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# Efficiency Wages and the Economic Effects of the Minimum Wage: Evidence from a Low-Wage Labour Market\*

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## Abstract

This paper exploits a natural experiment provided by the 1999 introduction of the UK National Minimum Wage (NMW) to test for efficiency wage considerations in a low-wage sector, the UK residential care homes industry. The empirical results provide support to the wage-supervision trade-off prediction of the shirking model and suggest that the NMW may have operated as an efficiency wage in the care homes sector, leading to a reduction in supervision costs. These findings can explain earlier evidence suggesting that although the NMW introduction increased wages dramatically in the care homes sector, it generated only moderate negative employment effects.

JEL Classification: J31, J38, J41

Keywords: Efficiency Wages, National Minimum Wage, Wage-Supervision Trade-Off

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## I. Introduction

Efficiency wages theory has been used to explain downward wage rigidity at the microeconomic level (Weiss, 1991) and thus involuntary unemployment as well as labour market segmentation (Bulow and Summers, 1986) and wage differentials across firms or industries (Krueger and Summers, 1988).

The essence of the theory is that, provided that wages affect employees' productive behaviour or quality<sup>1</sup> and that certain restrictions prevent the use of optimal employment contracts such as 'bonding', the second-best solution for employers is to set compensation above the market clearing level in order to recruit, retain or motivate employees (Carmichael, 1985, 1990). Whether any restrictions in the implementation of first-best contracts, that open the door to efficiency wages, arise in practice is an empirical question (Dickens *et al.*, 1985).

Although, there is a vast number of empirical studies of efficiency wages, there are many who view the evidence as unpersuasive and inconclusive (Manning and Thomas, 1997; Autor, 2003). This is mainly due to the numerous identification problems that render the empirical testing of efficiency wages particularly challenging.<sup>2</sup>

Out of numerous empirical attempts to test some of the implications of efficiency wages models, the most credible studies to date are those that find ingenious ways to properly address the identification problem either by analysing samples of firms in sectors where there is limited concern of unobserved heterogeneity (Cappelli and Chauvin, 1991; Krueger, 1991), or by

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<sup>1</sup> Under asymmetric information higher relative wages decrease shirking (Shapiro and Stiglitz, 1984), reduce quits and turnover costs (Salop, 1979), improve the quality of potential employees (Weiss, 1980) and workers' association with the firm (Akerlof, 1982).

<sup>2</sup> Identification problems have received attention in empirical studies of efficiency wages based on observational data. In recent years there has been also evidence produced by laboratory experiments providing some support to efficiency wages and in particular to the 'gift-exchange' model (Fehr *et al.*, 1993; Fehr and Falk, 1999). However, the results of these experiments have been challenged by more recent evidence (Gneezy and List, 2006) that fail to provide support to the 'fair wage-effort' hypothesis (at least in the long-run) and by the criticism related to the extent that the behaviour of laboratory subjects can be a good indication of actual behaviour in labour markets.

exploiting natural experiments (Groschen and Krueger, 1990; Holzer *et al.*, 1991; Rebitzer, 1995). Most of these studies report evidence of a negative relationship between higher wages and alternative means of regulating employees' effort (supervision) which is consistent with a prediction of the shirking model of efficiency wages (Shapiro and Stiglitz, 1984). An important limitation of studies exploiting a quasi-experimental design is that because they exploit unusual features of a specific labour market their results cannot be generalised to other settings. Despite this limitation there are many who believe that this evidence is as 'goods as it gets' (Autor, 2003).

As Rebitzer (1995) puts it 'It is too early to know whether the theory of efficiency wages will survive rigorous empirical investigation. The difficult problems such investigations confront make it unlikely that any single study will settle the issue decisively. The empirical fate of efficiency wage theory will more likely be determined by evidence from a variety of different investigations-each having important limitations and qualifications.'

The purpose of this paper is to offer an empirical test of the shirking model by exploiting the link between efficiency wages and the minimum wage. Such link can be justified firstly by the theoretical argument that a binding minimum wage and other features of low-wage labour markets impose constraints in the implementation of first-best contracts and thus open the door to efficiency wages (Krueger, 1991; Georgiadis, 2006).

Another link is offered by the fact that efficiency wages models (Calvo and Wellisz, 1979; Manning, 1995; Rebitzer and Taylor, 1995) have been deployed to explain the striking evidence of a non-negative employment effect of the minimum wage, produced by several empirical studies since the early 1990s (Card and Krueger, 1994, 1995).

Moreover, according to the shirking model (Shapiro and Stiglitz, 1984), provided that unemployment is sufficiently high so that a worker that is caught shirking and being dismissed does not find another job at the same wage instantaneously, the minimum wage may operate as an efficiency wage by creating a wedge between the wage at the current job and alternative wage opportunities. Finally, the introduction of a minimum wage provides a quasi-experimental design that can be used to provide empirical tests of efficiency wages.

Our identification strategy is based on exploiting variation in wages generated by the 1999 introduction of the UK National Minimum Wage (NMW), to identify the relationship between wages and monitoring and thus test for the wage-supervision trade-off implication of the shirking model on a sector of very low-wage firms, the residential care homes sector.

The care homes sector seems ideal to test for efficiency wages considerations as previous research (Machin *et al.*, 2003; Machin and Wilson, 2004) on the effects of the NMW in the sector found that although the wage structure in the sector was heavily affected by the NMW there were only moderate negative employment effects. Machin *et al.* (2003) and Machin and Wilson (2004) also find no evidence of adjustments to the NMW increases that could explain the small negative employment effects of the NMW introduction in the care homes sector. However, a potential explanation of the latter evidence is provided by Draca, Machin and Van Reenen (2011) who look at the previously under-investigated topic of the effect of the minimum wages on firm profitability analysing data for all UK firms and for care homes in particular and find evidence that the NMW introduction reduced UK firm and care homes' profitability. In this paper, we investigate whether there were efficiency wages-type of adjustments that can reconcile with the earlier evidence of the effects of the UK NMW introduction in the care homes sector.

We find evidence that in care homes in which the NMW had a larger impact on the wage bill, monitoring, as measured by different ratios of supervisory to supervised staff, fell by more, compared to homes that were less affected by the NMW. We also find evidence that supervisors and supervised staff are substitutes in production which implies that labour demand adjustments to the NMW introduction cannot be consistent with a wage-supervision trade-off. Thus, our findings suggest that the higher wage costs generated by the NMW were partly offset by gains in monitoring costs and that the NMW may have operated as an efficiency wage in the care homes sector.

Overall, our paper contributes to the efficiency wages literature by adding a credible test of the shirking model to the few existing studies and by producing evidence in support of efficiency wages. Moreover, we also fill a gap of the minimum wage literature by providing an empirical investigation of efficiency wage models (Calvo and Wellisz, 1979; Manning, 1995; Rebitzer, 1995) developed to explain the evidence of a non-negative minimum wage employment elasticity, which has been missing (Card and Krueger, 1995; Zavodny, 1996). The absence of such a test is quite striking considering the appeal that Card and Krueger (1995) made more than ten years ago that ‘a rigorous evaluation of the alternative models must await additional research’.

The paper is structured as follows: the following section presents a simple model that explains why the minimum wage may operate as an efficiency wage. Section three discusses the main empirical problems that hinder empirical studies of the wage-supervision trade-off and presents our identification strategy and the fourth section discusses the data and offers some sample descriptive statistics. Section five provides a discussion of the employment structure and

the nature of shirking and monitoring problems in the care homes sector. Finally, section six presents and discusses the empirical results and section seven then concludes.

## II. A simple model

Consider a simple extension of the model developed by Rebitzer and Taylor (1995)<sup>3</sup> to provide a rationale of the empirical findings of a non-negative minimum wage employment elasticity that accounts for endogenously determined supervision.<sup>4</sup>

In particular, the instantaneous probability of detecting a shirker is given by:

$$P = \min\left\{\frac{N}{L}, 1\right\} \quad (1)$$

where  $N$  and  $L$  is the number of supervisors and production workers respectively.<sup>5</sup> In line with Shapiro and Stiglitz (1984) and Rebitzer and Taylor (1995) under this environment the non-shirking condition (NSC) arising from the worker's decision making problem and firm's profit maximisation problem can be expressed as follows:

$$w^* = \mu + e + \frac{e(r + s + q)}{\frac{N}{L}(1 - q)} \quad (2)$$

where  $w^*$  is the optimal (efficiency) wage of production workers,<sup>6</sup> which is expressed as a function of the outside option  $\mu$ , the level of effort  $e$ , the discount rate  $r$ , the probability of finding a job  $s$ , and the quit rate  $q$ . Equation (2) expresses the prediction of the standard

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<sup>3</sup> Rebitzer and Taylor modified the Shapiro and Stiglitz model (1984) by treating the probability of detecting a shirker as inversely related to the size of the workforce (in the Shapiro-Stiglitz model the probability of detecting a shirker follows a poisson process) but assume that supervisory capacity is fixed.

<sup>4</sup> Rebitzer and Taylor's key result is a special prediction of a more general model presented by Calvo and Wellisz (1979) (Manning, 1995). The two models differ only in terms of the returns to scale to production, as Rebitzer and Taylor assume decreasing and Calvo and Wellisz constant returns to scale. However, their results are the same qualitatively, i.e. that a just binding minimum wage increases the employment of affected workers.

<sup>5</sup> We assume that 1 in equation (1) is never binding, otherwise the models specialises to the standard one in the theory of the firm. Odiorne (1963) and Gordon (1990, 1994) suggest that the supervisor to staff ratio is likely to be highly correlated with the extent of monitoring.

<sup>6</sup> We assume that there are shirking considerations for production workers but not for supervisors who are paid their outside option. This is the case if bonding can be implemented for supervisors but not for production employees which may be true if one thinks of supervisors as high-skilled, high-wage workers, for whom the minimum wage does not prevent employers tilting optimally the wage-tenure profile (Krueger, 1991).

shirking model that in equilibrium, ceteris paribus, there is a trade-off between wages and the probability of detection as measured by the supervisor to staff ratio  $\frac{N}{L}$ . Equation (2) can be rearranged to express monitoring intensity as a function of the optimal wage:

$$\frac{N}{L} = \frac{e(r + s + q)}{(w^* - \mu - e)(1 - q)} \quad (3)$$

In partial equilibrium the introduction/increase of a minimum wage under this framework, ceteris paribus, will raise wages above alternative opportunities<sup>7</sup> which decreases the worker's propensity to shirk and leads to relaxation of monitoring intensity.

In general equilibrium, where all firms in the sector pay the minimum wage, we need some unemployment to prevent shirking. Under this model a binding minimum wage decreases employment at the firm level (see appendix A for proof), which in general equilibrium leads to a reduction in the probability of finding a job  $s$ .<sup>8</sup> This in turns results in an equilibrium outcome under which all production workers in the firm are paid the minimum wage and do not shirk, but they are supervised less stringently.<sup>9</sup>

### III. Empirical problems and identification strategy

This section discusses the empirical problems that arise when one attempts to estimate an empirical counterpart of equation (3) and the strategy we implement in order to tackle them.

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<sup>7</sup> In the model this is  $\mu$  which stands for the value of leisure which is equal to the market clearing wage.

<sup>8</sup> The probability of finding a job is expected to fall even if employment is unchanged as a result of the minimum wage introduction/increase (this is the case in our model if the minimum wage is set infinitesimally above the initial optimal wage (see appendix A for proof)), as labour force participation is expected to rise.

<sup>9</sup> This point suggests that the key prediction of the model by Rebitzer and Taylor that in partial equilibrium a just binding minimum wage increases employment is not robust under general equilibrium. This is because if employment increases then the probability of finding a job  $s$  will increase and motivation will fall and thus the wage should be increased further to prevent shirking. This process will continue up to the point where the increase in the wage will lead to a fall in employment in partial equilibrium.



Empirical tests of the wage-supervision trade-off have been mainly hindered by various sources of endogeneity. One usual source of endogeneity arises from simultaneity as in the case of the wage/supervision relationship both wages and supervision are motivation devices that are set optimally and simultaneously to minimize costs per efficiency unit of labour (Rebitzer, 1995). In this case, as suggested by Rebitzer (1995), unobserved features of human resource policies that affect employees' motivation (e.g. employees' screening) are expected to be correlated with both wages and supervision and will lead to a positive bias that masks any underlying wage/supervision trade-off (Leonard, 1987).

Another potential source of upward bias in the wage-supervision relationship may also arise because of labour demand adjustments, as an increase in the wage of supervised staff may lead to an increase in the ratio of supervisors to production workers, provided that the production function allows for some substitution between the two inputs (Groshen and Krueger, 1990).

Our empirical strategy is based on exploiting the exogenous variation in wages generated by the 1999 introduction of the UK National Minimum Wage (NMW) in a very low-pay sector, the residential care homes industry. We estimate the causal effect of the change in the wage of supervised employees before and after the NMW introduction on the change in their supervision intensity by IV, where measures of the impact of the NMW across homes are used as instruments for the change in the wage.

In particular, we are estimating the following system of equations:

$$\Delta \ln S_{it} = \beta_0 + \beta_1 \Delta \ln W_{it} + \beta_2 X_{it-1} + u_{it} \quad (4)$$

$$\Delta \ln W_{it} = \alpha_0 + \alpha_1 MIN_{it-1} + \alpha_2 X_{it-1} + v_{it} \quad (5)$$

where  $\Delta \ln S_{it}$  is the change in the natural logarithm of the ratio of supervisors to supervised employees at home  $i$  between the period before (t-1) and after (t) the NMW introduction,  $\Delta \ln W_{it}$  is the change in the natural logarithm of average hourly wage of supervised employees at home  $i$  in the before and after NMW introduction period,  $MIN_{it-1}$  is a measure of the impact of the NMW on the pay of supervised employees at home  $i$  (defined later),  $X_{it-1}$  is a vector of period (t-1) level of average home and supervised employees' characteristics and  $u_{it}$  and  $v_{it}$  are error terms. The key parameter of interest is  $\beta_1$ , which measures the relationship between wage changes and the change in supervision intensity after controlling for other factors such as home and workers' characteristics.

Machin *et al.* (2003) used two measures of the impact of the UK NMW. The one measure is the proportion of workers at home paid their age specific NMW before and after the NMW introduction. The second measure is the wage gap which is the proportional increase in the weekly wage bill if the wages of all workers paid below the NMW before the NMW introduction are raised to reach their age-specific NMW. The age gap is defined as follows:

$$GAP_i = \frac{\sum_j h_{ji} \max\{W_{ji}^{\min} - W_{ji}, 0\}}{\sum_j h_{ji} W_{ji}} \quad (6)$$

The key identifying assumptions of our empirical strategy are that  $MIN_{it-1}$  is a valid and relevant instrument for the change in the wage of supervised staff before and after the 1999 NMW introduction. A potential threat to the validity of the instrument arises by the fact that because the minimum wage is set at the national level, variation in  $MIN_{it-1}$  across homes is driven from variation in the initial level of wages. Machin *et al.* (2003) tested this identifying assumption and found evidence that although the relationship between the change in the wage

and initial wages was negative in a counterfactual period where no minimum wage was introduced it has shifted markedly in the period of the NMW introduction.<sup>10</sup>

Moreover, the nature of the data is such that limits the problems of unobserved heterogeneity, as the care homes sector is characterized by homogeneous occupations and workers' skills and homogeneous services (Machin *et al.*, 2003). We also estimate first differences specifications that enable us to eliminate any unobserved heterogeneity or omitted variables that are time-invariant and additive.

As discussed above, another concern in the estimation of the wage/supervision intensity relationship arises by labour demand adjustments that may increase or decrease the relative employment of supervisors and production workers depending on the production technology. In particular, if supervisors and workers are gross substitutes in production then labour demand adjustments are expected to lead to an increase in the supervisors to staff ratio that will counteract any wage/supervision trade-off driven by efficiency wages-type adjustments. We touch at this issue in one of the following sections where we present estimates of the elasticity of substitution of supervisors and supervisees.

#### **IV. The data and descriptive statistics**

The data used in our analysis was collected by the Centre for Economic Performance at LSE through postal surveys implemented before and after the April 1999 UK NMW introduction. In particular, all UK care homes were surveyed twice, with the first survey being conducted during a period of nine months before the NMW introduction between July 1998 and March 1999 and

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<sup>10</sup> This is the same as testing for common trends in wages between high-wage (less affected) and low-wage (more affected) homes or for mean reversion in wages. Although the evidence suggests that the larger part of the variation in  $MIN_{i,t-1}$  is driven by the NMW introduction, there is a minor concern for mean reversion and that is why Machin *et al.* (2003) estimate wage specifications that include controls for differences in initial wages across homes that abate this problem.

the second survey conducted during a period of nine months after the NMW introduction between May 1999 and January 2000. Overall, 11,365 care homes were included in the pre-NMW introduction survey obtained from the list of all homes from the Yellow Page Business Database in July 1998 and 11,036 homes in the post-NMW introduction survey drawn from the same database in May 1999. It is expected that the timing of the post-NMW survey allowed sufficient time for homes to adjust to the NMW because adjustments costs in the sector are low due to the small firm size and low fixed costs (Machin and Manning, 2004). Both surveys achieved a reasonable response rate for a postal survey of the order of around 20 % and the returned sample was representative of the population as a whole (see Machin *et al.*, 2003 and Machin and Wilson, 2004, for more details about the survey).

Questionnaires were addressed to home managers asking questions about the characteristics of the home (ownership, number of beds and residents, price per bed, etc.) and of all employees (job title, age, gender, possession of a nursing qualification, weekly hours and wages, etc.).

Table 1 (see Tables section at the end) presents descriptive statistics of home and average worker characteristics in the sector. Descriptive statistics suggest that the average home is small in size (both in terms of the number of employees and the number of residents) and the average hourly wage is quite low especially for non-managerial employees (either including or excluding senior carers). The latter two skill groups of employees have an hourly wage very close to £3.60 per hour which is the level of the NMW at the point of its introduction.<sup>11</sup> The average wage of

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<sup>11</sup> This is the adult rate, with the development rate (the effective minimum wage for those aged between 18 and 21 inclusive) set at £3. The adult rate is expected to be the main effective rate as employees between 18-21 years old are a very small fraction of total employment in the care homes sector and the evidence suggests that the development rate was not effective for the majority of employees in the development rate age range (Metcalf, 2004).

more senior employees as managerial employees and senior carers is not expected to be affected much by the NMW introduction.<sup>12</sup>

Other prevalent characteristics of the sector is that the vast majority of employees are female (around 92% in both the full and the balanced sample), the average employee is around 40 years old, the principal occupation is that of care assistants,<sup>13</sup> and only one in ten employees has a nursing qualification (the only relevant qualification in the sector).

## **V. Shirking and monitoring in the UK residential care homes sector**

Since 2009 quality of care in the care homes sector is regulated by a government body, the Care Quality Commission. This was mainly the government's response to increasing public concerns over the poor standard of care provided by both public and independent/private care providers (Care Quality Commission Annual Report, 2011) and the press coverage of several incidences of abuse of older people by care home employees.<sup>14</sup> This suggests that shirking considerations in the sector in the form of low quality of care provided and poor practice are quite prevalent and the incentives to monitor care provision significant. However, monitoring in the sector may be costly because homes are operating twenty four hours a day and seven days a week and because it is difficult to verify the standard of quality of care provided by carers unless supervisors have the relevant qualifications and experience.

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<sup>12</sup> The wage gap for each category provides an indication of the 'bite' of the NMW on the average wages of each employees' skill group. The average wage gap for managers and senior carers is 0.7 % and 0.8% respectively whereas for non-managers and non-senior carers is 4.2 % and 6.1% respectively.

<sup>13</sup> Care assistants include senior, day and junior carers and comprise on average 60% of employees in the sector with the vast majority of them being day and junior carers (around 85 %). The occupation of care assistant is among the lowest paid occupations in the UK (Machin et al., 2003; Machin and Wilson, 2004).

<sup>14</sup> See for example several related articles at the Guardian at <http://www.guardian.co.uk/commentisfree/2011/jun/03/southern-cross-winterbourne-view-care-homes?INTCMP=ILCNETTXT3487>

Care homes are mostly private firms (around 85%) run by a team of managers (that usually includes the owner of the home/matron) (Machin *et al.* 2004), who alongside of administrative duties also perform supervisory tasks. Managerial employees are usually the longest-tenured employees who are also more likely to work full-time<sup>15</sup> and have a permanent contract compared to non-managerial employees who include care assistants and senior carers as well as catering and cleaning staff (Laing, 2008). The primary role of carers is to assist residents in their everyday activities and to provide personal care that does not include specialist medical care, as the residents of the care homes sector we consider do not need this type of care (Machin and Manning, 2004).

Table 2 presents information on the shares of managers and non-managers in the care homes sector engaging in supervisory responsibilities from the LFS 2001-2008 and indicates that 99% of managers in the sector report that they carry out supervisory responsibilities on the job.<sup>16</sup> Moreover, Table 2 also suggests that the majority of non-managerial employees do not engage in supervisory activities in the care homes sector. Thus, the distinction between managerial and non-managerial staff may provide a potential distinction between supervisory and supervised workers.

There is also some evidence from case studies conducted by the Low Pay Commission (LPC) investigating how care homes cope with the NMW increases (LPC report, 2008) that suggests that, in some cases, senior carers may have supervisory responsibilities because of seniority and qualifications. This seems to be supported by the fact that the share of senior carers

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<sup>15</sup> In the sample of all care homes responded to the survey the average tenure of managers is 7 years whereas that for non-managerial employees is 3.5 years. Moreover, around 60% of non-managerial staff work less than 30 hours per week compared to 25% of managerial staff.

<sup>16</sup> The 1998-9 care homes survey did not include questions on supervision firstly because it was based on a short questionnaire due to concerns for low response rate and because the key information of interest was employment and the internal wage structure of the home.

in all carers in the sample, which is 15 %, is very similar to the percentage of carers reporting supervisory responsibilities in the LFS 2001-2008 as presented in Table 2.<sup>17</sup>

Thus, in our analysis presented in the following section we consider two different proxies for supervision intensity across homes, the ratio of employment of managers to non-managers (in numbers of employees and in hours) and the employment of managers and senior carers relative to all other non-managerial employees in the care home (also measured in staff numbers and in hours).

Table 1 indicates that in the period before the NMW introduction there is on average one manager for every three non-managerial employees and the same ratio becomes one over two when measured in relative hours. Comparisons of the average hourly wage of supervised employees in the pre- and the post-minimum wage period suggest that wages of supervised staff increased markedly between the two periods in both the full and the balanced sample of homes and the same seems to be the case for supervision intensity. However, the latter may be the result of many forces that may be at play, as for example the business cycle, and thus in order to isolate the effect of wage changes driven by the NMW on supervision intensity across homes we turn to the econometric results presented in the following section.

## **VI. Results**

The first stage of our empirical strategy is to estimate equation (5) where the main causing variable, the change in log hourly wage of supervised employees, is regressed on the instrument(s) (the measure(s) of the impact of the minimum wage). Results of the first stage regressions are presented by Machin *et al.* (2003) who regress the change in the wage separately

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<sup>17</sup> Unfortunately the LFS does not include information that allows us to distinguish senior and non-senior carers.

on the proportion of workers paid initially below the NMW and the wage gap and find strong positive effects across specifications.

Table 3 presents more disaggregated first-stage results than those presented in Machin *et al.* (2003). In particular, for each definition of supervised employees, the average hourly wage of supervised staff is regressed on the different measures of the impact of the NMW on this group of employees and on a set of controls.<sup>18</sup> We also include specifications where the change in log hourly wage of supervised staff is regressed on both instruments. This is done for two reasons: (a) to check whether including both instruments explains larger part of the variation in the change in the average wage at home and thus whether precision of the second stage estimates could be improved, and (b) to assess which of the two measures is the best proxy of the impact of the minimum wage.<sup>19</sup>

Results presented in Table 3 suggest that non-managerial employees in a care home that had 10 % of such employees paid below their age-specific minimum, experienced a 1.3 % higher growth of average hourly wages relative to non-managerial employees in a home with no such employee paid below the NMW. Alternatively, non-managerial employees excluding senior carers in a firm that required 10 % increase in its weekly wage bill of these employees to comply with the minimum wage experienced a 9.2 % higher average wage growth relative to the same type of employees in a firm paid at least the minimum wage to all its non-managerial and non-senior care staff.

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<sup>18</sup> Note that we restricted estimation to the sub-sample of homes with non-missing information for wages, supervision intensity (measured in both staff numbers and hours) and for all controls included in the specifications.

<sup>19</sup> The two measures are strongly positively correlated which seems plausible as both measure the same thing but they may be quite different. According to Machin *et al.* (2003) ‘if the minimum wage caused all workers initially paid below it to lose their jobs, then the headcount might be the better measure but if it is more difficult to raise productivity of those a long way below the minimum wage than those near it, then the wage gap measure might be better’.



Comparing results of specifications that include each measure of the NMW impact separately to those that include both measures seems to suggest that including both instruments will not lead to more efficient estimation of the wage-elasticity of supervision intensity. This is mainly for two reasons. The first is that the R-squared of specifications including both instruments is the same as that of specifications including only the wage gap. The second reason is because the coefficient of the proportion of non-managerial employees paid initially below the NMW is insignificant in specifications that include also the wage gap among the right-hand side variables. These results suggest that the wage gap is a better measure of the impact of the minimum wage than the initial proportion of low-paid employees at a home. This is further consistent with the evidence of a moderate negative employment effect of the NMW introduction in the sector and the point suggested by Machin *et al.* (2003) that the proportion of low-paid employees at home is a better measure than the wage gap ‘if the minimum wage caused all workers initially paid below it to lose their jobs’.

We also check whether the NMW introduction had any impact on the wage of managerial staff, as, if this is the case, our instruments will not be valid because in the second stage the wage of supervisors is an omitted variable included in the error term. Results presented in Table 3 suggest that the minimum wage introduction had no systematic effect in the wage of supervisory employees at the same homes in which it increased the wages of supervised staff.<sup>20</sup>

Table 4 presents OLS and 2SLS estimation results of the structural equation (4) using two different measures of supervision intensity. We find a negative and significant effect of the change in log average hourly wage of non-managerial employees on the change in the log ratio of managerial to non-managerial employees measured both in staff numbers and in hours.

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<sup>20</sup> The sample size in these specifications is smaller than that of the first stage specifications in Table 3 because of missing information on the wages of supervisory employees.

In particular 2SLS estimates of the wage elasticity of the ratio of managerial to non-managerial employees suggest that on average a 1 % increase in the average hourly wage of non-managerial employees at home generates a 2.38 % fall in the number and 1.85 % reduction in the hours of managerial employees relative to the number and hours of non-managerial employees respectively. This is consistent with the wage-supervision trade-off prediction of the shirking model.

Moreover, we find that the wage elasticity of supervision intensity is negative also for the case of non-managerial employees excluding senior carers but the estimated coefficient is significant only when the supervisors to staff ratio is measured in number of employees. The estimate of the wage-supervision trade-off for these employees suggest that a 1 % increase in the average hourly wage of non-managerial employees such as day and junior carers and other support staff will result in a 2.5 % fall in the number of managers and senior carers per non-manager.

In general the magnitude of the wage elasticity of supervision intensity seems quite big. Under the efficiency wages framework discussed above this could be interpreted as implying that workers' propensity to shirk or effort is very responsive to wage rates. Thus, after the wage increase the same level of worker effort can be exerted with much less monitoring. In the case of the care homes sector, given that shirking is related to the provision of lower quality care and possible poor practice, the results could be interpreted as suggesting that wage increases led to significant improvements in the quality of care and this is why the number and intensity of work of supervisory staff could be significantly reduced. Unfortunately, we cannot empirically test the latter claim due to lack of direct proxies of quality of care in the data.

Note that the reduction of the supervisor to staff ratio can be produced by different adjustments in the employment of supervisors and supervised staff. For example the employment of supervisors may fall but that of supervisees increase, or both may fall or rise. Based on the fact that Machin *et al.* (2003) and Machin and Wilson (2004) found that total employment in the sector fell slightly as a result of the NMW introduction, and given that we also find a negative relationship between the change in the employment of supervised staff and the minimum wage,<sup>21</sup> we can infer that the fall of supervisors to staff ratio was generated by a reduction in the employment of both supervisors and supervisees, with the former being larger in percentage terms than the latter.

All in all the evidence produced seems to support a negative effect of the change in the wage generated by the NMW introduction on the supervision intensity of non-managerial employees and of non-managerial employees excluding senior carers.

However, one needs to check whether these results are merely due to labour demand adjustments arising from the change in the relative wage of supervisors and supervisees caused by the NMW introduction. As discussed earlier if supervisors and supervisees are gross substitutes then the fall in the wage of supervisees relative to supervisors driven by the NMW introduction would result in an increase in the employment of supervisors relative to supervisees which in turns will tend to mask the true magnitude of the wage-supervision trade-off.

Table 5 presents OLS estimates of the elasticity of substitution between managerial and non-managerial staff.<sup>22</sup> OLS estimates are uniformly positive and significant which imply that managers and non-managers are (gross) substitutes in production and thus labour demand

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<sup>21</sup> These results are not reported here but they are available on request.

<sup>22</sup> One cannot estimate elasticities of substitution with 2SLS using as instruments the wage gap for managers and non-managers because the former does not vary much across homes and is not significantly associated with the change in the wage of managerial staff and thus in this case the estimates of the elasticity of substitution will not be different than the estimates of the wage-supervision trade-off.

adjustments counteract the wage-supervision trade-off. Therefore, our estimates of the wage-supervision trade-off can be thought as a lower bound. The latter conclusion is supported by the pattern of the magnitude of the estimates of the wage-elasticity of supervision intensity of non-managerial employees in Table 4 and the magnitude of the estimates of the elasticity of substitution in Table 5.<sup>23</sup> In particular, the larger is the elasticity of substitution between supervisors and supervisees the smaller is the wage-supervision trade-off for the supervisees. The results suggest that the ease of substitution between supervisory and non-supervisory labour inputs is the highest when labour inputs are measured in hours and senior carers are included in the supervisory staff. This can be explained by the fact that senior carers have qualifications to perform some of the tasks of care assistants and thus are a rather close substitute for them. This could further explain why estimates of the wage elasticity of supervision intensity in terms of hours are not significant for non-managerial employees when senior carers are counted as supervisory rather than as supervised staff.

An alternative potential adjustment that is consistent with a cost-minimising response by firms and could explain the relative fall in the employment of managers to that of non-managers is the case where home owners save on wage costs by laying-off more managers than non-managers because managers have more flexible contracts than non-managerial staff. As discussed above this scenario does not seem very likely, as managers are more likely to work full-time, to have a longer job tenure with the firm, and to have a permanent contract which further suggests that non-managerial employees' contracts are more flexible than that of managers (Laing, 2008).

We also find that the OLS bias of the wage-supervision relationship is uniformly positive which is consistent with the shirking model. This is because the shirking model is predicated on

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<sup>23</sup> Note that for consistency the sample size in Table 5 is the same as that in the bottom panel of Table 3.

the assumption that wages and supervision are substitutes in eliciting effort from employees and thus unobserved firm heterogeneity related to personnel policy is expected to be positively correlated with both wages and supervision (Leonard, 1987; Rebitzer, 1995).

Overall, the evidence provides indirect support to the tenet of efficiency wages that wage rents<sup>24</sup> operate as a motivation device for employees and thus can result in productivity or efficiency gains (in this case gains in monitoring costs). Based on the theoretical framework discussed earlier the NMW introduction will increase wages above the profit maximizing level and thus any wage costs will be less than offset by gains in terms of monitoring costs leading to a fall in firm's profitability. The latter prediction reconciles with Draca *et al.* (2011) who find negative effects of the 1999 NMW introduction on the profitability of residential care homes.

Efficiency wage-type of adjustments to the NMW, as monitoring costs offsets, seem to provide a potential explanation of why although the NMW introduction increased wages in the care home sector dramatically there were only moderate employment effects. Earlier studies by Machin *et al.* (2003), Machin and Wilson (2004), Metcalf (2007) and Arulampalam *et al.* (2004) seem to rule out the possibility of other potential offsets, as price and productivity increases and cuts in training provision and fringe benefits<sup>25</sup> as a response to the NMW introduction.

Our findings seem to support the wage-supervision trade-off prediction of the shirking model and to suggest that because wage rents generated by the NMW introduction were partly

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<sup>24</sup> Based on the theoretical model of section two, in general equilibrium the level of rents generated by the minimum wage increases with the level of unemployment (the probability of finding a job s).

<sup>25</sup> Arulampalam *et al.* (2004) find no evidence that the introduction of the NMW reduced the training of affected workers and some evidence that it increased it. At the time of the NMW introduction there was no statutory training provision in the care homes sector. This was introduced in 2000 by the Care Standards Act which has set statutory requirements for the achievement of NVQ qualifications for employees in residential care homes. Moreover, Metcalf (2007) suggests that 'there is not much scope for cutting back on fringe benefits like subsidised meals or generous pension provision because the incidence of such benefits for minimum wage workers is low both absolutely and relative to higher paid workers'.

offset by a fall in supervision costs, the NMW operated as an efficiency wage in the care homes sector.

This evidence, as well as providing a potential explanation of the earlier findings on the employment effects of the NMW introduction in the care homes sector, also provides empirical support to efficiency wages model of the minimum wage literature (Calvo and Wellisz, 1979; Manning, 1995; Rebitzer, 1995).

## **VII. Conclusions**

The shirking model of efficiency wages theory is predicated on the assumption that higher relative wages affect employees' effort which is why wages are expected to substitute for alternative means of regulating employees' effort, such as supervision. The empirical testing of this prediction of the shirking model has proved quite challenging mainly because of the presence of unobserved employers' characteristics and practices that jointly determine wages and supervision and thus hinder the identification of their causal relationship.

In this paper, we exploit an ideal research design provided by the UK National Minimum Wage (NMW) introduction in a very low-pay sector, the residential care homes industry in order to address the empirical problems associated with the empirical testing of the wage-supervision trade-off prediction of the shirking model. The NMW introduction generated wage increases across care homes that are expected to be independent of unobserved care home determinants of wages and supervision and thus enable one to identify the relationship of interest.

We find evidence consistent with a wage-supervision trade-off for non-managerial employees that provides support to the shirking model. This evidence suggests that higher wage costs generated by the NMW introduction were at least partly offset by lower monitoring

expenses which implies that the NMW operated as an efficiency wage in the care homes sector. Our findings reconcile with evidence produced by earlier studies suggesting that although the NMW had a dramatic effect on care home wages there were only moderate employment reductions. Our analysis also provides a direct test that supports efficiency wages models developed to explain empirical findings of a non-negative employment effect of the minimum wage, which has been missing in the literature.

TABLE 1

*Survey descriptive statistics*

	All firms		Balanced panel	
	Pre- minimum	Post- minimum	Pre- minimum	Post- minimum
Number of homes	1646	2366	683	683
Number of workers	17.33 (12.33)	17.63 (23.61)	16.15 (9.69)	16.65 (12.09)
Hourly wage for managers	5.32 (2.07)	5.46 (2.12)	5.31 (2.1)	5.42 (2.11)
Hourly wage for non- managers	3.79 (0.78)	4.00 (0.73)	3.77 (0.7)	4.03 (0.66)
Hourly wage for senior carers	4.2 (1.14)	4.34 (1.33)	4.18 (1.14)	4.36 (1.26)
Hourly wage for non- managers (excluding senior carers)	3.71 (0.83)	3.88 (0.88)	3.68 (0.77)	3.92 (1.26)
Proportion Female	0.92 (0.11)	0.92 (0.11)	0.92 (0.11)	0.92 (0.11)
Average Age	40.25 (6.6)	40.52 (6.8)	40.2 (6.45)	40.58 (6.87)
Proportion Care Assistants	0.62 (0.26)	0.61 (0.27)	0.62 (0.26)	0.63 (0.26)
Proportion With Nursing Qualification	0.09 (0.17)	0.1 (0.18)	0.1 (0.18)	0.1 (0.17)
Number of Beds	21.09 (38.35)	20.54 (21.95)	18.68 (18.02)	19.26 (19.45)
Number of residents	18.6 (37.33)	18.16 (20.58)	16.55 (17.34)	17.12 (18.4)
Ratio of managers to non-managers (number of staff)	0.29 (0.74)	0.33 (0.92)	0.3 (0.66)	0.33 (0.97)
Ratio of managers to non-managers (weekly hours)	0.45 (1.33)	0.52 (1.63)	0.44 (1.36)	0.5 (1.41)
Ratio of managers and senior carers to non- managers (number of staff)	0.46 (1.06)	0.5 (1.07)	0.44 (0.71)	0.53 (1.18)
Ratio of managers and senior carers to non- managers (weekly hours)	0.75 (2.73)	0.81 (2.63)	0.67 (1.43)	0.9 (3.8)

*Notes:* Standard deviations in parentheses. Pre-minimum observations refer to responses received before April 1999 and Post-minimum to responses received after March 1999. Managers include employees with job title: head of home/manager, matron, deputy matron and assistant manager. Care assistants include senior, day, and junior carers but exclude night carers and sleep-ins.



TABLE 2

*Share of employees with supervisory responsibilities in managerial and non-managerial employment*

	Share in total employment	Share with supervising responsibilities
Managerial employees	0.1	0.99
<i>Non-managerial employees</i>		
Carers and care assistants	0.65	0.16
Other employees	0.25	0.2

Notes: Source is Labour Force Survey (LFS) 2001-2008.

TABLE 3

*The Effect of the NMW on the average home wages of supervised and supervisory staff*

	Change in log hourly wage of non-managers			Change in log hourly wage of non-managers excluding senior carers		
	(1)	(2)	(3)	(4)	(5)	(6)
Pre-introduction						
NMW impact measure						
Initial period low pay proportion	0.13*** (0.01)		0.003 (0.02)	0.13*** (0.01)		0.007 (0.017)
Initial period wage gap		0.93*** (0.07)	0.92*** (0.07)		0.92*** (0.07)	0.9*** (0.09)
R <sup>2</sup>	0.17	0.23	0.23	0.17	0.24	0.24
No. of observations	547	547	547	547	547	547
	Change in log hourly wage of managers			Change in log hourly wage of managers and senior carers		
Initial period low pay proportion	0.03 (0.05)		-0.03 (0.06)	0.03 (0.04)		-0.01 (0.06)
Initial period wage gap		0.4 (0.23)	0.53 (0.31)		0.28 (0.21)	0.34 (0.28)
R <sup>2</sup>	0.05	0.06	0.06	0.04	0.04	0.04
No. of observations	497	497	497	497	497	497

Notes: \*\* statistically significant at the 0.05 level, \*\*\* at the 0.01 level, robust standard errors in parentheses. All specifications include controls for proportion female, average age, proportion with nursing qualification, average intensity of work, proportion of residents who either pay local authority prices for beds or who have their care paid for by the Department of Social Security (DSS), region dummies, response month dummies, whether part of larger organisation and ownership type. In each specification the change in log hourly wage and workers' controls are computed for the same group of employees.

TABLE 4

*OLS versus 2SLS estimates of the wage elasticity of supervision intensity*

	Change in log ratio of managers to non-managers (number of staff)		Change in log ratio of managers to non-managers (hours)	
	(1)	(2)	(3)	(4)
	OLS	2SLS	OLS	2SLS
Change in log average wage	-0.42	-2.38***	-0.18	-1.85**
	(0.4)	(0.86)	(0.41)	(0.9)
Controls	Yes	Yes	Yes	Yes
R-squared	0.09	0.07	0.09	0.07
Number of Homes	547	547	547	547
	Change in log ratio of managers and senior carers to non-managers (number of staff)		Change in log ratio of managers and senior carers to non-managers (hours)	
	OLS	2SLS	OLS	2SLS
Change in log average wage	-0.86	-2.5***	-0.56	-1.54
	(0.48)	(0.9)	(0.54)	(1.01)
Controls	Yes	Yes	Yes	Yes
R-squared	0.08	0.05	0.08	0.06
Number of Homes	547	547	547	547

*Notes:* \*\* statistically significant at the 0.05 level, \*\*\* at the 0.01 level, robust standard errors in parentheses. In the 2SLS estimation we use the wage-gap for non-managers and the wage-gap for non-managers excluding senior carers as an instrument for the change in the average hourly wage of non-managers and non-managers excluding senior carers respectively. Controls include: proportion female, average age, proportion with nursing qualification, average intensity of work, proportion of residents who either pay local authority prices for beds or who have their care paid for by the Department of Social Security (DSS), region dummies, response month dummies, whether part of larger organisation and ownership type. In each specification the change in log hourly wage, instruments and workers' controls are computed for the same group of employees.

TABLE 5

*OLS estimates of the elasticity of substitution between supervisory and supervised employees*

	Change in log ratio of managers to non-managers		Change in log ratio of managers and senior carers to non-managers	
	Number of staff	Hours	Number of staff	Hours
Change in log ratio of hourly wage of non- managers to hourly wage of managers	0.29*** (0.09)	0.38*** (0.11)		
Change in log ratio of hourly wage of non- managers to hourly wage of managers and senior carers			0.25** (0.12)	0.45*** (0.14)
Controls	Yes	Yes	Yes	Yes
R-squared	0.02	0.02	0.02	0.02
Number of Homes	497	497	497	497

*Notes:* \*\* statistically significant at the 0.05 level, \*\*\* at the 0.01 level, robust standard errors in parentheses. Controls include output proxies as the number of residents in the care home.

## Appendix A: the employment effect of the introduction of a minimum wage in a shirking model with endogenous supervision intensity

Under the extension of the model developed by Rebitzer and Taylor (1995) discussed in Section two the typical firm chooses the wage employment and supervision to maximize profits subject to the non-shirking condition (NSC):

$$\max_{w,L,N} \Pi(w, L, N) = \max_{w,L,N} f(eL) - wL - cN \quad (A.1)$$

$$s.t \ N(w, L) = \frac{Le(r+s+q)}{(w^* - \mu - e)(1-q)} \quad (A.2)$$

where  $e$  is effort which is assumed to be binary (1 if working and 0 is shirking) and  $c$  is the wage of supervisors. Substituting the NSC in the profit function and assuming that when the NSC binds workers will always work the profit maximization problem can be written as follows:

$$\max_{w,L,N} \Pi(w, L) = \max_{w,L} f(L) - wL - cN(w, L) \quad (A.3)$$

The first order conditions have as follows:

$$\Pi_L = 0 \Rightarrow f_L - w - cN_L = 0 \quad (A.4)$$

$$\Pi_w = 0 \Rightarrow -\frac{cN_w}{L} = 1 \quad (A.5)$$

The change in employment after the introduction/increase of a minimum wage is given if we totally differentiate equation (A.4) which leads to the following condition:

$$\frac{dL}{dw} = -\frac{\Pi_{Lw}}{\Pi_{LL}} \quad (A.6)$$

where  $\Pi_{LL}$  is the own second order partial derivative of the profit function with respect to employment and  $\Pi_{Lw}$  is the cross partial derivative of the profit function.

Therefore, provided that the second order conditions for profit maximization hold we have:

$$\text{sign}\left(\frac{dL}{dw}\right) = \text{sign}(\Pi_{Lw}) \quad (\text{A.7})$$

where  $\Pi_{Lw}$  can be expressed as follows:

$$\Pi_{Lw} = -1 - cN_{wL} \quad (\text{A.8})$$

by (A.5) and the fact that  $cN_{wL} = cN_w / L$ , it is implied that employment does not change after the imposition of a just binding minimum wage ( $\Pi_{Lw} = 0$ ) and thus employment is expected to fall for minimum wage increases above a left neighborhood of the optimal wage. This result suggests that the positive employment effect of the minimum wage in the model of Rebitzer and Taylor hinges heavily on the assumption that supervision is fixed.

Although our results suggest that in a more general setting the shirking model is not consistent with a positive employment effect of the minimum wage, the predictions can still reconcile with the bulk of more recent evidence supporting a small negative or no employment effect of the minimum wage (Machin *et al.*, 2003).

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