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CONTRACTED WORKDAYS AND ABSENCE*

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We present results of a negative binomial model on the determinants of the number of days of absence in a given year for a sample of 2049 workers drawn from three factories. We find evidence of the terms of the remuneration contract being important and we offer an interpretation of the differential effect of the company sickpay scheme on the behaviour of workers contracted to work four or five days a week.

1 Motivation

The number of days lost due to absence is often taken as an indicator of the effectiveness of the personnel policies in a given firm, and evidence that it occupies the thoughts of personnel managers can be gleaned from an examination of absenteeism surveys by the Confederation of British Industry (1995) in which the main object of attention is the number of days of absence in various industries. Economists also have an interest in the study of absence as it can reveal aspects of the relationship that might exist between workers' behaviour and their contractual arrangements. Personnel managers should also be interested in this relationship as it could inform the design of their personnel policies. In this paper we analyse the effect of a company sickpay scheme which, we argue, will impact differently on workers with different contracts.

2 Data

The data are drawn from a manufacturing firm operating production lines (see Barmby *et al.*, 1991, 1995). Workers have fixed daily hours and weekly days of work, N. Workers are contracted to work either four or five days

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in a week, but four-day workers do not necessarily work fewer daily hours. The workers, as part of their remuneration contract, are entitled to company sickpay which is a function of their past absence history. The essence of this scheme is that workers with low absence (where 'low absence' approximates to less than 10 days per year on average, calculated over the previous two years) will be graded A and entitled to replacement of basic earnings plus normal bonuses (up to a third of basic pay) when absent. However, there are exceptions to this rule, with some absence defined as 'condonable' and disregarded by the firm in calculating future sickpay entitlement. An additional factor involves the conditions under which the firm can recover part of the sickpay costs from the government; for some absence this will not be possible and consequently will impact more on sickpay entitlement. Those workers with higher absence, between 10 and 20 days' absence, on average, will be graded B and only entitled to basic pay, and those workers with more than 20 days' average absence will be graded C and not entitled to any company sickpay at all. This sickpay scheme therefore defines the earnings lost for a day's absence and we incorporate this directly as an explanatory variable in the same way as in Barmby *et al.* (1997). This cost is on average smaller for grade A workers. Of the 1099 workers who were in grade A in 1988 over half, 568, earned bonuses above a third of normal pay; and their conditional average cost was £6.36. For grade B workers cost equals normal bonuses; 611 of the 675 workers were in receipt of these in 1988, with a conditional mean of £9.12. For grade C workers cost is the difference between normal earnings and the statutory minimum sickpay level; this applied for all 275 workers in the grade with a mean of £30.18. It is important to note that the sickpay for both four and five day a week workers is determined under this scheme.

3 A Count Data Model of Absence

Our estimation uses a negative binomial model for the number of days of non-condonable absence recorded for a worker in a given year in three factories. Summary statistics on this variable are given in Table 1.

Table 1
Number of Non-Condonable Days of Absence

Factory	*Mean of absence*	*Standard deviation of absence*	*Number of workers*
1	9.8817	17.8473	668
2	7.1797	8.2537	651
4	9.5137	16.7563	730
All	8.8921	15.0563	2049

The negative binomial model is fully described by Winkelmann (2000), but briefly the distributional form results from allowing for unobserved heterogeneity in a Poisson model in the following way. Assume Y_i (the count of the event) has a Poisson distribution written as

$$f(y_i \mid \lambda_i) = \frac{\exp(-\lambda_i)\,\lambda_i^{y_i}}{y_i!} \qquad \lambda_i = E(Y_i) = \mathrm{var}(Y_i) \tag{1}$$

Assume that unobserved heterogeneity is incorporated multiplicatively such that the parameter of the above Poisson can be written as $\lambda_i \exp(u_i)$ where u_i is an individual specific unobserved effect. Assume that $\exp(u)$ is distributed over the population from which the sample is drawn according to a gamma distribution $\mathrm{G}(1/\alpha, 1/\alpha)$ or, which is equivalent, that u has a log-gamma distribution. Integrating out this unobserved effect gives a marginal density of a negative binomial form:

$$\begin{aligned} Y_i \sim g(y_i \mid \lambda_i, \alpha) &= \int_0^\infty f[y_i \mid \lambda_i \exp(u_i)]h(u_i)\,\mathrm{d}u_i \\ &= \frac{\Gamma(1/\alpha + y_i)}{\Gamma(1/\alpha)\Gamma(y_i + 1)} \left(\frac{1}{\alpha\lambda_i + 1}\right)^{1/\alpha} \left(\frac{\alpha\lambda_i}{\alpha\lambda_i + 1}\right)^{y_i} \end{aligned} \tag{2}$$

with $E(Y_i) = \lambda_i$ and $\mathrm{var}(Y_i) = \lambda_i + \alpha\lambda_i^2$. Note that since $E(Y_i) < \mathrm{var}(Y_i)$ this mixing argument is often referred to as 'accounting for overdispersion'.

4 A Model of Absence

To implement the above model we can write $\lambda_i = \exp(x_i'\beta)$ and estimate by maximum likelihood, where x_i' will contain a vector of regressors relevant to the worker's absence decision. In constructing our specification we are guided by the idea that workers' absence, *ceteris paribus*, is conditioned on the terms of their remuneration contract. In particular we pay very close attention to constructing a measure of the cost, to an individual worker, of a day's absence. As we have already discussed, this cost will be driven by a number of things including the worker's sickpay grade, their basic pay and their 'normal' overtime and bonus payments, which we observe.

One of the main objectives of this paper is to consider the effect of the weekly number of workdays on absenteeism. On average four-day workers do not work fewer daily hours than five-day week workers; indeed the respective conditional means are 9.62 hours as against 7.25 hours, reflecting differing shift patterns. To focus on the effect of contracted days let Y denote the total number of days of absence in a year and consider two workers with the same underlying propensity to be absent but who have different contracted days. The expected number of absence days will be higher for the worker with more contracted days. This is simply a 'period-at-risk' effect, which might well obscure other systematic effects. Referring to the standard result on the derivation of a Poisson density, the expectation of the number of observed occurrences of the event is the hazard of the underlying waiting time distribution multiplied by the period at risk. We take the period at risk to be the number of contracted days minus the number of condonable absence days in the year,[1] and we write that

$$E(Y_i \mid N_i) = \exp(x_i'\beta)\, N_i = \exp(x_i'\beta + \ln N_i) \tag{3}$$

where $\exp(x_i'\beta)$ defines the underlying propensity (or hazard) for absenteeism that might depend on factors such as gender, wage, sickpay etc. Clearly for otherwise identical five- and four-day week workers

$$\frac{E(Y \mid N = 5)}{E(Y \mid N = 4)} = \frac{5}{4} \tag{4}$$

We will test this proportionality assumption against a model where the weekly number of workdays has an effect over and above the effect of period at risk. Define a dummy $D_{N=5}$, which takes the value 1 if the worker is contracted for five days and 0 if the worker is contracted for four days, and rewrite (3) as

$$E(Y_i \mid N_i) = \exp(x_i'\beta + \delta D_{N=5})\, N_i = \exp(x_i'\beta + \delta D_{N=5} + \ln N_i) \tag{5}$$

Now

$$\frac{E(Y \mid N = 5)}{E(Y \mid N = 4)} = \exp(\delta)\frac{5}{4} \tag{6}$$

and $\exp(\delta) - 1$ measures the percentage difference in absence rates of five-day workers relative to four-day workers, and the appropriate null hypothesis to test for such a difference is $H_0\colon \delta = 0$; this is the testing procedure we use in this paper.[2]

[1]To test for the possibility that the annual hours might be a more appropriate measure of exposure, following footnote 2 we enter ln(hours) and ln(annual days) as regressors and test jointly for both coefficients being equal to one; this hypothesis was rejected on our sample.

[2]Note that this requires the inclusion of a logarithmic offset with coefficient set equal to one: some package programs may not allow this. Two simple to implement alternatives are available. First, noting that $\ln N = \ln 4 + (\ln 5 - \ln 4)D_{N=5}$, model (5) can be written as

$$E(Y \mid N) = \exp[\ln 4 + x'\beta + (\ln 5 - \ln 4 + \delta)D_{N=5}] = \exp(\ln 4 + x'\beta + \delta' D_{N=5})$$

where $\ln 4$ becomes part of the constant. The hypothesis $H_0\colon \delta = 0$ can be restated as $H_0\colon \delta' = \ln(5/4)$. Second, we could omit the dummy variable in (5) and leave the coefficient on the offset γ unrestricted. In this case, the proportionality assumption leads to the hypothesis $H_0\colon \gamma = 1$.

TABLE 2
NEGATIVE BINOMIAL MODEL FOR NUMBER OF NON-CONDONABLE ABSENCES IN YEAR

Variable (mean)	*Coefficient*	*Standard error*	*|t ratios|*
Married (0.69)	0.1512	0.0701	2.16
Female (0.58)	0.2379	0.0779	3.05
Grade B (0.33)	0.4869	0.0642	7.58
Grade C (0.13)	1.0295	0.1423	7.24
Daily hours (7.62)	−0.9208	0.9904	0.93
$(\text{Daily hours})^2$ (60.26)	0.1669	0.1511	1.10
$(\text{Daily hours})^3$ (490.21)	−0.0095	0.0076	1.26
Five (0.84)	−0.6270	0.2779	2.26
Five × factory4 (0.29)	−0.3777	0.1680	2.25
Five × factory1 (0.31)	−0.2318	0.2904	0.80
Age/10 (4.22)	−0.4712	0.1840	2.56
$(\text{Age}/10)^2$ (19.34)	0.0478	0.0217	2.20
Factory4 (0.36)	0.3728	0.1504	2.48
Factory1 (0.33)	0.5455	0.2747	1.99
Cost (10.47)	−0.0240	0.0075	3.20
$(\text{Cost}/10)^2$ (2.63)	0.0401	0.0198	2.71
Constant	−0.5534	2.2123	0.25
ln(α)	0.3171	0.0357	8.89
ln-likelihood		−6446.732	
Diagnostics			
1. Overall goodness of fit	$248.4 > \chi^2_{16} = 26.30$		
2. Interactive terms	$9.6 < \chi^2_{11} = 19.68$		
3. Poisson against negative binomial	$16986.1 > \chi^2_1 = 3.841$		

Note: Sample size 2049.

5 RESULTS

The results of estimating a negative binomial count data model for the number of non-condonable days of absence for a sample of 2049 workers in 1988 are given in Table 2. The data used are from three of the four factories studied in Barmby *et al.* (1991) that have both four-day and five-day contracts.[3] We take as our dependent variable the number of non-condonable days of absence: certain reasons for sickness absence, such as hospitalization, are viewed as condonable absence by the firm (and do not attract any sickpay point penalty).

As shown in previous work by Barmby *et al.* (1991, 1995), women have a higher absence rate than men. Likewise we find the same strong effect of sickpay status and a significant negative effect of daily cost. The effect of cost appears to be non-linear and will be negative for all but five of the workers in our sample. We included daily hours together with squared and cubed terms as regressors and found the effect from hours to be robustly insignificant (collectively they are insignificant). In some ways

[3]The numbering of the factories is the same should any reader wish to cross-reference the work.

this is a bit of a puzzle as *a priori* it might be thought that, at higher contracted hours, a worker's higher marginal rate of substitution of goods for leisure might make the marginal non-market hour more valuable. However, in the context of these factories workers will select onto the longer hour shifts and those who will choose these lengthier shifts will tend, we conjecture, to have less steeply sloped indifference curves.

Other diagnostics included are the overall goodness of fit where the model is compared with a model which just includes a constant; we also interacted the $D_{N=5}$ dummy with other variables in the specification to see if the two groups of workers differed in other significant ways, and finally we included the standard test of the Poisson specification against a negative binomial. Our estimate of the variance α of the unobserved term is computed as 1.37.

The most surprising finding of our study, on the face of it, is that five-day week workers have significantly *lower* absence rates than four-day week workers. The effect is significant and large for all of the three factories studied, with the size of the effect ranging from $\exp(-0.6270) - 1 = 46$ per cent lower absence for five-day workers compared to four-day workers for factory 2 to $\exp(-1.0047) - 1 = 63$ per cent lower for factory 4, and we are at the same time conditioning for daily hours effects in a reasonably flexible way (although our estimates are statistically insignificant), so higher absence rates of four-day workers cannot be explained by their higher hours. Indeed if hours are removed from the specification the range of effects for five-day workers is $\exp(-0.2584) - 1 = 23$ per cent less to $\exp(-0.6500) - 1 = 48$ per cent less, and we would be understating our case due to the negative relationship between hours per day and days per week.

However, there is a rationale for four-day workers having a higher absence rate which is related to the operation of the sickpay scheme. Remember that the terms of the sickpay scheme apply equally to both four- and five-day week workers, and consider that, *other things remaining equal*, workers alter their absence rate so as to be in their chosen sickpay band. Since five-day week workers will work approximately 240 days in a given year, an absence rate of 4.16 per cent (or less) will keep them in grade A, between this and 8.33 per cent will mean that they are B graded and greater than this will put them in grade C. The equivalent rates for four-day week workers are 5.2 per cent and 10.4 per cent, i.e. 25 per cent higher. We suggest that, at least in part, the higher absence rates for four-day week workers is due to the disproportionate generosity of the sickpay scheme for four-day workers.

6 Conclusion

This paper analyses the absence behaviour of a sample of industrial workers employed in three factories of the same firm using a negative binomial model of annual days of absence. We find significant negative effects of the daily cost of absence, and suggest that, at least in part, the higher underlying propensity for absence found for four day a week workers can be rationalized in terms of the disproportionate generosity of the sickpay scheme towards four-day workers. Both of these findings add weight to the view that the terms of employees' remuneration contracts are important determinants of workers' (in this case absence) behaviour, and that quantifying these effects can provide important practical tools in economic personnel decisions.

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