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Working Paper

Overtime Working and Contract Efficiency

IZA Discussion Papers, No. 7560

Provided in Cooperation with:

IZA – Institute of Labor Economics

Suggested Citation: Hart, Robert A.; Ma, Yue (2013) : Overtime Working and Contract Efficiency, IZA Discussion Papers, No. 7560, Institute for the Study of Labor (IZA), Bonn

This Version is available at:

<https://hdl.handle.net/10419/90069>

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IZA DP No. 7560

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August 2013

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ABSTRACT

Overtime Working and Contract Efficiency^{*}

We present a wage-hours contract designed to minimize costly job turnover given investments in on the job training combined with firm and worker information asymmetries. It may be optimal for the parties to work 'long hours' remunerated at premium rates for guaranteed overtime hours. Based on British plant and machine operatives, we test three predictions. First, trained workers with longer job tenure are more likely to work overtime. Second, hourly overtime pay exceeds the value of marginal product while the basic hourly wage is less than the value of marginal product. Third, the basic hourly wage is negatively related to the overtime premium.

JEL Classification: J41, J33

Keywords: paid overtime, wage-hours contract, plant and machine operatives

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^{*} We are grateful to the Secure Data Services for granting and facilitating access to the New Earnings Survey Panel Dataset (NESPD) and the Annual Survey of Hours and Earnings (ASHE).

1. Introduction

Efficient long-term contracts must set hours of work as well as wages (Lazear, 1981; Kahn and Lang, 1992). For most workers, the wage rate and the number of hours are set such that the hourly wage is constant over all per period hours. For an important sub-set of workers, however, marginal hours are remunerated at premium overtime rates. What is the rationale for setting two rates – a basic rate and a premium rate – in terms of contract efficiency? Hart and Ma (2010) develop a wage-hours contract explanation which recognises that it may be optimal for the bargaining parties to agree a contract designed to encourage long hours of work. Designed to minimize costly turnover given investments in specific capital, and given information asymmetries, it establishes the need to pay a premium in excess of basic rates for overtime hours.

In this paper, we provide empirical tests of the theory. The work is based on longitudinal panel data in respect of British blue-collar male plant and machine operatives. This is a relatively homogeneous occupational group in which the incidence of working paid overtime is high.¹ In most of our specifications we make use of jobs-based data, as opposed to employer-based, where intra-firm jobs are delineated by 3-digit occupations. In line with our emphasis on jobs spells, on the job training is regarded as being task specific. This follows ‘the plausible idea that much of human capital accumulated on the job is due to task-specific learning by doing’ (Gibbons and Waldman, 2004). Specificity derives from the fact that a part of the capital

¹ Unlike the United States, there is no regulation on the overtime premium in Britain.

accumulation becomes unutilized when a worker moves to a higher- or a lower- level job either within the firm or between firms.

We explore three predicted outcomes from the wage-hours contract. First, overtime firms have an incentive to guarantee an overtime premium for extra hours undertaken by workers with relatively long job tenure. Second, contract efficiency dictates that the overtime premium is set such that hourly overtime pay exceeds the value of marginal product while the basic hourly wage is less than the value of marginal product. Third, the wage-hours contract contains a compensating rule in which the basic contractual wage is negatively related to the overtime premium.

Our wage-hours contract offers an alternative derivation of the negative wage-premium trade-off established in earlier work. The best known is the hedonic wage model of Lewis (1969). It describes the 'market equalising wage curve' that reflects the preference of employees and employers who are brought together in equilibrium with labor demand equal to labor supply at all job (i.e. hours) lengths. In essence, the parties agree compensation packages based the worker's objective of finding earnings/hours combinations that maximise utility coupled with the firm's objective of profit maximisation (see Kinoshita, 1987; Trejo, 1991).

2. Overtime working and an efficient wage-hours contract

We outline the essential features of our wage-hours contract model. It extends a contract formulation originally proposed by Hashimoto (1981) and Carmichael (1983). Workers are employed into specific jobs (or narrowly defined occupations) within the firm. The firm hires individuals to match with the level of task requirements at given job

levels. A marginal worker's pre-entry endowment of general human capital is worth w_a in the spot market and this is not augmented within the firm. The employer provides job training. The weekly cost of training is fixed (i.e. hours-independent). At the end of the training period (period 1), no further job training takes place. Workers entering the post-training period (period 2) are equally productive. The generation of a surplus during period 1 allows the parties to set a wage-hours job contract in period 2 that differs from a market-determined wage and hours settlement. There are transaction costs of verifying and communicating information in respect of the value of the marginal product (VMP) and the alternative hourly wage (w_a). We assume that the firm observes VMP and the worker observes w_a . The contract contains an agreed value of expected investment return. However, transaction costs preclude *ex post* agreement over the way in which random elements produce deviations from the agreed value of investment returns (Hashimoto and Yu, 1980). For example, such transaction costs may be linked to collective bargaining agreements which impose constraints on the relative pay and conditions applying across jobs in the jobs' hierarchy. In our data, while 93% of plant and machine operatives work in the private sector, 56% of all operatives work under collective bargaining agreements.

In period 1, the marginal worker has hourly productivity VMP_1 equal to w_a minus the hourly training cost. At the start of period 2 the worker is fully trained in respect of the required job tasks, with productivity VMP_2 . First and second period hourly wages are denoted w_1 and w_2 , respectively. Weekly hours on the job are denoted by h and in alternative employment by h_a . Weekly job earnings net of the disutility of providing

weekly hours are expressed $y = w \cdot h - d(h)$. For simplicity, VMP_2 is constant and invariant with respect to working hours.²

As a convenient starting point, suppose the firm and its workforce set fixed standard weekly hours based on custom and practice. The resulting second-period weekly earnings are given by $w_2 \cdot h_2$. The first-best separation rule is given by $w_a \cdot h_a - d(h_a) > VMP_2 \cdot h_2 - d(h_2)$. However, the worker would quit if $w_a \cdot h_a - d(h_a) > w_2 \cdot h_2 - d(h_2)$ and the firm would layoff the worker if $w_2 \cdot h_2 > VMP_2 \cdot h_2$. Due to asymmetric information combined with no permitted contract renegotiation, such quit/layoff rules allow the possibilities of inefficient separations. An inefficient quit would occur if

$$(1) \quad VMP_2 \cdot h_2 - d(h_2) > w_a \cdot h_a - d(h_a) > w_2 \cdot h_2 - d(h_2)$$

or the worker would quit the firm despite a positive (joint) surplus. An inefficient layoff would occur if

$$(2) \quad w_2 \cdot h_2 - d(h_2) > VMP_2 \cdot h_2 - d(h_2) > w_a \cdot h_a - d(h_a)$$

or the firm would fire the worker despite a positive (joint) surplus.

What if the firm and its workforce agreed to move away from setting hours through custom and practice? As long as a given worker's return $y_2 = w_2 \cdot h_2 - d(h_2)$ increases with h_2 [i.e. $w_2 > d'(h_2)$], then longer hours increase the return and hence induce a greater incentive for the worker to stay. Assuming $w_2 > d'(h_2)$, some marginal

² The assumption that VMP_2 declines in hours does not substantively change the main conclusions (Hart and Ma, 2010).

workers for whom $w_a \cdot h_a - d(h_a) > w_2 \cdot h_2 - d(h_2)$ held before the increase in h_2 would now be induced to stay by a reversal of this inequality. As for the firm, increasing h_2 involves a cost (weekly earnings are increased) and a gain (weekly marginal product is increased). As long as $VMP_2 \cdot h_2 \geq w_2 \cdot h_2$ the firm has no incentive to fire. In fact, given the assumption that $VMP'(h_2) \equiv 0$, a change in h_2 has no effect on layoffs. Increases in h_2 would occur up to the point where $y_2 = w_2 \cdot h_2 - d(h_2)$ is maximized for the marginal worker subject to the constraint that $w_2 \cdot h_2 \leq VMP_2 \cdot h_2$. Let the optimal hours for this worker be denoted h_o .

Operating under a (w_2, h_o) wage-hours contract does not rule out the possibility that $VMP_2 > w_2$, in which case the firm would prefer longer hours $h_2 > h_o$. This possibility is precluded in the contract as it stands because hours in excess of h_o would reduce y_2 ,
or

$$(3) \quad w_2 \cdot h_2 - d(h_2) < w_2 \cdot h_o - d(h_o) \text{ for } h_2 > h_o$$

implying that the probability that the worker quits is increased thereby increasing the likelihood of an inefficient separation.

One possibility of compensating the fall of y_2 for a rise in h_2 beyond h_o , is for the firm to offer overtime pay $k \cdot w_2$ in respect of marginal hours such that $w_2 \cdot h_o + k \cdot w_2 \cdot (h_2 - h_o) - d(h_2) > w_2 \cdot h_o - d(h_o)$. Using inequality (3), this implies that the overtime premium k would be set such that

$$(4) \quad k > \frac{d(h_2) - d(h_o)}{w_2 \cdot (h_2 - h_o)} > 1.$$

The firm pays an overtime premium $k > 1$ to compensate the worker for the disutility of 'involuntary' long hours.

The problem arises that the firm cannot pay all, equally productive, trained workers $k_2 \cdot w_2$ ($k_2 > 1$). This would increase marginal pay and hence increase the probability of layoffs. As things stand, the cost of retaining the marginal worker in period 2 is equal to the pay of a marginal worker. However, greater contract efficiency can still be achieved using premium overtime pay via a solution equivalent to the wage contract proposed by Carmichael (1983). This translates into creating junior and senior jobs for equally trained workers. Junior workers work h_0 hours at a single rate of w_2 while a fixed number of senior workers are guaranteed additional overtime hours at a premium rate, $k \cdot w_2$. Eventually, as a senior worker retires or leaves the firm for other reasons, it becomes the turn of a junior worker to be offered the additional premium-rated hours. Total employment is secured through a senior worker being replaced by a junior worker at cost w_2 . The firm's marginal hourly cost is $k \cdot w_2$ while the marginal hourly replacement cost is w_2 . Efficiency is achieved because the cost of retaining a marginal worker differs from the pay of a marginal worker.

What is the incentive for workers to agree to such an arrangement? It turns out that this overtime pay scheme has the automatic compensating rule

$$(5) \quad k \cdot w_2 > VMP_2 > w_2$$

that reduces both inefficient quits and inefficient layoffs (Hart and Ma, 2010). The incentive is to receive a wage for marginal hours that exceeds the value of the marginal

product. Figure 1 illustrates the overtime pay schematic resulting from these developments.

What is the relationship between the contractual wage and the overtime premium in our wage-hours contract? There is an inverse relationship, or

$$(6) \quad \frac{\partial w_2}{\partial k} < 0.$$

Lowering w_2 increases profit to the firm but also increases the probability of the worker quitting. Hence the wage stopping rule is where the marginal profit to the firm equals to marginal loss of an extra unit reduction of w_2 . Similarly, an increase of k reduces the profit to the firm but increases the probability of the worker staying, which in turn enhances the firm's profit. Hence the premium stopping rule is where the marginal loss to the firm equals to marginal profit of an extra unit increase of k .

In our empirical work, a potential complication to the foregoing theoretical discussion arises if the senior overtime job involves significantly different job tasks from the junior job. In this case, the initial training programme would need to produce workers being equally capable of doing the junior and the senior job and, moreover, numbers of workers in junior and senior jobs would need to be set such that marginal product of a worker in each type of job is the same (Carmichael, 1983). We tackle this issue empirically by concentrating on job spells in which jobs are demarcated at 3-digit occupation levels. An internal job move entails a change in job tasks under a new 3-digit classified job and this marks the start of a new two-period job spell consisting of training and post-training periods.

3. Empirical Tests

The foregoing model leads to three predictions concerning overtime working. First, paid overtime within jobs is undertaken by senior trained workers. Second, overtime premium pay is greater than the value of marginal product which in turn is greater than the basic wage or $k.w_2 > VMP_2 > w_2$. Third, there is an inverse relationship between w_2 and k .

Consistent with our first prediction, we would expect that the probability of working paid overtime to be positively related to the length of job tenure. For exposition, we concentrate on linear terms in job tenure (*JTEN*) and age (*AGE*).³

Let

(7) $OVT_{it} = 1$ if worker i at time t is working paid overtime

$OVT_{it} = 0$ otherwise.

In order to accommodate the likely procyclicality of OVT_{it} , we include as an explanatory variable the annual change in the national unemployment rate to capture business fluctuations. This requires us to tackle potential standard error biases associated with using an individual-level dependent variable alongside a national-level cyclical indicator. To this end, we adopt the two-step estimation approach first proposed by Solon et al. (1994).

Step 1 estimation is given by

³ Our data set most suited for this estimation – the British New Earnings Survey Panel Data (NESPD) – do not allow the calculation of work experience and so we use the individual's age in its place.

$$(8) OVT_{it} = \alpha_1 JTEN_{it} + \alpha_2 AGE_{it} + \alpha_3 BAR_{it} + \sum_{t=1}^T \theta_t D_t + I_{it} \mu + \varepsilon_{it}$$

where BAR_{it} is a dummy denoting an individual's job is covered by collective bargaining⁴, D_t is a year dummy, and I_{it} is a set of industry dummies. From our theory, we expect $\hat{\alpha}_1 > 0$. We also expect $\hat{\alpha}_3 > 0$ or contractual overtime is positively related to jobs in which collective bargaining takes place.

Step 2 estimation is given by

$$(9) \hat{\theta}_t = \beta_0 + \beta_1 \Delta U_t + \beta_2 Year_t + \omega_t$$

where ΔU_t is first-differenced national claimant count unemployment and $Year_t$ is a simple time trend. In order to facilitate use of the two-step method, we estimate (9) as a linear probability model using weighted least squares where weights consist of the number of individuals observed in each year. We expect $\hat{\beta}_1 < 0$ since the probability of working overtime rises towards cyclical peaks and declines near troughs.⁵

In the case of the second prediction, that $k.w > VMP > w_2$, we offer two tests.

⁴ Collective bargaining is treated as applying to entire lengths of job spells. There are instances where the data indicate a change of collective bargaining status within a job spell. We do not know whether these derive involve decisions within the firm or (perhaps more likely) from measurement error. We adopt the approach of Abraham and Farber (1988) and treat an individual as covered by a collective bargaining agreement within a complete job spell if the first and last observations and at least two-thirds of all observations report coverage. The equivalent rule is applied to the classification 'not-covered'.

⁵ We also estimated a probit model incorporating clustering for the unemployment variable. This yielded marginal effects similar to our 2-step approach.

If, overtime is remunerated under efficient contracts at a rate higher than *VMP* then we would expect lower job separation probabilities for this class of worker.

Let SEP_{it} denote a binary variable such that

$$(10) \quad SEP_{it} = 1 \text{ if worker } i \text{ separates from his job at time } t$$

$$SEP_{it} = 0 \text{ otherwise.}$$

Then, following the same empirical approach as before, we specify a linear probability model such that

$$(11) \quad SEP_{it} = \gamma_1 AGE_{it} + \gamma_2 OVT_{it-1} + \gamma_3 BAR_{it} + \sum_{t=1}^T \varphi_t D_t + I_{it} \tau + \varepsilon_{it}$$

where $OVT_{it-1} = 1$ if the worker worked overtime in the previous period. Note that $JTEN_{it} = 0$ at points of separation. We expect $\hat{\gamma}_1 < 0$ given younger workers display more job mobility than older workers (e.g. Macaulay, 2003). As discussed above, we expect $\hat{\gamma}_2 < 0$. However, while our model assumes equally productive workers within jobs, we cannot exclude the possibility that high ability workers and/or workers with strong job matches may be paid higher hourly wages by the firm in order to extend their job tenure. Accordingly, we also include estimates of equation (11) that control for individual and job-match fixed effects.

Step 2 estimation is given by

$$(12) \quad \hat{\varphi}_t = \delta_0 + \delta_1 \Delta U_t + \delta_1 Year_t + \omega_t$$

where we expect $\hat{\delta}_1 < 0$, or separations are procyclical.⁶

⁶ Again, a probit allowing for marginal effects and clustering in respect of unemployment produced similar outcomes.

The difficulty with formulating a more direct test of the inequalities in (5) – viz. $k \cdot w_2 > VMP_2 > w_2$ – is that we require measures of individual productivities. Such variables are not available in our British data sources. However, a modelling approach introduced by Kahn and Lang (1992) - who test for the relative strengths of agency versus human capital theories in predicting long term associations between the wage and *VMP* - gives us a way to proceed. This involves obtaining statistics on actual and desired hours. As discussed in Section 4 and the Appendix, we are forced to use an alternative data set to undertake estimation⁷ and this requires us to make use of employer tenure (*ETEN*) in place of job tenure (*JTEN*).

Assuming that *ETEN* reasonably captures individual accumulated productive returns on-the-job, after controlling for general labor market work experience, three relationships are of interest.

$$(13) \ln w_{it} = \lambda_1 ETEN_{it} + Z_{it}\Gamma_1 + \varepsilon_{1it},$$

$$(14) \ln VMP_{it} = \lambda_2 ETEN_{it} + Z_{it}\Gamma_2 + \varepsilon_{2it},$$

$$(15) \ln(k \cdot w)_{it} = \lambda_3 ETEN_{it} + Z_{it}\Gamma_3 + \varepsilon_{3it},$$

where *Z* is a set of controls and where we expect, given (5), that $\lambda_1 < \lambda_2 < \lambda_3$ (see Figure 1).

⁷ Equations (13) - (15) are estimated using the British Household Panel Survey (BHPS) since, unlike the NESPD, this data source provides information on workers' desired hours. It also allows us to measure work experience – given by the number of years in the workforce since the end of full-time education - and experience replaces age in the relevant regressions.

The probability that desired hours exceed contract hours is the probability that the hourly wage (standard or overtime) exceeds VMP . This is expressed

$$(16) \Pr[\text{desired hours} > \text{contract hours}] = \Pr[(1 - OVT_{it}) \cdot \ln w_{it} + OVT_{it} \cdot \ln(k \cdot w)_{it}] > \ln VMP_{it}$$

If $OV = 1$ then $k \cdot w > VMP$ and workers will desire more hours. If $OVT = 0$, $w < VMP$ and less hours would be desired. Using (13), (14) and (15), we can re-write equation (16) as

$$(17) \Pr[\text{desired hours} > \text{contract hours}] = \Pr[Z_{it}(\Gamma_1 - \Gamma_2) + OVT_{it} \cdot Z_{it}(\Gamma_3 - \Gamma_1) + (\lambda_1 - \lambda_2) \cdot ETEN_{it} + (\lambda_3 - \lambda_1) OVT_{it} \cdot ETEN_{it} + (1 - OVT_{it})\varepsilon_{1it} + OVT_{it}\varepsilon_{3it} - \varepsilon_{2it} > 0].$$

Providing that the error terms are normally distributed, then (17) can be estimated as a bivariate probit equation. Our theory predicts that (i) the coefficient on tenure should be negative, (ii) the coefficient on $OVT \cdot EMP$ should be positive, and (iii) the sum of these coefficients should be positive. Finally, $(\Gamma_1 - \Gamma_2)$ and $(\Gamma_3 - \Gamma_1)$ can be any sign for Z and for $OVT \cdot Z$, respectively.

However, there is a problem with estimating (17) as a simple probit. From Table 1, we find that over half of respondents in our BHPS sample report that they are satisfied with their actual hours. This same problem is found by Kahn and Lang (1992) in their work on agency versus specific capital. They suggest two model modifications to accommodate the problem. Equivalent lines of reasoning apply here.

The first modification is to assume that respondents report an inequality between actual and desired hours only if the deviations are nontrivial. Then we can define a dummy taking the value 1 for a sufficiently large positive deviation, -1 for a sufficiently large negative deviation, and 0 for deviations that do not trigger either of these responses. Then equation (17) can be estimated as an ordered probit.

The second modification concerns the fact that the overtime model outlined here is most relevant to long-term employment relationships that incorporate the objective of minimising quits and layoffs given potential losses of returns to specific capital investments. In effect, our model treats overtime as a guaranteed payment. But we know that paid overtime arises for a range of other, often more *ad hoc* and short-term, reasons. The firm may employ overtime hours to meet rush orders, to fill the gap of a temporary shortfall of labor given unanticipated rises in product demand, to provide cover for absenteeism, and so on. So the inequality arising from the structural assumptions behind equation (17) might reasonably be taken to be conditional on an expected long-term employer-worker relationship. A simple bivariate probit is then interpreted as capturing workers who are constrained in this way.

We might also expect that longer term contractual hours arrangements are more likely to apply to experienced, prime-age, workers. For many workers, job shopping in early years in the labor market will result in improved job matches that eventually give the parties more confidence in investing in longer term relationships. Older workers who, for whatever reason, have changed jobs may be less likely to receive significant new job opportunities given shorter expected time horizons in which to amortize

investment outlays in training. Accordingly, we carry out estimation both with respect to all plant and machine operatives and those aged between 25 to 45 years. Age distributions of plant and machine operatives over the period 1991-2011 are shown in Figure 2, covering all workers as well the sub-set working overtime. The two distributions are almost identical. Of all observations, 55% are within the 25-45 age range.

The last prediction from the theory is that $\partial k/\partial w < 0$, or the overtime premium and the hourly standard wage are inversely related. The NESPD provides data on total weekly hours (H), standard weekly hours (HS), weekly overtime hours $HP (= H - HS)$ as well as hourly earnings including overtime (e) and the standard hourly wage (w). Then, for each worker, the average overtime premium, p , is given by

$$(18) \quad p_{it} = \frac{\left(\frac{e_{it}}{w_{it}}\right) H_{it} - HS_{it}}{HP_{it}} .$$

where $p_{it} > 0$ if $H_{it} > HS_{it}$, and $p_{it} = 0$ if $H_{it} \leq HS_{it}$.

We investigate the wage-premium trade-off via the wage equation

$$(19) \quad \log w_{it} = \pi_1 p_{it} + \pi_2 JTEN_{it} + \pi_3 AGE_{it} + \gamma_4 BAR_{it} + Z_{it}\Omega + \varepsilon_{it}$$

where $\log w_{it}$ is the log of the real basic wage rate (excluding overtime) and where Z_{it} are controls consisting of time and industry dummies. We expect $\hat{\pi}_1 < 0$ from the theory.

We estimate (19) by OLS. Again, since our theory is predicated on equally productive

workers within job spells, we additionally control for individual and job-match fixed effects.

4. Data

Our estimation is carried out using data on British male plant and machine operatives reported in the NESPD (British New Earnings Survey Panel Data) and the BHPS (British Household Panel Survey). These consist of a relatively homogeneous group of blue-collar occupations.⁸ Britain's best statistical source for pay and hours is the company-based NESPD. We make use of this data set from 1991 to 2011. However, the NESPD does not ask questions concerning individuals' desired working time and so we use the household-based BHPS in this respect. These data are available from 1991 to 2008. The comparative advantage of NESPD is its large sample coverage and accuracy. It is based on company payroll records and, unlike the BHPS, it does not rely on self reporting. The comparative advantage of the BHPS is that it allows for a wider set of controls, including household and educational background. For both our data sets, Table 1 shows that over half of individuals/households covered by our plant and machine operators' samples report working paid overtime.

The complete NESPD is comprised of a random sample of 1% of the entire British workforce. Employers complete a questionnaire, based on their payrolls, that relates to a specific week in April. Since the same individuals are in the sample each year, the NESPD is

⁸ The NESPD's coverage of plant and machine operatives embraces sixty-two 3-digit occupations. These are grouped by process operatives (food drink and tobacco; textile and tannery; chemicals, paper, plastics and related; metal making and treating; metal working; other routine) and by other work (assemblers/lineworkers; road transport; other transport and machinery; plant and machine).

a panel data set. Completing the survey questionnaire is a legal requirement and so the response rate is very high. Since the data are taken directly from the employer's payroll records, the earnings and hours information in the NESPD are considered to be very accurate. A question in the Survey allows us to identify job movers and so we can accurately measure spell lengths of 3-digit level jobs.

The BHPS is an annual survey consisting of a nationally representative sample of about 5,500 households recruited in 1991 and containing a total of approximately 10,000 interviewed individuals in Great Britain. In 1999, additional samples were added consisting of 1,500 households in each of England and Wales. The sample is a stratified clustered design drawn from the Postcode Address File and all residents present at those addresses at the first wave of the survey were designated as panel members. These same individuals are re-interviewed each successive year and, if they split-off from original households to form new households, they are followed and all adult members of these households are also interviewed. Similarly, new members joining sample households become eligible for interview.

As indicated in the previous section, one downside of the BHPS data, in contrast to the NESPD, is that employment refers to length of stay in the firm rather than stay within given occupations in the firm. This is clear when comparing lengths of tenure in the two data sets reported in Table 1.⁹ So changes in tenure in the BHPS may involve

⁹ Even given the distinction between job tenure and employer tenure, the differences in average tenure lengths – about 2.8 years in the NESPD compared with 5.5 years in the BHPS – appear too large. This arises because interviewees in the BHPS are asked when they started with the current firm and this is recorded as the tenure starting point even

job promotions that are not accommodated by the assumptions behind our efficient contract design.

From Table 1 we find that standard weekly hours of plant and machine operatives are comparable in the data sets, averaging about 40 hours per week. Overtime hours of plant and machine operatives are high, averaging around 10/11 weekly hours for those working overtime and around 5/6 hours over all operatives. Average real weekly earnings in the NESPD and BHPS, including overtime pay, compare closely. The average overtime premium is 1.4 in both surveys.¹⁰

6 Results

Within 3-digit level jobs, we obtain evidence in Table 2 in support of the prediction that the probability of working paid overtime increases with job tenure. In Section 2, we argue that the NESPD jobs-based data provide a strong test of the proposed contract model because we can control against senior workers undertaking more overtime due to major changes in their job descriptions. We note also from Table 2 that the probability of undertaking paid overtime, controlling for job tenure, rises in age. Figure 2 shows that the incidence of overtime working peaks among individuals in their middle 20s to middle 40s. We find that the probability of overtime working is positively related to jobs in which collective bargaining takes place, a result compatible

if they are first recorded at a later stage. No such retrospective question is asked in the NESPD and this accentuates the tenure gaps between the two panel surveys.

¹⁰ Note that this is an average across weekly overtime hours of the individual. The marginal rate may be higher. For example, some individuals may work during weekends or holiday periods at higher premium rates. There is quite strong British evidence, however, that the overtime premium does not vary by length of overtime hours (Bell and Hart, 2003).

with our wage-hours contract formulation. Finally, the probability of working overtime is found to be strongly procyclical.

Our model provides an incentive to work long hours by paying hourly contract wages for all trained workers below marginal product and hourly overtime pay for longer tenured workers above marginal product. Under such an incentive structure we would expect that this would serve to reduce the probability of job separation among overtime workers. This expected outcome is supported by our results in Table 3. The probability of separations in a given time period is significantly lower among workers who worked overtime in the previous period. Age is also negatively related to job separations, which is a well known result in the literature. Younger workers generally display more job mobility than older workers. We find that the probability of job separations among plant and machine operatives is significantly procyclical. Our theory is couched in terms of equally productive workers in given jobs. Therefore, we additionally control for individual fixed effects and job-match fixed effects. From the last two columns in Table 3 we see that, if anything, our results are enhanced in these specifications.

Table 4 contains the BHPS estimates that are designed to test if our modelling outcomes are consistent with the overtime schematic portrayed in Figure 1, with $k.w_2 > VMP_2 > w_2$. As discussed earlier, we show estimates based on both ordered and simple probits. If these inequalities hold then the prediction is, via equation (17), that the probability desired hours exceed actual hours should correlate (i) negatively with tenure, (ii) positively with tenure interacted with working overtime, and (iii) positively

over the sum of these two effects. We argue in Section 3 that there is reason to test the underlying empirical model in respect of all operatives (aged 16 to 65) and prime age operatives (25-45). All three predicted signs hold for both age ranges. However, statistically, the restriction in (iii) is supported by a Wald test only in respect of the narrower age sample.

We plotted the average real hourly wage rates (excluding overtime) associated with estimated average premiums rising in steps of 0.05 in the range 1.0 to 2.0. Outcomes in respect of all operatives are shown in Figure 3. For most of the range the relationship is strongly negative. Only at very high average premiums – in excess of 1.55 – does the relationship cease to hold. Only 11.7 % of overtime workers receive an average premium higher than 1.55. In line with this evidence, our wage regression estimates of equations (19), shown in Table 5, support a significantly negative wage-premium relationship. Additionally, we find positive wage returns to job tenure and to age. We also find that wage rates are higher for workers covered by collective agreements. Directions of impact and significance levels are not altered when we control for individual and job match fixed effects but the steepness of the negative wage-premium trade-off is reduced.

7 Conclusion

Given job specific human capital combined with information asymmetries, we view premium-paid overtime working as providing a means of the firm and its workers achieving mutual benefits from working long hours. Where work schedules beyond the standard workday are considered to be potentially profitable, then paying for overtime

hours above marginal product to senior trained workers and standard hours below marginal product to all trained workers provides a more efficient contractual outcome than the payment of a single hourly wage rate. Despite other motives for working paid overtime, such as to meet short-term unforeseen bottlenecks, our proposed model gains support from evidence based on British plant and machine operatives.

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Appendix: Desired and actual hours in the BHPS

The key question asked in the BHPS is: "*Thinking about the hours you work, and assuming that you would be paid the same amount per hour, would you prefer to (a) work fewer hours, (b) work more hours, (c) continue with the same hours.*"¹¹ How does this question link to our analysis? For a respondent who works no overtime and is remunerated at the basic hourly rate, the interpretation of the question is unambiguous. Consider the response of an overtime worker. In this case, the question arises as to whether the respondent treats the marginal wage as the basic wage or the overtime wage (i.e. the basic rate times the overtime premium). Two possibilities arise. First, an overtime worker regards a desired increase/decrease in hours in terms of a change in overtime hours. This is likely to be the case because basic hours are generally stipulated in British wage contracts to constitute the first hours worked during the working day or week. If overtime is scheduled then overtime hours follow on from the agreed number of basic hours. It follows in this case that an overtime worker would perceive that changing hours at the margin means changing overtime hours. Second, a less likely response among overtime workers may occur if the BHPS question was interpreted as referring to basic hours in relation to basic wage rates. They may then indicate that they would prefer to work fewer basic hours while regarding their overtime hours as unchanged. Thus the BHPS question may result in an under-estimation of a positive hours' response.

¹¹ Additionally, the survey records 'inapplicable', 'proxy respondent' and 'don't know' responses, which we ignore.

Figure 1 Second-period hourly pay profile

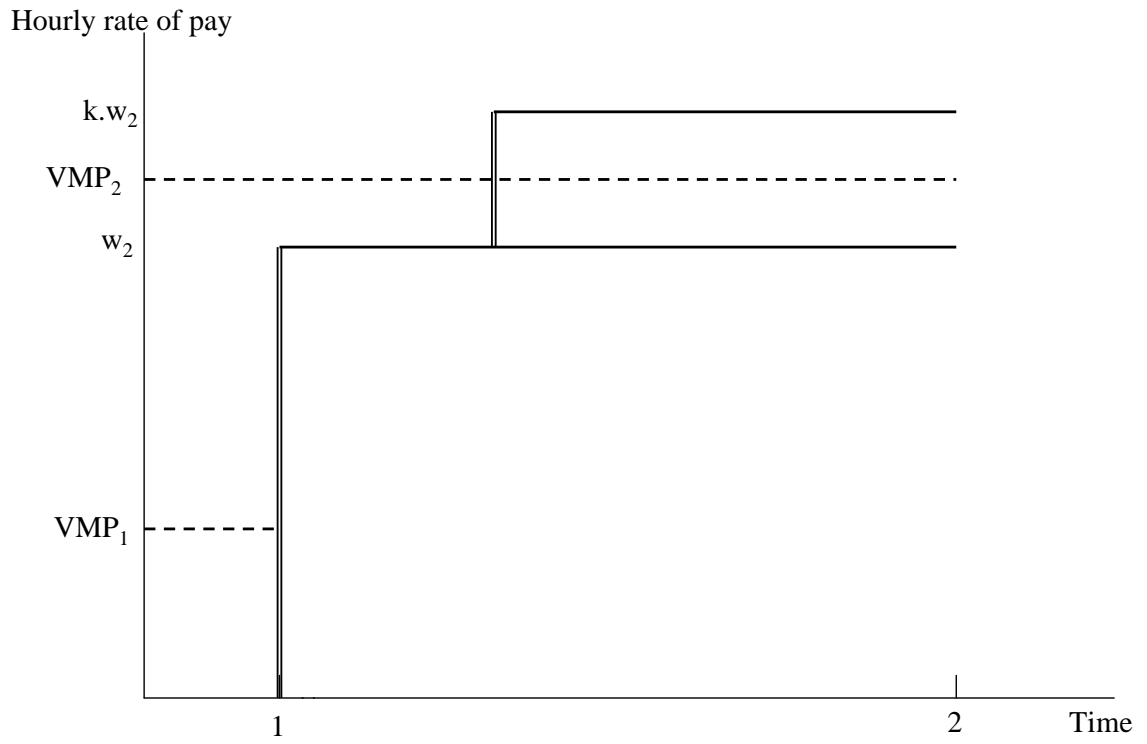


Figure 2 Age distribution of plant and machinery observations: 1991-2011 (NESPD)

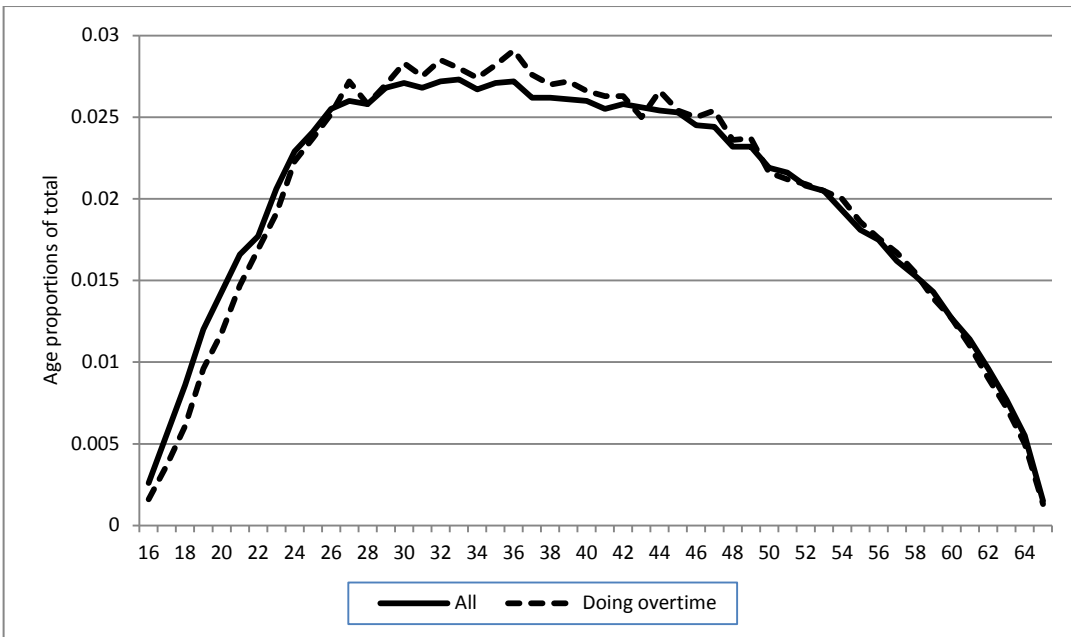


Figure 3 Real basic hourly wages and the overtime premium: plant and machine operatives aged 16-65, 1991-2011 (NESPD)

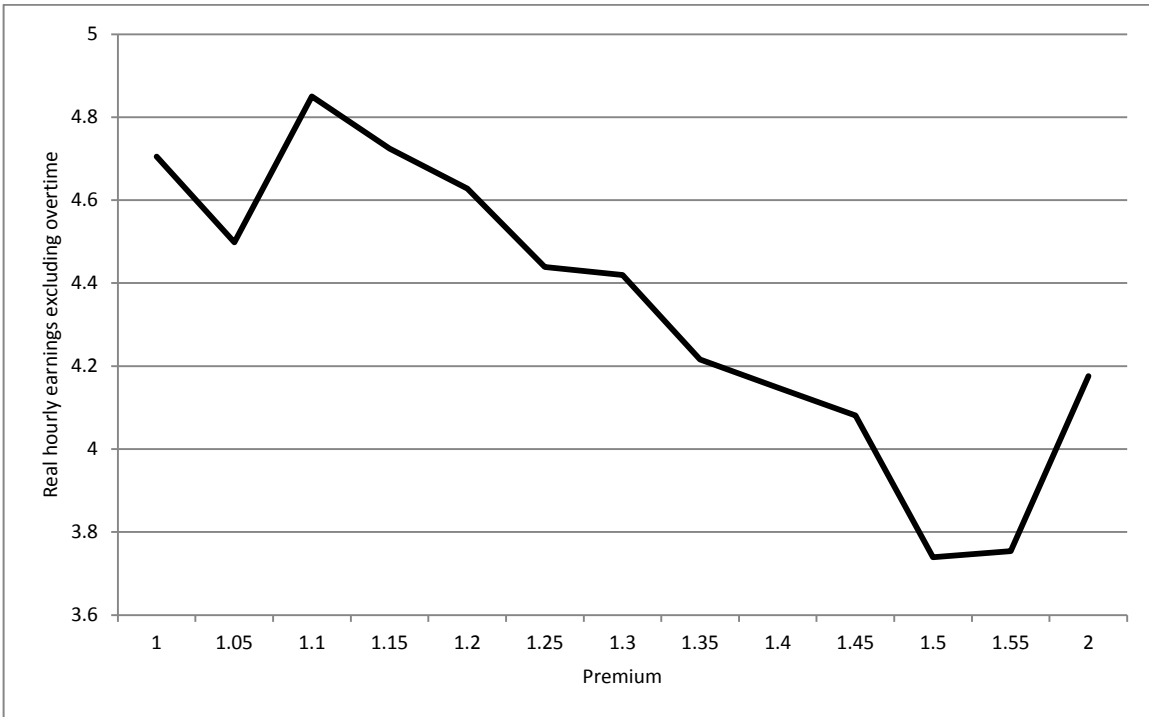


Table 1 Background statistics: plant and machine operatives, NESPD (1991-2011) and BHPS (1991-2008)

	Operatives aged 16-65		Operatives aged 25-45
	NESPD	BHPS	BHPS
Percentage working paid overtime	54.3	53.1	54.8
Standard weekly hours of overtime workers	39.4	40.3	40.7
Standard weekly hours of all workers	39.4	40.4	41.0
Average weekly paid overtime hours of overtime workers	9.5	10.7	11.1
Average weekly paid overtime hours of all workers	5.2	5.7	6.1
Average years of job tenure (NESPD)/employer tenure (BHPS) of overtime workers	2.8	5.4	4.1
Average years of job tenure (NESPD)/employer tenure (BHPS) of all workers	2.8	5.5	4.4
Average real weekly earnings of overtime workers (£'s)	222.3	212.3	222.3
Average real weekly earnings of all workers (£'s)	203.5	200.9	211.6
Average overtime premium	1.4	1.4	1.4
Proportion of total males whose desired hours > actual hours	-	6.7	7.0
Proportion of total males whose desired hours = actual hours	-	56.5	56.2
Proportion of total males whose desired hours < actual hours	-	36.8	36.8

Table 2 OLS estimates of working paid overtime: plant and machine operatives, NESPD, 1991-2011

	Step1 estimates
JOB TENURE	0.0082** (0.0016)
(JOB TENURE)²/100	-0.0459** (0.0127)
AGE	0.0157** (0.0011)
AGE²/100	-0.0185** (0.0014)
COLLECTIVE BARGAINING	0.0186* (0.0056)
Industry and year dummies	Yes
Sample size	62,275
	Step 2 estimate
Δ (UNEMPLOYMENT)	-0.0150** (0.0045)
Constant and time trend	Yes
Sample size	21

Notes: Sample: male plant and machine operatives aged 16 to 65. Bracketed figures are standard errors and ** (*) denotes 1% (5%) significance.

Table 3 OLS estimates of job separations: plant and machine operatives, NESPD, 1991-2011

	OLS	Individual fixed effects	Job fixed effects
	Step 1 estimates		
WORKED PAID OVERTIME IN PREVIOUS PERIOD	-0.0268** (0.0033)	-0.0354** (0.0045)	-0.0310** (0.0043)
AGE	-0.0057** (0.0010)	-0.0256** (0.0054)	-0.0520** (0.0056)
AGE²/100	0.0040** (0.0012)	0.0137** (0.0030)	0.0512** (0.0040)
Industry, collective bargaining, and year dummies	Yes	Yes	-
Industry and year dummies	-	-	Yes
Sample size	40,242	40,242	40,242
	Step 2 estimates		
Δ (UNEMPLOYMENT) (all separations)	-0.0184** (0.0038)	-0.0120** (0.0025)	-0.0146** (0.0020)
Constant and time trend	Yes	Yes	Yes
Sample size	21	20	20

Notes: Sample: male plant and machine operatives aged 16 to 65. Bracketed figures are standard errors and ** (*) denotes 1% (5%) significance.

Table 4 Ordered probit and probit estimates of wanting more versus less hours at the same hourly wage rate: plant and machine operatives, BHPS, 1991-2008

	Operatives aged 16-65		Operatives aged 25-45	
	Ordered	More versus Less	Ordered	More versus Less
ETEN	-0.0100** (0.0037)	-0.0242** (0.0082)	-0.0186** (0.0062)	-0.0426** (0.0146)
OVT.ETEN	0.0104* (0.0047)	0.0318** (0.0105)	0.0297** (0.0083)	0.0667** (0.0183)
EXP	-0.0310** (0.0058)	-0.0408** (0.0120)	-0.0178 (0.0202)	0.0082 (0.0413)
(EXP)²/10	0.0049** (0.0011)	0.0054* (0.0025)	0.0035 (0.0057)	-0.0045 (0.0116)
OVT.EXP	-0.0209* (0.0043)	-0.0344** (0.0089)	-0.0175 (0.0107)	-0.0263 (0.0220)
(OVT.EXP)²/10	0.0038** (0.0011)	0.0045 (0.0025)	0.0008 (0.0045)	-0.0016 (0.0093)
[more hours]ETEN + [more hours]OVT.ETEN = 0 Prob > chi2	0.89	0.27	0.05	0.04
Sample size	6,260	2,725	2,709	1,232

Notes: Bracketed figures are standard errors and ** (*) denotes 1% (5%) significance. OV is a dummy variable that equals 1 if a worker is working paid overtime, otherwise zero. Additional controls in the BHPS regressions are (i) levels of pre-work education (five levels from university degree to legal minimum years of schooling), (ii) a dummy denoting whether cohabiting with partner, (iii) dummy denoting whether divorced, (iv) the age of youngest dependent child, and (v) year fixed effects.

Table 5 Estimates of wage – premium relationship: plant and machine operatives, NESPD, 1991-2011

	OLS	Individual fixed effects	Job fixed effects
AVERAGE PREMIUM	-0.0275** (0.0013)	-0.0169** (0.0009)	-0.0120** (0.0008)
JOB TENURE	0.0291** (0.0010)	0.0156** (0.0008)	0.0196** (0.0019)
(JOB TENURE)²/100	-0.1149** (0.0078)	-0.0685** (0.0062)	-0.0594** (0.0053)
AGE	0.0450** (0.0070)	0.0436** (0.0018)	0.0290** (0.0022)
AGE²/100	-0.0521** (0.0008)	-0.0447** (0.0012)	-0.0317** (0.0017)
COLLECTIVE BARGAINING	0.1233** (0.0035)	0.0390** (0.0043)	-
Year dummies	Yes	Yes	Yes
Industry dummies	Yes	-	Yes
Sample size	62,265	62,265	62,265

Notes: Dependent variable is log (real basic hourly wage rate). Sample: male plant and machine operatives aged 16 to 65. Bracketed figures are standard errors and ** (*) denotes 1% (5%) significance.