant transformed proportions on variables of interest as well as a set of dummy variables which control for year of observation, region of observation, and gender (since we focus on a single age group the cohort information is confounded within the year information). In each case, we present the p-values for the joint significance of the history of the NMW bite (row F-test bite), the unemployment rate (row F-test Unemployment Rate) and their interaction (row F-test Interaction) separately, as well as the joint significance of the distribution of the employed workforce across broad sectors (row "F-test Sector"). Next to the estimates conditioning for the "long history", we present estimates which condition only on the group NMW bite, unemployment rate and their interaction as they are observed at age 18.

In the case of (general) secondary qualifications obtained at, before or around age 16 (column 11 and 12) we would not expect the NMW bite to have much of an effect since education is compulsory up to age 16 for our cohorts. The possible effect of the bite and of the NMW may arise through the opportunity cost of not taking up a more vocational route instead, i.e completing a vocational qualification like a Btec or enrolling for an apprenticeship. Our results suggest, however, that the proportion of students obtaining their highest qualification at the secondary level does not depend significantly on the NMW bite. As might be expected, neither the history of unemployment rate, nor the history of the bite (nor their interaction), appear to contribute significantly to the determination of the proportions of individuals with general secondary qualifications only.

In the case of A-level we could imagine that the NMW bite would measure the effect of the increase in the opportunity cost of taking up further studies after passing A-level examinations or as students proceed during their further and higher education. In column 9, the effect of the bite seems to be limited to the effect at age 23 where the elasticity is large and significantly positive (with a value of 0.866). This suggests that an increase in the bite at age 23 may have a positive effect on the proportion of a cohort of individuals with A-level as their highest qualification. The likely mechanism is that an increase in the minimum wage makes the likelihood of finishing their Higher or Further Education studies by age 23 smaller. Although the history of unemployment rate is jointly significant overall none of the point estimates for the elasticity of the proportions of individuals with A-level as their highest qualification relative to the unemployment rate are significant at the 5% level. Note however that our ability to explain the evolution of these proportions is limited since we explain less than 2.5% of the variance of the transformed proportions.

In the case of the more vocational qualifications Btec (higher) and Btec (general), (columns 3 to 6), it is the elasticity of the unemployment rate at age

22 which is precisely measured. However the sign of this elasticity differs between the higher and the general versions of the Btec qualification. In the case of the general (less advanced) versions of the qualification both the history of the bite and the history of the unemployment rates are jointly significant. In the case of the higher version of the qualification the history of the bite and of the unemployment rate are not jointly significant. Furthermore, when we limit ourselves to the effect of the bite and of the unemployment rate at age 18, in the case of the general versions of the qualification the elasticity of the bite is large and significantly positive (with a value of 0.491) implying an increase in the NMW bite will strongly encourage individuals to pursue qualifications of broad knowledge base. In the case of the Btec (higher) neither the elasticity with respect to the unemployment rate nor the elasticity with respect to the bite at age 18 are precisely measured (i.e. they are not significant at the usual levels).

Finally the results for apprenticeship are mixed, whether we control for the long history of the NMW bite and of the unemployment rate (column 1) or whether we control for the NMW bite and the unemployment rate at age 18 (column 2) only the elasticity of the bite at age 18 is precisely measured. However the elasticities with respect to the bite at age 18 vary significantly. In the former case it is small and positive (about 0.07) while in the latter case it is large and negative (-0.721). In the first case, we fail to find evidence of joint significance between the histories of the bite, the unemployment rate and their interaction. In addition it is only for the proportions of apprentices that we find that the distribution of employees across sector is significant. Overall, we conclude that although it is possible to rationalise ex-post the significant elasticities we report in Table 3, our findings are not systematic enough to give a reliable picture of the effects of the national minimum wage bite or of the economic activity on the evolution of the proportion of individuals with a given highest qualification.

### **C. Apprenticeships**

Following on from the analysis of the previous section we provide further analysis which focuses on apprenticeships. An obvious question concerns whether any negative estimate of the effect of the bite can be attributed to the demand or the supply side. The methodology we have applied here does not allow us to answer this clearly, indeed movements on both side of the market could explain our findings. For example, as the bite increases and since apprentices are exempt from the NMW, firms may substitute away from workers with other qualifications towards apprentices for costs reasons, while when making schooling/training decisions, students/pupils may consider that the trade-off between acquiring an apprenticeship and other forms of training (and possibly the option of no training/qualification) leans in favour of the latter rather than the former. Another aspect which confuses the findings further is the constant introduction and withdrawal of government schemes in favour of apprenticeships or designed to support and train young workers without qualifications which are modified in one way or another. Hence our estimate can only be understood as a net effect of the bite on the apprenticeship rate.

**Table 4: Proportion achieving apprenticeship at age 23 relative to proportion achieving another qualification (1968<cohort<1987)**

	First Degree		Btec, bec, tec (higher)		Btec, bec, tec (general)		A-level		GCSE/O-level		Other qualifications	
	1	2	3	4	5	6	7	8	9	10	11	12
Elasticity % wrt Unp'Rate age 23	0.576	-	1.891*	-	0.243	-	1.036	-	0.575	-	0.107	-
Elasticity % wrt Bite age 23	-0.560	-	-1.116*	-	-0.203	-	-0.822*	-	-0.486	-	-0.719	-
Elasticity % wrt Unp'Rate age 22	0.156	-	0.917***	-	0.308	-	0.012	-	0.249	-	0.406	-
Elasticity % wrt Bite age 22	-0.266*	-	-0.309**	-	-0.299*	-	-0.354*	-	-0.219	-	-0.052	-
Elasticity % wrt Unp'Rate age 21	-0.208	-	-0.106	-	-0.118	-	-0.379	-	-0.211	-	0.447	-
Elasticity % wrt Bite age 21	-0.001	-	-0.095	-	0.200	-	0.009	-	0.180	-	-0.242	-
Elasticity % wrt Unp'Rate age 20	0.296	-	0.697	-	0.715**	-	0.655**	-	0.394*	-	0.685	-
Elasticity % wrt Bite age 20	0.020	-	-0.022	-	-0.206	-	-0.108	-	-0.085	-	0.195	-
Elasticity % wrt Unp'Rate age 19	-0.131	-	-0.473	-	-0.557**	-	0.616**	-	-0.317	-	-0.311	-
Elasticity % wrt Bite age 19	0.177	-	0.673***	-	0.067	-	0.225	-	0.236	-	0.176	-
Elasticity % wrt Unp'Rate age 18	0.102	-0.080	0.019	0.128	0.113	0.085	0.112	0.093	0.245	0.165	-0.641*	-0.432
Elasticity % wrt Bite age 18	-0.337**	-0.314***	-0.304	-0.146	-0.200	-0.297**	-0.251*	-0.191	-0.249*	-0.211*	-0.205	-0.317*
N	344	344	307	307	341	341	322	322	345	345	300	300
# Explanatory Variables	47	32	46	31	47	32	46	31	46	31	47	32
R <sup>2</sup> (adjusted)	0.568	0.561	0.343	0.288	0.497	0.477	0.446	0.378	0.358	0.355	0.494	0.437
F	18.83	19.85	-	-	14.43	-	-	-	-	-	9.084	9.128
F-test Bite	0.00***	-	0.01***	-	0.00***	-	0.00***	-	0.11	-	0.00***	-
F-test Unemployment Rate	0.22	-	0.00***	-	0.00***	-	0.00***	-	0.02*	-	0.01**	-
F-test Unp'Rate*Bite	0.29	-	0.00***	-	0.00***	-	0.00***	-	0.07	-	0.34	-
F-test Sector	0.08	0.00***	0.07	0.00***	0.00***	0.00***	0.13	0.00***	0.09	0.00***	0.2	0.1

legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

To study this aspect further we extend our analysis and focus on the evolution of the ratio of the proportions completing an apprenticeship relative to the proportion achieving an alternative qualification. In particular we compare Apprenticeships to a list of qualifications as well as the "other qualification" category. As Figure 3 shows the proportions in the 'Other' category remain broadly constant over time, and we can understand it as a broad default category. We expect this category to be mainly comprised of holders of qualifications awarded from institutions outside the UK since the relevant category in the LFS groups such individuals with those who claim to hold a qualification other to the "standard" ones mentioned in the survey's questionnaire. We control for the history of the bite, the unemployment rate and their interaction at the yearxgenderxregional level from age 18 to 23. Table 4 presents estimates of the elasticities evaluated at the sample means. A positive elasticity indicates an increase in the proportion of completed apprenticeships relative to the proportion of the alternative qualification.

Relative to all qualifications, the history of the bite is significant (see the F-test Bite row) although the point estimates at different ages of the elasticities of the relative proportions are not stable. The history of the unemployment rate is significant in most cases except when we compare the proportion of apprentices with the proportion of individuals in a cohort reaching degree level. When we test for the significance of the interaction between the bite and the unemployment rate (F-test Unp'Rate\*Bite row) we obtain significant results for the "Btec" and "A'level" alternatives. Controlling for the distribution of employees in a region across sectors matters in a significant fashion (F-test Sector row) when we concentrate only on the bite and unemployment rate at age 18 (except for "other qualifications"). The consistently significant parameter concerns the elasticity of the ratio of proportion relative to the national minimum wage bite evaluated at age 18. In all cases it is negative, i.e. an increase in the bite at age 18 decreases the proportion of individuals completing an apprenticeship by age 23. The elasticity takes a value between -0.146 and -0.337 which would indicate that a one percent increase in the bite, leads to a decrease in the proportion of individuals completing an apprenticeship of around -0.250 percent. In contrast the effect of the unemployment rate at the same age (18) is almost always insignificant (the exception arises when the alternative is "other qualification" and we control for the history of the bite and the unemployment rate from age 18 to 23).

Overall our findings suggest that Apprenticeships are the qualifications which respond the most to changes in the NMW bite caused by variation in the NMW. As we argued we cannot distinguish with the methodology we use here between a supply or demand interpretation; this is a serious weakness and does not lead to clear cut policy advice. However, we note that the effect of the bite is consistent throughout the relative comparisons of apprenticeships with most qualifications whether they are of a general nature (degree level, A-level) or of a vocational nature (Btec). Whatever the reasons for this response, it suggests

that it is the proportion of a cohortxgroup completing an apprenticeship which responds to the change in the NMW-bite rather than the proportion for the alternative qualifications. This finding is reinforced further when one notes that the (parameter and elasticities) estimates across the alternative qualifications are broadly similar.

#### **D. Firm training and the NMW**

Finally, in this last section, we turn to the effect of the NMW and the unemployment rate on training among employed workers aged between 16 and 65. Using the LFS we calculate for each year, age group, gender and (broadly defined) sector the proportion of workers claiming to receive some training, either on the job, outside the job or both during the last 4 weeks. As we did in our earlier section, we use the transformed proportions (i.e. we calculate the logarithm of the ratio of the proportion to its complement to 1) in a regression model where we control for the bite, the unemployment rate (regionxgenderxage group specific) as well as group specific fixed effects. Each observation is weighted by the number of observations it represents given the sampling weights available. The parameter estimates and the elasticity estimates we present in Table 5 rely on LFS data for the longest series of hourly pay (since 1994) [column 1], on LFS data since 1997 [column 2] and on the matched LFS/ASHE data [column 3] where we use the measurement of the bite and the median wage based on the ASHE data only. The upper part of the table presents our findings for young workers (between 16 and 25) while the bottom part of the table presents our findings for older workers (between 26 and 65).

Between columns the parameter estimates change in magnitude, this is in particular the case for the effect of the age group unemployment rate and of the interaction between the age group unemployment rate and the bite. This pattern holds for both young workers and older workers. Controlling for cohort group per sector, gender and year, the overall fit of our models is good since we explain substantial proportions of the observed variance of the transformed proportions (i.e. about 45% for younger workers and about 70% for older workers).

Our elasticity estimates suggest that the proportion of workers within sectors being trained responds neither to the unemployment rate nor to the level of the bite. Indeed our elasticity estimates are insignificant in all cases except in the case of the elasticity with respect to the bite when we use the matched LFS-ASHE data on younger workers. In this case an increase of one percent of the bite reduces the proportion of employees being trained by 0.243 of one percent. The elasticity of the proportion of trained workers with respect to the unemployment rate is in all cases insignificant.

Our estimates suggest that, over time, training across employees responded little to changes in unemployment or to changes in the minimum wage relative to the group median wage. The notable exception concerns younger workers

where we measure a significant negative effect of the bite on the proportion of workers engaging in training.

**Table 5: Proportion of workers being trained (per year x cohort x gender x sector )**

a) Young Workers 15<age<26			
Variable	LFS	LFS	LFS+ASHE
	1994-2009	1997-2009	1997-2009
	1	2	3
Bite	-0.215	-0.349	-0.648*
Log mediab wage	-0.417	-0.547	-0.589
Unp'Rate	0.884	1.390	-0.051
Age Unp'Rate*Bite	3.005	0.202	3.241
Elasticity % wrt Unp'Rate	0.002	0.008	0.009
Elasticity % wrt Bite	-0.067	-0.120	-0.243*
N	2112	1707	1688
# Explanatory Variables	27	24	24
R <sup>2</sup> (adjusted)	0.451	0.456	0.459
F	16.44	15.85	15.04
legend: * p<0.05; ** p<0.01; *** p<0.001			
b) Older Workers 25<age<66			
Variable	LFS	LFS	LFS+ASHE
	1994-2009	1997-2009	1997-2009
	1	2	3
Bite	0.318	0.196	0.097
Log mediab wage	0.539***	0.566***	0.586*
Unp'Rate	3.236	6.774	6.468
Age Unp'Rate*Bite	-2.506	-6.508	-5.707
Elasticity % wrt Unp'Rate	0.015	0.029	0.026
Elasticity % wrt Bite	0.086	0.042	0.018
N	7669	6236	6182
# Explanatory Variables	57	54	54
R <sup>2</sup> (adjusted)	0.708	0.708	0.708
F	22.15	11.94	11.96
legend: * p<0.05; ** p<0.01; *** p<0.001			

## Conclusion

The work we present here describes the association between human capital investment and the consequences of the introduction of the national minimum wage, and of its regular up-rating, on the wage distribution (as measured by the NMW bite). Furthermore, we look at the effect of the level of unemployment, measured at the cohort group level (i.e. within groups defined by yearly cohorts, gender, year), and, when relevant, measured either at the regional or the sectoral level, on such investment decisions. We have shown that the decision to stay on at school or enrol in further or higher education is more sensitive to the unemployment rate than to the magnitude of the national minimum wage bite, which we find to be statistically insignificant.

With respect to educational achievement, we do not obtain systematically statistically significant results across cohorts, so we cannot provide a reliable picture of the effects of the NMW bite, or of the economic cycle, on the proportion of individuals with a given highest qualification. On the whole we conclude that the association between the bite, the unemployment rate and the distribution of qualifications among people at age 23 is limited, and that other determinants are more important for the explanation of the proportion of individuals with a given education achievement.

When we focus further on the role of the minimum wage on the completion rate of apprenticeships relative to the completion rate for other qualifications, we find that the effect of the bite is significant and negative for individuals at the age of 18. This leads us to conclude that the completion of apprenticeships is negatively affected by the level of bite of the minimum wage at age 18: a higher NMW bite (a value of NMW which is closer to the median wage for a particular group) leads to lower apprenticeship completion.

Finally, we turn to the effect of the bite and of the unemployment rate on the training received while in employment. In general, we find that the NMW bite and the unemployment rate, do not significantly explain the proportion of employees receiving training. However, when using the matched LFS-ASHE data, the effect of the NMW bite on the proportion of young workers receiving training is significant with an elasticity of about -0.25. The cohortxgroup unemployment rate has no significant effect. This suggests that if there is an impact of the NMW bite on training among employees, this effect is limited to younger workers and is relatively small in size: a one percent increase in the NMW bite, decreases the proportion of young employees involved in training by about a quarter of one percent.

Overall all our findings suggest that the minimum wage and economic activity may not have any significant and consistent effect on education enrolment and achievement, except in the case of apprenticeships. Moreover we cannot detect

any consistent effect of the minimum wage and economic activity on the incidence of training among employees distributed across broad sectors.

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## **Appendix**

### **Variable Construction Description (LFS)**

#### **Apprenticeship Training**

To measure the incidence of apprenticeship training we create a new variable that records whether the respondent (a) has completed, (b) is currently undertaking or (c) never had apprenticeship training. This new variable is highly correlated with the existing variable APPRENT for years 1984 to 1991; APPREN for years 1992 to 2003; APPR4 for 2004 to 2007 and APPR8 for 2008 and 2009. In variable APPREN the category 'Continuing 2nd year (Northern Ireland only)' is only included for the years 1984, 1986 and 1987. From 2004, respondents in either the first or second year of their apprenticeship training are grouped in the "Continuing" category for consistency.

#### **Industrial Classification**

In constructing a consistent variable coding Industrial Classification across the LFS and the ASHE the main problems that needs to be overcome is the implementation of different classification frames both between surveys and across years. The ASHE follows a rather more aggregate framework and for consistency we follow this. The Industrial classification in the ASHE is based on the Standard Industrial Classification of Economic Activities (SIC) system of 2003 whereas in the LFS both SIC92 and SIC07 have been used. There are high correlations between the systems and many disparities at the four digit level disappear due to aggregation. In the ASHE we group Public Administration, Education and Health with Other Services in a distinct category using variable SIC03. In the LFS we use variables INDF, INDG, INDH, INDJ, INDA, INDB and IND for the years 1984 to 1991 respectively; INDMAIN for years 1992 and 1993; INDM92M for years 1994 to 2008 and INDD07M for 2009. The recoded variable coding Industrial Classification of Economic Activity has therefore got ten categories, namely, farming & fishing, energy & water, manufacturing, construction, distribution, hotel & restaurant, transport and communication, bank, finance & insurance, public administration, education & health & other services and working outside the UK.

#### **Highest Qualification**

The variable coding the highest qualification a respondent holds is constructed from the following variables QUALA in 1984; QUALSM1 in 1985 and 1986; QUALSM1 and HIQUAP for years 1987 to 1991; HIQUAP for 1992 and 1993 and HIQUAP and HIQUAPD for 1994 to 2009. The original variables are very similar with added categories in the newest to include additional qualifications that were introduced at the time. A categorisation according to the NQF and the ISCED97 would have created too broad categories with potential loss of information on specific qualifications. Therefore, we create eleven categories including "No

Qualifications” and “Other Qualifications”. The latter includes qualifications awarded from foreign institutions and bodies as well as professional and vocational qualifications not included in the questionnaire. It is not possible from available information to identify these more precisely and assign them to our recoded categories.

### **Current Education Received**

The outcome variable coding current education is derived from CUREDF, CUREDG, CUREDH, CUREDJ, CUREDA and CUREDB for the years 1984 to 1989 respectively and CURED for 1990 to 2009. We code six distinct categories of education currently being received by respondents.

### **Economic Activity**

The respondents’ economic activity is coded using variables ECOACRF in 1984, ECONACRG in 1985, ECARH in 1986, ECACJ in 1987, ECARA in 1988, ECARB in 1989, ECAR in 1990 and 1991, INECACR in 1992 to 2004 and INECAC05 in 2005 to 2009. We recode the variables to create a new variable with six groups, namely (1) employee, (2) self-employed, (3) unemployed, (4) on training, not seeking work (inc students), (5) NEET/inactive (inc retired/housework/disabled) and (6) at school/under 16.

### **Training Incidence**

We draw information from a number of available variables to construct measures of on-the-job and off-the-job training and training incidence. It is a well known limitation of the LFS that it only records a training incidence should it occur in the four weeks period prior to the interview date. We use variables JOBTRAIN from 19984 to 1991 and JOBTRN from 1992 to 2009; FONCOR and JRTRF for 1984; EONCOR from 1985 to 1991; JRTRG for 1985; JRTRH for 1986; JRTRJ for 1987; JRTRA and JRTRB for years 1988 and 1989 respectively; JRTR for 1990 and 1991; TRSITE from 1992 to 2009 (in year 1997 we use variable FTEDYT which records whether the respondent has had any training or education before looking for gainful employment) and variable ED4WK from 1992 to 2009.