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Industrial accidents: an economic interpretation

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I. INTRODUCTION

An accident is commonly held to be an event which occurs by chance; it may even be defined as such. Closer investigation of a random sample of factory accidents has given apparent support to this view:

> 'It appeared to the investigating Inspectors that in 50·3 per cent of the cases, no reasonably practicable precautions could have been taken by anyone in the factory to prevent the accident or to mitigate the injury; in a further 7·3 per cent, the feasibility of such precautions was in doubt.'[1]

Examples of seemingly arbitrary causes of accidents included, 'strained back mopping floor', and 'pulled chest muscle lifting a bucket (20 lbs)'. However, it could be argued that such incidents are only symptoms of general conditions which give rise to accidents. Certainly other views are held. HEINRICH (1950, p. 20) claimed to have analysed 75 000 accident cases and concluded 'that 98 per cent of industrial accidents are of a preventable kind'.

Another common view is that accidents would be reduced if employers were made aware of the actual costs incurred:

> '. . . instances are reported of young persons being almost pushed into danger as a result of misconceived ideas of economy or to maintain production. The most distressing aspect of this false economy is that it takes a serious accident . . . to act as a spur to improvement.'[2]

The presumption that the interests of *false* economy are served is indicative of a healthy humanitarian bias. It remains, however, a presumption. It requires little imagination to

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[1] *Annual Report of H.M. Chief Inspector of Factories* (1968) p. 79. These results are from a survey which covered a 5 per cent random sample of factory accidents, notified to the Inspectorate in the period 1 July to 31 December 1968.

[2] *Annual Report of H.M. Chief Inspector of Factories* (1965). See also HEINRICH (1950) p. 50, BLAKE (1963) p. 32, and BECKINGSALE (1963).

understand that the cost of preventing certain types of accident is often prohibitive; few pedestrians would be injured if all vehicles travelled in underground tunnels. In general terms,

> 'The law of diminishing returns can . . . apply to the development of new methods of guarding, and some regard must be had to the cost effectiveness before an industry is asked to accept new standards in an attempt to prevent a very small number of accidents.'[3]

Controversy over the preventability of accidents, and whether accidents serve the interests of false or true economy, is sufficient justification for attempting an economic interpretation of industrial accidents. An analogy between the accidental injury of an employee and the breakdown of a machine is the basis for the attempt.

II. AN ANALOGY

The productive life of machinery is directly related to the intensity of its use. *A priori* the probability of a mechanical fault will vary inversely with the amount of maintenance given to the machine. In the event of a breakdown, production can be resumed only when the machine ir repaired or replaced.

Similar considerations apply to the use of labour. If a worker is injured (breaks down), production can be resumed only when the man is repaired or replaced. Replacement of labour may be by other employees performing extra tasks, or by new recruits.[4]

The analogy between men and machines requires an appropriate couterpart to the maintenance of machinery. If we assume a work-period of standard length (hours per year), then non-work time – tea and lunch breaks, rest periods, holidays etc – can be taken as time for recuperation (and hence maintenance). Overtime working is then to be regarded as the neglect of maintenance. If this argument is sound, the extent to which injured workers may be replaced by others working overtime is limited, since the probability of further accidents will be directly increased. Unless the factory work-force is underemployed, replacing the injured with new recruits would appear to be the more efficient alternative. However, whereas technical considerations generally limit the speed of mechanical repairs/replacement, the ease with which injured workers may be replaced by new recruits is more likely to depend upon the state of the labour market.

III. THE MODEL

To simplify the model the direct loss of production is taken to be the only cost of breakdowns (injuries) and routine maintenance.[5] For any given level of productive inputs, an inverse technical relationship between breakdowns and maintenance is assumed. Breakdowns are at

[3] *Annual Report of H.M. Chief Inspector of Factories* (1969) p. xiii.

[4] A third alternative would be for firms to carry a 'stand-by' labour force of size $N(1+p)$ where p is the probability of an accident occurring and N is the optimum size of an accident-immune labour force. Two considerations make this impractical in all but the largest of factories: (1) p is likely to be very low (e.g. $<0{\cdot}01$ per quarter); (2) if the labour force is heterogeneous, 'stand-by' men would need to be Jacks-of-all-trades.

[5] We thus ignore the effects of institutional determinants, e.g. availability of accident insurance, variability of premiums, factory legislation etc. In addition there is an implicit assumption that a given amount of lost production, whenever it may occur, is constant in value.

a maximum when maintenance is zero. Breakdowns are reduced as maintenance is applied, but after initial reductions it is reasonable to assume diminishing returns.

Initially, there is one factor of production E, which breaks down and is maintained. Thus

$$A = f(M, E) \qquad f_e > 0; \; f_m < 0 \qquad \text{(assumption A)}$$

where A is the number of breakdowns per period, M the units of maintenance per period, and E the factor of production. If factor inputs are raised, breakdowns at any given level of maintenance would be expected to rise more than proportionately, i.e.

$$f_e > A/E. \qquad \text{(assumption B)}$$

Entrepreneurs are assumed to minimize production loss P, defined as

$$P = P_m M + P_a A$$

where P_m is the loss of production per unit of maintenance, and P_a the loss of production per breakdown. Initially P_m and P_a are assumed to be constant. From assumption A

$$P = P_m M + P_a[f(M, E)].$$

For a given level of E, to minimize P

$$\frac{\partial P}{\partial M} = P_m + P_a f'(M, E) = 0.$$

To expand production requires increased factor input. Production loss is again assumed to be minimized at this higher level of production. It is reasonable to assume that total production loss will itself be at a new higher absolute level; i.e.

$$\frac{dP}{dE} = [P_m + P_a f_m] \frac{dM}{dE} + P_a f_e > 0 \qquad \text{(assumption C)}$$

A priori we might expect the optimal expansion path to be such that the accident rate remains constant as employment increases; i.e.

$$\frac{d[f(M, E)]}{dE} = f_m \frac{dM}{dE} + f_e = \frac{A}{E} \qquad \text{(hypothesis 1)}$$

which implies that

$$\frac{dM}{dE} > 0.$$

Hypothesis 1 is clearly consistent with assumptions A, B and C.

Where the productive input is labour, the magnitude of P_a (production loss per breakdown) can reasonably be held to vary with the ease of replacing the injured employee (as indicated by an index of labour scarcity, namely the ratio of unfilled vacancies V, to the level of unemployment U). Thus

$$\frac{dP_a}{d(V/U)} > 0. \qquad \text{(assumption D)}$$

Given the condition for minimizing production loss (see above), accidents would be expected to vary inversely with the cost involved, i.e.

$$\frac{\partial A}{\partial P_a} < 0.$$

It follows that

$$\frac{\partial A}{\partial (V/U)} < 0. \qquad \text{(hypothesis 2)}$$

If expansion of production is common among firms, increased employment will lead to increased labour scarcity, i.e.

$$\frac{\mathrm{d}(V/U)}{\mathrm{d}E} > 0. \qquad \text{(assumption E)}$$

It then follows from the above that

$$\frac{\mathrm{d}A}{\mathrm{d}E} = \frac{\partial A}{\partial (V/U)} \frac{\mathrm{d}(V/U)}{\mathrm{d}E} + \frac{\mathrm{d}[f(M,E)]}{\mathrm{d}E}.$$

On the R.H.S. the first term is negative and the second term is equal to the average accident rate. The low magnitude of the latter makes it likely that accidents and employment are inversely related. Thus

$$\frac{\mathrm{d}A}{\mathrm{d}E} < 0. \qquad \text{(hypothesis 3)}$$

Once employment reaches a maximum, output can be expanded only by employing a new input, e.g. overtime working T. This is regarded as the neglect of maintenance. Then from assumption A

$$\frac{\partial A}{\partial T} > 0.$$

Initially, production would be expected to increase. However, as negative maintenance, overtime would be associated with production loss from a higher level of breakdowns. Beyond an optimal level, overtime working would produce negative returns.

IV. TESTS OF HYPOTHESES

The hypotheses to be tested are:

(1) $\frac{\mathrm{d}[f(M,E)]}{\mathrm{d}E} = \frac{A}{E}$

The marginal accident rate will equal the average accident rate, because of variations in the level of maintenance to maintain optimum production.

(2) $\frac{\partial A}{\partial (V/U)} < 0$

Industrial injuries will vary inversely with the degree of labour scarcity.

(3) $\frac{dA}{dE} < 0$

Since labour becomes more scarce as the general level of employment rises, it is very likely that accidents and employment will vary inversely.

(4) $\frac{\partial A}{\partial T} > 0$

Industrial injuries will vary directly with the amount of overtime working.

Using quarterly data for Great Britain, 1965–71, the following least squares regression equation was obtained:

$$A_{pt} = \underset{(0{\cdot}51)}{11\,247} - \underset{(7{\cdot}15)}{16\,861}(V_{yt}/U_t) + \underset{(8{\cdot}36)}{1{\cdot}66}T_{yt} + \underset{(1{\cdot}23)}{0{\cdot}0034}E_{yt} - \underset{(7{\cdot}67)}{5110}S_t \qquad (1)$$

$$R^2 = 0{\cdot}883 \quad F = 43{\cdot}5 \quad \text{D.W.} = 2{\cdot}08$$

(|t |values in brackets)

where (see Appendix):

subscript p = all factory processes
subscript y = manufacturing industry
subscript t = time in quarters
A = number of reported accidents
V = unfilled vacancies
U = number of unemployed (all sectors)
T = hours ('000) of overtime worked in a representative week
E = employment
S = third quarter seasonal dummy.[6]

Hypotheses 2 and 4 are clearly supported by the coefficients of Equation 1. If the ratio of unfilled vacancies to unemployment falls from 1 in 3 to 1 in 4, the quarterly total of industrial accidents can be expected to increase by over 1400 (i.e. > 2 per cent of the quarterly average of total accidents, 1965–71). Equation 1 also shows accidents to be significantly related to overtime (negative maintenance). Although working overtime means that men are at risk for longer periods, the size of the coefficient governing T indicates more than this.[7]

Hypothesis 1 is also supported since the coefficient governing E is not significantly different from the average accident rate of 0·007 per quarter.

To test hypothesis 3 requires the omission of the labour scarcity variable from the regression.

[6] Most employees take an annual holiday in the third quarter. When on holiday persons continue to be recorded as employed; obviously they are not at risk to industrial accidents.

[7] For every 1000 hours overtime per week, 1·66 accidents are predicted. 1000 hours of overtime is roughly equivalent to 25 extra employees (1000 ÷ 40 hour week). The average (1965–71) accident rate for all factory processes was 0·007 per quarter: this gives 0·013 accidents per week per 25 employees.

TABLE 1. $A_{pt} = a + b(V_{yt}/U_{yt}) + cT_{it} + dE_{it} + eS_t$

	Industry/process (i,p)									All
	Food	Chemicals	Metal	Engineering	Textiles	Clothing	Bricks	Timber	Paper	(y)
Constant	5961 (2·18)	−2223 (1·69)	6790 (1·95)	18919 (1·37)	−224 (0·49)	272 (0·70)	−249 (2·48)	1045 (0·83)	−3962 (1·93)	11247 (0·51)
V_t/U_t	−879·9 (2·50)	−860·3 (5·21)	−2975·7 (3·37)	−6280·7 (4·87)	−263·5 (1·36)	−187·4 (1·94)	−379·7 (2·05)	+530·9 (2·46)	−907·2 (5·34)	−16861·1 (7·15)
T_t	2·28 (4·50)	2·81 (7·80)	5·13 (6·58)	1·19 (4·14)	0·80 (5·84)	1·65 (3·88)	1·58 (3·25)	0·20 (0·29)	0·77 (2·72)	1·66 (8·36)
E_t	−0·0038 (1·01)	0·0069 (2·97)	−0·0048 (0·71)	−0·0004 (0·10)	0·0046 (6·41)	0·0006 (7·04)	0·0111 (3·10)	0·0043 (0·87)	0·0096 (2·66)	0·0034 (1·23)
S	−197·5 (1·44)	−243·4 (4·42)	−635·5 (3·17)	−2351·6 (5·90)	−371·5 (8·45)	−84·6 (3·99)	−185·1 (3·34)	−291·0 (3·44)	−310·8 (5·48)	−5110·1 (7·67)
R^2	0·597	0·768	0·728	0·776	0·928	0·611	0·735	0·481	0·779	0·883
F	8·5	19·0	15·4	19·9	73·7	9·0	15·9	5·3	20·2	43·5
D.W.*	1·36	1·93	1·92	1·83	2·03	1·58	2·17	1·51	1·75	2·08

$|t|$ values given in brackets: coefficients significant at the 1 per cent level where $|t| > 2·49$, 5 per cent level where $|t| > 1·71$ and 10 per cent level where $|t| > 1·31$, all one tail tests.

* At the 1 per cent level $dL = 0·94$
$dU = 1·51$

The following equation was obtained:

$$A_{pt} = 92\,609 + 1{\cdot}34T_{yt} - 0{\cdot}5853E_{yt} - 4835S_t \quad (2)$$
$$(2{\cdot}78) \quad (3{\cdot}93) \quad (1{\cdot}38) \quad (4{\cdot}14)$$

$$R^2 = 0{\cdot}624 \quad F = 13{\cdot}3 \quad \text{D.W.} = 0{\cdot}82$$
($|t|$ values in brackets).

The coefficient governing E has become negative, and is significantly different from zero at the 10 per cent level (one-tail test).

Routine maintenance of employees has been found to be quantifiable only in the negative form of overtime working. One important type of maintenance is the proper functioning of safety routines and equipment within factories. Expenditure on such items can properly be regarded as productive investment. However, the present model demonstrates that the returns from such investment vary directly with the relative scarcity of labour. There are also reasons to believe that the response of the labour force would also support the observed relationship between accidents and labour scarcity: (a) workers may be more willing to accept the risk of injury when they feel their jobs threatened by unemployment; (b) unions may become preoccupied with problems relating to the unemployed at the expense of policies to improve safety standards. However, the effect of these factors is to leave labour passively responding to the changing trade-off between breakdowns and routine maintenance.

V. INDUSTRIAL DISAGGREGATION

It was possible to fit Equation 1 to data for nine separate manufacturing industries/processes. The results are given in Table 1. The level of overtime working showed the most consistent relationship; all coefficients were positive with only that for timber proving insignificant. This industry was also perverse in that it was the only one to show a positive coefficient for the labour scarcity variable.

As far as the accident-employment relationship is concerned, however, the situation is less clear. In Table 2 a comparison is made between marginal accident rates (from Table 1) and

TABLE 2.

	Accident rates		Standardized value
	Marginal (standard error)	Average (1965–71)	$S = \frac{M-A}{\text{s.e.}}$
Food	−0·0038 (0·0038)	0·0079	−3·08
Chemicals	0·0069 (0·0023)	0·0061	+0·35
Metal	−0·0048 (0·0067)	0·0154	−3·00
Engineering	−0·0004 (0·0039)	0·0064	−1·74
Textiles	0·0046 (0·0007)	0·0052	−0·86
Clothing	0·0006 (0·0008)	0·0017	−1·38
Bricks	0·0111 (0·0036)	0·0074	+1·03
Timber	0·0043 (0·0050)	0·0084	−0·82
Paper	0·0096 (0·0036)	0·0045	+1·43
All processes	0·0034 (0·0027)	0·0071	−1·37

average accident rates. Seven of the nine sectors show insignificant differences between average and marginal rates at the 5 per cent level (two-tailed test). However, if we consider the standardized values as a whole we find the ten observations have mean $\bar{S} = 0{\cdot}94$ and variance $\hat{\sigma}_s^2 = 2{\cdot}33$. The null hypothesis is:

$$H_0 : \bar{S} = 0$$
$$H_1 : \bar{S} \neq 0.$$

The test is

$$t = \frac{-0{\cdot}94 - 0}{\sqrt{(\hat{\sigma}_s^2/n)}} = \frac{-0{\cdot}94}{0{\cdot}48} = -1{\cdot}96$$

which means we can accept the null hypothesis at the 5 per cent level ($t < |2{\cdot}05|$) or reject it at the 10 per cent level ($t > |1{\cdot}70|$).

VI. A TREND FOR INDUSTRIAL ACCIDENTS?

The Factory Inspectorate is keen to establish a downward trend in the level of industrial injuries. If legislation and propaganda are producing a distinct trend it is arguable that any of the time-series variables, E, V/U and T,[8] might be acting as a proxy for the time trend. This point was checked by adding a quarterly time variable $Q(1, 2, 3, \ldots, 28)$ to Equation 2.

A comparison of the results in Table 3 with those of Table 1 shows that the addition of variable Q left the situation of the other variables generally unchanged. For timber, however, the change was significant. The extraordinary positive coefficient governing V/U has become negative (significant at the 5 per cent level). It will also be recalled that timber was alone in having an insignificant coefficient governing T. With the addition of the trend variable the coefficient becomes significant at the 10 per cent level.

For 'all processes' the trend was insignificant. Among the nine sectors, timber had the most significant trend coefficient. Its value would have reduced the quarterly total of accidents in this sector by 735 (i.e. 25·2 per cent over six years).

One practical application of the time-series model could be as an indicator of the effectiveness of various accident preventative measures over time. Simply comparing average accident rates between years appears to be inadequate in view of the relationships discussed above.

VII. CROSS-SECTION ANALYSIS

There is no obvious reason why the relationships revealed in the time series analysis should not exist at a point of time. The seasonal dummy and the trend value are no longer relevant, but to apply the reduced equation to cross-section data would be to invite spurious correlation. Given the considerable differences in size between industries or regions, the levels of accidents, overtime and employment would be expected to be positively related. To avoid this problem, the first two variables were divided by employment, giving

$$A_i/E_i = a + b(V_i/U_i) + cT_i/E_i + dE_i \qquad (3)$$

[8] The increase in overtime working is a well-established trend; see DEPARTMENT OF EMPLOYMENT (1971), Table 84. Also, for this study period, employment and unfilled vacancies were generally in decline as unemployment increased.

TABLE 3. $A_{Pt} = a + b(V_{yt}/U_{yt}) + cT_{it} + dE_{it} + eS_t + fQ_t$

	Industry/process (i,p)									All
	Food	Chemicals	Metal	Engineering	Textiles	Clothing	Bricks	Timber	Paper	(y)
Constant	6710 (2·17)	−2858 (2·23)	5136 (0·92)	8223 (0·63)	−353 (0·29)	−661 (0·86)	776 (0·45)	3043 (3·43)	−3435 (1·92)	−3632 (0·14)
V_t/U_t	−675·5 (1·30)	−1169·3 (5·27)	−2850·2 (2·97)	−3955·3 (2·67)	−265·4 (1·34)	−196·6 (2·07)	−609·4 (3·04)	−457·9 (2·07)	−540·3 (2·80)	−15057·1 (5·33)
T_{it}	2·32 (4·46)	2·66 (7·64)	4·99 (5·66)	1·17 (4·54)	0·79 (4·93)	1·65 (3·96)	2·26 (4·15)	0·62 (1·36)	0·98 (3·84)	1·61 (7·98)
E_{it}	−0·0050 (1·14)	0·0087 (3·66)	−0·0020 (0·20)	−0·0019 (0·50)	0·0048 (2·82)	0·0023 (1·56)	0·0009 (0·15)	−0·0011 (0·32)	0·0079 (2·47)	0·0050 (1·63)
S_t	−187·6 (1·34)	−254·3 (4·72)	−641·3 (3·13)	−2396·9 (6·67)	−371·9 (8·24)	−92·3 (4·29)	−177·2 (3·45)	−285·0 (5·22)	−310·4 (6·31)	−5195·2 (7·80)
Q_t	7·06 (0·55)	−9·88 (1·96)	9·62 (0·38)	77·91 (2·52)	0·99 (0·12)	4·50 (1·39)	−16·41 (2·20)	−26·26 (5·76)	12·29 (2·92)	71·08 (1·14)
R^2	0·602	0·802	0·730	0·826	0·928	0·642	0·783	0·793	0·840	0·890
F	6·7	17·9	11·9	20·9	56·5	7·9	15·8	16·9	23·2	35·6
D.W.*	1·42	1·90	1·88	2·08	2·03	1·67	2·39	1·65	1·82	2·18

$|t|$ values given in brackets: coefficients significant at the 1 per cent level where $|t| > 2·50$, 5 per cent level where $|t| > 1·72$ and 10 per cent level where $|t| > 1·32$, all one tail tests.

* At the 1 per cent level $dL = 0·88$
$dU = 1·61$

where

A_i = accidents (in industry/region i)
E_i = employment
T_i = hours of overtime worked in a representative week
V_i = unfilled vacancies
U_i = the number of unemployed, who last worked in industry i, or in region i.

The accident rate in a given industry/region is held to depend on the amount of overtime worked, and the relative scarcity of labour.

Ordinary least squares was applied to the cross-section data (1969) of the nine industries/processes. The supposition that accident rates would not vary with the level of employment (which led to hypothesis 1) was borne out by a totally insignificant coefficient on E_i. The relationships between the other variables were confused by multicolinearity. However, it is interesting to note that for T_i/E_i and V_i/U_i the zero order correlation coefficient was $-0{\cdot}85$. Industries where labour was scarce worked least overtime per worker.

The hypothesised relationships were also tested with regional cross-section data. However, it is necessary to hold constant the effect of industrial concentration within regions. In 1969 the 'reported accident incident rate per 1000 employees'[9] ranged from 73·8 (metal manufacture) to 8·1 (clothing and footwear). Regional differences in industrial patterns will give rise to different accident rates. To account for this new factor, a hypothetical accident rate (H_r/E_r) was calculated for each region: H_r is the number of accidents which would have occurred in region r if each of its industrial sectors had experienced the national accident rate relevant to those sectors.[10]

Data relating to overtime working per employee in various regions is not available, so the following regression equations were obtained for eight regions:

$$\frac{A_r}{E_r} = \underset{(0{\cdot}71)}{-0{\cdot}0228} - \underset{(1{\cdot}15)}{0{\cdot}0182(V_r/U_r)} + \underset{(2{\cdot}70)}{2{\cdot}62H_r/E_r} - \underset{(0{\cdot}57)}{0{\cdot}000\,003E_r} \tag{4}$$
$$R^2 = 0{\cdot}906 \quad F = 12{\cdot}8$$

$$\frac{A_r}{E_r} = \underset{(0{\cdot}74)}{-0{\cdot}0221} - \underset{(2{\cdot}59)}{0{\cdot}0250(V_r/U_r)} + \underset{(2{\cdot}90)}{2{\cdot}61H_r/E_r} \tag{5}$$
$$R^2 = 0{\cdot}808 \quad F = 22{\cdot}1$$

($|t|$ values in brackets).

Again the level of employment is shown to be an insignificant determinant. The accident rate is significantly inversely associated with the degree of labour scarcity.

Although the accident rate would have been expected to be positively associated with the hypothetical rate, the coefficient of 2·61 is rather large. With relative labour scarcity held constant, the interpretation is that regions where high accident rates are expected (on the basis of industrial composition) experience higher than expected rates; regions where low

[9] *Annual Report of H.M. Chief Inspector of Factories* (1969) Appendix 8.
[10] The calculation involved is similar to that more frequently employed in regional studies to calculate hypothetical growth rates. See MACKAY (1968).

TABLE 4.

Region	A_r/H_r	A_r/E_r	V_r/U_r
S. East and E. Anglia	0·742	0·019	1·129
Midlands	0·836	0·025	0·827
S. West	1·099	0·028	0·700
N. West	1·216	0·031	0·543
Scotland	1·415	0·041	0·286
Yorkshire and Humberside	1·511	0·045	0·660
Wales	1·824	0·064	0·266
North	1·842	0·057	0·234

accident rates are expected, experience lower than expected rates. This is apparent even from the original data, although they reflect relative labour scarcities as well. In Table 4 the ratio of actual to expected accidents (A_r/H_r) is compared with the accident rate for 1969 for each of the eight regions. The ranking is virtually identical. In the two regions with the lowest accident rates, the actual number of accidents was 74 per cent and 84 per cent of the respective expected numbers.

One possible explanation is that if a plant in a given industry is located in an area in which low accident rate industries are concentrated, then there is an incentive to emulate the general performance. On the other hand, if that same plant were located in a region of high accident rate industries, then there might be some complacency about its own performance. In short, there may be a demonstration effect.

VIII. CONCLUSION

The analogy between mechanical breakdowns and human injuries appears to be a fair one in view of the results obtained from time series and cross-section data. The appropriateness of the model might further be investigated if more elusive data, relating to other aspects of labour maintenance (holidays, breaks, general facilities etc.) were obtained.

Variations in accident levels and accident rates can be interpreted as economic phenomena. As accidents become more costly (for whatever reason) their occurrence probably becomes noticed at higher levels of management; those directly involved would then be stimulated by eyes from above. There is scope for this type of control and a belief in its effectiveness:

> 'The top managements of the firms concerned in this research were all keen about the promotion of safety in their factories. . . . We found that the picture was not quite so good when we probed a little deeper but, even so, our firms were probably among the best. The top management of a large firm does not often go walking round the workshops – it has other things to do. But neither did we find it sending its representatives to any appreciable extent. In three of our shops, the presence of a safety officer, a plant engineer or a designer was an event. In the fourth shop, we did not see it at all.'[11]

[11] POWELL *et al.* (1971) p. 5.

The evidence is that economics is a key issue in the incidence of industrial accidents. Although stricter enforcement of the Factories Act would be expected to reduce accident totals, the maximum fine which can be levied against an employer for breach of its provisions is £300. In addition, employees are left to fight their own claims for damages: 'it has been estimated that only 10–20 per cent of work accident victims are subsequently awarded compensation by the courts'.[12]

If it is considered desirable to reduce the total of industrial accidents, a logical suggestion would be to make accidents a more expensive item for employers. The suggestion appears a practical one.

APPENDIX

Notes on data

Accidents Included are all accidents notifiable to H.M. District Inspector of Factories, namely those accidents which (a) cause loss of life to a person employed in premises subject to the Factories Act; or (b) disable any such person for more than three days from earning full wages at the work at which he was employed. Accidents are recorded against specific 'factory processes'. Factory process is defined to include any premises in which persons are employed in manual labour involving (a) the making of any article or part of an article; or (b) the altering, repairing or ornamenting, furnishing, cleaning or washing, or breaking up or demolition of any article; or (c) the adapting for sale of any article; where the work is carried on for the purposes of gain. It then follows that within an industry the number of employees subject to the Factories Act is less than the total number of employees. However published estimates of numbers of employees subject to the Factories Act are based on the assumption that, 'in each industry there has been no change in recent years in the ratio between the numbers of employees in the industry who are subject to the Act and those who are not'.[13] For this reason, the author used total employment figures.

Process/industry Quarterly accident statistics related to factory processes; employment and overtime statistics relate to industries.[14] Processes and industries were married as closely as possible. Although, for example, some engineering processes would be present in metal manufacturing industries, the pairings would appear to be reasonable.[15]

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[12] AIKIN and REID (1971) p. 366.
[13] *Annual Report of H.M. Chief Inspector of Factories* (1968) Appendix 11.
[14] *Standard Industrial Classification* (1958) and (1970).
[15] Details may be obtained from the author on request.

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