SOME ANALYSES OF CAR INSURANCE CLAIM-RATES

BY

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Editorial Comment

We have printed the foregoing paper by Mr. Munden as submitted because we think that the detailed analysis will be of interest to all who have interests in the field of motor insurance rating. Of necessity, the data does not lend itself to analysis with respect to some of the known variables and we are conscious that some of the conclusions are controversial; some factors have also emerged from the discussions within ASTIN on motor insurance and it is therefore hoped that the following comments will be of value in relation to the paper.

It is of the utmost importance that a clear distinction is drawn between the concept of accident proneness and the heterogeneity shown from observations of claim frequencies under insurance policies. As the discussion at La Baule brought out, the first conclusion to be derived when a compound Poisson distribution emerged is that there is a degree of heterogeneity in the data. This might be due to differences in accident probabilities of the underlying risks, but it could be due, for example, to different exposures of similar risks. Lanteli's paper to the Rättvik colloquium showed a substantial variation of claims experience with annual mileage and thus without an analysis controlled with respect to mileage the conclusion that a proneness factor is solely involved must be suspect.

Another factor which must have some effect is the incidence of "no claim discount" or, to use the term first introduced by Carl Philipson, "hunger for bonus". What evidence is available from studies of claims distributions by amounts, shows a drop in claim frequency of about the expected amount in the region of smaller claims. Probably there is also a relationship with the age of car, as minor damage is more likely to be the subject of a claim on a new car than an old. These factors may underly the increase in frequency shown at durations 6 and 7, as this feature has been noted in experiences to which the explanation in the paper would not apply.

Finally it would seem that the third party and comprehensive policies experience must be treated with caution as there are conflicting influences involved. New cars tend to be insured under comprehensive policies and old cars for third party risks only. There is also a tendency for young owners to first acquire an old car. The result of these tendencies, coupled with the known improvement in claim frequency in the early years of driving experience and the tendency for mileage to be heaviest in the earliest years of acquisition of a car must be a very complex pattern if the overall frequencies are related to duration alone. There must also be some element of switching

from one class of policy to another, which would introduce further difficulties in regarding the heterogeneity in policy claims experience as due to proneness of drivers.

In addition to the references in the paper we would also refer readers to the correspondence in J.I.A. 84, pp. 123/4, 1958.

We hope that the publication of Mr. Munden's paper will stimulate further investigations into this very difficult statistical field and that it will be possible to devise methods for control of the factors we have mentioned.

1. Introduction

1.1. Although much is known about the effect of factors such as road layout and regulations on the frequency of road accidents, comparatively little is known about the personal factors such as, for instance, driving experience and accident-proneness. It is difficult to study these from the official accident records, but motor insurance policies and the claims made on them provide useful material for the analysis of some of these factors. This paper presents the analysis made by the Road Research Laboratory, Great Britain of claim records kindly supplied by an insurance company and is mainly concerned with the effects of age and experience, and with claim-repeaters. An earlier analysis of some of the data has been made by Johnson and Garwood (1).

2. Data

2.1. The data relate to 2 765 policies which were renewed between October, 1954 and December, 1955 and which had run continuously since their inception. Every policyholder, therefore, had had at least one year's exposure to risk and a few had had more than thirty years' exposure. The details of each policy used in this study include the date of inception, the extent of cover, the number of drivers covered, the class of use, the place where the car was normally garaged, and the age and sex of the policyholder.

2.2. Eighty-nine per cent of the policies studied were issued for 'any driver' and most of the remainder were issued for 'owner only driving', while 79 per cent provided 'comprehensive' cover. Seventy-four per cent were issued for 'use Class I' (private and personal business use only) and 23 per cent were issued for 'use Class II' (all business purposes excluding commercial travelling and motor trade). Seventy per cent of the policyholders garaged their cars in London and the Home Counties.

2.3. For purposes of identification of claims, only the dates on which they were made have been used. A 'claim' is defined in this study as any incident known to the company, excluding fire and theft, whether it was made known by the policyholder or the third party, and includes cases where the incident was reported but no claim was made.

3. Variation of Claim-Rate by Calendar Years

3.1. The average annual claim-rates of the sample of drivers in three periods between 1933 and 1954 are given in Table I for each sex separately. The rates are the number of claims made in the particular period divided by the number of years of exposure to risk of all policyholders during that period.

Table I

Average claim-rates by calendar periods

Period	Males	Females	All policyholders
1933-39	0.22	0.19	0.22
1940-45	0.10	0.09	0.10
1946-54	0.15	0.13	0.15

3.2. The claim-rates of female policyholders are slightly lower than those of male policyholders. The post-war (World War II) claim-rate is about 30 per cent lower than the pre-war rate. The differences in the average age and average experience of drivers in these two periods were slight and would not have accounted for much of the reduction. Analysis of individual post-war years shows that at no time did the claim-rate reach that of the pre-war years.

4. Age and Experience of Policyholders

4.1. There is considerable variation with age of policyholder in the claim-rate per policy-year. Two curves of claim-rate against age when exposed to risk are shown in Fig. 1; one curve was obtained using all the available data and the other shows the average claim-rate during the first year of experience * of policy-

* Experience in this paper means experience with the company concerned and does not necessarily mean driving experience.

holders. In each case there is a rise from just above 0.1 in the early twenties to a peak of about 0.3 in the late twenties. Then follows a fairly steady decline in the 'irrespective of experience' curve and a flattening out from about ages 39 to 53 after which the curve rises to another peak at age 59. The 'first year' curve does not reach its minimum until age 47 but it also begins to rise at age 53 to a peak at age 59. Although both curves are irregular after age 60, presumably because the numbers of policies involved are smaller, there is a tendency for both to fall. The 'first year' curve is higher than the 'irrespective of experience' curve at most ages.

4.2. Average claim-rates for each year of experience (or policy age), irrespective of age of driver, are shown in Fig. 2. From the curve it would appear that there is a general decline in the claim-rate throughout the duration of a policy, at first a steep and later a more gradual decline. This decline in claim-rate with experience was evident in all age-groups up to age 60. Two features which need to be explained, however, are:

(i) the hump in the seventh and eighth years
(ii) the reversal of the downward trend when the policy is about 20 years old.

4.3. The hump effect is probably due mainly to chance but it may also be associated to some extent with the war. Men who took out policies in 1938 or 1939 would have had little pre-war experience and probably not much opportunity to drive in the war years. Returning to more regular driving in 1945 or 1946 they might well increase their claim-rate to the level of that of a driver of only one or two years' experience. There is no hump at this point in a similar curve for female policyholders.

4.4. The increase in the claim-rates of the oldest group of policies is due to the age of the policyholders. The mean age of policyholders, when policies are 20 years old or more, is about 60, which has already been shown to be a peak age for claims.

5. Claim-Rates in Earlier and Later Years

5.1. Johnson and Garwood showed in their paper that those people who claimed frequently in their early years of experience were much more likely to claim in their later years. The following

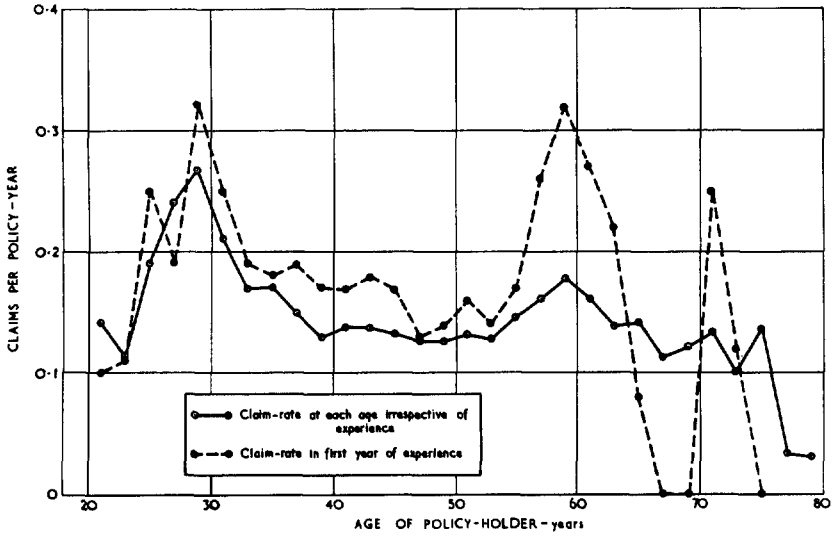

Fig. 1. Claim-Rates by Age of Male Police-Holders

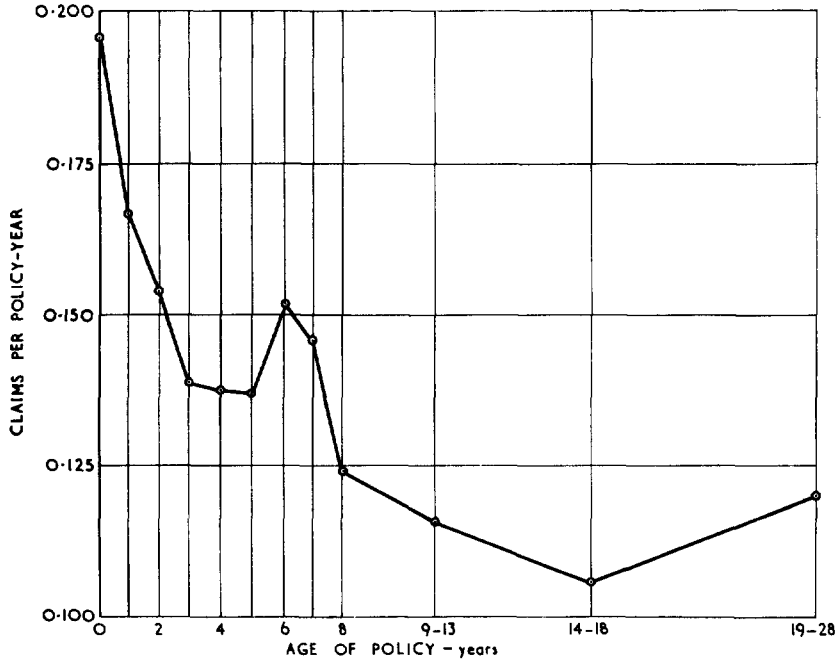

Fig. 2. Effect of Experience on Claim-Rates of Male Policy-Holders

analyses, which were based on the claim-rates of 845 male and 164 female policyholders who had insured with the company for at least six years, confirm their findings.

5.2. Table II shows the male policyholders divided into two groups, according to whether or not they claimed in their first n years* of experience, where n has alternative values of one, two, three, four or five. For each of the groups of policyholders, subsequent claim-rates are given, both for all years subsequent to the fifth and for all years after the first n years for each value of n.

TABLE II

Subsequent claim-rates of male policyholders according to early claims experience

n	With or without claims in first n years	No. of policies	After 5 years		After n years	
			Years exposed to risk	Claim-rate	Years exposed to risk	Claim-rate
1	With	97	729	0.200	1117	0.242
	Without	748	6762	0.123	9754	0.123
2	With	178	1338	0.188	1872	0.218
	Without	667	6153	0.118	8154	0.114
3	With	231	1689	0.192	2151	0.205
	Without	614	5802	0.113	7030	0.110
4	With	269	1982	0.191	2251	0.196
	Without	576	5509	0.109	6085	0.109
5	With	324	2400	0.185	2400	0.185
	Without	521	5091	0.105	5091	0.105

5.3. The subsequent claim-rates of the 'with claims' people are from 60 per cent to 100 per cent higher than those of the correspond-

* The policies in Tables II-IX are classified on the basis of a nominal year, which is the difference between the calendar years of claim and of inception of policy, plus one. Thus, for example, nominal year 4 could represent any month of the policy from the 25th to the 48th. The use of nominal years does not affect any trends that appear in the claim-rates provided that the appropriate exposure times are used in the calculations.

ing 'without claims' people. There is little difference in the 'after n years' and the 'after 5 years' rates for the 'without claims' groups; but for the 'with claims' groups the 'after n years' claim-rate is always higher, when n is less than 5. This indicates a reduction in liability to claim with increasing experience.

5.4. The female policyholders have been classified in the same way in Table III. They show the same tendencies as for males but the difference between claimers and non-claimers is generally not so marked.

TABLE III

Subsequent claim-rates of female policyholders according to early claims experience

n	With or without claims in first n years	No. of policies	After 5 years		After n years	
			Years exposed to risk	Claim-rate	Years exposed to risk	Claim-rate
1	With	13	103	0.117	155	0.155
	Without	151	1325	0.098	1929	0.114
2	With	30	230	0.148	320	0.200
	Without	134	1198	0.090	1600	0.098
3	With	42	319	0.147	403	0.179
	Without	122	1109	0.112	1353	0.091
4	With	57	440	0.120	497	0.157
	Without	107	988	0.090	1095	0.087
5	With	66	517	0.126	517	0.126
	Without	98	911	0.085	911	0.085

5.5. The results shown in Tables II and III require some interpretation. At least part of the difference in the subsequent claim-rates of the 'with claims' and the 'without claims' people can be attributed to a difference in exposure to risk. In other words some people habitually drive further, in more difficult traffic conditions, very frequently at night, or in accident-prone cars, etc. Another explanation might be that some people are accident-prone, that is, they have an inherent tendency to make more claims than others

even when driving under the same set of conditions. It is probable that the groups of policyholders in Tables II and III who have consistently high claim-rates consist of people affected by either one or both of these considerations. It is impossible to determine from the present data what proportion of the claim-repeaters are repeaters merely through abnormal exposure to risk and what proportion, if any, are accident-prone, but Table IV throws some light on the existence of accident-proneness. Here the figures in Tables II and III for male and female policyholders are combined and claim-rates are given for several individual years of experience.

TABLE IV

Claim-rates and experience

Claim-rate in year no.	1	2	3	4	5	>5
With claims in first year	2.509	0.336	0.355	0.264	0.282	0.178
Without claims in first year	NIL	0.131	0.119	0.121	0.133	0.113
All policies	0.274	0.154	0.145	0.137	0.150	0.119

5.6. From the second year onwards there is a noticeable downward trend in the claim-rates of those who claimed in their first year. There is a significant correlation in these figures, which provides strong evidence that these drivers were improving with each additional year of experience. On the other hand, there is no significant variation in the corresponding rates for other drivers. But in the rates for the whole population of drivers there is a fall from 0.274 in the first year to 0.154 in the second and it seems likely that this improvement in claim-rate is largely attributable to the 'with claims' group of policyholders.

5.7. The claim-rate of the 'with claims' people after 5 years is 47 per cent lower than that in the second year of experience, as compared with a reduction of only 14 per cent for the 'without claims' people. As explained later it is considered unlikely that this is due entirely to a reduction in the exposure to risk, nor is it likely that the no-claims bonus would have induced people in the first group to suppress claims more than people in the second group.

5.8. The improvement with experience, which affects only the 'with claims' group, is shown again in Table V, in which policies are grouped by year of inception in five-year groups. The average experience of successive groups during the after-5-year period is, beginning with the oldest, approximately 14, 11½, 9 and 6½ years. Although the 'with claims' people show an improvement with experience the 'without claims' people again show no significant change. It is interesting to note that Table V, where the claim-rates of *different* policyholders with different average experiences are compared, gives a similar result to that in Table IV, where the claim-rates of the *same* policyholders at different points in their experience are compared.

TABLE V

*Policies grouped by year of inception**

Year of inception	With claims in first five years		Without claims in first five years	
	No. of policies	Claim-rate after five years	No. of policies	Claim-rate after five years
1930-34	44	0.156	78	0.088
1935-39	87	0.135	93	0.078
1940-44	34	0.199	49	0.077
1945-49	231	0.265	325	0.086

* Policies taken out before 1930 are omitted here as their claim records were incomplete.

6. EFFECT OF CERTAIN FACTORS ON THE DIFFERENTIAL CLAIM-RATE

6.1. Some of the factors which affect the accident risk have been studied in relation to claim-repeating. First, policies were divided into two groups, one group being composed of cars which are garaged in one of the large cities and the other group composed of those garaged elsewhere. In the first group the average claim-rate was 50 per cent higher than in the second. When each group was divided into two sub-groups, those who claimed and those who did not claim in their first year, in both cases the 'with claims' people had consistently higher claim-rates in later years of experience.

6.2. Although no figures of mileage are available, the average mileage driven by the various-use classes must be considerably different. Table VI shows the same effect as before for each class but the effect is less marked as the amount of business usage increases. The final column gives the claim-rate of the 'with claims' people divided by that of the 'without claims' people.

TABLE VI

Policies grouped by class of use

Use class	In first year	No. of policies	Claim-rate after first year	Claim-rate (With claim in first year) / Claim-rate (Without claim in first year)
I (Private use)	With claims	64	0.202	1.9
	Without claims	671	0.106	
	All	735	0.114	
II (Business)	With claims	39	0.269	1.7
	Without claims	193	0.161	
	All	232	0.179	
III (Commercial travelling	With claims	7	0.293	1.2
	Without claims	33	0.249	
	All	40	0.256	

6.3. As shown earlier the tendency to claim is influenced by the age of the policyholder, and this may be associated to some extent with the different average mileage driven. Policies were therefore divided into three groups, by age of policyholder at inception, in which the average claim-rates were markedly different; the age-groups were (i) up to 34 years, (ii) 35 to 49 years, (iii) 50 years and over. Again the groups were subdivided into those with claims and those without claims in the first year of experience, and again in each case the 'with claims' groups had considerably higher subsequent claim-rates than their corresponding 'without claims' groups.

6.4. It would seem possible that a contributory cause at least of the 'without claims' group of policyholders having a lower subsequent claim-rate is that they do not report all accidents. Some light may be shed on this possibility by the analysis of comprehen-

sive and third-party policies separately (see Table VII). It is noteworthy that the effect is the same and in the same proportion for both types of policy.

TABLE VII

Policies grouped by type of cover

In first five years	Comprehensive		Third-party only	
	No. of policies	Claim-rate after 5 years	No. of policies	Claim-rate after 5 years
With claims	254	0.183	36	0.092
Without claims	507	0.110	112	0.055
All policies	861	0.135	148	0.064

7. OTHER METHODS OF DETECTING CLAIM-REPEATING GROUPS

7.1. In Table VIII policyholders who claimed in their first year have been further subdivided according to the number of claims they made in that year.

TABLE VIII

Analysis by number of claims in first year

No. of claims in first year	No. of policies	Claim-rate in		
		2nd year	3rd year	4th year
0	899	0.13	0.12	0.12
1	87	0.29	0.30	0.25
2	19	0.32	0.37	0.37
3	3	1.50	1.50	—
4	1			

7.2. There is a relation between the number of claims in the first year and the subsequent claim-rates. Johnson and Garwood (1) predicted, assuming a certain pattern of accident liability, that they would be linearly related, but the numbers of policies and claims are too small to test this.

7.3. One final method of grouping policyholders has been adopted, that is by the policy-year in which their first claim was made. Table IX shows the subsequent claim-rates of these groups.

TABLE IX

Analysis of policies according to first year in which claim occurred

Year of first claim	No. of policies	After 5 years	
		Years exposed to risk	Claim-rate
1	110	832	0.178
2	98	736	0.162
3	65	440	0.182
4	53	414	0.138
5	64	495	0.148
No claim in first 5 years	619	6002	0.097
Total	1009	8919	0.119

7.4. The highest claim-rates after 5 years belong to those drivers who made their first claim in the first three years. The lowest subsequent rate belongs to those drivers who made no claim in the first five years. Excluding the group of drivers who first claimed in their first year (Table IV shows that their rates were continually improving) the claim-rates agree reasonably closely with theoretical figures derived in the Appendix. The results obtained in Tables II, III, VIII and IX are all consistent with the same theoretical model of claim-proneness. They represent slightly different ways of looking at the same phenomenon but each may be of practical value in different circumstances.

8. CONCLUSIONS

8.1. The curve of claim-rate by age of policyholder (Fig. 1) is similar in some ways to a curve of the ratio of blameworthy drivers to innocent drivers. The latter curve, obtained from national statistics of personal injury accidents (2), has a U-shaped form and reasons have been given for suggesting that this curve can be interpreted as giving the variation of accident rate per mile with age. It differs from the curve in Fig. 1 at ages of less than 30 and greater

than 60, by having peaks at the adolescence and old age points of the age scale. The dissimilarities are probably attributable mainly to the mileage variations between age-groups, which are not allowed for in Fig. 1. Thus a man probably drives less and less in the years after retirement. The rising claim-rate in the late fifties, however, would appear to be a genuine mark of the effect of age on accident-proneness. Both curves indicate that 40-50 is the safest age-group for a driver.

8.2. Figure 2 shows that claim-rates decrease continually with increasing age of policy, apart from an abnormality possibly associated with World War II. This downward trend is shown by further analysis to be evident for most ages of driver but is most marked in the case of younger drivers. On the other hand Table IV seems to indicate that the downward trend is restricted to those who claimed in the first year, claim-rates for other drivers remaining at about 0.12 from the second policy-year onwards.

8.3. It has been shown by three methods that a high early claim-rate is correlated with a high subsequent claim-rate. The high rates must be due partly to a greater amount of driving, and analysis shows that driving in cities entails greater risk than driving elsewhere.* Although some people habitually drive unsafe cars, mechanical imperfections of the vehicle are unlikely to be the primary cause of an accident in the majority of cases, even though mechanical faults probably occur more often than official statistics suggest. The question remains as to whether any proportion of the high claim-rates is due to accident-proneness on the part of the driver. In this context accident-proneness means the tendency to incur more accidents than the average driver would under the same conditions and with the same amount of driving, the tendency being real and not attributable to chance.

8.4. The data do not provide direct evidence about accident-proneness but it is difficult to account for the fact, that drivers with a high claim-rate in their early years as a group reduce their claims continuously throughout the life of their policies while other drivers

* Numbers of claims, but not necessarily cost of claims, per policy higher in large cities. See page 190.

do not, solely on the basis of hypotheses other than proneness (see Table IV). Some of the reduction for the former group probably arises from a tendency for those who claimed in their first year to drive on the average a greater mileage in their first year than those who did not claim, and for this mileage to drop with the passage of years to a level nearer the overall average mileage. Again drivers who have driven a greater mileage and hence, have gained more experience, might be expected to improve more quickly than others. It is not known how large these two effects might be but it seems improbable that they could account for the whole of the 47 per cent drop in the claim-rate.

8.5. Some drivers thus appear to have an accident-prone characteristic which it may be possible to remove or reduce, for example, by increasing skill with experience or by taking fewer risks. It is a difficult task in practice, however, to separate those who incur accidents through greater exposure to risk from those who, initially at any rate, are accident-prone.

8.6. As regards the completeness of the data the policyholder has a contractual duty to report all accidents, whether he wishes to claim or not. The figures used in these analyses for claims include some claims which have not been allowed and some reported incidents on which claims have not been made, and, because a third party is also involved in about 90 per cent of road accidents involving cars, few of these accidents can be unrecorded by the company. Moreover, it is unlikely that a driver, whose claim-rate is continually decreasing, is, in fact, paying more and more for repairs out of his own pocket. Any lack of reporting which does occur will, therefore, have a relatively small effect on the conclusions reached in this paper.

8.7. Although drivers other than the policyholder incurring the accidents have not been taken into account, the conclusions should not be affected apart from making any effects appear less marked than they really are.

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(1) Johnson, N. L. and Garwood, F., "The Analysis of the Claim Records of a Motor Insurance Company". *J. Inst. Actu.*, 1957, 83 (3), 277-94.

(2) Garwood, F., "Some Applications of Statistics in Road Safety Research", Manchester, 1956 (Manchester Statistical Society).

Appendix

Relation between year of first claim and claim-rate

In Table IX it is shown that there is a decline in the subsequent claim-rate as the year of first claim becomes later. This decline can be shown to be approximately exponential.

If an individual has an expected accident rate λ in year 1, then his probability of having no accidents in year 1 is $e^{-\lambda}$.

Now it appears from the second line of Table IV that the risk per driver due to external conditions is not noticeably altering from year to year, and this conclusion is borne out by the annual post-World War II claim-rates. So, if it is assumed that the risk is the same in year 2, the probability of an individual having no accidents in year 2 is also $e^{-\lambda}$. The probability of having no claims in years 1 to $m-1$ but having 1 or more in year m is

$$e^{-(m-1)\lambda}(1-e^{-\lambda})$$

If, in the same way as Johnson and Garwood, we assume a Type III distribution of individual claim-rates, i.e.

$$p(\lambda) = (K/\bar{\lambda})^K \lambda^{K-1} e^{-K\lambda/\bar{\lambda}}/(K-1)!$$

where K is a constant, then the expected claim-rate in any later year of people who first claim in year m is:

$$C_m = \frac{\int_0^\infty e^{-(m-1)\lambda}(1-e^{-\lambda}).\lambda.p(\lambda)d\lambda}{\int_0^\infty e^{-(m-1)\lambda}(1-e^{-\lambda}).p(\lambda)d\lambda} =$$

$$= \frac{K}{(X-1)X} \frac{X^{K+1}-(X-1)^{K+1}}{X^K-(X-1)^K}$$

where $X = m + K/\bar{\lambda}$.

K has been estimated by two methods, giving a mean value of 1.25. To compare with the claim-rates in Table IX, the people who claimed in year 1 were omitted as they showed considerable improvement in successive years and to have allowed for this would have complicated the model. $\bar{\lambda}$ was taken to be 0.113 (the after-5-year rate in Table IV). These values were used in the above expression for $m = 1, 2, \ldots\ldots\ldots$ The following values of C_m were obtained: 0.195, 0.179, 0.166, 0.155, 0.145, 0.136, 0.128, 0.121, indicating a fall of C_m with increasing m, which is approximately exponential.

It should be noted that the value for $m = 1$ in the above series is appropriate to year 2 in Table IX, the value for $m = 2$ is appropriate to year 3, etc.