CHAPTER IV

REBATES AND PENALTIES

4.1 INTRODUCTION

In Chapter III it was argued that differential levies
by themselves are like payroll taxes and, as such, have
an ambiguous direct effect on safety, with a possible long-
term resource-allocation effect.   To make levies a more
direct tool to promote safety, some method of relating the
levy to the firm's accident experience is necessary.   This,
however, poses complex difficulties and countries which
have experimented with various forms of experience rating
do not provide conclusive evidence that any feasible system
is in fact effective.   The basic problem is to find a way
of determining whether a firm's experience is 'better' or
'worse' than the average of the industry to which the firm
belongs.   It is important, therefore, that the industry
is well specified and that the set levy is an accurate re-
flection of the average expected experience.   Somers and
Somers cite one reason for experience rating as the removal
of rate inequity within a class.[1]   But this then would re-
flect the deficiency of the original classifications and have
nothing to do with safety.   In order to be able to say that
any firm has a better or worse accident experience than other
comparable firms, it would seem that the larger the firm and

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1.   See H & A Somers, pp.106-9 for discussion of effects
      of merit-rating.

the longer the time period, the more credibility can be given to the firm's actual experience as truly representative of its average. When there is insufficient statistical data to provide this assurance, then rebates and penalties will tend to remove the benefits of 'loss spreading' that insurance provides.

The breakdown in the pollution-accident analogy came because accidents are insurable. An ideal insurance situation can only exist when the events to be insured against are outside the control of the insuree. When the incidence of the event is influenced by the insuree then 'moral hazard'[1] exists and insurance becomes less desirable from an allocation point of view, e.g. when medical fees are completely insured, the patient after paying a lump-sum premium, perceives the cost of medical care as zero, and demands more than he would if required to meet actual costs of consultations. This highlights the essential difference between pollution and accidents. Effluent charges are successful because they are uninsurable, whereas accidents are ideal insurance prospects because under usual circumstances they are not likely to increase as a result of the insurance arrangement. Clearly there is a direct conflict between the goal of relating levies to the firm's actual experience and the desirable goal of loss spreading. To outlaw insurance would provide a pure accident tax situation, but would have

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1. K. Arrow was the first economist to discuss this phenomenon, well recognised in insurance circles, which arises from elasticity in the demand for such things as medical care; see K. Arrow, 'The Welfare Economics of Medical Care', American Economic Review, v.53, 1963, pp.941-73.

possible disastrous consequences for the firm due to the
irregularity of accidents, and the unpredictability of
costs involved.   Only when a firm can predict its accid-
ent costs with a high degree of certainty, the need for
insurance evaporates, and the firm, through self-insurance,
experiences correct incentives on its safety effort.

   Some of the ways in which various types of experience-
rating have been used overseas will be examined, but first
of all some simple statistical theory will be discussed to
establish elementary guidelines for the implementation of
rebates and penalties if the goal is to reward and penalise
those whose record is statistically significantly different
from the average.

4.2 ACCIDENT EXPERIENCE AND THE UNDERLYING AVERAGE

4.2.1 The Poisson Distribution.

   Poisson Distribution of accidents as rare discrete events
should be approximated satisfactorily by the Poisson Distrib-
ution.   The Poisson Distribution is derived from the Bi-
nomial distribution as the limiting case where the probab-
ility, p, of occurrence of an event is small and, n,
the number of times the event may have occurred tends to
infinity.   Where m is the average number of occurrences
of accidents, then the probability of occurrences is des-
cribed by respective terms of the expansion of

$$e^{-m}(1 + m + \frac{m^2}{2!} + \frac{m^3}{3!} + \ldots)$$

If a firm is to be rewarded or penalised for being better or
worse than average, then an acceptable criterion could be that

if the firm's actual accident experience is within the 95%
confidence limits of the expected number of accidents, the
hypothesis that its accident rate differs from the average,
would not be accepted.

Some permutations of the following will be tested to
see how, or if, the criterion is fulfilled for typical New
Zealand firms of differing characteristics.

Size	Small	Average	Large
Risk	Low	Average	High
Time Period	1 year	3 years	5 years

For every combination that can be taken, e.g. small firm,
average risk, three-year time period, there will be a
corresponding probability distribution of costs of accid-
ents which have occurred, reflecting the relative severity
and other characteristics of the accident. To incorporate
severity or cost as a factor will decrease the certainty of
the reliability of the firm's experience and for the pur-
poses of this simple analysis, severity factors will be ex-
cluded and the risk factor only refers to accident frequency.

Firm Size:

The New Zealand work force is distributed as foll-
ows:

TABLE 4.1

DISTRIBUTION OF WORK FORCE

MAJOR INDUSTRIAL DIVISION	% Work Force
Agriculture, hunting, forestry and fishing	11.5
Mining and Quarrying	0.5
Manufacturing	25.1
Electricity, gas and water	1.2
Construction	17.7
Transport, storage and communication	9.2
Finance, insurance, real estate	5.8
Community, social and personal services	19.4
Activities not adequately defined	1.2

Source: Department of Statistics, New Zealand Official
          Year Book 1977, Wellington, pp.780-1.

The Manufacturing section accounts for 25.1% of the work force and Table 4.2 gives the size characteristics of the 7690 establishments taken from the Department of Statistics Bulletin on Industrial Production 1973-4.   This data includes only establishments of two or more persons and excludes those in a purely distributive capacity.   From the data, it can be seen that the majority of firms are small, i.e. there are 6726 firms, or 87.46%, which employ fewer than fifty persons.   This accounts for the employment of 83,451 persons, or 34.11% of the work force surveyed.   For those firms which are greater than 200, there are only 27 of over 800 employees, 17 are over 1,000 the bulk of whom are in the food industry.

Typical sizes chosen from this data are :

Small	3 persons
Average	32 persons
Large	475 persons

TABLE 4.2

SIZE OF ESTABLISHMENT ACCORDING TO NUMBERS OF

PERSONS ENGAGED - 1973-4.

	Under 6	6-10	11-20	21-50	51-100	101-200	Over 200	Total
No. of Establishments	2,287	1,444	1,482	1,313	530	245	189	7690
% of Total Establishments	29.74	21.38	19.27	17.07	6.89	3.19	2.46	100.00
No. of Persons Engaged	7,788	12,684	21,738	41,241	37,358	33,975	89,738	244,522
% of Total Persons Engaged	3.18	5.19	8.89	16.87	15.28	13.89	36.70	100.00
Persons Engaged per Establishment	3.41	7.72	14.67	31.41	70.49	138.67	474.80	31.80

Source: N.Z. Department of Statistics, Industrial Production 1973-74, Wellington, 1976, p.19.

Risk or Accident Frequency:

The last published frequency figures were for 1970.[1]

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1.   N.Z. Dept. of Statistics, Industrial Injuries 1971, Wellington, 1971, p.14.   Subsequent data was not considered adequate to determine frequencies for 1972 and 1973 and then the responsibility for collecting accident statistics was passed to the Accident Compensation Commission, who have not yet published frequency data.

Basically, three measures were used:

(a) Frequency Rate, i.e. accidents per 100,000 man hours worked. These are accidents involving lost time beyond the day or shift of the accident. The accuracy of such a measure depends crucially on correct accident reporting and accurate man hour figures.

(b) Economic Severity Rate. This measures the total lost man hours per 100,000 man hours worked. Because losses for long-term accidents or fatalities vary with the age of the injured, a fact which has nothing to do with the relative hazard, a third measure is used:

(c) The Injury Severity Rate. This measures the man hours lost per 100,000 man hours worked allowing for constant lost time for fatalities and permanent disabilities.

Table 4.3 lists the Frequency and Severity Rates for Major Industrial Groups for 1970. To calculate the expected number of injuries per time period, frequency, data are converted to approximate accidents per man year by taking 2,000 man hours = 1 man year - see column 2, Table 4.3, and the injury and economic severity rates are converted to lost-time per accident. For the manufacturing sector, frequencies range from 0.282 accidents per man year in the meat freezing industry, to a low of 0.024 in the footwear and other clothing industries with an average of 0.112. These figures will be used for high, low and average risk respectively.

TABLE 4.3

FREQUENCY RATES AND SEVERITY RATES BY INDUSTRIAL

DIVISION 1970

Industrial Division	Frequency Rate per 100,000 man hours	Frequency Rate per man year	Injury Severity Rate per 100,000 man hrs	Injury Severity Rate Lost Time per Injury	Economic Severity Rate per 100,000 man hours	Economic Severity Rate. Lost time per accident.
Agriculture, Forestry, Mining and Fishing	4.41	0.088	2628	595.92	2698	611.79
Mining and Quarrying	13.98	0.275	4891	349.86	5786	413.88
Manufacturing	5.62	0.110	1556	276.87	1559	277.40
Building and Construction	6.74	0.135	2980	442.14	2975	441.39
Electricity, Gas, Water, Sanitary Services	5.98	0.119	2058	344.18	2078	347.49
Commerce	1.67	0.033	476	285.02	471	282.03
Transport, Storage and Communication	3.77	0.075	1244	329.97	1263	335.01
Services	1.20	0.024	315	262.5	262	218.33
Averages	3.88	0.078	1333	343.56	1335	344.07

Source: Adapted from N.Z. Department of Statistics,
Industrial Injuries 1971, Wellington, p.14.

Time Period:

Three time periods are chosen as being administrat-

ively possible, one year, three years and five years.   A

longer time period would give better results, but waiting say

ten years to decide whether a firm is better or not divorces

the reward too much from the experience.

TABLE 4.4

THE EXPECTED NUMBER OF ACCIDENTS PER TIME PERIOD FOR

DIFFERENT SIZED FIRMS WITH DIFFERENT INDUSTRIAL FREQUENCIES

SIZE	FREQUENCY	E_a for TIME PERIOD = 1 YEAR	E_a for TIME PERIOD = 3 YEARS	E_a for TIME PERIOD = 5 YEARS
Small (3 persons)	0.024	0.07	0.21	0.35
	0.112	0.34	1.02	1.70
	0.282	0.85	2.55	4.25
Average (32 persons)	0.024	0.76	2.28	3.80
	0.112	3.58	10.74	17.90
	0.282	9.0	27.0	45.0
Large (475 persons)	0.024	11.40	34.20	57.00
	0.112	53.20	159.60	266.00
	0.282	134.00	402.00	670.00

4.2.2 Statistical Certainty and Rebates and Penalties.

Table 4.4·gives the expected number of accidents E_a for different sized firms, different class frequencies and three time periods. $E_a = nft$.

Where n = number of employees,

f = frequency per man year for the industrial class,

t = time period in years.

The distribution of accidents for a particular firm should be approximated by the Poisson Distribution, and if actual accident experience falls within the confidence interval, as illustrated, then rebates and penalties would not be justified.

FIGURE 4.1

CONFIDENCE LIMITS FOR E_a

Rebate   Penalty

E_a

95% Confidence Interval
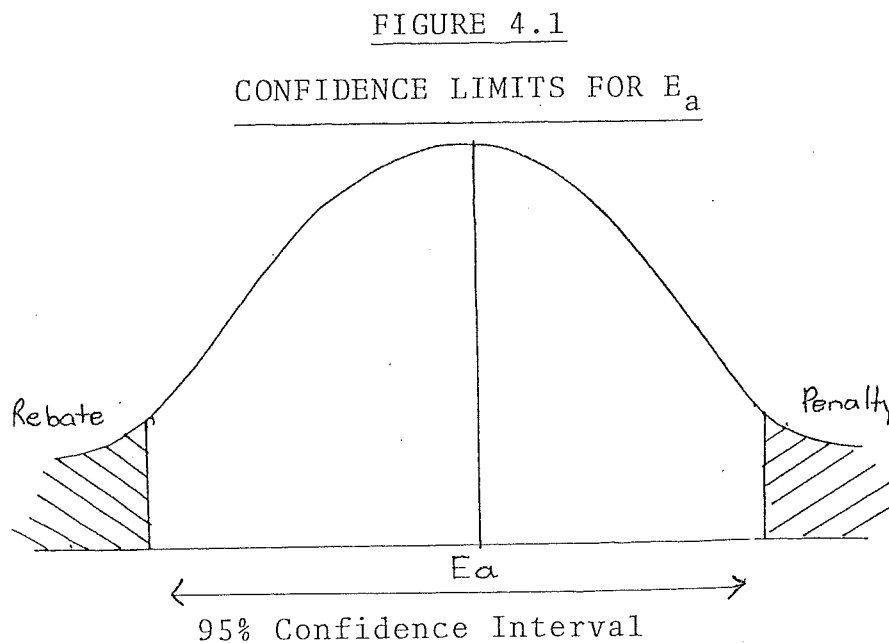
Actual accident experience will fall in the penalty area with probability of only 0.025 if the firm's underlying E_a is no worse than that of the industry. Similarly, there is only a 0.025 probability that the firm's actual experience will fall in the rebate area if it is no better than average.

Table 4.5 lists the probabilities associated with a given accident experience A_a, for a small firm, low industry frequency and for each of the three time periods. For each actual accident experience the ratio of $\frac{A_a}{E_a}$ is calculated.

TABLE 4.5

PROBABILITIES ASSOCIATED WITH A GIVEN ACCIDENT EXPERIENCE
FOR A SMALL FIRM, LOW FREQUENCY, ONE, THREE, FIVE YEAR
TIME PERIOD

A_a	1 YEAR, E_a = 0.07		3 YEARS, E_a = 0.21		5 YEARS, E_a = 0.35	
	Probability of Occurrence	$\frac{A_a}{E_a}$	Probability of Occurrence	$\frac{A_a}{E_a}$	Probability of Occurrence	$\frac{A_a}{E_a}$
0	0.923	0	0.819	0	0.705	0
1	0.074	14.3	0.163	4.8	0.246	2.8
2	0.003	28.6	0.017	9.6	0.043	5.7
3	0.000		0.001	14.3	0.006	8.6
4	0.000		0.000		0.000	11.4

Table 4.6 does the same for a small firm, high industry frequency:

Table 4.7 lists the probabilities associated with a particular A_a for time period 1 year, low frequency, and each of small, average, large-sized firms:

TABLE 4.7

PROBABILITIES ASSOCIATED WITH A GIVEN ACCIDENT EXPERIENCE: ONE YEAR TIME PERIOD, LOW FREQUENCY, SMALL, AVERAGE AND LARGE FIRMS

A_a	SMALL FIRM $E_a = 0.07$		AVERAGE FIRM $E_a = 0.76$		LARGE FIRM $E_a = 11.40$	
	Probability of Occurrence	$\dfrac{A_a}{E_a}$	Probability of Occurrence	$\dfrac{A_a}{E_a}$	Probability of Occurrence	$\dfrac{A_a}{E_a}$
0	0.923	0	0.472	0		
1	0.074	14.3	0.355	1.3	Cumulative Probability A_a 0-5	
2	0.003	28.6	0.132	2.6		
3			0.034	3.9	0.028	
4			0.006	5.2		
5			0.001	6.6		0.4
6-18					0.946	1.6
> 18					0.026	

TABLE 4.6

PROBABILITIES ASSOCIATED WITH A GIVEN ACCIDENT EXPERIENCE: SMALL FIRM, HIGH FREQUENCY, ONE, THREE, FIVE YEAR PERIOD

A_a	ONE YEAR $E_a = 0.85$		THREE YEARS $E_a = 2.55$		FIVE YEARS $E_a = 4.25$	
	Probability of Occurrence	$\dfrac{A_a}{E_a}$	Probability of Occurrence	$\dfrac{A_a}{E_a}$	Probability of Occurrence	$\dfrac{A_a}{E_a}$
0	0.427	0	0.091	0	0.015	0
1	0.364	1.2	0.217	0.4	0.063	0.2
2	0.156	2.4	0.278	0.8	0.138	0.4
3	0.044	3.5	0.209	1.2	0.185	0.6
4	0.007	4.7	0.125	1.6	0.205	0.9
5	0.002	5.8	0.060	2.0	0.163	1.1
6	0.000	7.0	0.024	2.4	0.114	1.4
7			0.009	2.8	0.069	1.6
8			0.004	3.2	0.036	1.9
9			0.001	3.6	0.017	2.1
10			0.000		0.007	2.4
11					0.003	

FIGURE 4.2

SMOOTHED POISSON DISTRIBUTION CURVES FOR SMALL E_a s

Probability

0.025

O Ea_1 Ea_2 Ea_3
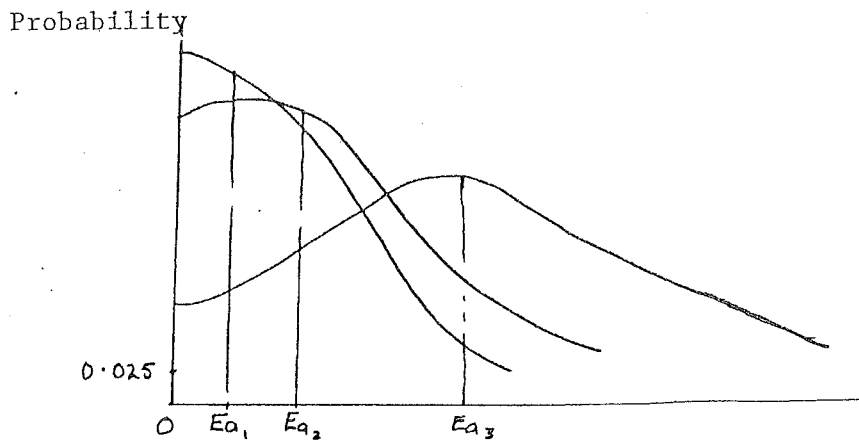
Results:

For a small firm, for all frequencies and time periods considered, the attainment of a $\frac{A_a}{E_a}$ ratio less than one is not a statistically acceptable basis for a rebate of any kind to be given. Thus the zero accident case has probabilities of occurrence associated with its achievement of greater than 0.025.

For an average-sized firm, rebates could be feasible for average frequencies, 3 and 5 year periods and high frequencies 1, 3 and 5-year periods. Consider the case of an average firm of high industry frequency, 1 year period, where $E_a = 9.0$ (see Table 4.3) and suppose $A_a = 0$, then probability if the firm's frequency = the industry's = 0.000. To find the appropriate adjustment factor to apply to the firm's levy rate, some estimate is required of the firm's actual expected number of accidents or E_a'. The most conservative estimate of this will be the highest E_a which could achieve the zero-accident experience with a probability of only 0.025, see Figure 4.3.

FIGURE 4.3

ESTIMATE OF THE TRUE E_a' FOR THE FIRM
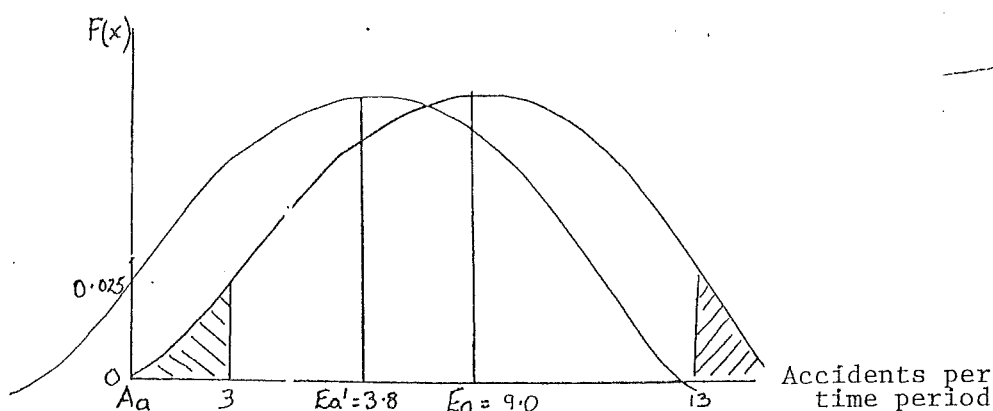
From Poisson Tables for $E_a = 3.8$ $p(A_a = 0)$ is 0.022.
The interpretation of this data is that using the same
certainty criterion as before, the firm is operating at a
frequency which corresponds to an E_a of 3.8 or better and
to be safe a rebate could be given on the assumption that
the firm's true $E_a' = 3.8$. Thus the rate modification
factor would be $\frac{3.8}{9.0} = 0.42$. Penalties are not theoretic-
ally inconsistent using this technique for a firm of any
size or any industrial frequency. From Table 4.5, small
firm, low frequency, penalties would apply for $A_a \geqslant 2$ for
1 and 3 years and $A_a \geqslant 3$ for 5 year period. For small
firms, high frequency, penalties would apply from 4, 6, 9
accidents for the 1, 3, 5 year periods respectively. As
the time period increases, the $\frac{A_a}{E_a}$ ratio at which penalties
begin to apply decreases. For a given time period, the
higher the frequency, the lower the $\frac{A_a}{E_a}$ ratio at which pen-
alties apply. From Table 4.7, as the firm size increas-
es, with constant time period and frequency, the $\frac{A_a}{E_a}$ ratio
decreases at which penalties may apply, i.e. the signif-
icance of a firm's experience being x% worse than expected
increases.

For average and large firms, as the frequency and time period increases, the E_a increases and the Poisson Distribution approaches normal distribution. Using confidence interval estimates, one can expect a sample statistic of one time period's accidents to be within two standard deviations of its average about 95% of the time. Thus, a rough criterion of whether the firm should be rewarded or penalised could be if its experience lies outside the two standard deviations. If it is assumed that accidents are still Poisson-distributed, then the fact that the standard deviation is equal to the square root of the mean can be used.

$$E_a = \mu \text{ (mean)}$$

$$\text{and } \sigma^2 = E_a$$

Standard deviation $\sigma = \sqrt{E_a}$

E_a = no. of accidents per time period.

Example: For a large firm, 3 year period, average frequency, the expected no. of accidents

$E_a = 160.$ (see Table 4.4)

Standard deviation $= \sqrt{160}$
$= 12.6$

Range of acceptable experience = 135-185.

Suppose $A_a = 200$

Then the firm's true mean is E_a' or greater.

$$E_a' + \sqrt{2} \ E_a' = 200$$

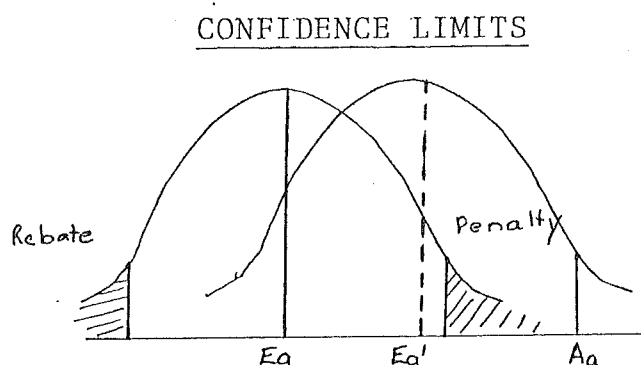solving for E_a'

$E_a' = 174.$

Thus the rate modification factor $\dfrac{E_a'}{E_a} = \dfrac{174}{160}$

$= 1.08.$

Penalty = 8%.

FIGURE 4.4

ESTIMATED E_a' FOR THE FIRM WHEN A_a OUTSIDE E_a

CONFIDENCE LIMITS

Rebate · · · Penalty

E_a · · · E_a' · · · A_a

Rebates and Penalties for Small Firms:

The statistical technique indicated above indicates that for small firms penalties are feasible, but not rebates. Care must be taken in the pure application of the criterion however. A small firm may experience one disastrous accident which injures more than several men, and thus produces a basis for a penalty assessment. However, in such a case, basic equity may be in question. The accident may occur as an Act of God or because of something outside the firm's control. For example, suppose a tanker crashes into a petrol station causing an explosion and injury to many of the employees. It is difficult to see that assessing or imputing costs to the employer in such cases will not reintroduce the fault concept. For average-sized firms, the same argument would apply for all but long-time periods and relatively high industrial frequencies.

4.2.3 Severity as a Parameter.

The discussion so far has indicated that where frequency alone is considered, in theory there could be statistically acceptable grounds for rebates and penalties. From Table

4.7 it is clear that the hours lost per 100,000 man hours worked, varies considerably among Industrial divisions. The highest lost-time per accident comes in the Agriculture, Forestry, Hunting and Fishing division, where 595.92 hours are lost per accident on average. Within the Manufacturing Sector, Meat Freezing and Preserving has the highest frequency, but average lost time per accident is only 168.93. The average for the manufacturing sector is 276.86. The treatment of severity requires some kind of value judgment to be made as to how to charge the individual firm. If all accidents are costed at an average for the industry, then the whole weight is thrown onto the frequency of accidents and the strong assumption is made that the firm has no control over severity. In practice, schemes in operation overseas devise some system of handling severity, so that the larger the firm the more emphasis is given to actual costs. This is so in the experience-rating formula used in most states in America which applies to all firms whose annual premium is $750 or more.

The rate modification factor, R, is determined from the following formula which applies to a three year period:

$$R = \frac{Ap + [B + (1-W)Ee] + WAe}{Ep + [B + (1-W)Ee] + WEe}^{1}$$

Ap = primary actual losses for all accidents. This includes all payments for accidents with total compensation

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1. See L. Russell, 'Safety Incentives in Workmen's Compensation Insurance', The Journal of Human Resources, 9(3), Summer 1974, p.364. As a result of the application of this formula, a firm must have at least 2500 employees to be fully experience-rated. A firm of fewer than 10 employees is not experience-rated at all and even at 300, only 50% of the premium is determined by firm's own experience. See also L. Russell, 'Pricing Industrial Accidents', Supplemental Studies VIII, Washington, 1973, pp.34-5.

costs of less than $750. For individual accidents of more than $750, a formula is applied to determine how much is primary and how much excess. (This proportion, D, varies from industry to industry).

Ae = excess actual losses for all accidents;

Ep = primary expected losses (based on the industry experience);

Ee = excess expected losses;

B and W are weights, both functions of total expected losses.

Total Expected Loss = twL

Where t = expected loss rate for the class
w = average three yearly wage
L = labour employed.

(in absence of experience-rating, the firm pays rwl where:

r = class rate and contains the proportion t which covers compensation only).

The weights B and W decrease respectively, as twl, total expected losses, increase. This has the effect of giving greater weight to the actual losses of the firm being rated as twl increases. B varies from $7500 \rightarrow 0$ and W from $0 \rightarrow 1$.[1]

From the formula it can be seen that for low twl where $w = 0$ and B is a maximum, then:

$$R = \frac{(Ap + Ee) + B}{(Ep + Ee) + B}$$

Thus no weight is given to the firm's actual excess losses. The effect of B as a constant is to reduce the ratio when it is 1, and increase it when it is less than 1, thus

1. L. Russell, _ibid_, p.365, lists actual values for B and W from a complete table supplied by the National Council on Compensation Insurance. The two extremes, $W = 0$, $B = 7500$ and $= 1$, $B = 0$, apply for twl $10,000 and $350,000 respectively.

modifying the effect on R. The larger B, the closer the rate modification factor will be to one. When B = 0 and W = 1, the other extreme, then $R = \frac{Ap + Ae}{Ep + Ee}$, i.e. the firm will be totally experience-rated. L. Russell examined the way in which the formula works in practice and determined by firm size, the elasticities of the formula with respect to accident frequency and severity. She concluded that the financial incentives provided by experience-rating are negligible for small firms and thus to follow recommendations made by the National Commission who wanted to extend experience-rating to still smaller firms would be unjustified.

Her method was to express the formula in terms of the firm's frequency rate, f, (accidents per employee per three year period), the expected loss rate, t, average primary loss $\bar{p}$, and average excess loss per accident, $\bar{e}$, and firm size, L. From this formula the elasticity with respect to different parameters can be calculated.

The firm's actual losses = Ap + Ae

$$= \bar{p}fL + \bar{e}fL.$$

E_p = DtwL. E_e =   (1-D) twL

Where D varies from industry to industry with typical value of 0.60.

Then

$$R = \frac{\bar{p}fL + B + (1-W)(1-D)twL + W\bar{e}fL}{twL + B}$$

All other variables are held constant, and the experience factor R is calculated for different typical levels of f for each of several firm sizes.[1] Then accident frequency

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1. The formula for elasticity with respect to frequency is given by $\frac{\partial R}{\partial f} \cdot \frac{f}{R} \quad \frac{\bar{p}fL + W\bar{e}fL}{\bar{p}fL + B + (1-W)(1-D)twL + W\bar{e}fL}$

   see L. Russell, 'Safety Incentives in Workmen's Compensation Insurance', p.368.

is held constant and the effect of changes in accident severity on R examined. Finally, she investigated the effect of increasing the benefits (i.e. twL) on safety incentives.

The results showed that as the firm improves its frequency, the modification factor declines, but the range over which R declines is much smaller for small firms than for large, indicating a much smaller elasticity of response for small firms. For a firm of 25 employees which has achieved a frequency of 0.05, a further reduction in the rate of 10% will reduce premium costs by less than 1%. For fifty employees the saving will be about 1.5% and even for 1,000 employees only about 5%. Thus very small savings are possible and unless accident frequency reduction can be achieved at low cost, the incentive to safety is miniscule.

Furthermore, the results show that for all firm sizes the incentives are lower, the lower the frequency which the firm starts with. This suggests that in earlier years when frequencies for some industries was very high, exper- ience-rating might have provided considerable incentive to safety. Once frequency is reduced below a certain level, experience-rating under this formula is less effective.

The incentives offered by this formula to reduce severity for small firms is also low, and the effect of increasing the level of benefits, even substantially, has also insig- nificant effect for small and average sized firms.

4.3   THE CASE FOR EXPERIENCE-RATING

The two most widely used variants of experience-rating
are merit-rating and penal-rating.   The premium adjust-
ment in each case can be prospective, i.e. used to adjust
premium rates charged in the future or retrospective, i.e.
cash bonuses or penalties can be made to adjust payments
made in the past.   In merit-rating the class levy could
remain the same if rebates and penalties balance.   When
the emphasis is on rebates, then the class levy rate must
rise for the group if it is to remain a mutually-funded
group unless an excess of rebates indicates that the class
levy rate has fallen.   In penalty-rating no attempt is made
to relate the penalty to the excess loss, and penalties may
greatly exceed that which is actuarially necessary.

4.3.1   Merit-Rating.

The evidence most frequently offered to support the
hypothesis that experience-rating influences accident rates
is the negative correlation between firm size and accident
frequency.   Russell, for example, cites National Commission
data in which 39 manufacturing industries were taken and
the ratio of injury rates for firms of different size to the
average for the industry computed as illustrated by the
following figure:

FIGURE 4.5

RATIO OF INJURY RATE FOR FIRMS OF VARIOUS SIZES

IN RELATION TO THE AVERAGE INJURY RATE IN THEIR
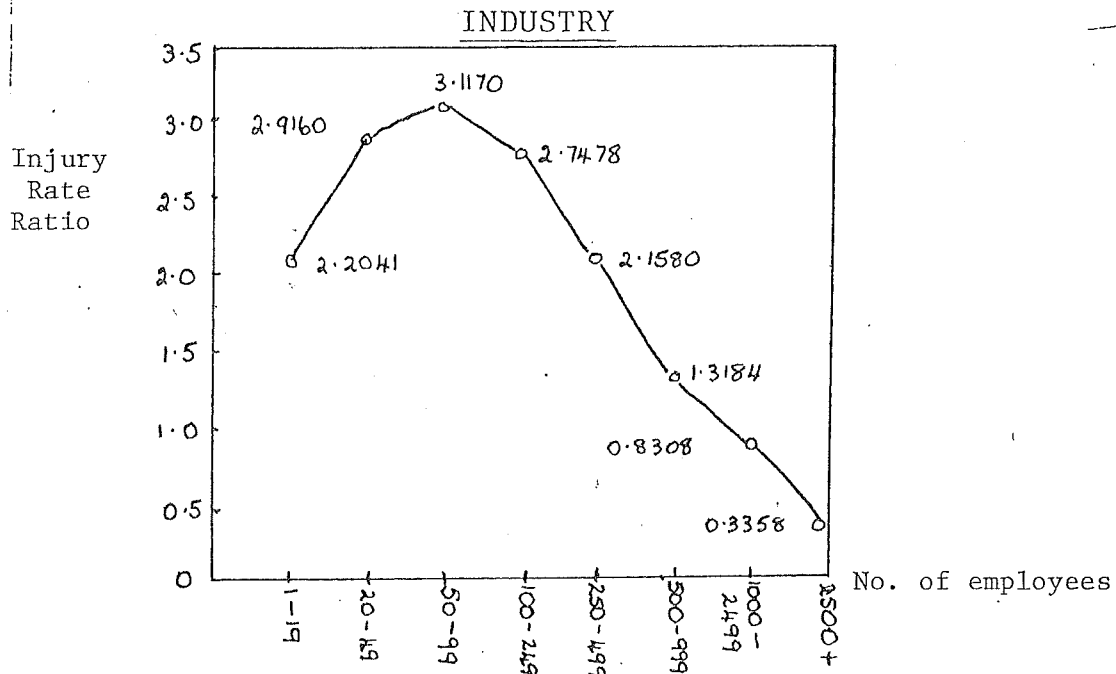
INDUSTRY

(Ratios are weighted average for 39 manufacturing industries).

Source: L. Russell, 'Safety Incentives ...', p.362.

Because the weight given to the firm's own experience in the rating formula increases with firm size, one would predict that frequency ought to decline with firm size if the hypothesis is correct. Unfortunately the hump in the results, which indicates that frequency increases for small to middle-sized firms, is at variance with this explanation. And even for middle-size to large firms, correlation of lower accident frequency with firm size does not prove that experience-rating was influential. Large firms may experience economies of scale in safety investments, or there may be a variation in the type of work carried out in large factories. Perhaps large firms may be more able to act from humanitarian motives and actively promote worker welfare.

An examination of this type of evidence left Atijah also
unconvinced that experience-rating was effective in pro-
ducing accident reduction.[1]   Some of the reasons he dis-
cusses to account for the lack of incentives provided,
apart from the most obvious one that most firms are too
small to be experienced-rated, are :-

(a)   Time lag:

Premium adjustments have to be made on the
basis of past experience.   Where prospective rating is
used on the basis of a three or five-year moving average,
then the reward or penalty will relate to out-of-date
experience.   When premiums are set in 1975 for 1976, the
relevant experience will be 1970-1974 or 1972-74.   Mean-
time many changes may have taken place in the company, e.g.
plant, personnel, etc.   Suppose in 1976 the firm genuine-
ly reduces its long-term frequency;   it will not receive
benefit till 1978 and then the reduction in premium will
at first only affect one year out of the experience period.
In addition, a time-lag in inflationary times will minimise
benefits and penalties.

(b)   The Cost-Benefit Equation:

It is difficult for a firm to accurately calculate

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1.   Atijah quotes similar British statistics.   Although no
formal experience-rating formula is used in Britain,
flexibility in setting employers' liability premiums
amounts to much the same thing.   The data shows the same
sort of correlation as in the American case.   See P.
Atijah, 'Accident Prevention and Variable Premium Rates
for Work-Connected Accidents - II', International Law
Journal, June 1975, pp.90-1.

I. Campbell, Director of Safety, Accident Compensation
Commission, has expressed the similar view in an unpub-
lished paper on Merit-Rating, that the figures he was
able to examine in Toronto relating to a 6-year period
'... clearly demonstrated that merit-rating had no
effect on the accident rate'.

returns on safety expenditure so that they can be sure that
an expenditure of $x on safety will result in at least $x
reduction in premiums. .In addition, accounting procedures
may disguise the true allocation of premium costs among
activities within a company.   It is very difficult with
the types of experience-rating formulae which are feasible
for a firm to calculate how much the premium costs will
decrease for a given accident frequency reduction.   With
new technologies, e.g. nuclear energy, lasers, electronics,
past accident experience is limited and the costs of likely
accidents conjectural.   In addition, the cost of damage
of unhealthy work environment, e.g. noise, dust pollution,
compared with the cost of prevention, may be very difficult
to evaluate, but relevant as more and more occupational
diseases become compensatable.   Where competitive forces
are weak, penalties may be passed forward in prices rather
than impose the correct incentive on the employer.

(c)   Difficulties of Measurement:

Frequency figures are sensitive to reporting
practices[1].   If only compensatable accidents are record-
ed, the sample may be undesirably reduced as a wide exper-
ience is necessary to provide reliability for future pre-
dictions on accident rates.   The definition of a compen-
satable accident, i.e. one which involves lost time of
greater than some minimum time period, is subject to var-
iation in interpretation and opinion.   Medical and social

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1.   If frequency is based on hours worked, these are
     difficult to police.   Under-reporting of accidents
     is also a problem in most accident compensation or
     workers' compensation schemes.

attitudes may thus influence the firm's apparent accident frequency.   Where costs are not true social costs, e.g. they may exclude hospital charges, etc., the value of experience-rating will be less.   Where costs of serious accidents are charged as they occur, rather than a total cost imputed in the year of the accident, an employer may be paying a premium based on these costs even if his accident frequency improves.   The difficulties of accurately imputing an amount to the firm at the time of the accident to cover all future costs associated with the accident are immense, particularly if the assessment is to cover such in-tangibles as future lump sum awards for pain and suffering.

4.3.2 Penalty-Rating.

The limitations of merit-rating has resulted in a system of penal charges in some countries, notably Canada. The Ontario System was influential in the penal provisions incorporated in the New Zealand Act.[1]   However, Atijah describes the system as 'gravely suspect':

> In the first place the penalty rate system is applied to small concerns on the basis of very small numbers of accidents in a way which totally neglects the probability theories underlying experience-rating. In consequence many small firms are penalty-rated as the result that offends common sense. Doubtless employers can be stimulated to prevent many of the accidents that occur in industry, but there is certainly an irreducible minimum number of accidents and the distribution of these among small firms cannot be shown to be due to anything other than random chance.[2]

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1.   For a description of how the Ontario scheme operates, see Appendix I.

2.   P. Atijah, 'Accident Prevention ...II', p.99.

Atijah details results for 15 firms who were penalty-rated
and discounts the evidence which looks superficially
persuasive.[1]   Although he is critical of the system for
a wide-ranging number of considerations, his argument
against penal rating centres around the extreme statist-
ical difficulty in deciding that a firm is "bad".   As a
precondition one must be convinced of the "rightness" of
the class mean and with advancing technology and other
changes this can quickly become out of date.   Penalty-rating
involves imposing sums which are like criminal penalties
and Atijah questions whether a Compensation Commission or
Board can provide adequate appeal procedures, and suggests
that penalty-rating, which can involve large sums of money,
is an abuse of criminal law.

4.4   CONCLUSION

     In section 4.2 a simple statistical criterion has
been proposed as the basis of a rebate, penalty system
if frequency alone is considered.   The 95% certainty
criterion also gives a guide as to the maximum rate modif-
ication factor which the underlying probabilities suggest
would be prudent to apply.

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1.   P. Atijah, op.cit. pp.99-102.   However, others have
      been persuaded of the value of penalty-rating, e.g.
      I. Campbell, 'Merit Rating', unpublished paper to
      Accident Compensation Commission, p.1.   Also the U.K.
      Royal Commission on Civil Liberty and Compensation for
      Personal Injury, Report v.II, London, HMSO, 1978,
      quotes figures from the Metal Industry which, they
      claim, with several qualifications, provides prima facia
      evidence that the Ontario system leads to lower accid-
      ent rates;   see pp.187-9.

Such probability theory is not explicit in the American rating formula which incorporates severity, but obviously lies behind it. It is suggested that such a formula provides limited incentive for small firms, a fact which has relevance in the New Zealand case, where the vast majority of firms have less than 50 employees. There would seem to be a choice in the New Zealand scheme, either to base rebates and penalties on straightforward measures of accident frequency or to develop an American-type weighting and discounting formula. Very few, if any, New Zealand firms could be wholly experienced rated because the benefits for long-term disability are so generous and one single claim could exceed the premium paid.

Any merit-rating scheme should not be implemented, however, without objective and explicit criteria and at least some degree of certainty that in fact safety incentives will be enhanced.