# CONTRACTED WORKDAYS AND ABSENCE

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# *Discussion Paper*

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## 1   Motivation

The analysis of numbers of workdays lost due to absence is of interest to at least two groups. Firstly, evidence that personnel managers in industry are interested is found in the 1995 report of the Confederation of British Industry (CBI) which discusses a survey of its members where the main variable focussed on is days lost due to absence. Secondly, academic economists will also have interest in the study of absence as it will be potentially revealing about the relationship which exists between workers' behaviour and their contractual arrangements. In this paper we analyse the effect of a sickpay scheme which, we argue, will impact differently on workers with different contracts. In addition in analysing data of this type different workers potentially will be contracted to work different numbers of days in any particular period. Therefore observing workers to be absent for different numbers of days doesn't necessarily reflect that they have different underlying propensities to be absent, we discuss ways in which this can be accounted for.

## 2   Data

The data is drawn from a manufacturing firm operating production lines, see Barmby,

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Orme and Treble (1991,5). Workers have fixed daily hours and weekly days of work, $N$. Workers will either be contracted to work 4 or 5 days in a week, but 4 day workers don't necessarily work fewer weekly hours. All but one 4 day workers are on 39 hours a week contracts, which is the modal contract, whereas 22 percent of 5 day workers work fewer than 35 hours, (this characteristic of the sample will be important in the interpretation of our results). 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 the scheme is that workers with low absence (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 1/3 of basic pay) when absent, those workers with between 10 and 20 days absence, on average, will be graded B and only be entitled to basic pay, and those workers with more than 20 days average absence will be graded C and not be 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 Barmby, Bojke and Treble (1997). This cost is essentially zero for grade A workers (as very few would earn normal bonuses which exceed 1/3 of basic pay); for grade B workers it will equal normal bonuses over and above basic earnings and for grade C will be the difference between normal earnings and the statutory minimum sickpay level, the grade C cost will almost certainly be the largest. It is important to note that the sickpay for both 4 and 5 day week workers is determined under this scheme.

## 3   A Count Data model of Absence

Our estimation uses a Negative Binomial model for the observed number of days absence, this is fully described in Winkelmann (1997). This 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

$$f(y_i|\lambda_i) \;=\; \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!}$$

$$\lambda_i \;=\; \mathrm{E}(Y_i) = \mathrm{Var}(Y_i) \tag{1}$$

Assume that unobserved heterogeneity is incorporated multiplicatively such that the parameter of the above Poisson can be written as $\lambda_i u_i$ where $u_i$ is an individual specific unobserved effect . Assuming that $\epsilon^u$ is distributed over the population from which the sample is drawn according to a Gamma distribution $G(\frac{1}{\alpha}, \frac{1}{\alpha})$; (or equivalently that $u$ has a log-gamma distribution, denoted by $h(u)$ and the individual specific unobserved terms in the sample are drawings from this distribution). Integrating out the unobserved term to form the Marginal density gives

$$Y_i \quad \sim \quad g(y_i|\lambda_i, \alpha) = \int f(y_i|\lambda_i u) h(u) du$$

$$g(y_i|\alpha_i, \lambda_i) \quad = \quad \frac{\Gamma(1/\alpha_i + y_i)}{\Gamma(1/\alpha_i)\Gamma(y_i + 1)} \left(\frac{1}{\alpha\lambda_i + 1}\right)^{1/\alpha_i} \left(\frac{\alpha\lambda_i}{\alpha\lambda_i + 1}\right)^{y_i} \tag{2}$$

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

## 3.1   Specifying 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. Our specification decision will be driven by the idea that workers' absence 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, of a days 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. We observe the first two of these and we approximate the last by taking the average for the individual over the year.

The way in which workers differing contracted days and therefore their different "period of risk" effects are discussed in the next section, but of course 4 and 5 day a week workers might well differ in other influential ways. In particular, four days workers work on average 9.70 hours per day, while fives day workers work on average 7.15 hours per day, this reflects different shift patterns worked. It could, for instance, be the case that absenteeism is an

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increasing function of daily working hours. Without controlling for this effect, this would upward bias the estimated absence rate of four days workers.

To test for a possible effect of daily working hours we estimate the regression including daily hours in the specification, along with gender, sickpay grade and daily cost. The models considered so far are restrictive in that they limit the influence of the number of work days or part-time work to a shift in the intercept. A more general model would allow the slope parameters to vary between the different type of workers as well. We will test for the presence of such interactive terms in what follows. This might be particularly important which respect to the cost term as in some sense 4 day a week workers might be less sensitive to a given level of daily absence cost than 5 day workers as their exposure to it is less.

### 3.2 "Period at risk" effects

To consider the effect of the number of weekly workdays on absenteeism, let $Y$ denote the total number of days absent in a year. Consider two workers with the same underlying propensity to be absent but who have different contracted days; the expected number of absent days would be higher for the worker with more contracted days. This is simply a "period-at-risk" effect, which might well obscure other systematic effects. As a benchmark, we model the expected number of absent days as proportional to the weekly number of work days $N$:

$$
\begin{aligned}
E(Y|N) &= \exp(x\beta)N \\
&= \exp(x\beta + \log N)
\end{aligned}
\tag{3}
$$

where $\exp(x\beta)$ defines an underlying propensity for absenteeism that might depend on factors such as sex, wage, and sick-pay status. Clearly, for otherwise similar workers,

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

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

$$
\begin{aligned}
E(Y|N) &= \exp(x\beta + \delta D_{N=5})N \\
&= \exp(x\beta + \delta D_{N=5} + \log N)
\end{aligned}
\tag{5}
$$

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Now,

$$\frac{E(Y|N=5)}{E(Y|N=4)} = e^{\delta}\frac{5}{4} \tag{6}$$

and $e^{\delta} - 1$ measures the percentage difference in absence rates of five days workers relative to absence rates of four days workers.

Based on the regression (5), we can immediately test for the effect of number of workdays by proposing the null hypothesis $H_0 : \delta = 0$. The problem with this approach is that is requires the inclusion of a *logarithmic offset* in the regression (i.e. the logarithm of the period at risk with coefficient restricted to one). Not every software package will allow this, (STATA is one that does, but LIMDEP is one that dosen't). We now present two alternative tests that avoid the requirement for including an offset.

Note that since $\log N = \log 4 + (\log 5 - \log 4)D_{N=5}$, Model (5) can be rewritten as

$$\begin{aligned} E(Y|N) &= \exp[\log 4 + x\beta + (\log 5 - \log 4 + \delta)D_{N=5}] \\ &= \exp[\log 4 + x\beta + \delta' D_{N=5}] \end{aligned} \tag{7}$$

where $\log 4$ gets absorbed into the constant. The hypothesis $H_0 : \delta = 0$ can now be restated as $H_0 : \delta' = \log(5/4)$. If $\delta' > (<)\log(5/4)$, then five days workers have overproportionally more (fewer) absence days than four days workers. The advantage of this approach is that it a) has a very intuitive interpretation, and b) does not require a software package with the ability to handle offsets. In a similar way as above the percentage difference in absence rates between 5 and 4 day week workers can be computed as $e^{\delta' - \ln(5/4)} - 1$

Finally, we can in (5) omit the dummy variable and leave the coefficient for the logarithmic offset unrestricted. Rewriting Model (5) we obtain

$$\begin{aligned} E(Y|N) &= \exp[(1-\gamma)\log 4 + x\beta + [\delta + (1-\gamma)(\log 5 - \log 4)]D_{N=5} + \gamma\log N] \\ &= \exp[(1-\gamma)\log 4 + x\beta + \delta'' D_{N=5} + \gamma\log N] \end{aligned} \tag{8}$$

where $(1-\gamma)\log 4$ gets absorbed into the constant. But if we omit the dummy variable we have $\delta'' = 0$, *i.e.* $\gamma = 1 - (\log 4 - \log 5)\delta$. Therefore, the restriction $\delta = 0$ now implies that $\gamma = 1$. In other words, in a regression of $Y$ on $x$ and $\log N$, a test of Model (3) against Model (5) is a test of the restriction $\gamma = 1$.

It has to be emphasized that all three tests can be conducted by standard $t$-tests and lead to numerically identical results. In our empirical analysis we use the second formulation due to ease of implementation.

# 4    Results and Discussion

Results are given in Table 1, these estimated parameters and standard errors for a negative binomial model. A likelihood ratio test of the Poisson against the Negative Binomial gives a test statistic value of 4321.669 clearly identifies the negative binomial model as the superior model, i.e. the Poisson assumption of equal conditional expectation and variance is overly restrictive. Tests for joint significance show that the models are well determined. Moreover, the negative binomial model shown here cannot be rejected against a more general model where all $x$-variables are interacted with the five days dummy. In other words, the effect of the number of workdays is sufficiently well captured by a shift in the intercept. These test statistic values are also given in the Table.

**Table 1: Regression Results for Absenteeism Data**

(Standard errors in parentheses)

|                                          | Negative Binomial |          |
| ---------------------------------------- | :---------------: | -------- |
| Female                                   | 0.2830            | (0.1107) |
| Grade B                                  | 0.5601            | (0.1145) |
| Grade C                                  | 1.4962            | (0.2950) |
| Cost                                     | -0.0356           | (0.0140) |
| Daily hours                              | -0.0252           | (0.0424) |
| Five day dummy                           | -0.2823           | (0.1707) |
| $\ln(\alpha)$                            | 0.1140            | (0.0650) |
| Constant                                 | 2.0367            | (0.4408) |
| Log Likelihood                           | -1952.96          |          |
| Likelihood Ratio Test Statistics:        |                   |          |
|    1. Overall Goodness of Fit | 79.36         |          |
|    2. Interactive Terms   | 6.36              |          |
|    3. Poisson against Negative Binomial | 4321.669 |       |
| Number of Observations                   | 615               |          |

As shown in the previous work by Barmby, Orme and Treble (1991,5), women have higher absence rates than men. Likewise, we find the same strong effect of sickpay status and daily cost on the expected number of absent days, which confirm the importance of this part of the contract structure.

The surprising finding of our study is that five days workers are significantly less absent than four days workers. The effect is highly significant and large. While, based on the pure period-at-risk effect, we would expect five days workers to have $5/4-1 = 25$ percent more absent days, we find that they are predicted to have $e^{-0.2823} - 1 = 24.6$ percent fewer absent days. Hence, compared to four day workers, they have a $e^{-0.5054} - 1 = 39.7$ percent lower absence risk. Alternatively, consider a four days worker with 1 expected absent day. A five days worker with the same absent risk should have 1.25 absent days. The actual prediction is $1-0.246 = 0.754$ absent days. Hence, the absent rate of a five days worker is predicted to be $0.754/1.25 -1 = 39.7$ percent below the absent rate of a four days worker. The higher absence rates of four days workers cannot be explained by their higher daily working hours since we control for this effect. In fact, we find that the coefficient on daily hours is insignificant.

However there is a rationale for 4 day a week workers having a higher absence rate which is related to the operation of the sickpay scheme. Remember that the terms of the sickpay scheme applies equally to both 4 and 5 day a week workers, and consider that, *other things remaining equal*, workers alter their absence rate so as to be in their chosen sickpay band. Since 5 day workers will work approximately 240 days per year an absence rate of 4.16 % (or less) will keep them in grade A, between this and 8.33 % will mean they are B graded and greater than 8.33 % will grade them C. The equivalent rates for 4 day workers are 5.2 % and 10.4 %, that is 25% higher. We suggest that, at least in part, the higher absence rates for 4 day workers will be due to the disproportionate generosity of this sickpay scheme for 4 day workers.

## 5  Concluding Remarks

This short paper outlines ways in which data on counts of absence days can be analysed when workers in the sample are contracted for different numbers of working days. It develops three equivalent tests for whether the number of contracted days has an effect over and above the

alteration of the period at risk. This test could also be thought of as testing the proposition that workers with different contracted days have the same propensity of absenteeism.

We find significant (negative) effects from the daily cost of absence, and suggest that the higher underlying propensity for absence found for 4 day workers can be rationalised in terms of the disproportinate generosity of the sickpay scheme toward 4 day workers. Both of these 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 provide important practical tools in economic personnel decisions.

# References

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# LIST OF DISCUSSION PAPERS