Career wage profiles and the minimum wage

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A model of on-the-job training in the presence of a minimum wage is presented. This predicts that, in most cases, the minimum wage will have a negative effect on a worker's subsequent wage growth when wages are determined by individual bargaining but no effect when wages are determined by collective bargaining. If the minimum wage is set especially high, it may actually have a positive effect on wage growth in both sectors. These predictions are then tested using data from the Annual Survey of Hours and Earnings in the United Kingdom. Workers who were affected by the minimum wage before age 22 are found to have significantly lower wage growth later in life than others, but only if they worked on jobs that were not covered by a collective labour agreement. Evidence suggests that this difference in wage growth reflects differences in productivity between workers. No evidence is found of an upward-sloping relationship between the minimum wage and subsequent wage growth.

1. Introduction

Although it has been extensively debated by economists, a growing consensus has formed that minimum wage laws have little effect on employment levels, even though they raise hourly wage rates (Brown 1999). This implies either that employers are able to recoup the costs associated with the minimum wage by economising on aspects of the total employment package other than the basic hourly wage or that the labour market is not perfectly competitive, so that employers can absorb the cost increase and still make excess profits. One way that employers might attempt to offset increases in the minimum wage is by adjusting the amount of on-the-job training offered to workers. In a seminal paper, Becker (1962) established that when the labour market is competitive, firms will only pay for training if it is specific to the firm. This implies that firms should cut back on general training whenever they are compelled to raise wages due to the minimum wage (Rosen 1972). More recent work has shown that the situation is more complex when there is not perfect competition in the labour market (Acemoglu and Pischke 1999) and that firms might actually *raise* general training for some workers when the minimum wage increases (Acemoglu and Pischke 2003).

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The nature of the relationship between the minimum wage and training has important implications for policy makers. The fact that on-the-job training has a large effect on subsequent wage growth and most training takes place during the early stages of workers' careers is often given as a justification for allowing young workers to be paid wages less than the adult minimum (Eyraud and Saget 2005). However, if Acemoglu and Pischke's model applies, such 'youth rates' or 'sub-minimum wages' may have the opposite effect to that intended and may hinder young workers' abilities to move up the wage distribution over their working lives.

Previous empirical research has not conclusively established whether the minimum wage affects either the prevalence of on-the-job training or the rate of wage growth later in a worker's career (which should change if training levels are adjusted). Some authors have reported a negative relationship, while others have found insignificant results. Acemoglu and Pischke's work points to the importance of the level of competitiveness in the labour market, but no previous study has examined the role that the nature of wage bargaining plays in the relationship between minimum wages and subsequent wage growth. In some jobs wages are negotiated at the individual level, while in others, wages are bargained collectively. This variation may occur even within industries. If Pareto efficient outcomes are more likely to occur when wages are bargained collectively, it is possible that workers might be able to mitigate any negative effects of the minimum wage in this case.

This paper examines whether the long-run effects of the minimum wage on wage growth vary according to the nature of wage bargaining. A simple model of on-the-job training is presented, which implies that the minimum wage should have different effects on a worker's subsequent rate of wage growth depending on whether the worker is employed in the individual bargaining or collective bargaining sector of the labour market. Highly accurate longitudinal data from the Annual Survey of Hours and Earnings in the United Kingdom are then used to test these predictions. A natural experiment approach is taken, which involves comparing the wage growth of otherwise identical workers who were affected by the youth minimum wage to different degrees because they entered the labour market at different times. As well as providing the first evidence of how the effects of the minimum wage on wage growth vary by wage bargaining system, the paper provides evidence on the efficacy of youth rates in raising the wages of low-wage workers over their entire working lives.

2. Background

Early empirical studies of the training effects of the minimum wage used workers' wage growth rates as a proxy for their level of on-the-job training. These studies found a negative relationship between the minimum wage and wage growth (Leighton and Mincer 1981; Lazear and Miller 1981; Hashimoto 1982). Grossberg and Sicilian (1999) noted that there are three main problems with using wage growth as a proxy for training: wage growth depends on the fraction of job-specific training that takes place and the relative bargaining power of firms and workers; other theories of pay structure (such as Lazear's (1979) delayed compensation model) imply wage changes that are independent of productivity; and using wage changes across all workers fails to account for the fact that most training occurs early in a worker's career. As a consequence of these problems, more recent studies have used direct measures of training participation. Some of these found negative effects (Schiller 1994; Neumark and Wascher 2001), whereas others found an insignificant relationship (Simpson 1984; Grossberg and Sicilian 1999; Acemoglu and Pischke 2003; Arulampalam *et al*. 2004; Fairris and Pedace 2004).

Although the use of direct information on training avoids the issues noted by Grossberg and Sicilian, it suffers from a number of other problems. Firstly, the available training data are almost always poor measures of the breadth and extent of actual activities that raise a worker's future productivity. Secondly, the benefits of some training might be very small or might be primarily received by firms, meaning that they have little direct effect on a worker's welfare. Finally, a narrow focus on training is unable to provide evidence to policymakers of how much the introduction of a youth minimum wage rate might raise young workers' incomes over their entire careers.

For these reasons, this paper revisits the link between minimum wages and subsequent wage growth, using modern panel data and a natural experiment design to address Grossberg and Sicilian's concerns. Two recent papers have examined how a person's exposure to the minimum wage while young affects his/her subsequent wage outcomes. However, neither of these takes into account the extent to which the minimum wage affects a specific young worker's wage (and potentially level of training). Neumark and Nizalova (2007) only observe mature workers and determine what minimum wage they were likely to have faced in the past, based on their age and current state of residence. Cardoso (2009) used longitudinal data over a long period,

but assigned a minimum wage based only on the year workers were born and when they entered the labour market, not on whether they were actually bound by the minimum wage during their youths. Neumark and Nizalova found evidence of a negative long-term effect of the minimum wage on wages, whereas Cardoso found evidence of a positive effect on wages but also a negative effect on the wage-tenure profile.

Furthermore, unlike other studies that have looked at wage growth, the focus here is on the *difference* in wage growth between minimum wage workers in two sectors of the economy – jobs with individual wage bargaining and jobs with collective bargaining. The only related previous study was Acemoglu and Pischke (2003), who analysed how the effects of the minimum wage on training vary by level of labour market competitiveness, as measured by industry wage differentials. They found some weak evidence that training is positively related to the minimum wage among workers in less competitive sectors of the United States economy. However, Acemoglu and Pischke were restricted by their data source (the National Longitudinal Survey of Youth 1979) to focus on training undertaken between ages 22 and 29, which is likely to be too late to capture most of the general on-the-job training undertaken by minimum wage workers. These data also provided rather imprecise measures of a worker's hourly wage (and hence whether the worker was bound by the minimum wage), as they rely on retrospective survey responses.

3. The United Kingdom National Minimum Wage

A national minimum wage was introduced in the United Kingdom on 1 April 1999, covering all workers aged 18 and over. Initially, this consisted of an adult rate for those aged 22 and over, set at £3.60, and a development rate for those aged 18-21, set at £3.00. On 1 October 2004, a (lower) rate was introduced for workers aged 16-17. On 1 October 2010, the age limit for the adult rate was lowered to 21 and an apprentice rate was introduced, for apprentices aged 16-18 or those aged 19 and over and in their first year of their apprenticeship. The minimum wage rates are reviewed each year by the Low Pay Commission, an independent advisory body which makes recommendations to the Government. The Government has chosen to increase all of the rates each October since 2000, but by varying amounts each year. By October 2010, the adult rate was £5.93, the development rate was £4.92, the 16-17 rate was £3.64 and the apprentice rate was £2.50.

The minimum wage applies to all workers who have a contract to do work personally, rather than for a customer or client. Hence, it applies to casual workers, temporary workers and agency workers, but not to the self employed. For the purposes of the minimum wage, a worker's hourly wage is calculated by dividing his/her total gross pay for the reference period (normally a month) by total hours worked during that period. Incentive pay is included in this calculation, but not premium pay for shift or overtime work. All time spent doing on-the-job training (and time spent travelling to and from it) is subject to the minimum wage.

4. Theory

Consider a model in which each worker, indexed by *i*, is assumed to work in the labour market for $T+1$ periods. A worker's marginal revenue product is assumed to consist of a fixed component μ, which captures differences in productivity between workers, and a time-varying component γ, which captures the fact that productivity initially increases over the life cycle, before falling. Workers are able to engage in on-the-job training; however, the decision of whether to provide this is made by the firm. Training is assumed to take place during the initial period of employment only and to produce human capital gains for the following *T* periods. The cost of training manifests itself as a fall of θ in marginal revenue product in the first period, where $\theta \in [0, \theta_{\max}]$. The benefits of training are a rise of $f_t(\theta)$ in marginal revenue product in periods 1 to *T*. To ease exposition, the following functional form is used:

$$f_t(\theta_i) = \beta_t \theta_i, \text{ where } \beta_{t+1} > \beta_t \text{ and } \Delta\beta_{t+1} < \Delta\beta_t, \ \forall t. \quad (1)$$

Equation 1 is consistent with a setting in which the benefits from training (in terms of increases in marginal revenue product) are realised over multiple periods, but that the largest gains come first and that eventually the growth rate in marginal revenue product falls to that of untrained workers.

All training is assumed to be general in nature and, hence, perfectly transferable to other jobs. There is an exogenous job separation rate (among jobs with the same wage) of *p* and a discount rate of *r*. It will be assumed that the marginal cost of training will be outweighed by the expected marginal benefits of training after $\hat{t}$ post-training periods (where $\hat{t} < T$):

$$\sum_{t=1}^{\hat{t}} \frac{(1-p)^t \beta_t}{(1+r)^t} > 1. \quad (2)$$

Assume that the labour market is imperfectly competitive, so that there is a surplus equal to ϕ per worker each period.[1] It is assumed that there are two sectors in the labour market: a sector with individual bargaining and a sector with collective bargaining and that workers can freely move between sectors. The situation in each sector is discussed in turn.

Individual bargaining

If workers bargain individually, they will be unable to obtain any of the surplus. Therefore, a worker's wage in any period is given by:

$$w_{it} = \begin{cases} \mu_i + \gamma_t - \theta_i & \text{if } t = 0 \\ \mu_i + \gamma_t + \beta_t \theta_i & \text{if } t = 1,...,T \end{cases}. \quad (3)$$

Suppose initially that there is no minimum wage. The level of training has no effect on a firm's profits, but the firm can maximise their workers' utility by choosing the optimal level of training:

$$\max_{\theta_i} -\theta_i + \sum_{t=1}^{T} \frac{(1-p)^t \beta_t \theta_i}{(1+r)^t}. \quad (4)$$

Given the assumption made about training costs in equation 2, it must be the case that all firms choose the maximum amount of training available, $\theta_{\max}$, which is the same for all workers.[2] From equation 3, the wage in the initial period is $w_{i0}^* = \mu_i + \gamma_0 - \theta_{\max}$.

Suppose now that a minimum wage $\overline{w}$ is introduced. The firm's profit maximisation problem can be written as follows:

$$\max_{\theta_i} \mu_i + \gamma_0 + \phi - \theta_i - w_{i0} + \sum_{t=1}^{T} \frac{(1-p)^t (\mu_i + \gamma_t + \phi + \beta_t \theta_i - w_{it})}{(1+r)^t}, \text{ subject to}$$

$$w_{i0} = \max\{\mu_i + \gamma_0 - \theta_i, \overline{w}\} \text{ and } w_{it} = \max\{\mu_i + \gamma_t + \beta_t \theta_i, \overline{w}\}, \ \forall t = 1,...,T. \quad (5)$$

Obviously, if the minimum wage is set below w_{i0}^*, it will have no effect on the amount of training taking place. However, if $\overline{w} > \mu_i + \gamma_0 - \theta_{\max}$, the minimum wage will prevent the optimal level of training from taking place, because the firm's profits

[1] The presence of a surplus implies that the firm operates in an imperfectly competitive product market and implicitly assumes that the workers and firms are bargaining over points on a vertical contract curve.

[2] This contrasts with Acemoglu and Pischke's (2003) model, which assumed that no training takes place in the absence of a minimum wage.

will fall in this case. Because both γ and β increase over time, as the minimum wage rises, it will bind first in period 0, then in period 1 and so on. If it binds only in period 0, the optimal level of training will be:

$$\bar{\theta}_i = \mu_i + \gamma_0 - \overline{w} = \theta_{\max} - \overline{w} + w_{i0}^*. \tag{6}$$

Equation 6 represents a case of perfect crowding out between the minimum wage and the amount of training, as would occur in a perfectly competitive labour market. As Becker (2009) explains, firms "provide general training only if they [do] not have to pay any of the costs".

Note that the following relationship holds between a worker's wage and his/her level of training in the constrained and unconstrained states:

$$\begin{aligned} \overline{w} - w_{i0}^* &= \overline{w} - (\mu_i + \gamma_0 - \theta_{\max}) \\ &= \theta_{\max} - \bar{\theta}_i. \end{aligned} \tag{7}$$

There is a negative relationship between training and the minimum wage. Once the minimum wage rises so high that training is cut to zero, the firm will retain the worker as long as it still makes excess profits from doing so. Further minimum wage increases will have no effect on training, until the minimum wage binds in period $\hat{t}$. When this happens, the firm will find it profitable to increase training up to the point where the worker's post-training wage is just equal to the minimum wage, namely:

$$\bar{\theta}_i = \frac{\overline{w} - \mu_i - \gamma_{\hat{t}}}{\beta_{\hat{t}}} = \frac{\overline{w} - w_{i0}^* + \gamma_0 - \gamma_{\hat{t}} - \theta_{\max}}{\beta_{\hat{t}}}. \tag{8}$$

As in Acemoglu and Pischke (2003), the level of training is now positively related to the minimum wage, because by increasing training, firms can raise productivity in the following period, knowing that they can continue to pay the minimum wage regardless.

Therefore, a complete description of the firm's decision is that it will provide the following amount of training:

$$\bar{\theta}_i = \begin{cases} \theta_{\max} & \text{if } \overline{w} \le w_{i0}^* \\ \theta_{\max} - \overline{w} + w_{i0}^* & \text{if } w_{i0}^* < \overline{w} \le \mu_i + \gamma_0 \\ 0 & \text{if } \mu_i + \gamma_0 < \overline{w} \le \mu_i + \gamma_{\hat{t}} \\ \dfrac{\overline{w} - w_{i0}^* + \gamma_0 - \gamma_{\hat{t}} - \theta_{\max}}{\beta_{\hat{t}}} & \text{if } \mu_i + \gamma_{\hat{t}} < \overline{w} \le \mu_i + \gamma_{\hat{t}} + \beta_{\hat{t}}\theta_{\max} \\ \theta_{\max} & \text{if } \mu_i + \gamma_{\hat{t}} + \beta_{\hat{t}}\theta_{\max} < \overline{w} \end{cases}, \tag{9}$$

provided that it makes non-negative expected profits from doing so, that is:

$$\mu_i + \gamma_0 + \phi - \bar{\theta}_i - w_{i0} + \sum_{t=1}^{T} \frac{(1-p)^t (\mu_i + \gamma_t + \phi + \beta_t \bar{\theta}_i - w_{it})}{(1+r)^t} \geq 0 . \quad (10)$$

Note that when $\phi = 0$, equation 10 reduces to the profit constraint for the competitive sector: $\mu_i + \gamma_0 - \theta_i \geq \bar{w}$.

Collective bargaining

Suppose now that workers bargain collectively and obtain a share, π, of the total surplus. Hence, their wage schedule will be:

$$w_{it} = \begin{cases} \mu_i + \gamma_t + \pi\phi - \theta_i & \text{if } t = 0 \\ \mu_i + \gamma_t + \pi\phi + \beta_t \theta_i & \text{if } t = 1,...,T \end{cases} . \quad (11)$$

Since the firm still earns the same rent each period, regardless of the level of training, in the absence of a minimum wage, the optimal level of training will be the same as under individual bargaining (that is, $\theta_{\max}$). However, now if a minimum wage is imposed, the situations diverge. If the firm acts unilaterally in response to the minimum wage, the optimal level of training will be the same as in equation 9, except that now $w_{i0}^* = \mu_i + \gamma_0 + \pi\phi - \theta_{\max}$. This outcome is Pareto inefficient, because by reducing future wages but increasing training, firms can increase workers' lifetime income without affecting profits. When workers bargain collectively with firms, it is reasonable to think that they will be able to achieve the Pareto efficient outcome.

Specifically, if workers' wages are reduced by some amount α in every future period, they can be increased by $\alpha \sum_{t=1}^{T} (\frac{1-p}{1+r})^t$ in period 0 to leave firms' expected profits unchanged. Workers will wish to keep substituting future wages to keep training at the unconstrained optimum ($\theta_{\max}$) until $\alpha = \pi\phi$. At this point, future wages will be equal to those in the individual bargaining sector. The firm will not be willing to swap future wages for training any further, because they know workers will switch to the individual bargaining sector immediately after period 0. Hence, the optimal training is given by:

$$\bar{\theta}_i = \begin{cases} \theta_{\max} & \text{if } \bar{w} \le w_{i0}^* + \psi \\ \theta_{\max} - \bar{w} + w_{i0}^* + \psi & \text{if } w_{i0}^* + \psi < \bar{w} \le \mu_i + \gamma_0 + \pi\phi + \psi \\ 0 & \text{if } \mu_i + \gamma_0 + \pi\phi + \psi < \bar{w} \le \mu_i + \gamma_{\hat{t}} \\ \dfrac{\bar{w} - w_{i0}^* + \gamma_0 - \gamma_{\hat{t}} - \theta_{\max}}{\beta_{\hat{t}}} & \text{if } \mu_i + \gamma_{\hat{t}} < \bar{w} \le \mu_i + \gamma_{\hat{t}} + \beta_{\hat{t}}\theta_{\max} \\ \theta_{\max} & \text{if } \mu_i + \gamma_{\hat{t}} + \beta_{\hat{t}}\theta_{\max} < \bar{w} \end{cases}, \qquad (12)$$

where $\psi \equiv \pi\phi \sum_{t=1}^{T} (\frac{1-p}{1+r})^t$, provided that the firm makes non-negative expected profits from doing so, that is:

$$\mu_i + \gamma_0 + (1-\pi)\phi - \bar{\theta}_i - w_{i0} + \sum_{t=1}^{T} \frac{(1-p)^t (\mu_i + \gamma_t + (1-\pi)\phi + \beta_t \bar{\theta}_i - w_{it})}{(1+r)^t} \ge 0. \qquad (13)$$

By swapping future wages for period 0 training, the workers are able to completely offset the detrimental effects of the minimum wage on training, at least up to the point where the 'wage gap' in period 0 ($\bar{w} - w_{i0}^*$) is equal to ψ. Obviously, the larger the amount of total surplus or the larger the fraction of the surplus that goes to workers, the more likely workers are to be able to negotiate to keep training at $\theta_{\max}$.

It is reasonable to think that this type of behaviour will only occur when workers bargain collectively for two reasons. Firstly, workers are unlikely to obtain any of the surplus when they bargaining individually, so that $\pi = 0$, as assumed in this section. Secondly, collective wage agreements specify the wages received by workers at each level of job tenure. Hence, firms will not only receive the same expected profit for each *worker*, but their *overall* profit will remain unchanged in each period, assuming they employ a representative sample of workers with different tenures, because the increases in training costs among young workers will be offset by wage savings among more senior workers.

Equilibrium wage growth

The change in a worker's wage between any two post-training periods is given by the following (assuming the worker does not change sectors):

$$w_{i(t+1)} - w_{it} = (\beta_{t+1} - \beta_t)\bar{\theta}_i + \gamma_{t+1} - \gamma_t. \qquad (14)$$

In the individual bargaining sector, the optimal level of training is given by equation 9, therefore a worker's period 0 wage gap should have a U-shaped effect on his/her subsequent wage growth. In the collective bargaining sector, the optimal

training level is given by equation 12 and the downward-sloping segment of relationship will be deferred so that the period 0 wage gap has no effect on wage growth, up to some point. The relationship between wage growth and the wage gap in each sector is depicted in Figure 1. If the minimum wage is set at a low level (so that the wage gap is less than ψ), it will have different effects on wage growth in each sector. However, if the minimum wage is set at progressively higher levels, wage growth in both sectors will fall to zero, but eventually may rise again in both sectors (the 'Acemoglu and Pischke effect').

5. Data

The analysis draws on data from the Annual Survey of Hours and Earnings (ASHE), which is an annual survey that collects data on the wages, work hours and other employment arrangements of around 1% of the UK working population (Office for National Statistics 2013). Basic additional information, such as age and sex, is also included. The ASHE was introduced in 2004 and replaced the New Earnings Survey (NES). However, by applying ASHE methodologies to NES data for the 1997-2003 period, the Office for National Statistics has produced ASHE datasets for 1997 onwards. The analysis in this study uses data for 1997-2011.

The ASHE sample is drawn from HM Revenue and Customs' Pay As You Earn (PAYE) register, based on the last two digits of a worker's National Insurance Number. Survey forms are sent to all employers of the selected workers to complete. The questions in the ASHE refer to a reference week, which is in early April of each year. Since the responses are provided by employers rather than by employees, the ASHE wage and hours data are considered to be highly accurate, compared to traditional household surveys and censuses.

If a person does not work in a given year, he/she will not appear in the dataset. Therefore, the only way to determine whether someone has moved out of employment is by their absence from the data in a given year. Obviously, this will also include people who have moved abroad or died. However, as long as the fraction of people making these transitions is constant across the wage distribution, this will not bias the results from the empirical strategy outlined in the next section. Workers might also be absent from the ASHE if an employer fails to respond to the questionnaire or if they are not included in the PAYE register because their earnings fall below the National Insurance Lower Earnings Limit.

The sample is restricted to those who were aged between 22 and 31, had full-time jobs and who were employed in the following year. In cases where a person reported more than one full-time job in a year, only the job on which he/she worked the most hours is included. The period during which people are subject to the 16-17 year-old rate or the development rate for ages 18-21 (or 18-20 since 2010) is assumed to be the phase of a worker's career in which on-the-job training takes place (period $t = 0$ in the model of the previous section).[3] Therefore, the sample is further restricted to those who had a full-time job at some point between 16 and 21 and who were not bound by the minimum wage when they first entered the labour market. The latter restriction ensures that there is no downward bias in the estimated effect of the minimum wage on subsequent wage growth, since workers who are initially hired at the minimum wage may already be receiving less training than they would in the absence of a minimum wage.

The empirical analysis follows the approach used by Linneman (1982) and Currie and Fallick (1996), which involves the construction of a treatment variable measuring how much extra an employer must pay to retain a current employee after a minimum wage increase. The treatment variable, $WAGEGAP_i$, measures the cumulative effect of all minimum wage increases between 16 and 21 on person *i*. It is defined as follows, where AGE_{it} is the person's age in year t, w_{it} is his/her current hourly wage (in 2012 pounds, adjusted using the RPI) and $\overline{w}_{i(t+1)}$ is the relevant minimum wage in the following year (taking into account the worker's age):

$$WAGEGAP_i = \sum_{16 \le AGE_{it} \le 21} \max\{\overline{w}_{i(t+1)} - w_{it}, 0\}. \qquad (15)$$

About 13% of the workers in the sample (accounting for 11% of the observations) were bound by the minimum wage sometime between ages 16 and 21. Means for the main variables used in the analysis are given in Table 1, separately for those workers who were bound by the minimum wage before age 22 and those who were not. Compared to the unbound workers, the bound workers earn less, are more likely to be male and are less likely to have job with a collective agreement. Among bound workers, average annual wage growth was 34 pence, whereas among the unbound workers, it was 46 pence.

[3] During the sample period, young people were allowed to leave school during the school year in which they turned 16.

To examine the effect of collective bargaining, the analysis draws on a question in the ASHE which asks whether a worker's pay was "set with reference to an agreement affecting more than one employee", for example, agreements with trade unions or workers' committees. A second wage gap variable was calculated, taking into account only those cases in which a worker was covered by a collective agreement between ages 16-21, as follows:

$$COLAGWAGEGAP_i = \sum_{16 \le AGE_{it} \le 21} COLAG_{it} \times \max\{\overline{w}_{i(t+1)} - w_{it}, 0\}, \quad (16)$$

where *COLAG* is a dummy for whether a worker was covered by a collective agreement in a given year.

Figure 2 plots average real wages between ages 16 and 31, according to whether or not a person was bound by the minimum wage before age 22 and whether or not they had spent most time on collective agreement jobs before age 22. Overall, wages increase steadily with age. The unbound group has very similar wages at each age level, regardless of whether workers had collective agreement jobs or not. The bound group has lower wages than the unbound group and has similar wages before age 22, regardless of collective agreement status. However, among the bound workers, those who had collective agreements before 22 experienced much faster wage growth between 22 and 31, whereas the non-collective agreement group fell further below the unbound group. The next section examines whether this difference in wage growth persists, once the effects of other possible determinants are controlled for.

6. Analysis

The empirical strategy is to compare the wage growth rates of otherwise identical workers who have different values of *WAGEGAP* because they entered the labour market at different points in time and hence were subject to different values of the minimum wage during their youth. The wage gap will vary for a number of reasons: the overall introduction of the national minimum wage in 1999, the introduction of the 16-17 and apprentice rates, the lowering of the age of eligibility for the adult rate and the annual increases in all rates by different amounts.

To begin with, the following basic specification is used:

$$\Delta w_{i(t+1)} = \alpha_0 + \alpha_1 WAGEGAP_i + \alpha_2 w_i + \alpha_3 AGE_{it} + \mathbf{X}_{it}\boldsymbol{\gamma} + \lambda_t + u_{it}. \quad (17)$$

where w_i is a person's real wage during his/her first year in full-time work (between ages 16 and 21) and controls for differences in wage growth that are due to differences in inherent productivity across people. Hence, the specification compares workers who initially earn the same wage, but who enter the labour market in different years and therefore experience different wage growth before 21 due to changes in the minimum wage. *AGE* is included as a proxy for the γ terms in equation 15. **X** is a vector of control variables, comprising a person's wage gap in year *t* (that is, $\max\{\overline{w}_{i(t+1)} - w_{it}, 0\}$) and dummy variables for whether the person is male and whether the wage on his/her job is set by a collective agreement. The contemporaneous wage gap controls for the possibility that workers' wages will grow because they continue to be bound by the minimum wage after age 21. The collective agreement dummy controls for the possibility that wage growth may be lower in cases where unions act to compress the wage distributions (Freeman and Medoff 1984). λ is a year fixed effect and *u* is an error term. All standard errors are clustered by person.

The first column of Table 2 presents the results of estimating equation 17 using the ASHE sample. The youth wage gap (*WAGEGAP*) has an insignificant coefficient, but the initial real wage has a significant positive effect. Among the control variables, the contemporaneous wage gap has a coefficient that is significantly larger than the value of 1 predicted, men and those on non-collective agreement jobs are found to have significantly greater wage growth than others and wage growth is found to decline with age.

Although *WAGEGAP* has no overall effect on wage growth, the theory in Section 2 predicts that it should only have an unambiguously negative effect on wage growth among workers who were covered by collective agreements. In order to allow the coefficient on *WAGEGAP* in equation 17 to vary according to whether a person worked in, *COLAGWAGEGAP* was added as a regressor:

$$\Delta w_{i(t+1)} = \delta_0 + \delta_1 WAGEGAP_i + \delta_2 COLAGWAGEGAP_i + \delta_3 w_i + \delta_4 AGE_{it} + \mathbf{X}_{it}\boldsymbol{\varphi} + \mu_t + v_{it}. \quad (18)$$

A significant estimate of δ_2 in equation 18 indicates a difference in the relationship between wage growth and the wage gap in the collective and non-collective agreement groups. As seen in the third column of Table 2, the overall wage gap has a significant negative coefficient, indicating that the minimum wage has a

negative effect on wage growth among those workers who were not covered by a collective agreement. The value of this indicates that a wage increase of £1 between the ages of 16 and 21 brought about by the minimum wage will result in a 9 pence decrease in annual wage growth after 21.[4] However, consistent with theory, the effect of the wage gap is significantly different for those workers who were covered by a collective agreement before 22 and the overall effect of the wage gap is insignificant for these workers.

The assumption of decreasing returns to training (implied by the shape of β in the model) means that the effect of the wage gap should fall as a worker ages. To examine this, the regression was run separately for workers aged 22-26 and 27-31 (see columns three and four in Table 2). As predicted, the coefficients on *WAGEGAP* and *COLAGWAGEGAP* were much stronger among the younger group. A binding £1 increase in the minimum wage between 16 and 21 is found to yield a 13 pence decrease in annual wage growth between 22 and 26, but no effect on wage growth between 27 and 31.

Overall, the results suggest that the existence of the development rate has significantly raised wage growth among low-wage workers. Compared to a scenario in which the adult minimum wage applied to all workers aged 18 and over, the average worker who was bound by the development rate experienced 8.2 pence (or 32% at the mean) higher per annum wage growth between ages 22 and 31. However, among those with non-collective agreement jobs only, the effect is 17.0 pence (or 67% at the mean).

Robustness checks

The model presented in Section 4 implies that when the wage gap is high enough, wage growth for the collective bargaining sector should fall to zero and that eventually wage growth might even rise again, in both sectors. To examine whether equation 18 obscures a U-shaped relationship, the coefficients on the wage gap measures are allowed to vary by quartile of *WAGEGAP*. As seen in the first column of Table 3, there is no evidence of an upward-sloping portion of the wage growth-wage gap relationship. The wage gap has a monotonic negative effect on wage growth in

[4] Taking into account equations 8 and 14, this result implies that every pound of training before age 21 yields benefits that grow by 9 pence a year between ages 22 and 31 on average.

non-collective agreement jobs, while the coefficients for the collective agreement group fluctuate from quartile to quartile.

Since collective agreements are likely to occur only in industries where there are excess profits, it is possible that the collective agreement effect that has been discussed so far simply reflects differences in the level of labour market competitiveness that are unrelated to the presence of collective bargaining. Under Acemoglu and Pischke's (2003) model, wage growth should rise in response to the minimum wage in imperfectly competitive labour markets because firms are able to increase marginal revenue product by training workers. To examine whether this explanation holds here, dummy variables were added to equation 18 for the five-digit industry of each person's first full-time job.[5] This is found to have little effect on the results (as reported in the second column of Table 3). Even within narrowly-defined industrial groups, having a non-collective agreement job results in significantly lower wage growth later in a worker's career, compared to workers on collective agreement jobs with the same wage gap.

In addition, collective agreement and non-collective agreement jobs are not randomly distributed. As a consequence, it is possible that the significant difference between the estimates of δ_1 and δ_2 in equation 18 simply reflects the fact that collective agreement jobs tend to be in those occupations which provide more general training anyway. To control for this, dummies for a person's four-digit occupation at the time he/she entered the labour market are added to the regression. Occupation data are only available from 2002, so the sample is restricted to those who entered the labour market after this point. As seen in the third column of Table 3, this has little effect on the coefficients and the results are stronger than in Table 2.

Grossberg and Sicilian (1999) and Neumark and Wascher (2001) pointed out that the minimum wage might flatten the age-earnings profile not because of any change in training levels but because firms may be forced to abandon the use of delayed compensation schemes. To examine whether this is responsible for the pattern observed among non-collective agreement jobs, *WAGEGAP* and *COLAGWAGEGAP* are interacted with a worker's current collective agreement job status and added to the regression (as well as the initial occupation dummies). If the reduction in wage growth is driven by reductions in individual productivity, it should not matter whether

[5] The UK Standard Industrial Classification of economic activities 2003 was used.

a worker changes sector after age 21 (at which age it is assumed all general training has been acquired). However, if firms in the individual bargaining sector choose to flatten the age-earnings profile in response to increases in the minimum wage, workers should only experience reductions in wage growth while they remain in that sector. The results (reported in the fourth column of Table 3) indicate that the wage gap coefficients do not vary significantly when a worker changes sector, thus suggesting that a worker is permanently affected by exposure to the minimum wage when young, which is inconsistent with a situation in which certain firms alter their pay policies in response to changes in the minimum wage.

In the results presented so far, all work done before age 22 is included in the calculation of the wage gap measures and all workers who commenced full-time work before this age are included in the sample. Some of these workers will have attained tertiary qualifications and therefore will constitute a poor control group for the minimum wage workers of interest in this study.[6] To examine how robust the results are to this decision, lower age cut-offs were used. Table 4 reveals that the coefficients on *WAGEGAP* and *COLAGWAGEGAP* remain significant when 19 and 20 are used as cut-off ages, although not when 21 is used.

Mechanisms

Although the ASHE data do not include a measure of training, it is possible to examine whether the negative relationship that has been uncovered between wage growth and the wage gap in the collective agreement group reflects reductions in levels of human capital. Table 5 decomposes the overall results for wage growth into the effects the wage gap has on the individual components of wage growth, namely growth in base pay, incentive pay (which includes bonuses, incentive pay, piecework and commission), shift and premium pay and overtime pay (the residual 'other pay' component is excluded).[7] All are expressed as per hour rates. Although the coefficients on *WAGEGAP* and *COLAGWAGEGAP* have the same sign in each regression, most of the results are insignificant. However, *WAGEGAP* has a significant negative effect on growth in incentive pay. Since this is the component of pay that is most closely tied to a worker's productivity, this result further reinforces

[6] No information on education is available in the ASHE.

[7] Since incentive pay and shift pay were only provided in the ASHE dataset from 2000, observations for this year onwards were used in these regressions.

the notion that increases in the minimum wage reduce productivity in the individual bargaining sector.

In Table 6, additional dependent variables are used in place of wage growth in equation 18. In the first column, the dependent variable is a dummy variable for whether a worker stayed at the same firm in the following year. The wage gap is found to have a significant negative effect on the likelihood of remaining at the same firm for workers who were not covered by a collective agreement as youths, but an insignificant effect for workers who were covered by a collective agreement. Similar results are found when the likelihood of remaining on the same job is considered (as shown in the second column of Table 6). Once again, these results are consistent with non-collective agreement workers experiencing reductions in human capital when the minimum wage rises. Being bound by the minimum wage as a youth is also found to have a negative effect on the likelihood of switching from a non-managerial to a managerial role (reported in the third column).[8] However, this is not found to differ by whether a person was covered a collective agreement as a youth or not.

7. Conclusion

This paper has examined whether the minimum wage leads to lower wage growth later in a worker's career and how this differs according to the nature of wage bargaining on a job. A simple model of training and profit maximisation yields two main predictions. Firstly, being paid the minimum wage when young should lead to lower wage growth thereafter for those who work in sectors of the labour market with individual wage bargaining, but that the minimum wage should have no effect on wage growth for those whose wages are determined by collective bargaining, at least up to a point. Secondly, if the minimum wage is set at a particularly high level, it may actually have a positive effect on training in all sectors of the labour market. Data from the Annual Survey of Hours and Earnings in the UK find support for the first prediction, but not the second. Workers who received large wage gains due to the minimum wage before the age of 22 experience lower wage growth between the ages of 22 and 31. However, this effect is only found for those who were not covered by a collective agreement before 22; the relationship is insignificant for those who were

[8] This regression was restricted to only those workers who were initially not in jobs that involved managerial responsibilities. Data on managerial responsibilities are only available for 2003-2011.

covered by a collective agreement. There is no evidence that the minimum wage has a positive effect on wage growth at any level. Overall, the results provide evidence in favour of having a lower rate of the minimum wage for those aged under 22, but that this only benefits those who have collective pay agreements.

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Figure 1

Predicted relationship between wage growth and wage gap in period 0

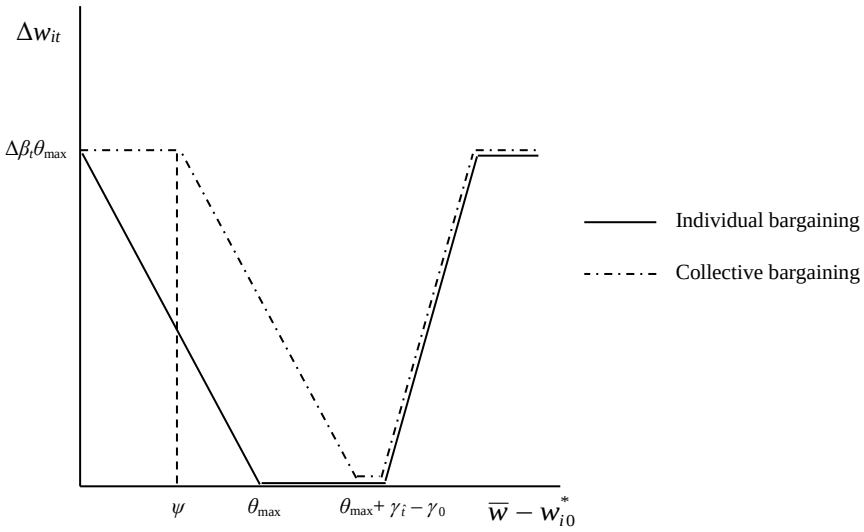
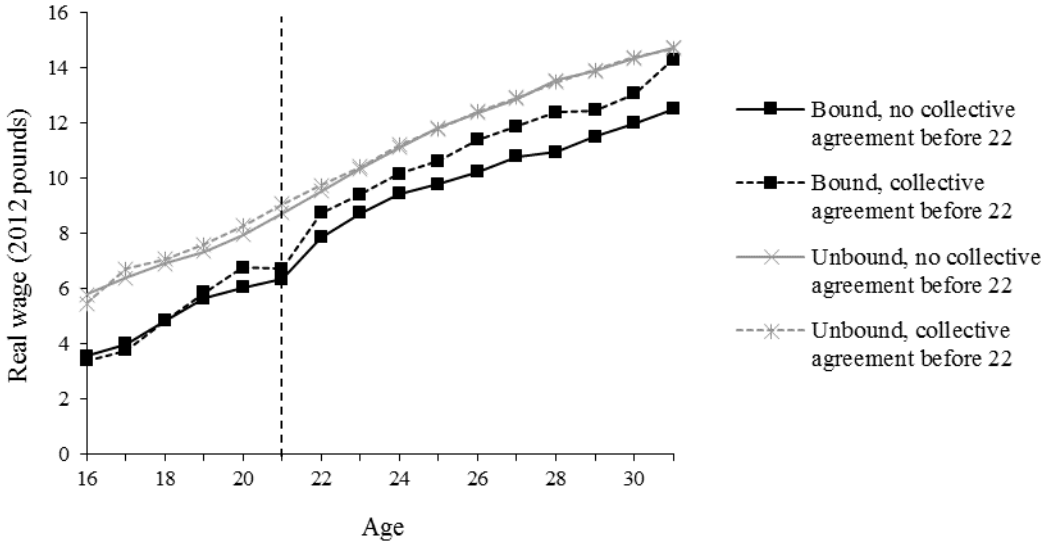


Figure 2

Mean wages for unbound and bound workers, by collective agreement status



Notes: Bound workers are those workers who had a positive wage gap value for any year between ages 16 and 21.
The collective agreement group refers to those workers with more periods on jobs with a collective agreement between ages 16 and 21 than on jobs without a collective agreement.
ASHE survey weights are used.

Table 1
Descriptive statistics for the estimation sample

Variable	All workers	Bound workers	Unbound workers
Change in wage	0.444	0.329	0.456
Youth wage gap	0.078	0.876	0
Contemporaneous wage gap	0.014	0.036	0.011
Real wage	12.025	9.984	12.223
Collective agreement	0.463	0.406	0.468
Male	0.577	0.630	0.572
Age	25.459	25.120	25.493
Sample size	64,346	5,548	58,798

Notes: ASHE survey weights are used.

Table 2
Results for wage growth regressions

Variable	All observations		Aged 22-26	Aged 27-31
	(i)	(ii)	(iii)	(iii)
Youth wage gap	–0.053	–0.109*	–0.153**	0.047
	(0.036)	(0.058)	(0.075)	(0.052)
Youth wage gap on collective agreement jobs	–	0.117*	0.170**	–0.076
		(0.065)	(0.080)	(0.077)
Initial real wage	0.022*	0.022*	0.039**	–0.018
	(0.011)	(0.011)	(0.017)	(0.036)
Contemporaneous wage gap	1.808***	1.810***	1.683***	2.277***
	(0.090)	(0.090)	(0.092)	(0.257)
Male	0.108***	0.108***	0.140***	0.049
	(0.020)	(0.020)	(0.029)	(0.063)
Age	–0.029***	–0.029***	–0.039***	–0.012
	(0.006)	(0.006)	(0.010)	(0.027)
Collective agreement	–0.060***	–0.061***	–0.109***	0.036
	(0.023)	(0.023)	(0.038)	(0.081)
R-squared	0.013	0.013	0.019	0.008
Sample size	64,346	64,346	43,376	20,970

Notes: All regressions include a full set of region (12 categories) and year (13 categories) dummies. Standard errors are clustered by person and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 3
Additional results for wage growth regressions

Variable	(i)	(ii)	(iii)	(iv)
Youth wage gap quartile 1	–0.061	–	–	–
	(0.056)			
Youth wage gap quartile 2	–0.059	–	–	–
	(0.057)			
Youth wage gap quartile 3	–0.065	–	–	–
	(0.066)			
Youth wage gap quartile 4	–0.207***	–	–	–
	(0.098)			
Youth wage gap on collective agreement jobs quartile 1	0.023	–	–	–
	(0.099)			
Youth wage gap on collective agreement jobs quartile 2	–0.077	–	–	–
	(0.085)			
Youth wage gap on collective agreement jobs quartile 3	0.167*	–	–	–
	(0.096)			
Youth wage gap on collective agreement jobs quartile 4	0.153	–	–	–
	(0.120)			
Youth wage gap	–	–0.104*	–0.118***	–0.154**
		(0.057)	(0.045)	(0.069)
Youth wage gap on collective agreement jobs	–	0.118*	0.202***	0.232**
		(0.063)	(0.065)	(0.103)
Youth wage gap × collective agreement	–	–	–	0.082
				(0.088)
Youth wage gap on collective agreement jobs × collective agreement	–	–	–	–0.069
				(0.133)
Initial real wage	0.022*	0.015	–0.004	–0.004
	(0.012)	(0.011)	(0.008)	(0.008)
Contemporaneous wage gap	1.810***	1.847***	1.615***	1.647***
	(0.090)	(0.090)	(0.158)	(0.158)
Male	0.107***	0.176***	0.080**	0.081**
	(0.020)	(0.023)	(0.039)	(0.039)
Age	–0.030***	–0.031***	–0.021**	–0.021**
	(0.006)	(0.006)	(0.010)	(0.010)
Collective agreement	–0.061***	–0.047*	–0.034	–0.037
	(0.023)	(0.028)	(0.035)	(0.036)
Initial industry dummies	No	Yes	No	No
Initial occupation dummies	No	No	Yes	Yes
R-squared	0.013	0.018	0.060	0.060
Sample size	64,346	64,329	17,885	17,885

Notes: All regressions include a full set of region (12 categories) and year (13 categories) dummies. Standard errors are clustered by person and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 4
Results for wage regressions using different training age ranges

Variable	Training age range			
	16-18	16-19	16-20	16-21
Youth wage gap	–0.090*	–0.120**	–0.051	–0.109*
	(0.051)	(0.054)	(0.050)	(0.058)
Youth wage gap on collective agreement jobs	0.117*	0.121*	0.080	0.117*
	(0.063)	(0.063)	(0.056)	(0.065)
R-squared	0.039	0.009	0.011	0.013
Sample size	14,075	28,095	44,122	64,346

Notes: All regressions include initial real wage, contemporaneous wage gap, male, age, collective agreement and a full set of region (12 categories) and year (13 categories) dummies.
Standard errors are clustered by person and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 5
Results using components of wage growth

Variable	(i) Base pay	(ii) Incentive pay	(iii) Shift pay	(iii) Overtime pay
Youth wage gap	–0.032	–0.022***	–0.003	–0.051
	(0.029)	(0.008)	(0.005)	(0.044)
Youth wage gap on collective agreement jobs	0.011	0.023*	0.001	0.078
	(0.041)	(0.013)	(0.007)	(0.051)
Initial real wage	0.030***	–0.007***	–0.001	0.001
	(0.011)	(0.002)	(0.001)	(0.001)
Contemporaneous wage gap	1.724***	0.047*	0.024**	0.045***
	(0.095)	(0.026)	(0.011)	(0.017)
Male	0.078***	0.011	0.003	0.009*
	(0.018)	(0.009)	(0.003)	(0.005)
Age	–0.022***	0.000	–0.001*	–0.003***
	(0.006)	(0.002)	(0.001)	(0.001)
Collective agreement	–0.070***	0.007	–0.001	–0.001
	(0.020)	(0.010)	(0.003)	(0.007)
R-squared	0.012	0.001	0.001	0.001
Sample size	61,064	61,064	61,064	61,064

Notes: All regressions include a full set of region (12 categories) and year (13 categories) dummies. Standard errors are clustered by person and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 6
Results for job change regressions

Variable	(i) Remain with firm	(ii) Remain in job	(iii) Promoted to manager
Youth wage gap	–0.007	–0.006	–0.009**
	(0.006)	(0.006)	(0.004)
Youth wage gap on collective agreement jobs	0.016**	0.017**	–0.001
	(0.008)	(0.008)	(0.006)
R-squared	0.057	0.057	0.005
Sample size	67,513	67,515	31,035

Notes: All regressions include initial real wage, contemporaneous wage gap, male, age, collective agreement and a full set of region (12 categories) and year (13 categories) dummies.
Standard errors are clustered by person and are presented in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.