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PLANNING--MODELS FOR GENERAL INSURANCE

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Abstract

This thesis is the result of work done on building a series of planning models for the General Insurance business of an Insurance Company. The traditional approach of preparing annual accounts and submitting returns on the business written has proved inadequate in describing the health of an insurance company. One of the main reasons for this is the very long time lag between the writing of policies and the final settlement of claims on these policies; up to some seven years being possible.

In periods of rapid, and particularly accelerating inflation it is proving difficult to set premium rates at the correct level to provide profits and to preserve the solvency margin. Three models have been developed to look at different aspects of the problem. The basis of these is the consideration of an insurance company as an ongoing concern where it is necessary to trace a particular year's policies from inception to final settlement of claims occurring on these policies to get a true picture of the effects of that year's underwriting.

a) Expenses model - to enable a more accurate system of budgeting to be undertaken by providing a framework within which budgets can be prepared on a quarterly or annual basis and discrepancies between actual costs and budget costs can be analysed and used to refine the budgeting process.

b) Solvency model - to compare the relative importance and effect of various parameters on the solvency margin, the capital employed and the return on capital.

c) Premium/Claims. This models the entire short term (annual) general insurance business from the basis of policies written each month. It calculates the claims and commission paid producing cash flows on a monthly basis and annual revenue accounts. It takes into consideration accounting conventions, inflation and time delays.

ACKNOWLEDGEMENTS

I have received help from numerous people during the course of this project. It would be invidious to mention only a few, and impossible to mention them all. I thank everyone who has been of assistance. However I thank especially Mr. G. Booth, B. Sc. F.I.A. who has provided substantial help and guidance. I also thank the Legal and General Assurance Society Ltd. for sponsoring this project, and my supervisor Mr. G. Salkin B. Sc. A.C.A.

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CHAPTER 1

1.1 Introduction

The company which has been used as the basis of this project is a composite insurance company. That is,it transacts both long-term and short-term business. Long-term insurance includes pensions, life, annuity, capital redemption and permanent health business. Short-term insurance, which is usually referred to as General Insurance (G.I.) covers fire, motor, property, accident and marine, aviation and transport business. Marine business is highly specialised and is excluded from this study. The results for marine are not determined (from an accounting point of view) until three years after the year in which the business is transacted and this company transacts no aviation or transport business.

The total world-wide premium income of the company in 1974 was £287.7m made up of:-

Pensions (including permanent health)	145.2
Other long-term business	76.2
General (excluding marine)	62.3
Marine	3.9
	287.7

The company operates throughout the United Kingdom and also in many countries overseas. The analysis of world written premiums on General Insurance business (excluding marine) is given in the annual report for 1974 as -

Written Premiums	£ 62.3m
	%
United Kingdom	66
Other European Countries	8
Africa	6
Asia	1
Australia	18
Other	1
	100

Although the overseas business is substantial it was excluded from the project entirely. Many of the principles used in the models could be adopted for the overseas business, although the problem of exchange rates would need to be considered.

The company's share of the United Kingdom G.I. market can be deduced from the annual reports and the figures provided by the British Insurance Association for the Industry as a whole (or at least its members who represent some 95% of the worldwide business of the British Insurance company market) (ref 1). In 1973 the company had about 2.3% of the UK market making it about 10th in market share. Some major competitors are given in Table 1.1 with the approximate UK written premiums for 1974, taken from the respective annual reports.

	Premium Income 1974 U.K. £m	
Commercial Union	154.5	(including Ireland)
Guardian Royal Exchange	151.	
Prudential	42	
Pearl	12	

Table 1.1

These are only approximate as the construction of the annual report differs from company to company. More detailed figures can be obtained from the returns made to the Department of Trade (Schedule 3 - part II and Schedule 2 - part V) (ref 2) under the Insurance Companies Acts 1958 to 1967 and the Insurance Companies Amendment Act 1973. These give written premiums and earned premiums for each risk group, and further parts of Schedule 3 give details of the claims frequencies. For each £100 of premiums written we can identify the major areas for the allocation of this money. The amounts will differ from class to class. For example approximate amounts for two classes are:-

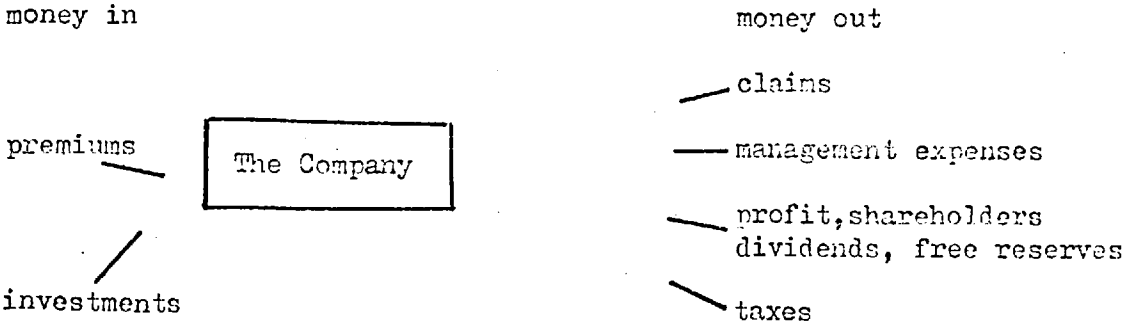
	Household Contents	Commercial Fire
Claims and Claims handling costs	40	60
Commission	20	12
Expenses	38	25
Reinsurance	1	2
Average Underwriting profit	1	1

Reinsurance costs are larger on the commercial accounts where the bulk of reinsurance occurs. Household policies are low cost and high volume, compared with commercial fire and the overheads form a larger proportion of the expenses. The underwriting profit is usually low, and can often be negative, the major proportion of profits coming from investment income on the free and technical reserves.

1.2 Nature of the General Insurance Business

G.I. business differs essentially from Life and Pensions in that it is much shorter term. Whereas the latter types may last (be on the Company's books) for 30 or 40 years, G.I. policies generally (but not invariably) last for only one year. However, this length of time, and the delay in settling claims is still enough to cause problems in forecasting claims amounts, premium income and policy volumes, and investment income - all the basis of the cash flow.

An insurance company deals entirely with money - money is received and some time later is paid out. Nothing is manufactured: nothing tangible is sold. The purpose of the company to the community is the providing of security.



It is interesting to contrast an insurance company with a general manufacturing or retailing company. A manufacturer buys raw materials - alters and reforms them and sells them on to the consumer or another manufacturer. This cycle of goods in to goods out may typically be about six months to a year and, importantly, the majority of costs are borne before the goods are actually sold. That is the company does, or should know how much to charge to make an adequate profit. (Whether the market will bear this price is another problem and involves different management decisions). On the other hand an insurance company bears the bulk of its costs long after the product (policy) has been bought. The company has to set a rate and agree on a price at the start of a policy and it is liable for an unknown amount of expense in the form of claims at some unknown date in the future (within certain wide limits). Once its course is set there is very little that can be done in retrospect. Premiums on new policies can be increased to provide income; however, this would introduce the economically and actuarially unwise practice of subsidising one group with another. It can be seen that there is great advantage in detecting an adverse claims experience as soon as possible and one of the objects of the project is to project current trends to show the future effects of current decisions.

The investment decisions of a manufacturing company are generally to decide on what new plant and machinery to buy - For an insurance company they are whether to invest the funds in, for instance, property, shares, or the money market. In both cases it is a question of taking decisions now for uncertain future returns. The investments of an insurance company are more flexible than for a manufacturing company in that assets may be realised and money reinvested elsewhere, but because of their very large holdings, their size limits their activities. The large scale switching of investments will of itself cause a reversal in the higher returns that they were seeking to exploit.

The value to the community of insurance is beyond dispute, but the system remains healthy and workable only so long as policyholders have complete faith in the survival of the company. This is especially true of Pensions and Life assurance where the long term well being of a family is concerned. Financial survival is not so critical (relatively) for a G.I. company where usually the only loss would be the premium of one year's insurance. However, the collapse of any major insurance or assurance company would undermine the confidence on which the industry is based. The withdrawal from industry and the public of freely available insurance would also have socially undesirable effects and economic situations which would force insurance companies into this position would be regarded as essential to avoid.

It is for these reasons that insurance companies have traditionally erred on the side of safety and preserved substantial reserves to cover any possible catastrophes. Nevertheless, companies have become bankrupt. However, as we shall see, in times of rapid (and especially with accelerating) inflation it becomes more and more difficult for insurance companies to maintain a satisfactory position.

The severe social consequences of the collapse of an insurance company (as seen for instance by "Vehicle and General") has caused successive governments to take an increasing interest in the finances of companies by making sure that adequate reserves are maintained for the amount of business they are writing.

We have also seen the effects on the industry of companies cutting rates. The danger and temptation here is that new business can be attracted easily by offering lower rates than other companies consider wise. It is hard to distinguish between what is 'legitimate' competition of producing lower rates by more efficient offices and lower costs or by differentiating the market (as explained later), and 'illegitimate' competition by reducing

rates below economic levels. This can distort the market by attracting away large numbers of policyholders from existing companies leaving their fewer remaining policyholders to cover a larger proportion of the overheads, the implication being that their rates will need to be increased to cover the overheads. Thus we have the possible situation of price cutting by one company resulting in price increases in another.

In yet further ways an insurance company is interesting to compare with a manufacturing company. Insurance companies produce, as a product, a large number of comparatively cheaply priced articles (the Society has approximately 200,000 motor policies, with an average premium of £40). In a manufacturing industry this would nearly always imply a uniformity of product - the concept of mass production but the problem with insurance is that each product is different from nearly every other product in some way. For instance, factors which identify a motor premium could be car type, drivers age, area he lives in, number of years driving experience, previous claims and the type of cover required. Because of this lack of uniformity there is a large personnel element in the industry and is why a substantial part of the premium will occur as expenses.

The highly technical nature of the business means that there is a large proportion of highly qualified people. For a company which trades with the general public it has probably one of the highest average salaries.

1.3 Economic Considerations

From an economic point of view, General Insurance has many characteristics which makes it different from, say, a manufacturing company. Each class of business within General Insurance has its own individual aspects. Commercial fire, for instance is virtually a saturated market. No company is going to risk the possibility of ruin by not having this cover. As the amount of new fire insurance coming onto the market is comparatively small it means that a company trying to expand its share of the market must do so by attracting business from other companies. Since price cutting is not very

satisfactory, other than on a modest scale this often rests on providing a better and more efficient service, and special expertise to the policy-holder (although in commercial fire the basic rates are set anyway amongst companies by operation of a tariff).

It is not good policy to advertise as being cheaper than anyone else but the emphasis is usually on service, skill and security.

Private motor, while being a saturated market (for the minimum cover) is also very price sensitive. Rate setting is very competitive and the problem here is that there is not one market, but many. Each one is not clearly defined and the statistical expertise comes in differentiating the market and charging each sector a reasonable economic rate. For instance, to take a simple but illustrative example. If one company charges a flat rate of £40 for motor cover to everyone then another company can take advantage of this by charging, say £30 to everyone who has not had an accident in the previous two years. Naturally all these drivers will go to the new company leaving the 'bad' drivers (who presumably have a greater risk of an accident in the future) with the original company which now has a worse group of policyholders. The problems for the original company are exacerbated in that it will not be immediately obvious to it that it is being left with a poorer class of risk. The quality of the risk itself is not important, so long as the premium is sufficiently large to make the business economic.

Much of the marketing is to find these holes in the rating structure and to exploit them. Since all companies are working with imperfect knowledge this is not easy. It depends on monitoring closely ones own risks and claims experience and trying to match this with the activities of competitors. This is accentuated because people shop around for motor policies much more than for other insurance. Also, as people change their cars fairly frequently there is a rapid turnover in policies.

The question of what factors to use in rate setting is also important. It is not necessarily true that a driver who has had an accident in the last two years is more likely to have one in the future and rate setting is always inaccurate in that present and past factors are used to forecast future behaviour. It is perhaps fortunate that the future cannot be accurately determined as then only those who would not have an accident would be able to get insurance. The advent of no-fault insurance in the USA where the insurance company of the driver pays irrespective of the legal fault of the insured has meant that the cause of negligence is often not determined and it is unfair to label a driver as 'accident prone' when he may have not been at fault.

Another interesting aspect is the effects on the industry of general economic retrenchment (recession) in the country. We have already seen that commercial fire is a saturated market. Even in times of recession companies will continue to insure.

On the other hand, 1974 and 1975 has seen a slump in the sales of new cars. This does not have the same effect on motor policy numbers because the people will retain their cars longer, although the value of the cars is declining. The petrol crisis of the winter 1973/1974 however reduced the amount of driving and the speed which in turn produced fewer and less costly accidents.

The ~~costs~~ expenses for renewing a policy are less than for issuing a new policy and this in theory should be reflected in the premium being less for renewals, but this rarely happens. In practice, in classes where policies tend to last for several years the costing is done on the assumption that the policy will be renewed. Thus an initial underwriting loss is made on the higher inception costs and these are only recovered in later years.

An effect of inflation is that OCR have been underestimated and companies are having to maintain them by transfers from general reserves. A known high level of inflation can be coped with, as in, for instance, Brazil;

however Britain has, over the last two years suffered from accelerating inflation which was not foreseen. Premium rates which were thought to be reasonable at inception are now seen to be uneconomic. Any one company which judged inflation correctly and altered its rates correspondingly would have found its policyholders leaving to go to other companies with less premonition. Perhaps the only solution is for companies to withdraw from markets that are uneconomic as has happened with some insurance in the USA. However it is difficult in general for the level of activity of a company to be reduced, or expanded rapidly although the international nature of the British insurance industry allows it some flexibility in selecting more profitable markets.

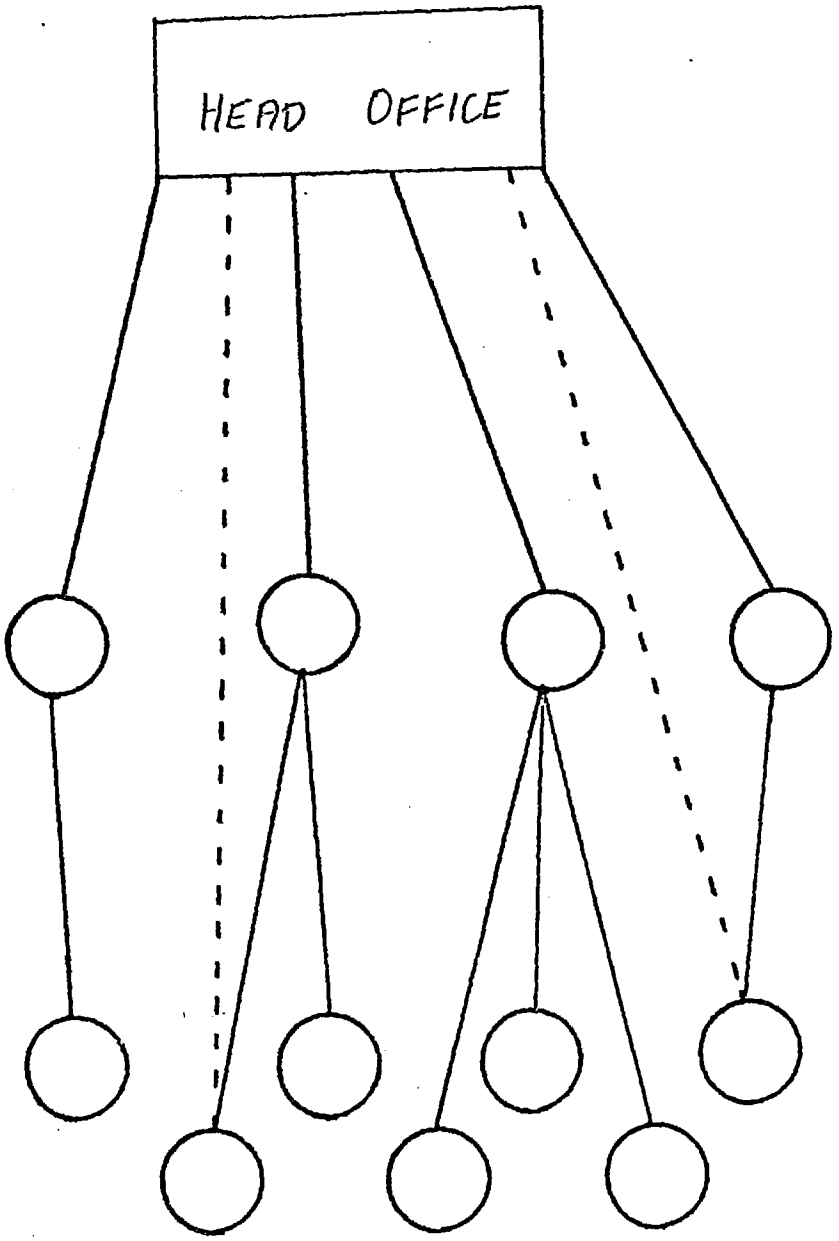
1.4 Company Structure

The company operates through a nationwide network at Sales Offices and Service Offices. The former number about 70 and are grouped under 14 Service Offices. There are also 7 regional offices and, of course, the head offices. There is a movement of the head offices out of London with different administrative groups being centred at Brighton, Kingswood in Surrey and Milton Keynes, although maintaining their city offices in Queen Victoria Street. The Sales Offices are classified as either area offices or district offices.

The organisational structure is complicated and not a direct tree structure. An area or district office may report to one regional office but also report to the service office of another region. The structure has arisen partly through the original life side of the business imposing a structure not entirely geared to the General Insurance business.

However, the only place in the project where the organisation structure is of importance is in the expenses model. Here it is reasonable to assume the hierachy shown in Fig 1.2 with a Head Office, the Service Offices and Sales Offices. The Sales Offices act primarily as 'post offices' for the 'General Insurance' business, passing it straight on to the Service Offices.

The Service Offices are taken to be the processing unit dealing with policies and claims and working in conjunction with the records and computer processing at head office.



Simplified Company Structure FIG 1.2

CHAPTER 2

Models

2.1 Introduction

The idea of producing corporate models has developed in recent years from the desire of all types of companies to have a more immediately responsive framework within which they can view their company than the traditional budgeting methods have provided. The engineer has long used models of aeroplanes in wind tunnels to examine their aerodynamic properties and to derive information about the characteristics of a full sized version. He has also used series of equations to represent these characteristics (equations which may, or more probably may not be solvable exactly) which is another way of constructing a model. Thus the idea of models has long been in existence. The advent of the computer has meant the greater sophistication of many types of model and a comparison of the relative costs and accuracies of the methods has to be done before choosing a particular method of modelling.

Similarly with models which portray a business situation there will inevitably be a choice of methods and some decision has to be made as to which is the best in a particular situation. A basic difference between most engineering models and business models is the importance of time in the latter cases. Many types of model, some using methods developed from scientific problems with others developed within operations research exist and a generic breakdown of the more common types is given in Fig 2.1. A feature of all is that they inevitably exist as computer programs as the speed and ability to handle large amounts of data makes a computer ideally suited to this problem.

2.2 Types of Model

The main division is between deterministic and non-deterministic models. The characteristic of the former is that the same data will give the same results on successive runs, but a non-deterministic model may not.

Non-deterministic models by their nature have built into them the effects of a random occurrence of an event or events from a predetermined probability distribution. This allows for the effects of chance or risk to be seen in the end result, although this often means large numbers of runs of a program to see what the probability distribution of the end result is after allowing for all intermediate distributions to have their effect. Deterministic models can be categorised as optimising or non-optimising. Optimising models have some form of objective function which may be thought of as a goal, for example, minimum cost, maximum profit or minimum distance for a transport network. It aims to produce the best solution in terms of the variables relative to the objective function. There are several optimisation methods available, the choice depending on the exact nature of the problem.

Of the non-optimising types, the statistical techniques are often used in conjunction with other methods and used as submodels of a larger model. The descriptive or 'what if' model is undoubtedly the most common, providing an answer to a given set of inputs. It usually consists of a computer model of a part or aspect of a company the program trying to reflect exactly what will happen in the company under the same conditions.

2.3 Other Models

Grinyer & Wooler (ref 3) produce the following numbers for each type of model from a sample of 50 taken in their study of corporate financial models. While they use the same division of models as in Fig 2.1, they use an alternative nomenclature

Optimisation only	1
Non-Optimisation only	39
Both	10
	50

of these with non-optimisation

Non-deterministic only	1
Descriptive only	37
Both	11
	49

They say that, with the exception of the oil companies the users were not generally happy with their optimisation models. Their work provides a considerable amount of information on attitudes, approaches and relative successes of various modelling projects and their evidence would seem to suggest the preference for descriptive models, at least initially.

2.4 Model Used

As this is a first approach to a model for general insurance it was felt that a purely deterministic 'what if' model would be the most useful in that it would enable the direct cause and effect of changing different parameters in the model to be most readily seen. It would seem a natural development to go from the simplest deterministic descriptive model to an optimising or stochastic model and perhaps there is future work for this. Additionally experience of other people has shown the necessity to gain management acceptance of modelling for it to be really successful, and it would seem that this is more readily obtained by first using a descriptive model. The user is then able to feel that he is in control and the program is only doing what he would wish to do himself if he had time. Modellers have been shown to be sceptical of incorporating forecasting techniques (ref 3) preferring to rely on intuition and commercial judgement. Grinyer & Wooler also say (ref 3). "[From the] experience of companies in our sample of fifty suggests modellers would be unwise to build [risk analysis] models until management has become more familiar with simpler deterministic models". Reinsurance is one area where a stochastic model would be more applicable. The problem of reinsurance has not been considered at all, except briefly in the solvency model as it is so essentially different from the other models produced. Also, the actual methods of reinsurance differ widely and much can be done using theoretical mathematical models. Much work has been done by Borch in this field and one may refer to reference 4 for a summary of several models.

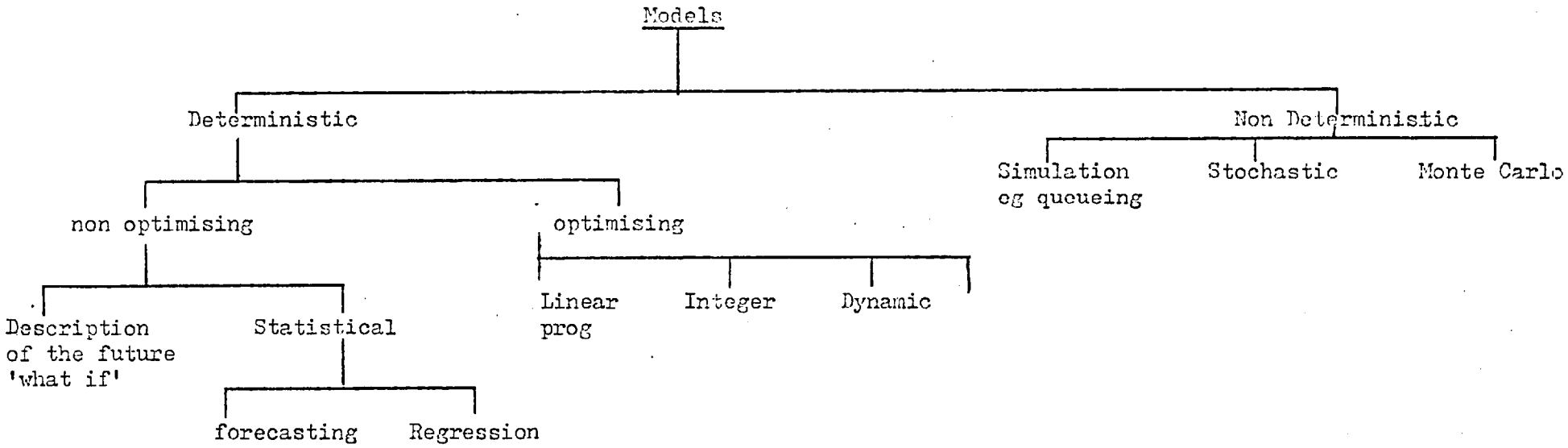

Models
Deterministic
Non Deterministic
Simulation
eg queueing
Stochastic
Monte Carlo
non optimising
optimising
Description
of the future
'what if'
Statistical
Linear
prog
Integer
Dynamic
forecasting
Regression

Fig 2.1

CHAPTER 3

Literature Survey

The literature appears to be devoid of any reference to computer based planning models of the type developed here. Since insurance is essentially based on mathematical and statistical principles the problems of risk, ruin and reinsurance have been examined extensively.

Borch has produced several mathematical models for the operation of a theoretical insurance company, many in terms of utility models. A survey is given in ref 4. However Borch suggests that while these analytical methods at one time seemed promising, in retrospect it is doubtful if they have fulfilled their expectations. He suggests two ways out of the problem of being unable to produce a simple analysis by neat closed expressions:-

a) Proceeding into abstract mathematics and seeking non-constructive existence proofs.

b) Using a computer simulation.

He considers both are likely to be long and expensive in mental effort or computer time;however it is approach b) that this thesis has attempted. This has probably been considered by mathematicians, such as Borch, who have developed insurance theory as aesthetically unsatisfactory. This at least is hinted in his paper.

The traditional approach to rate setting has been to work out the pure premium required to cover future claims (using the best data available for the probability and size of claims) and then to add a loading factor. Thus if P is the premium charged and C is the pure premium then commission is a proportion of the premium, say αP other expenses, say βP, profit γP and some element of fixed overheads, F. (ref 5).

Then $$P = C + \alpha P + \beta P + \gamma P + F$$

giving $$P = \frac{C + F}{1 - \alpha - \beta - \gamma}$$

Scarfield says that it is sometimes assumed F is zero taking all expenses as variable, however this is not realistic as there is much work which has to be done for a policy irrespective of its premium value. The treatment and allocation of expenses seems to have received very little treatment.

Beard (ref 6) produces a slightly different approach by expressing the premium (P) less expenses (E) as the product of the probability of an event (q) and the amount payable on that event ($\overline{C}$).

Thus $P-E = q * \overline{C}$ (1)

However he does recognise that the timing of transactions is of considerable importance and restates (1) as

$$\sum P_t - \sum E_t = \sum q_t \overline{C}_t \quad \text{where } t = \text{time}$$

One of the problems of insurance is the lack of reliable statistics and this can be attributed to three causes

a) The comparative lack of information of their own operations with which companies operate.

b) The different methods which companies have of expressing the same thing.

c) The considerable secrecy with which companies guard their own statistics.

Secrecy is very reasonable in terms of economic competition as insurance can be considered as an n person game each player working with imperfect knowledge. In support of b) one is referred to the words of a management consultant who has been involved in information systems for top management in insurance (ref 7).

"The weakness of the information that has been available to determine these matters [solvency, efficiency, effectiveness] and in particular the shortcomings that stem from the lack of uniformity in the methods used to determine the key indicators have been highlighted by the collapse of various insurance companies in recent years. We have found, however, that even in the financially sound and well-established companies it is difficult for top management to compare their business results with those of similar companies because of differences in the methods of describing the basic factors of premiums, claims and expenses."

For example, practices vary from company to company for the counting of claims when there is more than one claim from a single incident. Different policies in dealing with zero claims, (which occur, for instance when legal liability is disproved) can make substantial differences to the number of claims, and hence claim frequency and average value of a claim (ref 8).

The considerable delay in the settlement of some claims often seems surprising to those outwith insurance. However one is reminded of the 'Thalidomide Case' which was settled only many years after administration of the drug. In Italy, personal injuries can take more than 8 years to settle (ref 9) and in America law suits against doctors and surgeons for malpractice is often on results which have only become apparent years after the treatment.

The nearest approach to the idea of a corporate model is ref 7. The anonymous author takes a broader look at corporate planning for insurance and outlines a few of the problems facing insurance in what was then (1972) thought to be a period of high inflation. He mentions General Insurance and the lack of attention it has received from statisticians, actuaries and management accountants, until recently. He argues that companies have found the evaluation of risk factors, for say, motor and the relative weights to give each difficult. He suggests the development of a suite of models. A demand and marketing model which would look at the entire market for a particular

class of business and an underwriting and financial model which would look at the company's activities as a whole. It is the latter with which we are concerned. He concludes by saying that there remains much to change in management attitudes, marketing and control systems before a satisfactory situation is reached.

CHAPTER 4

DEFINITIONS

Before discussing the detailed workings of the programs, it is necessary to explain some of the terms which will be used. One has to be very careful in definition. The same expression will mean different things to different people, especially in different offices where individual practices vary. Because of the long term nature of the business subtle differences in the method of collection of statistics can lead to markedly different results. For example, total claims could be calculated according to the year the policy was incepted, or the year the claim was made or the year the claim was settled. Because, in general, the average value of a claim is increasing due to inflation these three definitions would give, respectively, lower and very different results. For substantiation of this remark the reader is referred to the quotation on Page 23.

Written Premium

Consider, for instance, a man taking out an insurance policy on his house to start from 1 January 1975 for one year. On that date the policy is incepted and the company is said to be on risk. The householder will pay a certain amount of money to the company, being the premium for the insurance cover. This total amount is the Written Premium, which is to be distinguished from the Earned Premium.

Earned Premium

Since the policy is in force for a year, and the service is discharged over this period, the income is only considered to be earned as this service is discharged. Thus at any time during the year part of the written premium will be earned and part will be unearned. For example, on 1 April 1974 $\frac{1}{4}$ of the premium will have been earned and $\frac{3}{4}$ will remain unearned.

Expenses

Expenses form a substantial part of the premium income as shown on Page 8, and as the expenses of handling a policy are incurred largely at the start of a policy a part of these can be deducted before calculating the amount of earned and unearned premium at any time. Claims handling expenses are often included in the cost of claims, as one is a consequence of the other, although they may not be a drain on the cash flow at the same time.

Expenses Ratio

This is a ratio frequently produced to indicate if expenses are forming too large a part of the premium income. It is given as

$$\text{Expenses Ratio} = \frac{\text{Total Expenses}}{\text{Total Written Premiums}} \quad \text{for a particular year.}$$

Unearned Premium Reserve

At the end of the financial year the revenue accounts will show the amount of premiums not yet earned as the Unearned Premium Reserve or U.P.R. As shown on Page 8 the amount of expenses will vary from class to class; however, the accounts are based on the aggregate society business. There are two methods for calculating the unearned premium on a Total Society basis, known as the 24th and the 30th rules.

24th and 30th Rules

These are rules for calculating the UPR. The underlying assumptions are that

1) The total number of policies incepted in a particular month come on risk uniformly throughout the month.
2) The relative frequencies of accidents are uniform throughout the life of a policy.

Thus if the total written premium in July is WP, then the earned premium, without making any allowance for expenses is WP/24 in July for those July policies. At the end of December, the earned premium up until then on July's business will be WP * 11/24 and unearned premium WP * 13/24.

When the revenue accounts are drawn up there will be unearned premiums accruing from each of the previous twelve months. This is given by

$$\text{UPR at end of month } i = WP_i * {}^{23}/_{24} + WP_{i-1} * {}^{21}/_{24} + \ldots\ldots\ldots + WP_{i-10} * {}^{3}/_{24} + WP_{i-11} * {}^{1}/_{24}$$

Where WP_i is the amount of written premiums in month i. The origin of the name 24ths is readily seen. However, since expenses form a large part of the written premium it means that on this basis severe and unrealistic reserving will occur. By law the maximum allowance which can be made for expenses before calculating U.P.R. is currently 20% of the written premium (soon to be made 15%). Thus the U.P.R. is calculated on $0.8 * WP$ in each month and it is seen that this reduces to give the statutory UPR as -

$$\text{UPR at end of month } i = WP_i * {}^{23}/_{30} + WP_{i-1} \; {}^{21}/_{30} + \ldots\ldots\ldots + WP_{i-10} * {}^{3}/_{24} + WP_{i-11} * {}^{1}/_{30}$$

Whence the name 30ths rule.

Exposure

The exposure is generally taken to be a measure of the risks involved. Since the policy premium is designed to reflect the risk it is often said that exposure is proportional to the premium. The actual risks may depend on a large number of factors - for instance with private car some risk factors are the driver's age, type of car, geographical region and the number of other drivers. The measure of exposure will vary from class to class. In aviation it could be the number of take-offs (most crashes occur at take-off or landing), passenger miles, plane miles, or the total sum insured.

Pure Premium

The pure premium is the amount of premium required to exactly balance the amount which will eventually be paid out in claims without any allowance being made for expenses, commission or profit.

Commission

Commission is normally earned by agents as a direct percentage of the written premium. The rate varies from class to class and is generally about 10% to 15%. There is usually a (short) delay between the inception of a policy and the agent being paid the commission.

Building Society Over-riding Commission

This is a special category of commission which is allowed for separately in the management accounts. A substantial amount of business is done with Building Societies in providing cover for the properties they have on mortgage. In return the Building Societies receive commission, known as over-riding commission. The Building Societies do a lot of the work associated with handling the policies and thus the commission is in return for the saving of expenses.

Cash and Credit Agents

The Society obtains its business almost entirely through a network of agents. Cash agents must obtain the authority of the Society and send in the money before issuing a policy, whereas credit agents are allowed to do business on the Society's behalf without recourse to the Society for authorisation. Credit agents usually do not settle their accounts immediately and thus there is a delay between inception of a policy and receipt of cash by the Society, which is longer than the delay between inception and notification.

Renewals

Looking at the example of our householder, his policy will come up for renewal at the end of December 1975. All policies falling due in a given month are called renewals. One of two things may happen. Either the policy is renewed (and another premium paid) or else it lapses and is withdrawn from the Society's books. During the life of a policy it may be cancelled, that is before the renewal date.

The lapse rate is the proportion of policies falling due for renewal in a period but which will eventually be lapsed.

The maintenance rate is the proportion of policies incepted in a period (new policies plus renewed) and which survive through the year to fall due for renewal.

Pre-debiting

The Society operates a system for pre-debiting renewals. That is, it assumes that all policies coming up for renewal are renewed until it is confirmed that a policy has lapsed. Thus, as there is a delay in notification of lapses (say, waiting a month after the second renewal reminder has been sent to the policyholder) the Society has more policies incepted on its books than it has in reality. This distorts the written premium and the earned premium by the amount of unnotified lapsed policies, although of course no claims will be made on these policies.

On the other hand, the accounting system counts new business from the date of debit (i.e. receipt of cash) which may be some time after inception. Here the accounts underestimate the written premium by the amount of policies incepted but not notified. This is virtually the only situation in which the accounting system under-reserves.

U.P.R. is calculated on the total for each month of:-

renewal income from the date of renewal
plus new business from the date of debit
less lapses from the date of notification of lapse.

Expense Strain

It is known that the costs of issuing a new policy are greater than for renewing a policy, and thus, all other costs being unaffected, the premium for a renewed policy should reflect this by being less than for a new policy. However, this is not generally the case (although the Society has now

introduced a £2 reduction for those renewing a private car policy). Looking at the breakdown of the application of premiums on Page 8 we see that expenses account for 38% of the total premium. If we now split this down we could say that new policy expenses are 42% of the premium and renewal expenses form 37% of premiums. Thus if a policy remains in force on average for 5 years then the average expenses = $\frac{4 * 37 + 1 * 42}{5} = 38\%$

Thus, for a given policy, in its first year an underwriting loss may be incurred and this is not recouped and a profit made until future renewals. This deficit in the first year is a temporary drain on the capital of the company and this is known as the expenses strain.

This method has the economic drawback of charging a loss making rate now in anticipation of future renewals and profits, which might not necessarily materialise.

IBNR

Some time during the life of our householder's policy a claim may occur. It will take some time for this to be notified to Head Office and again there will be a delay from notification to the final settlement of the claim. The former will usually be quite short, say a month, (but may be 2 or 3 years), whereas the latter will be often many months and sometimes years (especially for larger claims). It is often part of the policy contract that claims are notified within a certain period. Thus at the end of the financial year there will be claims which have occurred but which have not yet been reported and a reserve is made for these, and called the Incurred but not Reported reserve - I.B.N.R.

OCR

For those claims which are notified but not settled an estimate is made class by class of the total money which will have to be paid out to settle these claims. A reserve is made for this and is known as the Outstanding Claim Reserve.

EARNED CLAIMS RATIO

This ratio is used to indicate if claims are forming too large a part of the income. This can be evaluated on a class by class basis and trends watched so that action can be taken on an adverse claims ratio.

$$\text{Earned Claims Ratio} = \frac{\text{Incurred claims in a particular year}}{\text{earned premium for that year.}}$$

where incurred claims in 1975 = All claims paid in 1975

plus outstanding claims (including IBNR) at the end of 1975

less outstanding claims (including IBNR) at the start of 1975.

Reinsurance

Reinsurance is the method of sharing out large risks among a number of companies so that no one company has too much at risk on one policy. Much of the soundness and repute of the London insurance market has stemmed from its ability to reinsure adequately. This is done almost exclusively on the commercial accounts where the amounts insured are large and the number comparatively small. From the company's point of view there is a division between Inwards Reinsurance and Outwards Reinsurance. In the latter case this company holds the policy with the Insured. It then sells off part of the risk to a number of other insurers according to some fairly arbitrary rules. In inwards reinsurance this company is taking part of the risk for a policy from another insurance company. The actual mechanics of reinsurance vary and depend on the internal policy of the ceding company.

Since by reinsuring the company is reducing its risks it may be assumed that a cost is associated with reinsurance and there is a problem of not reinsuring away too large a proportion of profits, while at the same time maintaining a low enough level of risk.

Reinsurance performs the dual function of reducing the probability of ruin of the company, by avoiding individual catastrophic losses, and also of producing a more even cash flow by reducing the amounts payable on large but infrequent claims.

Solvency Margin

In addition to the specific reserves the company is required to maintain, by law, a certain level of free reserves. This is the Solvency margin and although it is hoped that the money in it will never be needed, it is there to provide for claims which are unexpected (even under the usual pessimistic reserving) and for which, consequently no reserve is made. It is on a sliding scale but for larger companies (over £½ million of written premium) it is 10% of the written premium. The European standards which are to be introduced in 1977 are:-

18% of first 10M European Units of Account (EUA's) of written premium

plus 16% of written premiums above 10M EUA's

or, on the average incurred claims over the last three years

26% on below 69,000 EUA's

plus 23% on claims above 69,000 EUA's

(2.4 EUA's = £1).

Policy Classes

Each policy which is written is allocated to a class of business according to the cover which the policy provides. There are general classes which are used for supplying returns to the DoT and these are:

Liability

Motor

Pecuniary Loss

Personal Accident

Property.

Each of these is again split down into individual risk classes and the structure of these will vary from office to office. Thus, for example Pecuniary Loss is divided into -

Consequential Loss

Mortgage Guarantee

Fidelity Guarantee

But within each risk group the exact cover may vary considerably. Thus, as is well known, the cover for a private car may be 'fully comprehensive' or 'Act only'. Another complication occurs, for example with commercial vehicles where the cover on one policy may be for a fleet of lorries and the exact exposure changes as the owner buys and sells his vehicles.

Most class names are self-explanatory; however, a few may be unfamiliar.

Consequential Loss

Known as 'Con. Loss' this is a commercial policy providing cover for a firm against loss of profits due to, for instance, a fire or flooding at its own premises or those of a supplier. Thus, a main dealer for a car manufacturer may insure in this way against a fire preventing the manufacturer supplying him with cars.

Mortgage Guarantee

This is somewhat different from other classes of short term business in that it usually remains in force for a number of years. It provides cover against a mortgagee defaulting on his repayments of the loan. As the mortgage is probably for a number of years so is the policy; however, as repayments are made, the amount of money at risk lessens. Different formulae are used to calculating for internal accounts (realistic), the published accounts (heavily over-reserved) or for taxation (no rational construction).

CHAPTER 5

Claims and the rate of Inflation

We have constructed a simple model to show the effects of inflation and the time taken to settle claims on the amount needed to be reserved for outstanding claims.

While, in the past, interest earned on outstanding claims reserves balanced increases in liability due to inflation, this is not now the case. Such things as repair costs and replacement costs are inflating faster than the rate of interest and judges have increased personal awards to take account of inflation since an accident. The time taken to settle claims varies considerably from class to class with such things as theft, glass and household being settled quickly, while with employers liability fidelity guarantee and engineering substantial proportions are outstanding after more than two years.

Not only is there an incentive to settle claims early now when the rate of inflation is greater than the rate of interest, but in the past companies could maintain a low underwriting profit knowing that an adequate rate of return on capital could be made from investment income. Now the underwriting profit must provide, in effect, the entire profit and premiums must be increased to maintain profit levels and also to prevent the claims reserves themselves falling into deficit. This rapid increase in premiums causes problems in maintaining the capital base at a sufficiently high level, which we look at in a later chapter.

In the model it is assumed that at a particular time (period 0) a certain amount of money has been reserved and will exactly pay the claims outstanding, but in future periods, if there is no inflation and no interest is earned on the money reserved.

However, we additionally assume

1) That a certain net rate of interest is earned on the money reserved at any time.

2) That, due to inflation, the claims outstanding (less amounts paid) increase from period to period.

Thus, when all claims have been paid there is a certain surplus or deficit remaining and it is the size of this surplus which we look at in the following pages.

In a hypothetical situation we consider that £10,000 of outstanding claims (in period 0 £'s) are settled over an eight year period. Several rates of inflation and interest, and various distributions of payment of the £10,000 over the eight years are considered and compared. Tables of the resulting surpluses are produced in the first 3 tables (5.1 - 5.3). In the following 3 tables (5.4 - 5.6) the percentage increase in the initial reserve needed to balance those reserves falling into debt is tabulated as this gives the most ready means of comparison.

A typical year by year analysis would be:-

RATE OF INTEREST- PER CENT PER PERIOD 18.000
RATE OF INFLATION- PER CENT PER PERIOD 14.000

PERIOD	CLAIMS PERIOD 0 LS	CLAIMS CURRENT LS	CASH AT END OF PERIOD
0	0.00	0.00	10000.00
1	1250.00	1425.00	10374.99
2	1250.00	1624.50	10617.98
3	1250.00	1851.92	10677.28
4	1250.00	2111.19	10487.99
5	1250.00	2406.76	9969.05
6	1250.00	2743.70	9019.77
7	1250.00	3127.82	7515.50
8	1250.00	3565.71	5302.58

Three different distributions are used and these are, in period 0 £'s.

	Amounts paid		
Year	A	B	C
0	0	0	0
1	1,250	0	2,500
2	1,250	0	2,500
3	1,250	0	1,250
4	1,250	0	1,250
5	1,250	2,500	625
6	1,250	2,500	625
7	1,250	2,500	625
8	1,250	2,500	625
	10,000	10,000	10,000

Tables 5.1., 5.2., 5.3 give the surpluses using the distributions A, B and C respectively. It is assumed that in the event of a deficit occurring before the final year interest charges are at the same rate as the interest earned. The amounts are positive for a surplus and negative for a deficit. The final amounts are in 'period 8' £'s, thus numerically similar amounts will have different 'values' if the rate of inflation has been different. Tables 5.4., 5.5., and 5.6 are in terms of 'period 0' £'s and thus the percent increases are comparable.

Delay Distribution in period 0 £'s settled

period	0	1	2	3	4	5	6	7	8	Total
amount	0	0	0	0	0	2500	2500	2500	2500	10,000

rate of interest % / inflation %	4	6	8	10	12	14	16	18
8	- 3620	- 2063	0	2406	5196	8416	12115	16346
10	- 6059	- 4356	- 2349	0	2732	5892	9530	13699
12	- 8545	- 6902	- 4955	- 2668	0	3095	6666	10767
14	-11301	- 9723	- 7842	- 5623	- 3024	0	3499	7526
16	-14353	-12845	-11036	- 8891	- 6367	- 3420	0	3947
18	-17727	-16295	-14565	-12500	-10058	- 7194	- 3859	0
20	-21452	-20103	-18458	-16480	-14127	-11354	- 8111	- 4347

Table 5.1

Delay Distribution in period 0 £'s settled

period	0	1	2	3	4	5	6	7	8	Total
amount	0	2500	2500	1250	1250	625	625	625	625	10,000

rate of.....interest % / inflation %	4	6	8	10	12	14	16	18
8	- 1839	- 1012	0	1225	2693	4438	6495	8906
10	- 2862	- 2098	- 1153	0	1391	3052	5020	7335
12	- 3962	- 3264	- 2388	- 1310	0	1575	3451	5667
14	- 5145	- 4515	- 3712	- 2712	- 1485	0	1780	3894
16	- 6418	- 5858	- 5131	- 4213	- 3073	- 1680	0	2007
18	- 7788	- 7301	- 6654	- 5819	- 4770	- 3474	- 1897	0
20	- 9262	- 8852	- 8287	- 7540	- 6585	- 5389	- 3919	- 2137

Table 5.2

Delay Distribution in period 0 £'s settled

period	0	1	2	3	4	5	6	7	8	Total
amount	0	1250	1250	1250	1250	1250	1250	1250	1250	10,000

rate of.....interest % / inflation %	4	6	8	10	12	14	16	18
8	- 2594	- 1414	0	1681	3665	5989	8695	11831
10	- 4075	- 2959	- 1611	0	1909	4154	6778	9826
12	- 5694	- 4644	- 3367	- 1830	0	2162	4698	7654
14	- 7461	- 6483	- 5280	- 3822	- 2075	0	2444	5303
16	- 9392	- 8488	- 7364	- 5989	- 4329	- 2347	0	2756
18	-11498	-10673	- 9633	- 8346	- 6778	- 4893	- 2649	0
20	-13795	-13054	-12102	-10908	- 9438	- 7655	- 5518	- 2983

Table 5.3

rate of ... interest % / inflation %	4	6	8	10	12	14	16	18
8	27.9	12.9						
10	44.3	27.3	12.7					
12	62.4	43.3	26.8	12.4				
14	82.6	61.0	42.4	26.2	12.2			
16	104.9	80.6	59.7	41.5	25.7	12.0		
18	130.	102.	78.7	58.3	40.6	25.2	11.8	
20	157.	126.	99.7	76.9	57.1	39.8	24.7	11.6

% increase in initial funds needed, from table 5.1.

to prevent the reserves falling into deficit

Table 5.4

rate of ... interest % / inflation %	4	6	8	10	12	14	16	18
8	13.4	6.3						
10	20.9	13.2	6.2					
12	28.9	20.5	12.9	6.1				
14	37.6	28.3	20.1	12.7	6.0			
16	46.9	36.8	27.7	19.7	12.4	5.9		
18	56.9	45.8	35.9	27.1	19.2	12.2	5.8	
20	67.7	55.6	44.8	35.2	26.6	18.9	11.9	5.7

% increase in initial funds needed, from Table 5.2. to prevent the reserves falling into deficit.

Table 5.5

rate of ... interest % / inflation %	4	6	8	10	12	14	16	18
8	18.9	8.9						
10	29.8	18.6	8.7					
12	41.6	29.1	18.2	8.5				
14	54.5	40.7	28.5	17.8	8.4			
16	68.6	53.3	40.0	27.9	17.5	8.2		
18	84.0	67.0	52.	38.9	27.4	17.2	8.1	
20	101.	82.0	65.4	50.9	38.1	26.8	16.8	7.9

% increase in initial funds needed, from table 5.3.

to prevent the reserves falling into deficit.

Table 5.6

Conclusions

While this is a simple model it does show the problems involved and the severe change which recent trends in rates of inflation and earned interest are causing to the traditional structure of the insurance industry.

The marked effect which the distribution of settling claims has upon the surplus can be seen and the beneficial effects of early settlement when the rate of inflation is greater than the rate of interest is apparent.

CHAPTER 6

The Expenses Model

Design of the Model

The structure of the model arose out of discussions with the Management Accountants who have concurrently been investigating methods of policy costing and the separation of variable costs, those dependent on policy volumes, from fixed costs.

An attempt has been made to identify those costs which are variable and to produce a unit cost per policy handled in each class of business for these costs. It is considered that most of the costs dependent on volumes occur at service offices, while most of the fixed costs occur at head office. Thus we have developed two different methods of handling these costs, known as Service Office Costs and Tree Structure Costs.

Tree Structure Costs

The majority of head office costs are considered not to be directly related to volumes and these are incorporated in what is known as the tree structure. Also included in the tree structure are the Sales Office costs. These act as 'post offices' for the transfer of policies to service offices and their work does not vary much with changing volumes. Probably, as more knowledge is obtained about costs more 'fixed costs' will be seen to have some element of relationship to policy volumes and then these can be incorporated in the service office type costs. The costs are split down by department to any required level and these values are fed into the terminal nodes of the tree, as shown in Fig 6.1. These are added up at the second level and finally at the first level to give the costs section by section. The costs for subsequent years may be generated either by feeding in discrete values, or by allowing a proportional change on the previous year at each node. Thus, for instance, different cost centres can be liable to different rates of inflation.

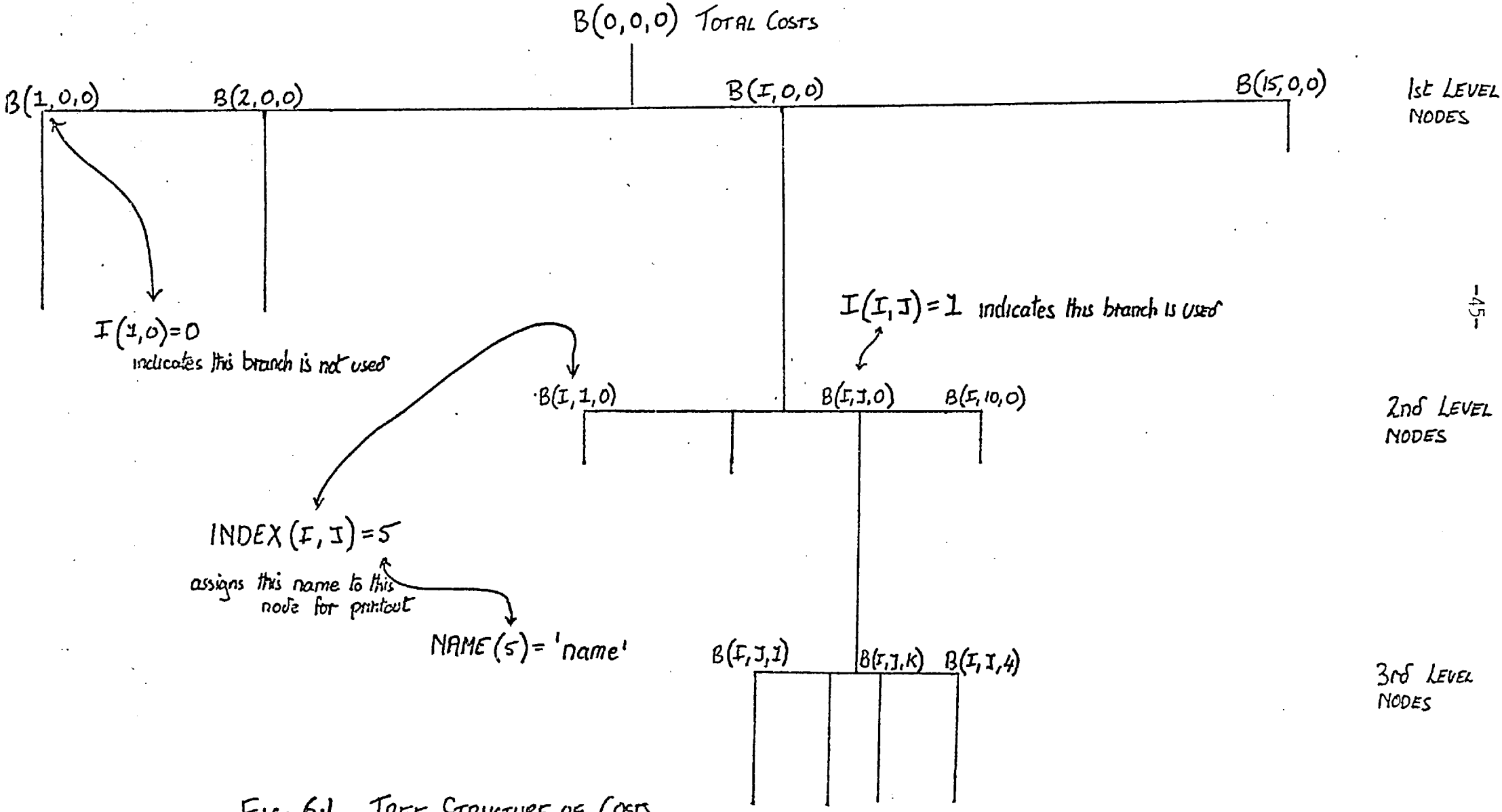


FIG 6.1 TREE STRUCTURE OF COSTS

Names can also be associated with 1st and 2nd level nodes which will be printed out with the results. These can be altered actually within the program or else by appropriate data cards during the running of the program.

Service Office Costs

We have considered that the work done directly on a policy can fall into one of five categories.

a) new policies
b) renewals
c) claims
d) alterations
e) cancellations and lapses

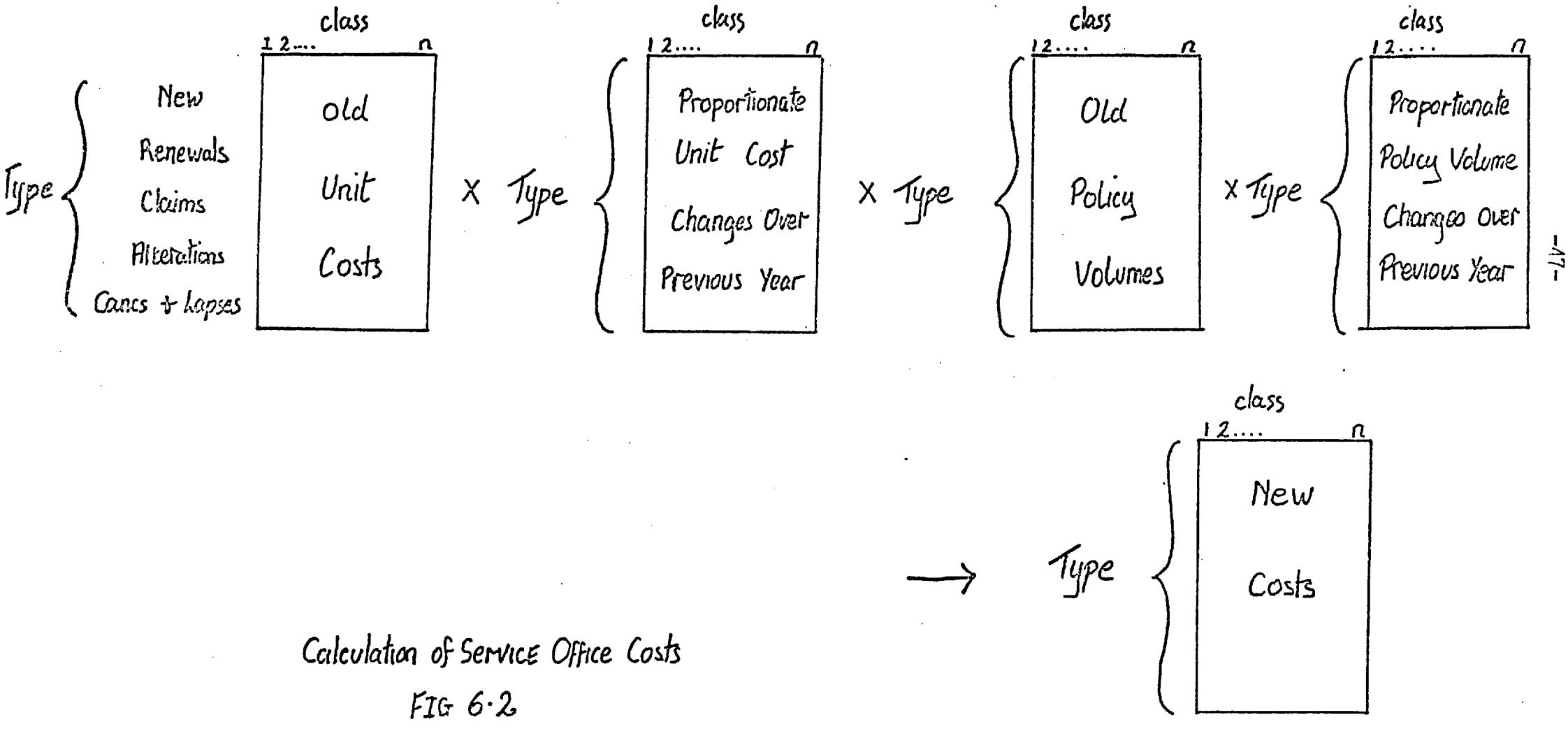
These are called the 'types of work'. All policies have been apportioned to one of four general classes of business.

f) motor
g) property private
h) property commercial
i) miscellaneous accident

The restriction in the number of classes is due to the lack of more detailed data - the program can handle up to 15 classes directly and more with slight alteration.

Management accounts have produced figures for the total costs of handling policies at each service office by each class of business for each type of work. Thus it has been possible to produce a unit cost for the same subdivision, and this is what is used as the basis for calculating the costs.

To produce the costs in the following year two further items of information are needed. These are the volumes for the next year, and the change in the unit cost (due, for example, to inflation (increase) or increased efficiency (decrease)). Thus this gives the new variable costs at each service office as shown in Fig 6.2. These can be summed to give the total



Calculation of Service Office Costs

FIG 6·2

variable costs for each class, each service office and each type of work.

There are also overhead costs at the service offices and these are included as discrete amounts. Two different types of overhead are allowed for at each service office and the amounts for each year can either be fed in as an actual amount or as a proportionate change on the previous year. Thus, having two categories allows, for example, for different rates of inflation, one perhaps for salary overheads which may be increasing at a different rate to establishment costs. Results are produced as in the scheme in Fig 6.3.

Some head office costs have been considered to be variable and can be handled by this method. These are

a) MSA charges and regional administration

b) GI-UK Head Office (excluding a))

These have been called Pseudo-service offices. In this case the unit costs are calculated from the total society volumes for the initial year, and costs in successive years are calculated in the same way as for a service office, but using the total volumes.

If the premium/claims model projections are used to provide the data for the expenses model then the volumes of business will only be given for the society as a whole, not by each service office. Thus, since the unit costs differ from office to office a method of assigning the volumes to individual service offices is necessary to allow the costs to be correctly calculated. This is done by inputting the society volumes for each type of work and class of business, and also data which gives the proportions of these volumes to be assigned to each service office. An alternative simplification for dealing with society volumes allows the user to specify the proportions, again for each class of business, but the proportions will be the same for each type of work, thus reducing the amount of data which has to be supplied. The actual methods for data input are given in the section on data codes.

The program is completely flexible and allows nodes (cost centres) in the tree structure to be added and deleted in each year and service offices to be decreased or increased. A prime use of the model would be for short-term budgeting, say for quarterly or annual costs. The program initially needs a data base of unit costs for handling work and fixed costs split down into suitable cost centres. With this and suitable estimates of cost changes and changes in the amount of work, quarterly budgets can be prepared. The model provides a framework within which budgeting may be refined by comparing budgeted costs with the costs which are actually incurred. Discrepancies can be examined and used to improve the accuracy of the data base. The model was used to produce an annual budget and this compared well with the figures produced by the standard budgeting process.

CHAPTER 7

Solvency Model

7.1 A model has been developed to take a broader view of the General Insurance business looking at the solvency margin, capital employed and return on capital employed. The model shows the relative influence which the various parameters in the model have on these factors.

The structure of the model is described first followed by a discussion of the results and an analytical interpretation of them.

The basis of the model is that a certain amount of premium is written each month. This premium goes towards

1) Claims
2) Expenses
3) Commission
4) Reinsurance Costs
5) Underwriting Profit

The first four are considered to be a certain percentage of the written premium. If this total is less than 100%, an underwriting profit is made and conversely if it is more than 100% an underwriting loss is made.

Expenses

The model, in effect, considers all costs to be variable so that costs change in direct proportion to the written premium.

Commission

This is taken as an immediate deduction as a percentage of the written premium.

Reinsurance

Reinsurance is considered as a cost to the society, since if the reinsurers do not earn a larger profit than by direct underwriting they are gaining no benefit from doing the business. It will be shown, as is generally realised, that a rapidly increasing premium income has a deleterious effect on the solvency margin. This model enables the effect on the solvency margin to be seen if larger amounts of premiums are reinsured away, but at a greater reinsurance cost per unit of written premium retained.

Claims

The amount of the written premium which will be paid out on claims is known and thus using the distribution of the delay from accident to final settlement this enables the amount of claims settled in each future month to be calculated. (In fact, in the model the only requirement is to know the amount of claims outstanding at the end of the year). The amount of claims may be large enough to form an underwriting loss, allowing, for instance, for inflation increasing the amounts of claims after the policy rates were set. At the end of the accounting year the claims paid and the claims outstanding are easily calculated.

Delay Distribution

This model only incorporates one delay distribution, the delay from an accident to settlement. This is provided as part of the data and allows the effects of different delays to be seen.

Earned Premium

The earned premium in each month is calculated using the 30ths rule and this is used for calculating the Unearned Premium Reserve according to the statutory requirements. A 'realistic' U.P.R. is also calculated and this is done on a 24ths basis after allowing for

2) Expenses

3) Commission

but not 4) Reinsurance costs

As well as the parameters already mentioned taxation, dividend payments and interest earned on investments are taken into account. For running the model under a set of parameters, the model will run for five years using a standard set of parameters to enable the claims reserves to be set up in an equilibrium state. The claims distribution used however is the one which will remain in force for the entire run. The other values used are:-

Tax	0%
Dividends	0%
Interest	0%

and, for each £100 of written premium

claims	£60
expenses	£25
commission	£12
reinsurance	£ 3

The initial capital is taken as £6,000 and the proportion of this put up by shareholders, and on which dividends are paid is .3 (£1800) . Changing the proportion is equivalent to changing the rate of dividend. The written premium is assumed to be constant at £1000 per month.

After this period a new set of parameters are taken each one of which can be altered from the data.

The values for these are:-

Tax	52%
Dividends	40%
Interest	10%

for each £100 of written premium

claims	£58
expenses	£25
commission	£12
reinsurance	£ 3

These are the basis for the graphs which follow. The delay distribution used for all the runs, except those specifically investigating the effect of different delay distributions is given in Table 7.1.

At the start there is considered to be a certain amount of capital in the company. This is composed of shares, on which dividends are paid, and what we can call retained earnings on which interest is not paid. The total capital at the start is CAPSTA and the proportion of this represented by shares is PROSHRE. Thus if the rate of dividend is RDIVI then the amount paid out to the shareholders in the form of dividend each year is

CAPSTA * PROSHRE * RDIVI

The total premium income for a year is taken to be the total written premium for the year. The direct outflows will be the total of

1) claims paid
2) expenses
3) commission
4) reinsurance

The difference is the money left from underwriting this year (although this is not the underwriting profit). Interest is earned on the total funds at the start of the year. This is CAPSTA, the initial capital, plus CASH, the amount of money (positive or negative balance) which the company has accumulated from its activities since the start. The rate of interest earned is given and thus the investment income is calculated. It is considered to be unfranked and is thus liable to tax after being allowed against any underwriting loss. Any increase in the Outstanding Claims or Unearned Premium Reserves is allowable against tax and the remaining taxable income is charged at a percentage rate.

Thus the format is:-

	Cash Inflow from Premiums (Total Income)
Less:	Expenses
Less:	Claims Paid
Less:	Commission
Less:	Reinsurance Costs
	Money left from Underwriting
Plus:	Investment Income
Less:	Increase in U.P.R. (30ths basis)
Less:	Increase in O.C.R.
	Taxable Income
	Tax
Also:	Money left from Underwriting
Less:	Tax
Less:	Dividends
Plus:	Investment Income
	Increase in Funds - added to CASH

The solvency margin is the number of times the free reserves cover the written premium for the year.

The free reserves are calculated as:-

	CAPSTA - initial capital
PLUS:	CASH
LESS:	OCR
LESS	UPR (30ths)
	Free Reserves

and the solvency margin = $\frac{\text{Free Reserves}}{\text{Written Premiums for year}}$

For calculating the capital employed and the return on capital employed we apportion the total funds between those economically needed to cover future claims and costs and the rest which is considered to belong (directly or indirectly) to the shareholders. For this we calculate a realistic UPR

on the 24ths basis after allowing for expenses.

Thus

CAPSTA - initial capital

PLUS: CASH

LESS: OCR

LESS: UPR - calculated after allowing for expenses

capital employed

The return on capital employed is taken as

$$\frac{\text{Taxable income for this year}}{\text{Capital employed at year end}}$$

7.2 Graphs

These show the results obtained by changing individual parameters

7.1A, 7.1B	different claims amount per £100 of written premium
7.2A, 7.2B	different dividend payment rates
7.3A, 7.3B	different rates of interest
7.4A, 7.4B	different rates of tax
7.5A, 7.5B	different amount of reinsurance
7.6A,	different amounts of policy costs per £100 of written premium
7.7A, 7.7B	different rates of change of written premium per month
7.8A, 7.8B	different delay patterns
7.9A	combined effects

The 'A' graphs give the solvency margin. The 'B' graphs give the capital employed (on the left side) and the return on capital employed (on the right side).

For the 7.7 graphs, of different rates of change of written premium per month, the written premium is taken to be of the form

$W_{i+1} = F\,W_i$ Where W_i is the written premium for month i and F is a factor. The graphs give results for different values of F.

Period	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Per Cent Settled	.1	.3	.5	.7	.9	1.1	1.3	1.7	2.1	2.5	3.1	3.5	4.2	4.6	4.6	5.1

Period	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Per Cent Settled	5.5	5.5	5.5	5.5	6.2	6.2	6.2	5.5	4.7	3.8	3.5	2.2	1.4	1.	1.

Table 7.1

Main Delay Distribution

Graphs 7.9A show the effect of changing several parameters. It is seen that the effects in graphs 7.1A to 7.6A, inclusive are substantially linear, in that successive changes in the prime parameter produce roughly proportionate changes in the solvency margin. The main reason for this is that the denominator in the definition of the solvency margin, the total written premium, remains constant, and the changes occur linearly in the numerator, although this may be affected by any time factors.

Thus we can construct a table, from the graphs, of the changes in the solvency margin for each parameter given in Table 7.2 below.

Commission has been disregarded as it has the same effect within the model as expenses.

Parameter	Change in Solvency Margin, %, for 1% change in the parameter, per year
claims	.4958
dividend	.1880
interest	1.0333
tax	.2467
reinsurance	.5875
expenses	.6000

Table 7.2

An increase in each of the parameters except for the rate of interest will reduce the solvency margin as this is increasing the money paid out by the company.

7.9B shows the effects of changing several parameters. The actual values taken are

Parameters	A	L	M	N
Tax	52	60	60	55
Dividends	40	50	60	55
Interest	10	15	18	15
claims	58	62	62	62
expenses	25	25	25	29
reinsurance	3	3	4	3

Table 7.3

If we assume that the effects of these parameters are linear, then the consolidation of the values in table 7.2 by the appropriate changes in the parameters from sequence A should give the change in the solvency margin. This can then be compared with the actual solvency margin as shown in table 7.4.

Parameter set	Calculated Solvency Margin relative to sequence A %	Solvency Margin relative to sequence A from Graph 7.9A %
L	+ 3.2	- 2
M	- 0.4	- 6.5
N	- 27.8	- 27.4

Table 7.4

There is thus a fairly close association between the values obtained from the model and also by assuming a linear relationship. The discrepancy is due to varing interactions of the parameters which will be examined later.

Referring to graph 7.7A it is seen that a change in the rate of writing premiums has a considerable effect on the solvency margin. If written premiums are decreasing then the money held as strains in the technical reserves is progressively released to the free reserves which thus are increasing while the total premium income each year is decreasing. This, particularly in periods of inflation will not occur unless a company is

specifically withdrawing from a market as, for example, the Eagle Star Insurance Company is from Canada (ref 10).

At current rates of inflation an increase in written premiums of 2% per month (compound) would only be sufficient to enable a company to maintain its market share and it is seen from the graph that, in this model this results in a halving of the solvency margin over a five year period. However after this the rate of decrease stops and the solvency margin remains steady at about 18%. Similarly, for a rate of increase of 1% per month the solvency margin declines to about 33% before slowly increasing again. It would seem that it is a change in the rate of inflation which has the main effect rather than a high rate of inflation itself. One important difference in this model from the situation facing insurance companies at the moment is that an underwriting profit is still being made. In reality, at the moment with an increasing rate of inflation the level of claims is higher than that allowed for when the rates were set thus underwriting losses are being made. It would seem imperative that rates are increased sufficiently to maintain profits after allowing for pessimistic forecasts of the rate of inflation. If this is done, and inflation does not increase continually, then the solvency margin can more easily be maintained at an adequate level.

Graph 7.8A shows the effect of different delay distribution. An increase of 5% in the solvency margin occurs over a ten year period if all claims are settled two months later. This increase is due to the extra income which is earned from the investments during this extra two months. In practice delaying payments would mean an increase in the amounts being paid on claims, due to inflation so the company would have to offset increased investment income against increased claims. If some estimate can be made of the rate of increase in claims then this can be examined with changing delay patterns in the model.

7.3 Mathematical Analysis

Let, in our notation, the written premium in month i be W_i. For each £100 of written premiums let the amounts paid out be:-

Claims	£C
Policy handling Expenses	£E
Commission	£Co
Reinsurance	£R

Also, let

$\mathcal{B}_K$ = bank balance at end of year K from business written since time = 0

Cap = initial capital at time = 0

$\mathcal{D}$ = rate of dividend paid on this capital

I = rate of interest earned

$\mathcal{T}$ = rate of tax

$\mathcal{R}_K$ = increase in the Outstanding Claims Reserve and the Unearned Premium Reserve, calculated on a 30ths basis in year K

OCR^K = actual Outstanding Claims Reserve at the end of year K.

$UPR30^K$ = Unearned Premium Reserve calculated on a 30ths basis for year K

$UPRecon^K$ = the minimum economic amount required for the Unearned Premium Reserve

Thus at the end of year K, for year K

Cash in (assuming no delays)		$\sum_{i=12K-11}^{12K} W_i$
Less		Claims Paid
	expenses	$E\sum W_i/100$
	commission	$Co\sum W_i/100$
	reinsurance	$R\sum W_i/100$
	giving Money Left	$\mathcal{M}_K$ (not profit)

The claims paid depend on the earned premiums (and hence the written premium), the claims per £100 of written premiums and the delay in settling claims. It will be the same from one year to the next if these are constant.

Underwriting money (not profit)	$\mathcal{M}_K$
investment income	$I * (\mathcal{B}_{K-1} + Cap)$
increase in reserves	$\mathcal{R}_K$
taxable income	$(\mathcal{M}_K + I * \mathcal{B}_{K-1} + I * Cap - \mathcal{R}_K)$
tax	$(\mathcal{M}_K + I * \mathcal{B}_{K-1} + I * Cap - \mathcal{R}_K)\,\tau$
dividends paid	$Cap * \mathcal{D}$
bank balance (excluding initial capital)	$\mathcal{B}_K$

where

$$\mathcal{B}_K = \mathcal{B}_{K-1} + (\mathcal{M}_K + I * \mathcal{B}_{K-1} + I * Cap)\,(1-\tau) + \mathcal{R}_K\tau - Cap * \mathcal{D}$$

Capital Employed is $\mathcal{B}_K + Cap - CCR^K - UPR^K_{econ}$

Solvency Margin $$\frac{\mathcal{B}_K + Cap - CCR^K - UPR^K_{30}}{\Sigma W_i}$$

which can be expressed as

$$\frac{\mathcal{B}_{K-1} + (1-\mathcal{D})\,Cap + (\mathcal{M}_K + I * \mathcal{B}_{K-1} + I * Cap)\,(1-\tau) + \mathcal{R}_K\tau - CCR^K - UPR^K_{30}}{\Sigma W_i}$$

Solvency Margin

This measures the extent to which the free reserves cover the written premiums and it is desirable that this value should be as large as possible. Thus we want the numerator to be as large as possible and the denominator as small as possible.

Numerator

The numerator is

$$\mathcal{B}_{K-1} + (\mathcal{N}_K + I * \mathcal{B}_{K-1} + I * Cap)\ (1-\tau) + \mathcal{R}_K\tau + Cap\ (1-d) - OCR^K - UPR30^K$$

Looking at each term, for a particular year, $\mathcal{B}_{K-1}$ and Cap are fixed. If I changes by an amount ΔI then the solvency margin changes by

$$\frac{\Delta I\ (1-\tau)\ (\mathcal{B}_{K-1} + Cap)}{\sum W_i}$$

This in a realistic situation will take the sign of ΔI

Similarly if τ changes by $\Delta\tau$ then the solvency margin changes by

$$\frac{\Delta\tau * \mathcal{R}_K - \Delta\tau\ (\mathcal{N}_K + I * \mathcal{B}_{K-1} + I * Cap)}{\sum W_i}$$

Any changes in expenses, reinsurance or commission will, in the framework of this model directly affect $\mathcal{N}_K$ alone, where if any of them decreases then $\mathcal{N}_K$ increases. The net effect on the solvency margin will be

$$\frac{\Delta\mathcal{N}_K\ (1-\tau)}{\sum W_i}$$

Outstanding Claims

$\mathcal{R}_K$ can be considered as the increase in outstanding claims and the increase in the unearned premium reserve.

Thus $\mathcal{R}_K\tau - OCR^K - UPR30^K$ can be written as

(increase in OCR plus increase in UPR30 this year) $(\tau-1)$

$$- (UPR30^{K-1} + OCR^{K-1})$$

Thus if the outstanding claims are reduced as much as possible, by settling claims early there is a decrease in the outstanding claims reserve but $\mathcal{N}_K$, the money left in year K will decrease by a similar amount and the total effect is to leave the numerator and the total value of the solvency margin unchanged. However, in the framework of this analytical model the solvency margin will remain constant only for the first year after such a change. As the reserves are now reduced less interest will be earned and

consequently it will affect the results in year K + 1. The progressive effects of different delay distributions can be seen from the computer model given in graphs 7.8A and 7.8B.

The model assumes sufficient reserves are made for outstanding at the time they are incurred, irrespective of the level of inflation. A further approach would be to consider the effects of inflation on claims the longer they are left unpaid. The facility for examining this exists in the premium/claims model.

Unearned Premium Reserve

The unearned premium reserve depends on the level of the written premiums, as does the denominator of the solvency margin. Any increase in the written premium during the year will increase the unearned premium reserve. $\mathcal{U}_K$ will also increase but by a lesser amount, in general, since the costs associated with policy handling usually form more than the 20% of the premium allowed as deductable by statute. The outstanding claims reserve will also increase since if the increase in written premiums is due to inflation, this is reflected by an increase in the average amount of a claim, and if it is due to an expansion of business, then the number of claims will increase.

The effects of a changing level of written premium is more difficult to examine analytically as both the numerator and denominator of the solvency margin are affected, and it is probably best examined by means of the computer model. An analytical solution is difficult and will not improve upon the computer model, which is more likely to represent reality by the greater flexibility in the setting of parameters.

However let us compare two years

At the end of the second year the numerator is

$$\mathcal{B}_{K-1} + (1-\mathcal{D})\ \text{Cap} + (\mathcal{U}_K + I * \mathcal{B}_{K-1} + I * \text{Cap})\ (1-\tau) + \mathcal{R}_K \tau -$$

$$OCR^K - UPR^K_{30}$$

This is compared with the corresponding numerator for the first year we get $\mathcal{B}_{K-1} + Cap - OCR^{K-1} - UPR_{30}^{K-1}$ (I)

If the underwriting profit is low then $\mathcal{N}_K \approx \mathcal{R}_K$, although since an allowance of 20% for expenses, as implied in $\mathcal{R}_K$ is usually somewhat low, then in general $\mathcal{R}_K > \mathcal{N}_K$

And we can rewrite $\mathcal{N}_K (1-\tau) + \mathcal{R}_K \tau$ as $\mathcal{R}_K$

and overestimate the numerator leaving

$\mathcal{B}_{K-1} + (1-\mathcal{D}) Cap + \mathcal{R}_K + (I * \mathcal{B}_{K-1}) (1-\tau) - OCR^K - UPR_{30}^K$

Also $\mathcal{R}_K - OCR^K - UPR_{30}^K = - (OCR^{K-1} + UPR_{30}^{K-1})$

giving $\mathcal{B}_{K-1} + (1-\mathcal{D}) Cap + (I * \mathcal{B}_{K-1}) (1-\tau) - OCR^{K-1} - UPR_{30}^{K-1}$ (II)

This is independent of the values of W_i for each month of year K. Thus if, say the premium income has doubled the numerator will not have kept up to maintain the value of the solvency margin. Thus the solvency margin is highly sensitive to changes in W_i, although this analysis is not directly extendable to more than two years due to the increasing complication of expressing $\mathcal{B}_{K-1}$.

Rate of Change of Written Premium

The UPR is in effect a weighted average of the written premium for each month of the previous year. Because it gives more weight to recent months, when compared with the total written premium for the year, it will be proportionately greater when premiums are increasing and less when premiums are decreasing.

For example if W_i is the written premium in month i and we take $W_{i+1} = F * W_i$, that is the written premium changes by a certain proportion of the previous month, then we can compare the UPR and the total written premium for different values of F.

The total written premium for a particular year is

$$W_1 + W_2 + W_3 + \ldots + W_{12}$$

which reduces to

$$W_1 (1 + F + F^2 + \ldots F^{11})$$

$$= W_1 \frac{(1 - F^{12})}{1 - F} \qquad \text{for } F \neq 1$$

and $12W_1$ for $F = 1$

The UPR, on a 24ths basis is

$$\text{UPR 24ths} = 1/24 \ (W_1 + 3W_2 + 5W_3 + \ldots 23W_{12})$$

which reduces to

$$1/24 \ W_1 (1 + 3F + 5F^2 + \ldots + 23F^{11})$$

Now

$$1 + 3F + 5F^2 + \ldots + 23F^{11}$$

$$= 1 + 4F + 6F^2 + \ldots + 24F^{11} - F - F^2 - \ldots - F^{11}$$

$$= 1 + 2 (2F + 3F^2 + \ldots + 12F^{11}) - (F + F^2 + \ldots + F^{11})$$

But

$$F^2 + F^3 + \ldots + F^{12} = \frac{F^2 (1-F^{11})}{1-F}$$

Hence

$$2F + 3F^2 + \ldots 12F^{11} = \frac{(1-F) (2F-13F^{12}) + F^2 (1-F^{11})}{(1-F)^2}$$

Thus we get

$$\text{UPR24ths} = W_{1/24} \frac{1 + F - 25F^{12} + 23F^{13}}{(1-F)^2} \qquad \text{for } F \neq 1$$

For $W_1 = 1$ we can compare the values we get for different values of F

F	UPR24ths = A	Total Written Premiums ÷ 2 = B	A/B * 100%
.7	.7300	1.6436	44.4
.75	1.0030	1.9366	51.8
.8	1.4026	2.3282	60.2
.85	1.9903	2.8592	69.6
.9	2.8565	3.5879	79.6
.95	4.1311	4.5964	89.9
.98	5.1664	5.38209	96.0
.985	5.3631	5.52894	97.0
.99	5.5676	5.6808	98.0
.995	5.780	5.8377	99.0
1.000	6.000	6.000	100.0
1.005	6.2297	6.1678	101.0
1.01	6.4668	6.3412	102.0
1.015	6.7134	6.5206	103.0
1.02	6.9696	6.7060	103.9
1.025	7.2356	6.8978	104.9
1.03	7.5117	7.0960	105.9
1.04	8.0960	7.5129	107.8
1.05	8.7254	7.9586	109.6
1.10	12.673	10.6921	118.5

Table 7.5

Conclusion

It would appear conclusive that rapid inflation is the most important factor affecting the solvency margin and this is made worse by the falling underwriting profits which are almost inevitably concomitant. There are few alternatives open to companies to protect their solvency margin. These primarily are:-

a) reduce inflation

b) reinsurance

c) increase premiums

d) stop underwriting

e) capital restructuring

a) Since a high rate of inflation is the cause, the removal of the cause must be considered the best solution; however this is outwith the sphere of action of the company. It can only emphasise the dangers of this situation to those who have economic control of the county. The same situation of a rapidly increasing written premium can occur when a company is increasing its market share. However the strain on the solvency margin is unlikely to be as severe because the underwriting profit should be maintained at a more adequate level even if some rate cutting is practised initially to attract the business.

b) A company can reinsure more of its premiums, but as the reinsurers require to make a profit this means that profits are reinsured away. Also it is not possible for all companies to reinsure more risks away without expanding the insurance industry, which would in itself require to fund the solvency margin.

c) Premiums should be increased to a level sufficient to provide for claims allowing for the most pessimistic forecast of the rate of inflation and also to provide profits at a level sufficient to maintain the free reserves. The solvency margin should be a reserve built up over a period of years. With

rapid inflation (and interest rates at a much lower level) reserves from previous years become a much smaller proportion of the written premiums. Thus proportionately more of the funding has to be provided from the current year.

Policies could be issued on a half-yearly basis allowing premiums to be more immediately responsive to a change in inflation. This has the severe disadvantage that a large proportion of the expenses are doubled, on an annual basis. However in classes where a large proportion of policies are cancelled or altered this might not be a drawback.

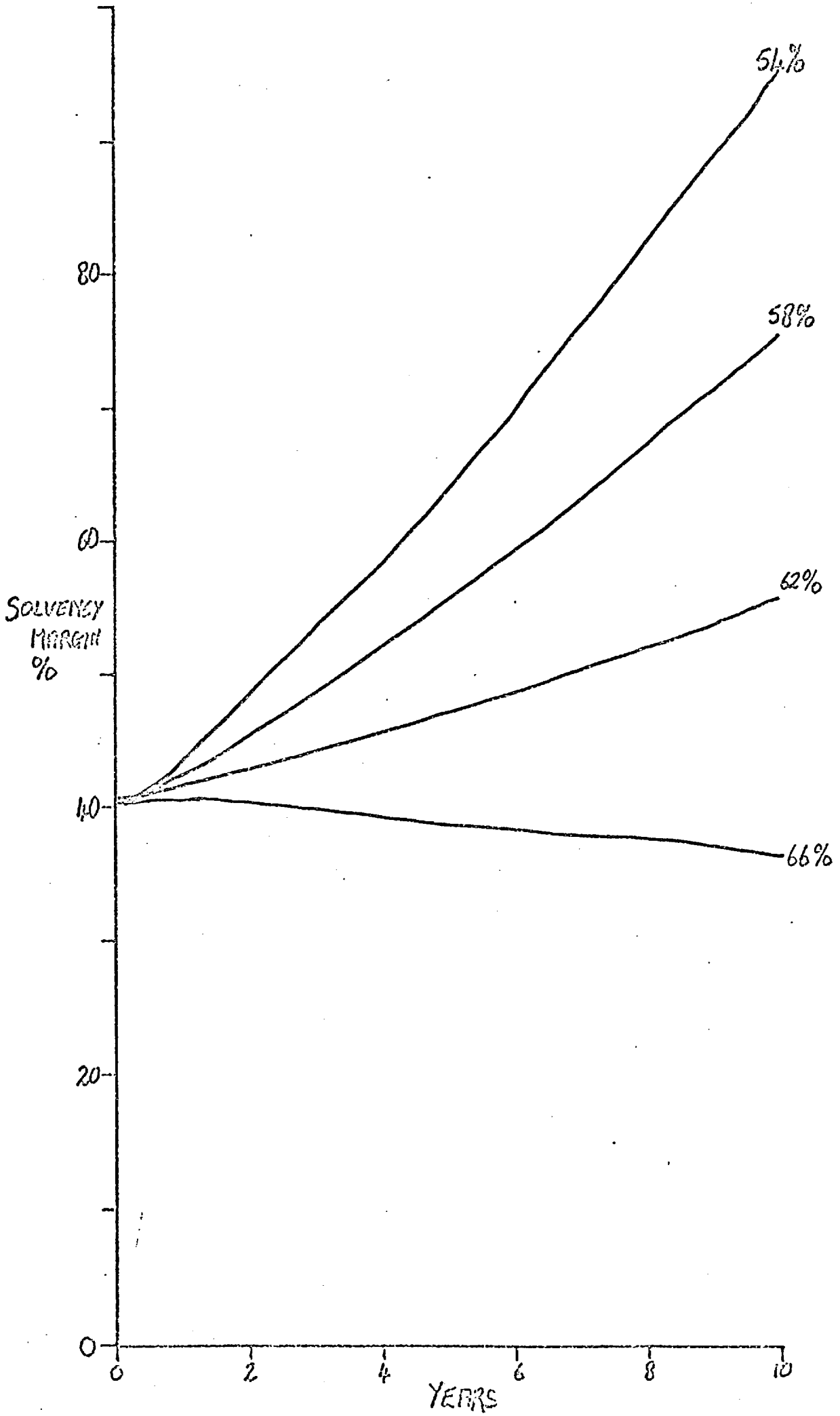
d) If the solvency margin falls to the legal minimum, and the company is unable to increase it, then that company will have no alternative but to stop underwriting. Should this happen throughout the industry there would be severe consequences for the traditional structure of industry, business and society.

e) Companies can alter their capital structure to provide for a larger capital base. The most common method of capital restructuring at the moment is rights issues in which existing shareholders are asked to put up money for more shares in proportion to the number they already hold. Between December and May of this year some £145 million was raised in this way by the insurance industry.

Alternatively a company such as an investment trust or property company can be acquired by the exchange of shares in the insurance company. This has been done, for instance, by Eagle Star in their acquisition of Grovewood Securities Ltd.

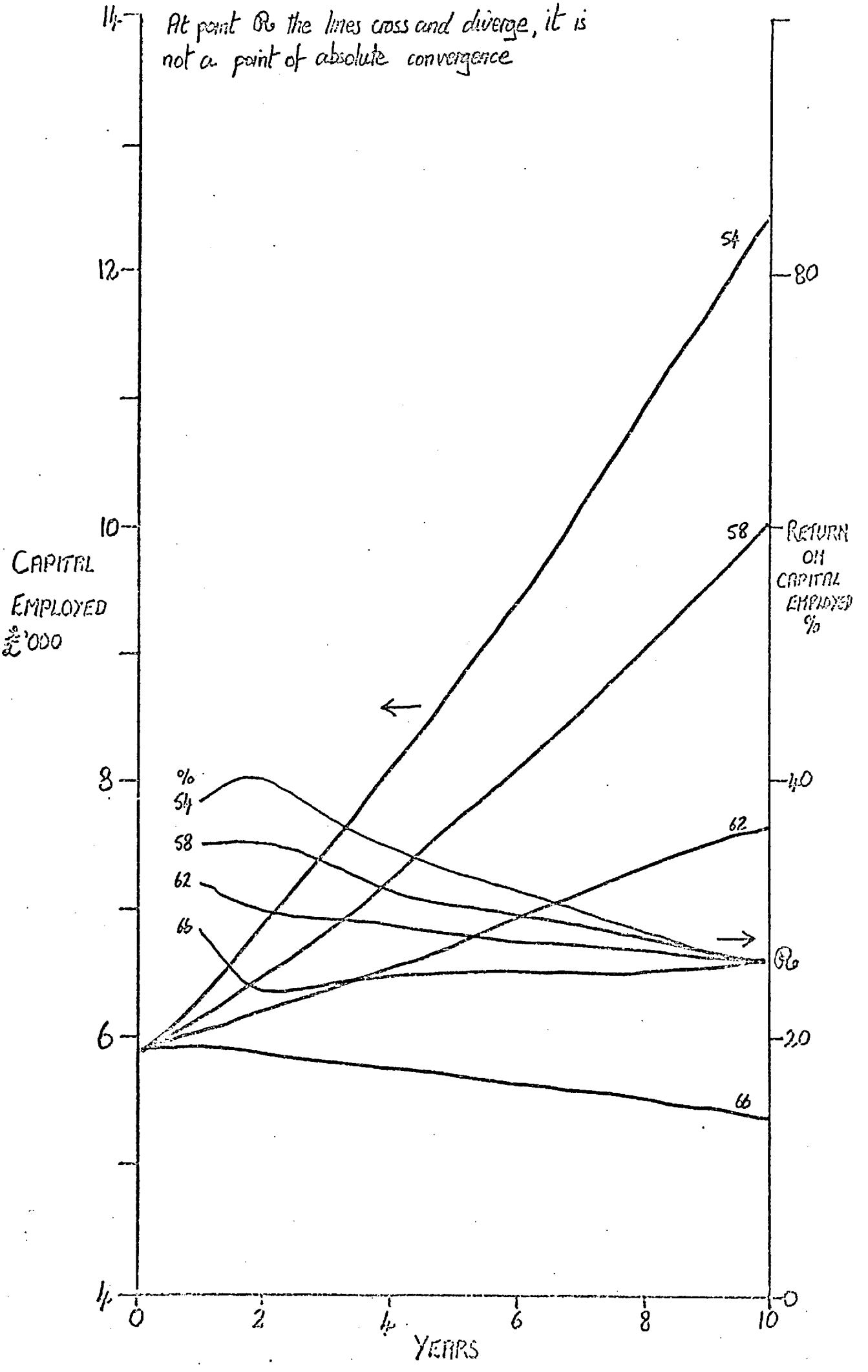
It should, perhaps, be emphasised that a low solvency margin is not necessarily in itself an indication of insolvency. Reference must always be made to the underlying profitability of the business being written (taking into account investment income), and in this inflation is most severe when it has not

been allowed for in rate setting. If inflation has been allowed for and the business is profitable, a low solvency margin is increasing the probability of ruin due to catastrophe, although this is largely reduced by reinsurance. Thus a low solvency margin due to unprofitable underwriting is much more dangerous than one due to the effects of inflation causing a rapidly increasing written premium.



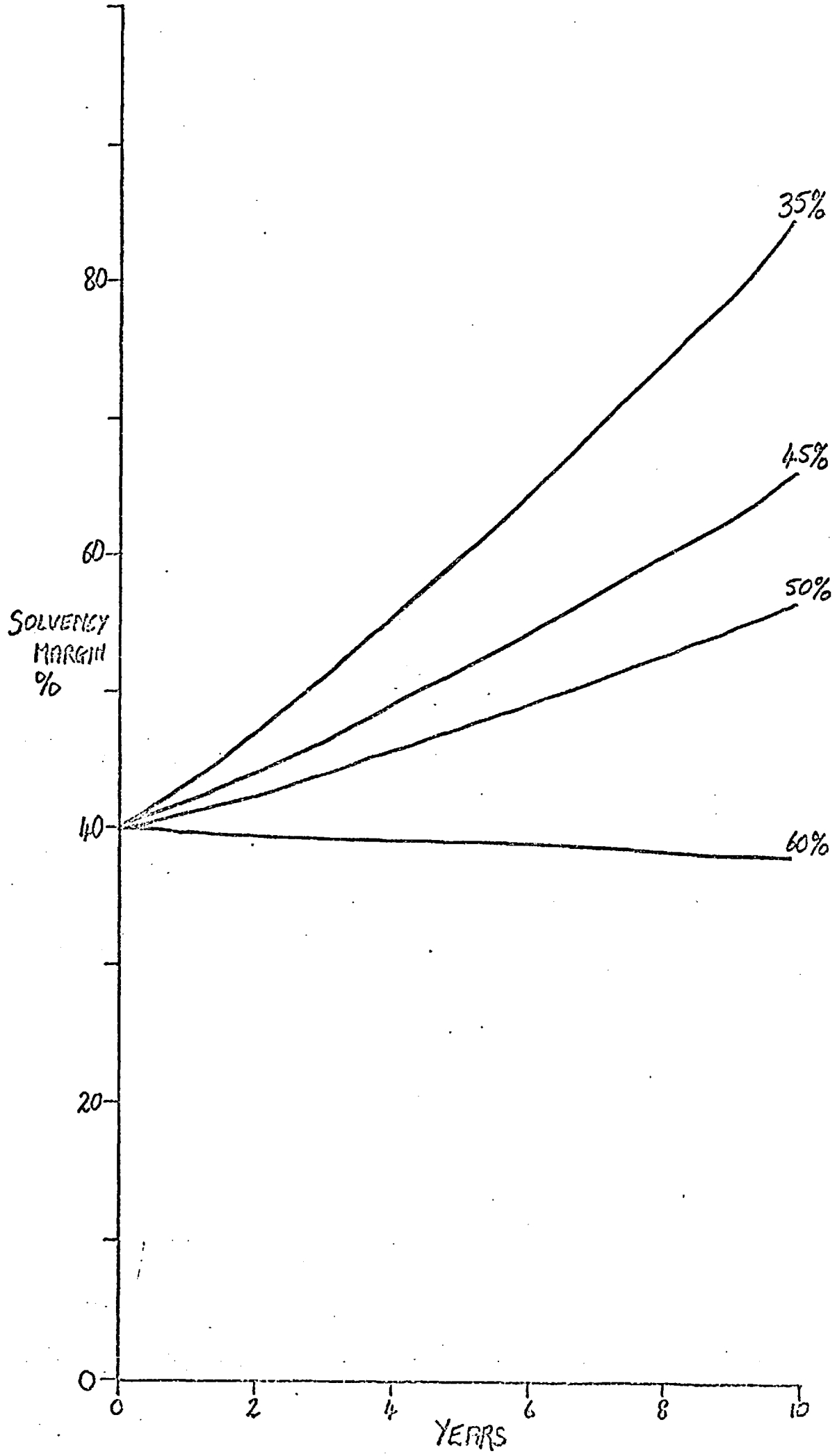
Changing Claims

FIG 7·1A



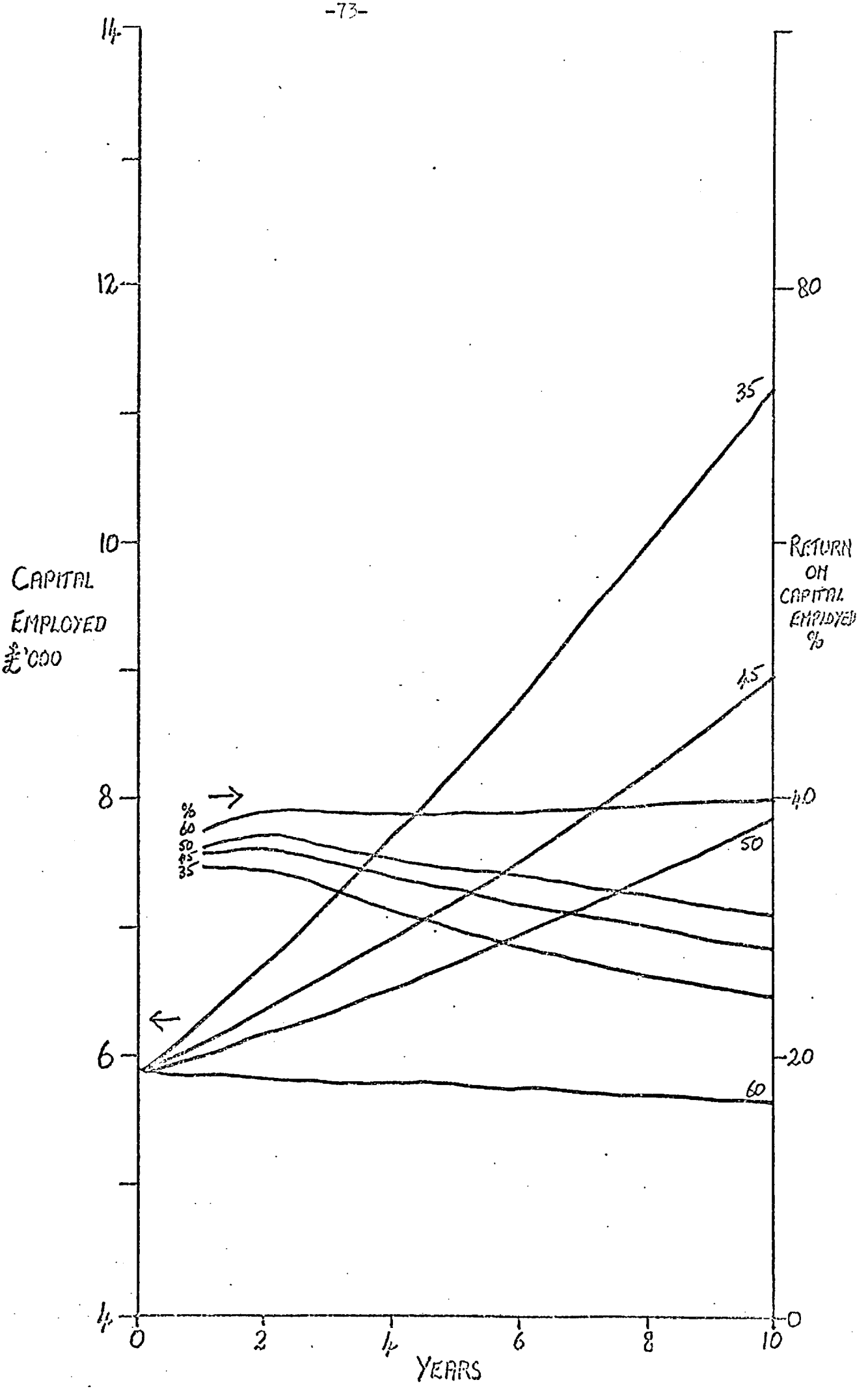
Changing Claims

Fig 7.1B



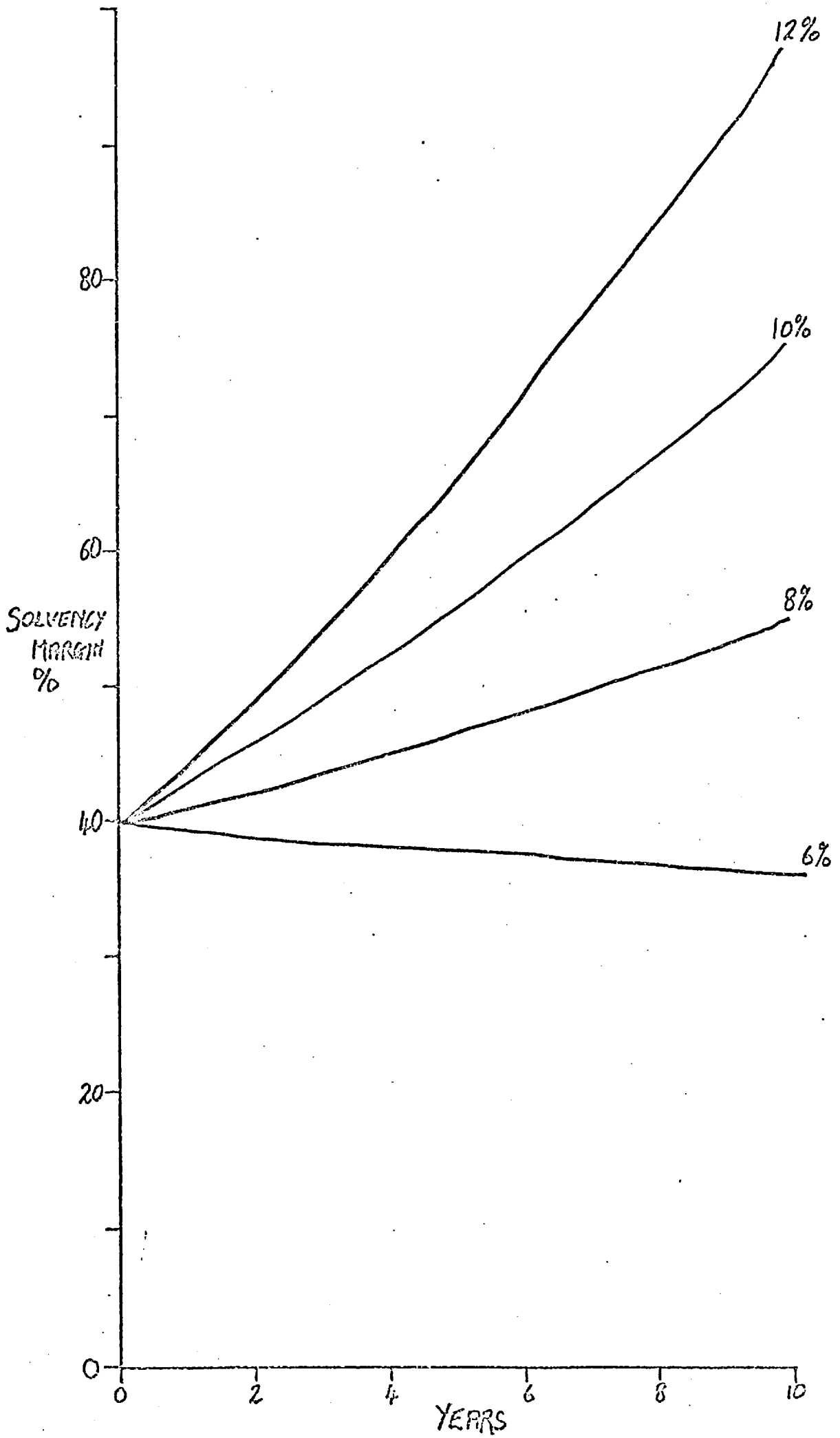
Changing Dividend

FIG 7·2A



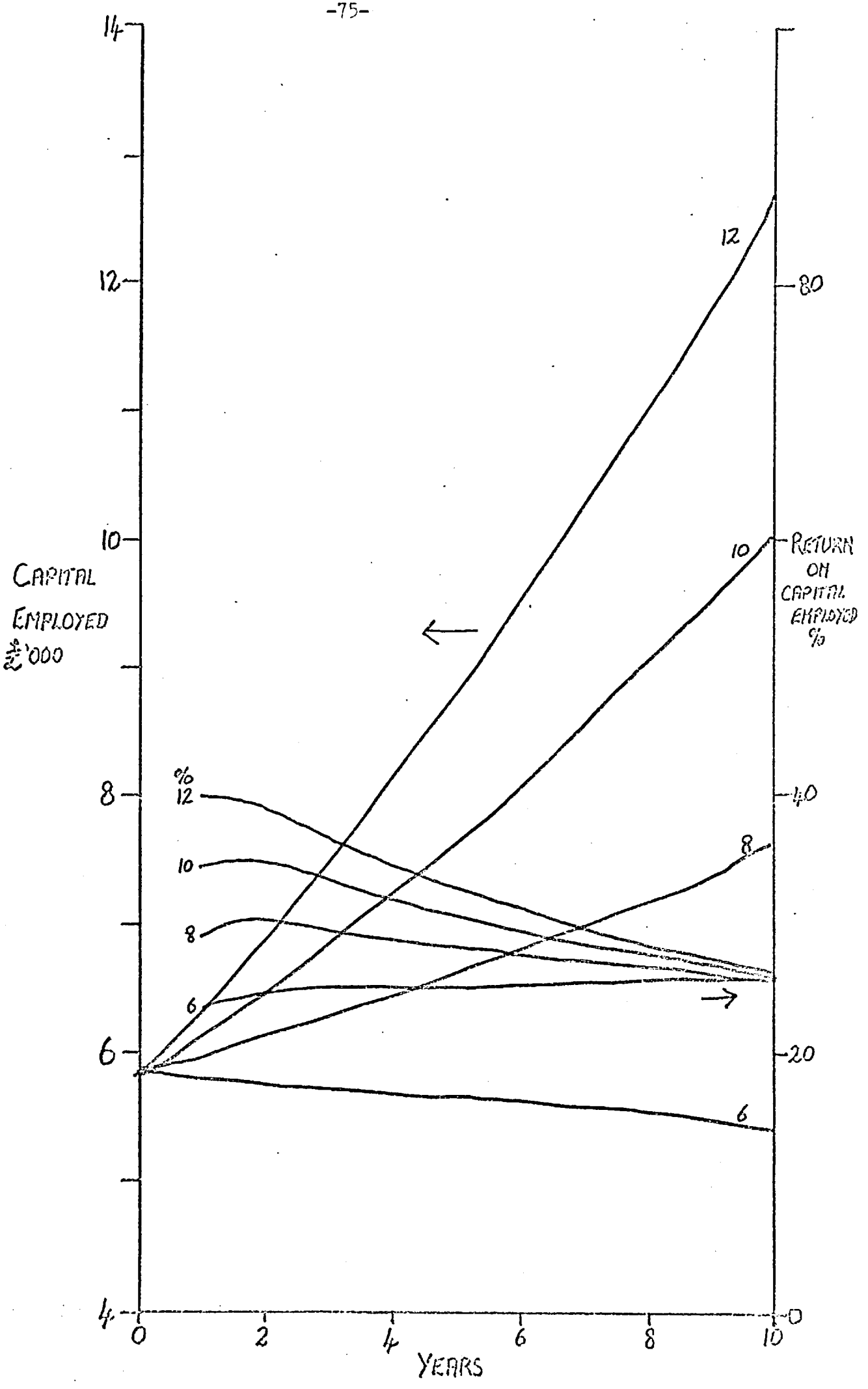
Changing rate of Dundend

FIG 7:2B



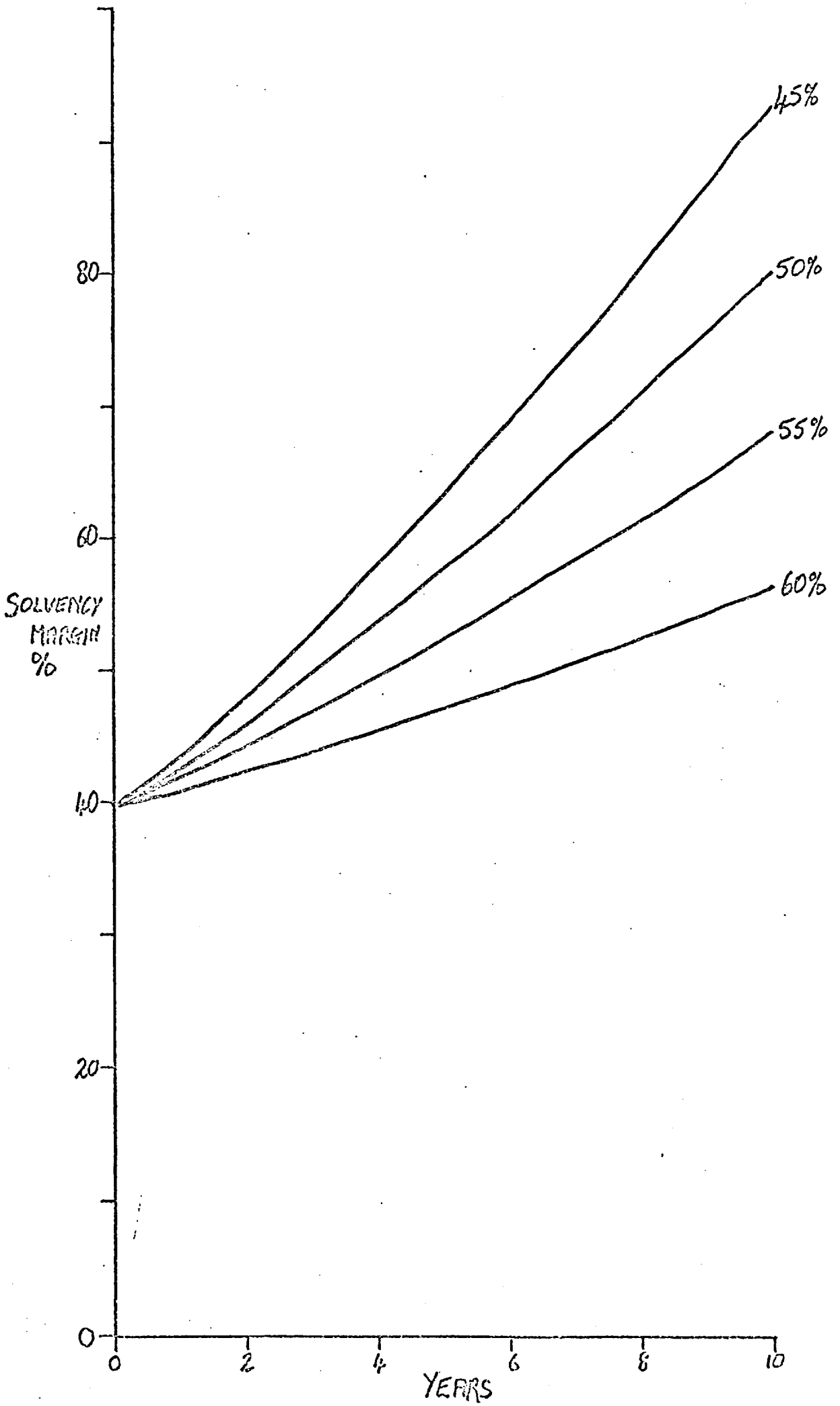
Changing rate of interest

Fig 7.3A



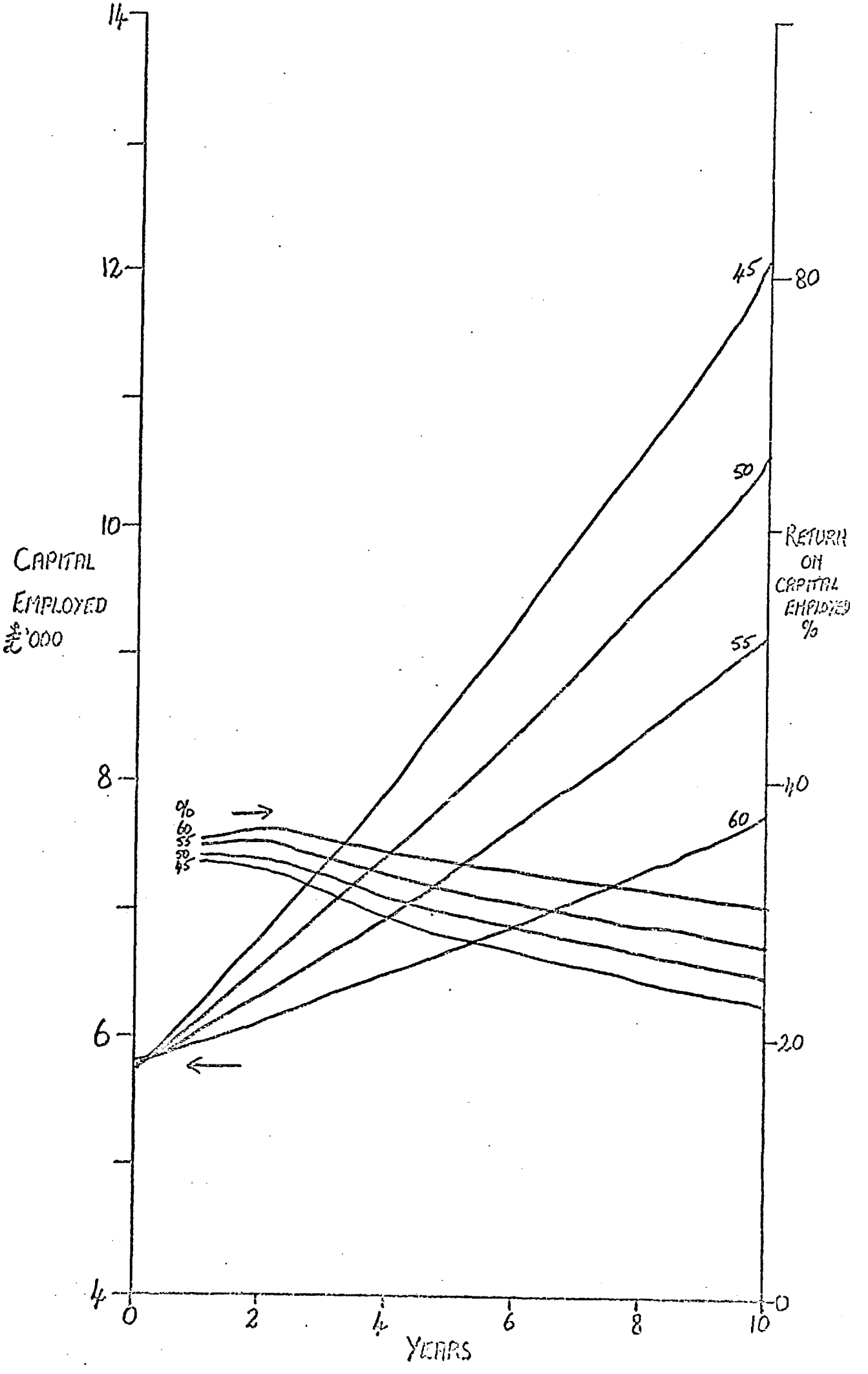
Changing rate of Interest

FIG 7·3B



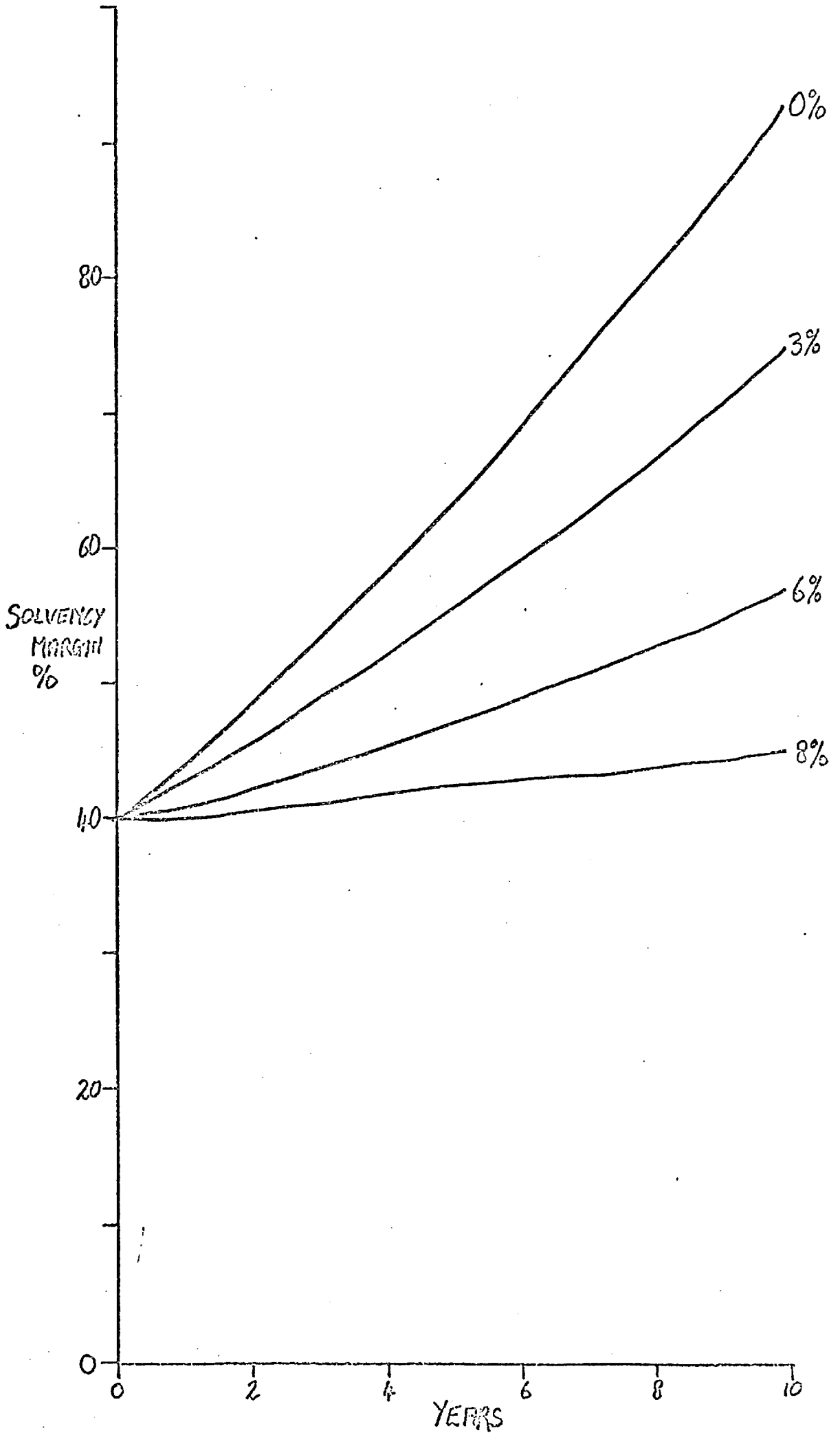
Changing rate of tax

FIG 7·4A



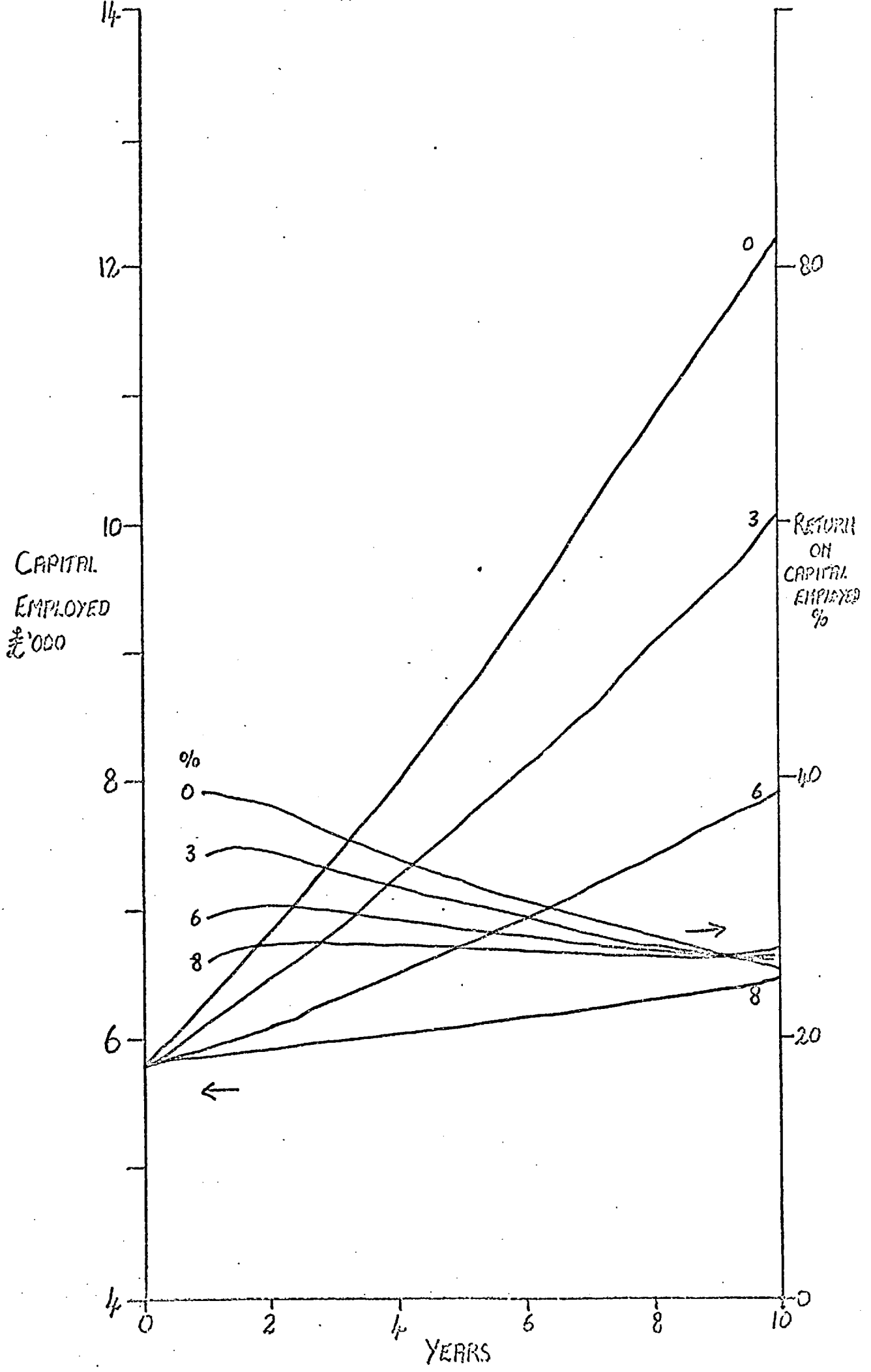
Changing rate of Tax

FIG 7.4B



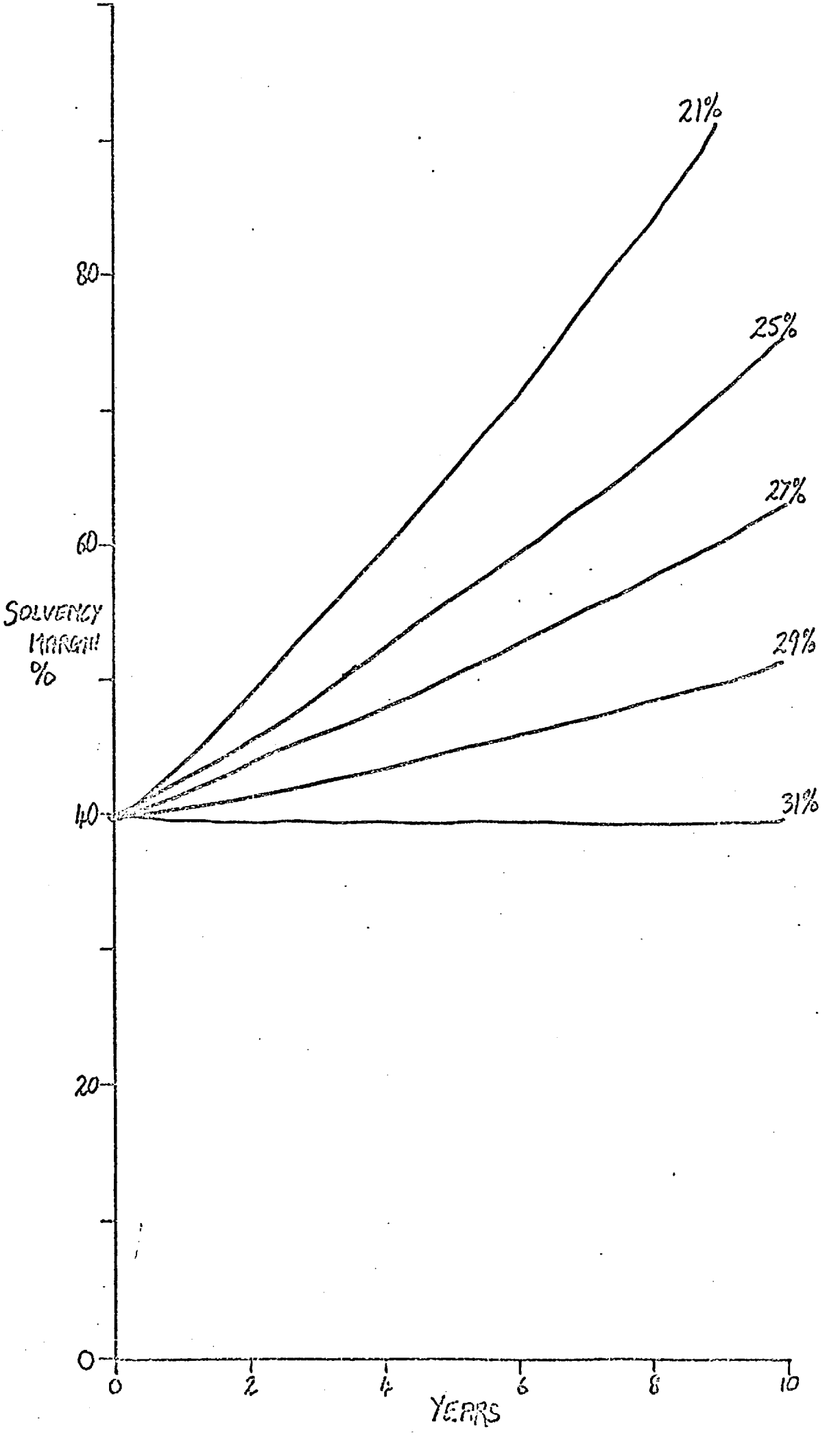
Changing amount of reinsurance

FIG 7·5A



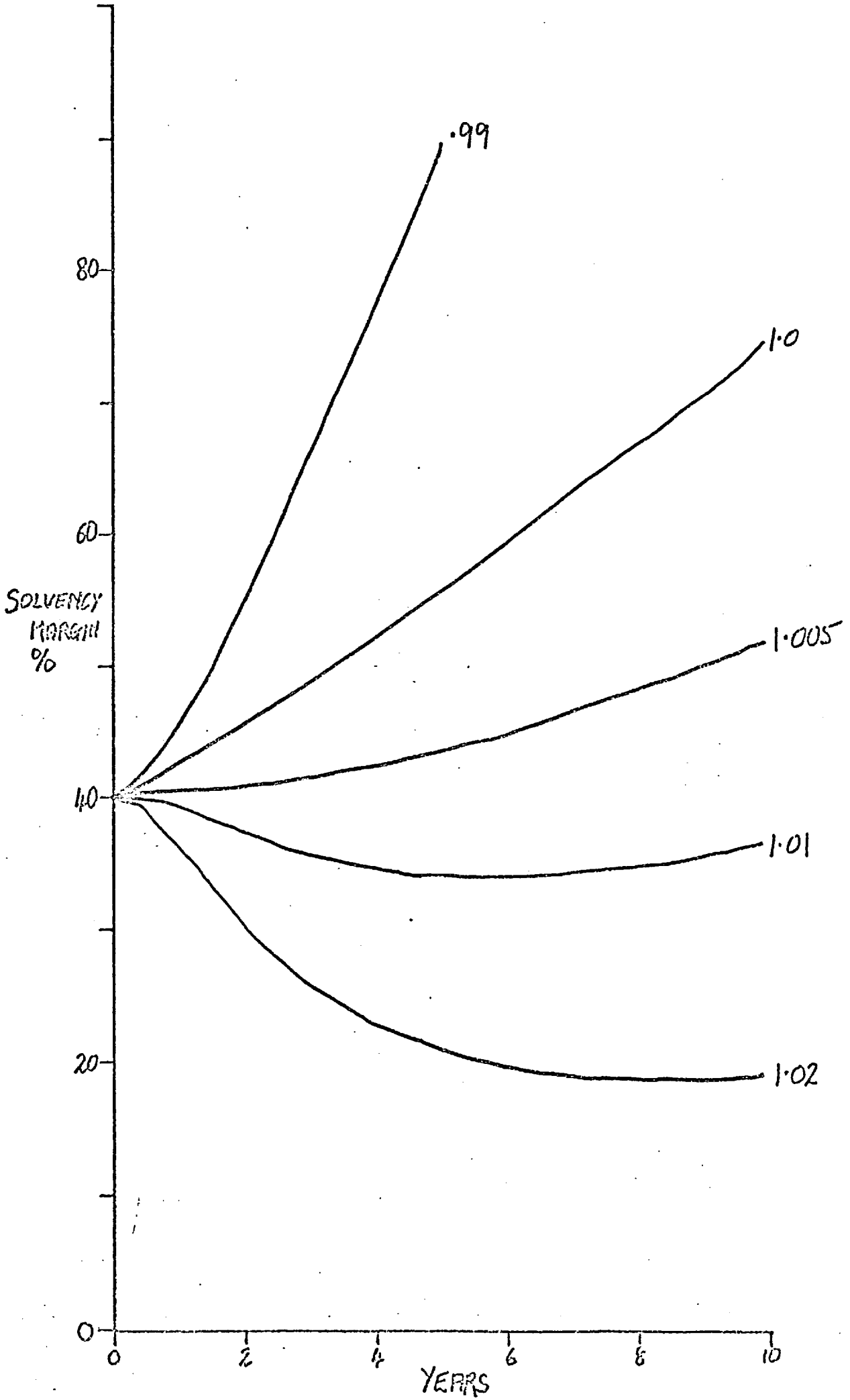
Changing rate of reinsurance

FIG 7·5B

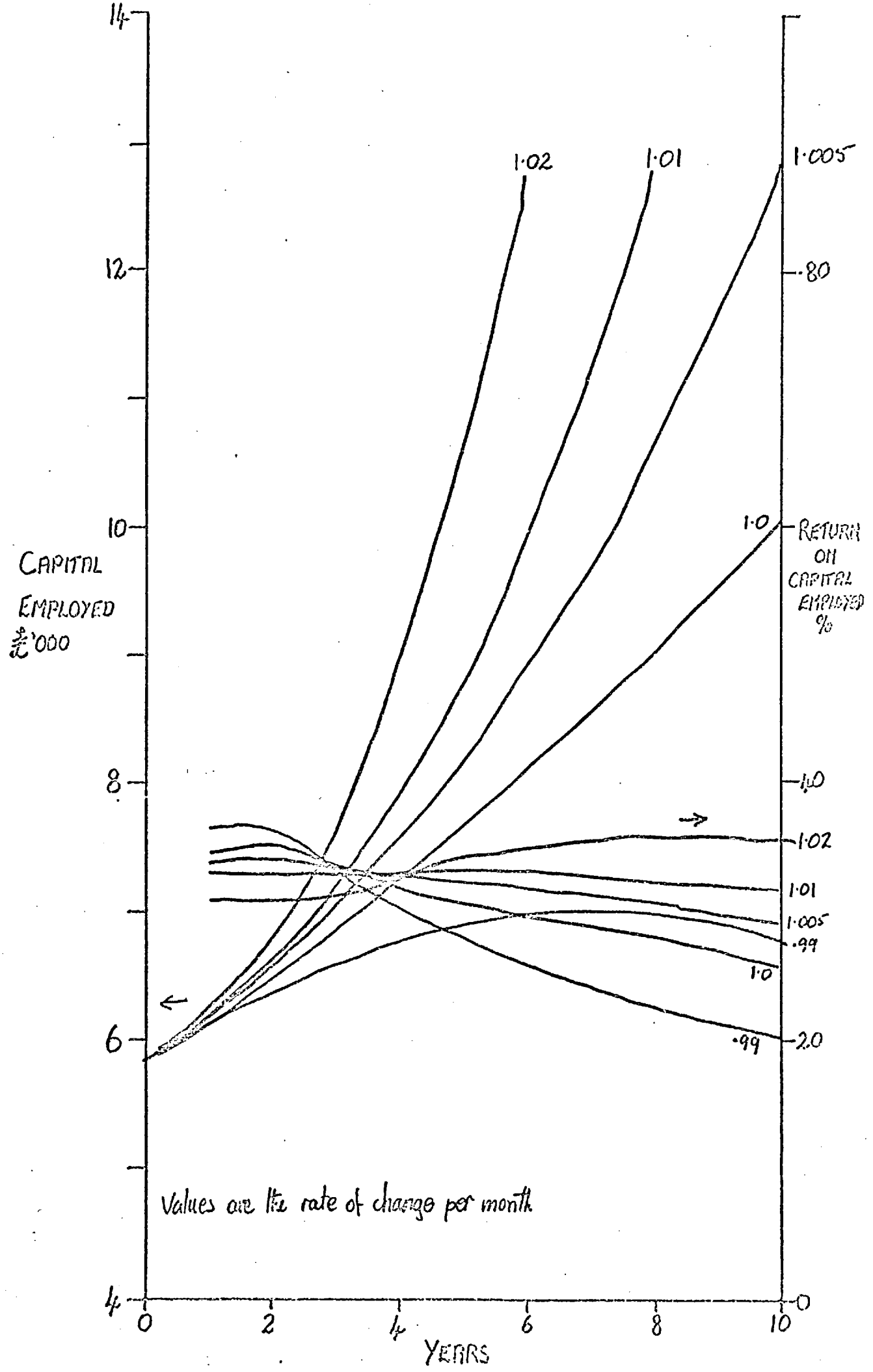


Changing amount of policy costs

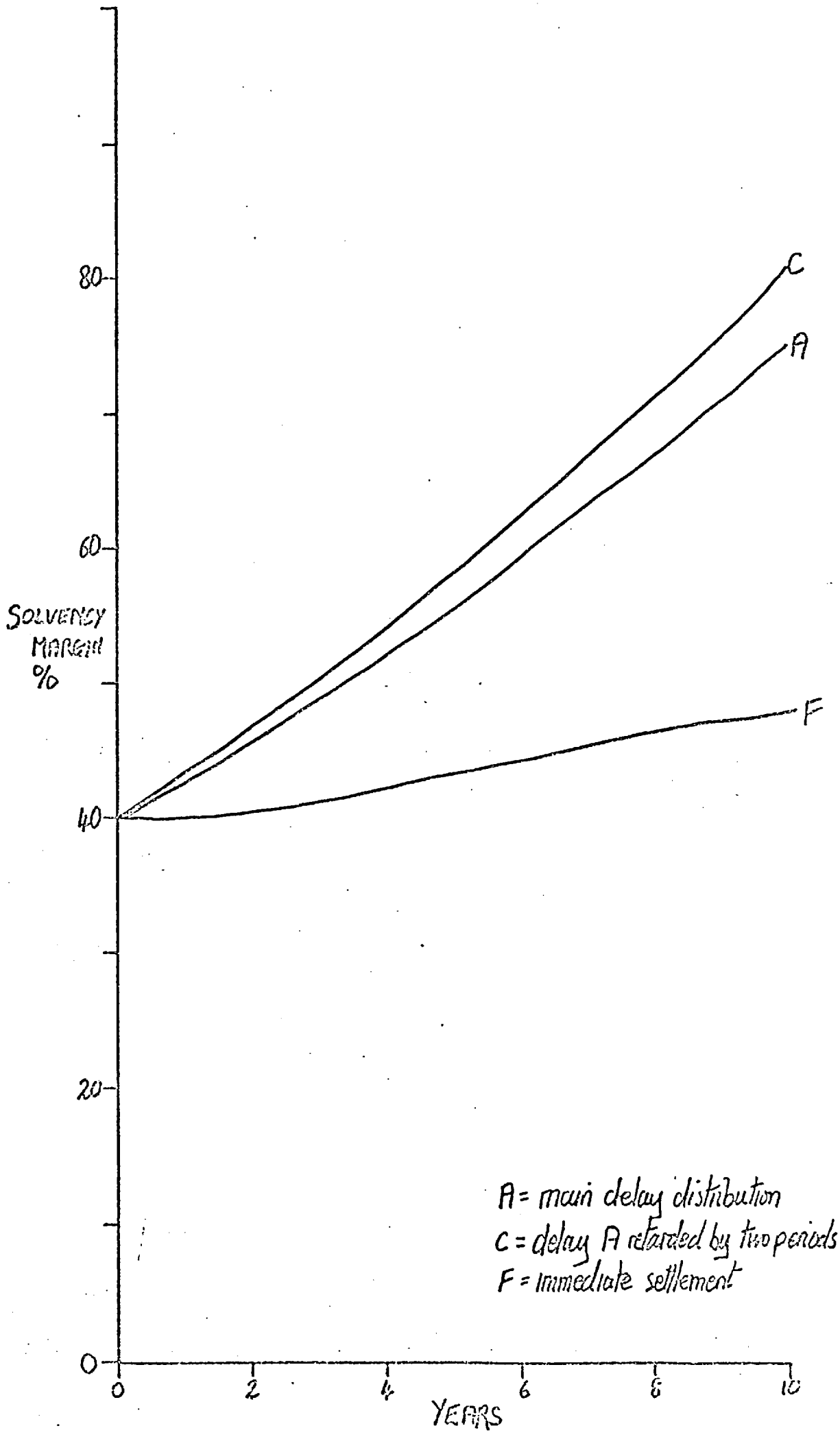
FIG 7·6A



Change in written premium per month, over previous month FIG 7.7

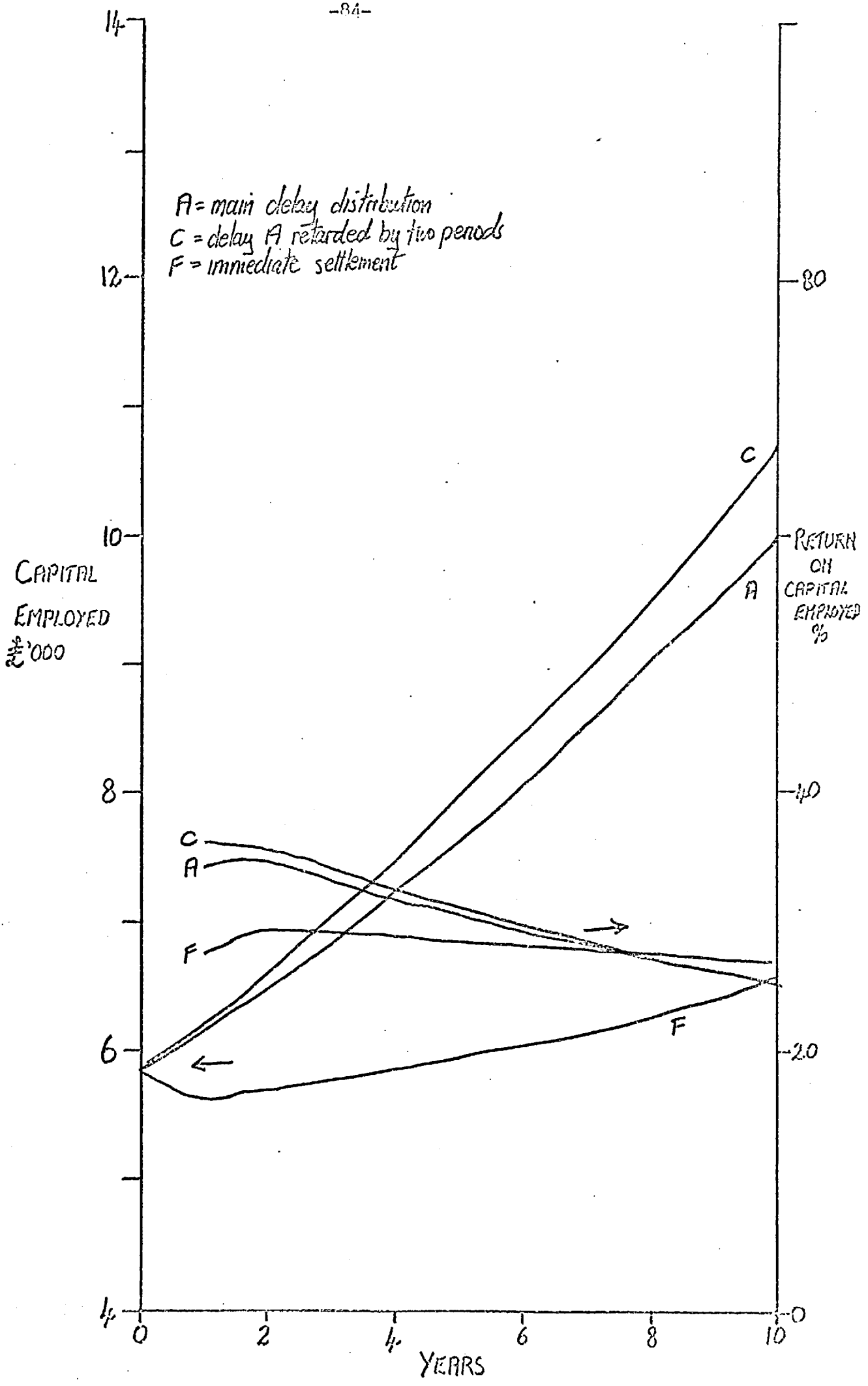


Change in written premium per month, over previous month FIG 7·7B



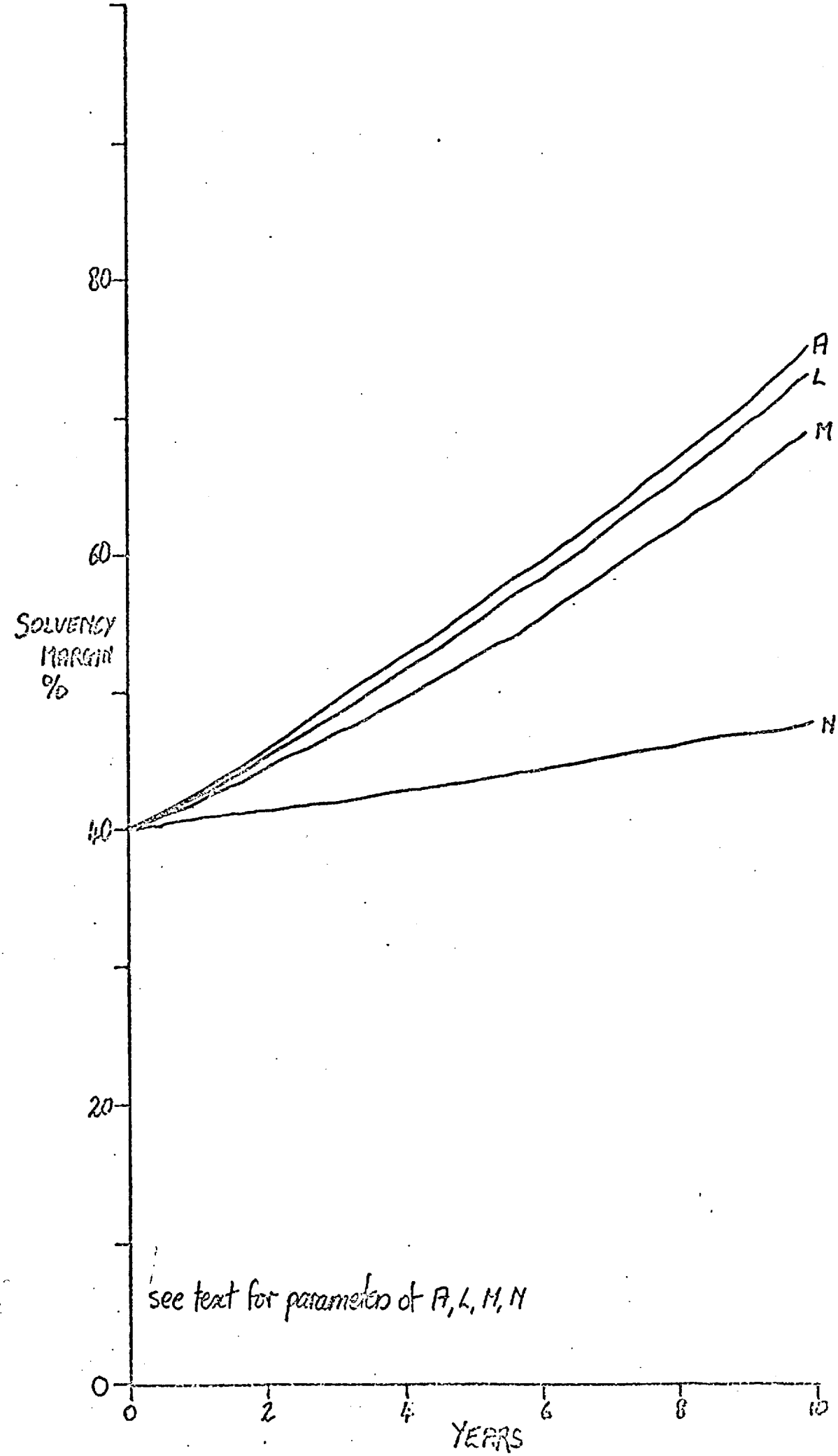
Changing delay pattern

FIG 7-8A



Changing delay patterns

FIG 7·8B



Combined effects

FIG 7·9A

CHAPTER 8

Premium/Claims Model

8.1 Introduction

The main model in this thesis is called the Premium/Claims model. It enables the cash inflows and outflows in the general insurance business to be simulated taking into account all the parameters which affect the business and allowing management to see the company as an ongoing concern. The standard method of producing an annual set of accounts has proved inadequate as an indicator of a company's health in that companies considered viable have collapsed. With the failure of several insurance companies in recent years the Government, through the offices of the Department of Trade has taken an increasing interest in the activities of insurance companies. It does this by requiring extensive returns to be made to them on the levels of business split down by country and risk group.

However this still depends on looking at figures which represent a static position and ratios which are considered 'adequate' if they have certain values and 'inadequate' if they have other values. The main problem is the long duration of the claims trail - up to some seven years. One set of statistics such as the annual accounts is unable to indicate which periods in time are profitable and which are not, and whether results are improving or getting worse. The position has to be looked at within each risk group to make sure each type of business being written is profitable and also is providing an adequate contribution to the overhead costs of the society.

The object of this model is to look at the society as an ongoing concern. The model is dynamic and enables the progressive results of present and past decision to be seen over a number of years into the future.

8.2 Analysis

8.2.1 Let

N_i = The number of new policies incepted in month i

O_i = The number of policies renewed in month i

P_{1i} = The average premium of a new policy in month i

P_{2i} = The average premium of a renewed policy in month i

V_i = The average amount of a claim C_i

C_i = The number of claims per policy incepted in month i

$LAPRT_i$ = Proportion of policies falling due in month i which are not renewed

$MAINTRT_i$ = Proportion of policies incepted in month i which remain in force for a full year.

The total number of policies incepted in month i is

$$N_i + O_i$$

and the true written premium is

$$N_i P_{1i} + O_i P_{2i}$$

This is the amount of money which will be received eventually on this month's business.

The number of these policies incepted which will stay in force for a year, and come up for renewal is

$$(N_i + O_i) \quad * MAINTRT_i$$

Of these the number which are actually renewed is, in month i + 12

$$(N_i + O_i) \quad * MAINTRT_i \quad * \{1 - LAPRT_{i+12}\}$$

which is equal to O_{i+12}.

The renewed premium and new premium may be different for both marketing and economic reasons. In private motor, which is highly competitive, an innovation in the society has been to provide a discount on the premium for renewed policies. This is economically justifiable in that the costs of renewing a policy are less than for issuing a new policy. On the other hand, in a market which, while being competitive, normally expects policies to be renewed for several years, new policies may be issued at a discount to attract business, and renewed premiums put at a higher level to produce a profit.

The model makes no allowance for the return of premiums on cancelled policies as this can be allowed for separately and does not affect the model overall. The incorporation of the number of cancelled policies in the model allows for the correct calculation of the number of renewed policies.

8.2.2 In Force Policies

An analytic model of the number of policies in force in a year can be described. If Y_t is the number of policies in force in year t, then this is made up of the proportion, K, of the policies in force in time t-1 plus the new policies.

Thus $Y_t = KY_{t-1} + N$

This is a first order linear difference equation and the solution is given by

$$Y_t = K^t Y_o + N \frac{1-K^t}{1-K} \qquad \text{for } K \neq 1$$

and $$Y_t = Y_o + N\,t \qquad \text{for } K = 1$$

for $-1 < K < 1$ this converges to Y^*

where $$Y^* = \frac{N}{1-K}$$

which is the case here since $o \leq K \leq 1$ and in practice $K \nless 1$.

This can be graphed for different values of K, and the general shape is shown in Fig 8.1. To obtain a particular level of business as an objective the amount of effort required to obtain new business can be compared with the renewal rate which must be achieved. The optimum combination of N and K can be used as an objective, although the rate of convergence is slower, the smaller the value of N, as shown in Table 8.1.

8.2.3 Receipt of Cash

There are two delays associated with the receipt of the money from premiums. TØ, the delay between inception and notification of inception of a policy (for renewed and new policies) and T1, the delay between notification and receipt of cash (Fig 8.2). The point of notification is when the computer files at Head Office have taken account of the policy. The receipt of cash is often delayed as agents, through whom most of the business is done, may retain money and send it, say, at the end of the month. We considered these delays, like all the delays in the model, as discrete probability distributions. Thus, if under TØ, K_n^i is the proportion of the written premium of month i notified in month i + n then

$$\sum_{n=o}^{\infty} K_n^i = 1$$

and the amount notified in month (i+n) from those incepted in month i is

$$K_n^i * (N_i P_{1i} + O_i P_{2i})$$

The total amount notified in month (i+n)

$$\sum_{j=o}^{i+n} K_{i+n-j}^j * (N_j P_{1j} + O_j P_{2j})$$

The earned premium for all policies incepted in the same month, in the month of inception and the month of expiry is

$$\frac{N_i P_{1i} + O_i P_{2i}}{24}$$

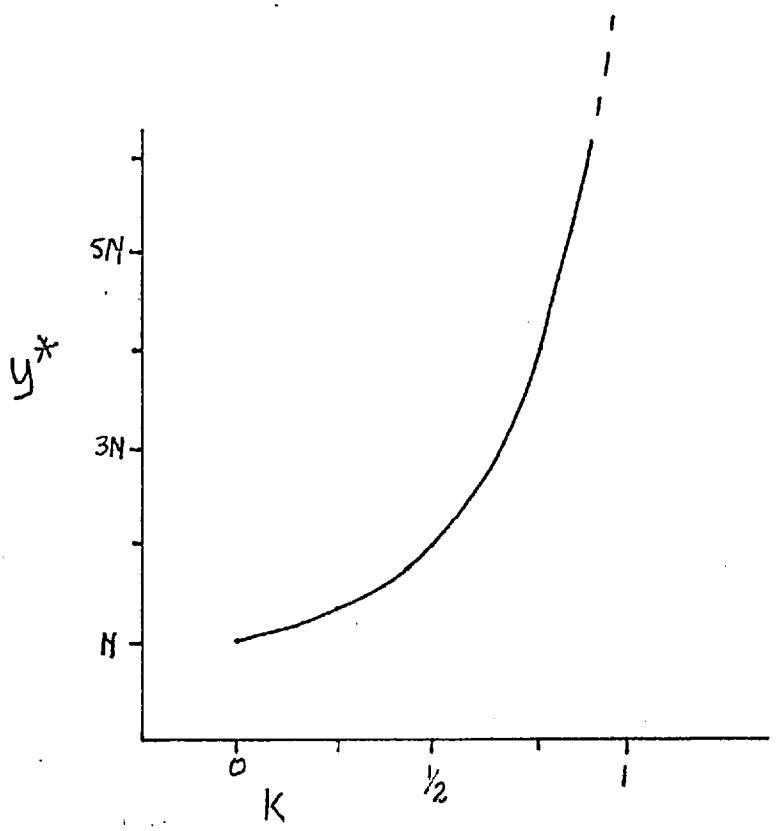


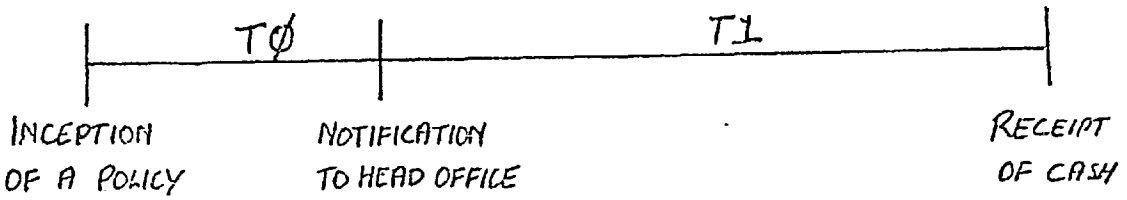
FIG 8·1

Value of convergence of solution sequence for different renewal rates

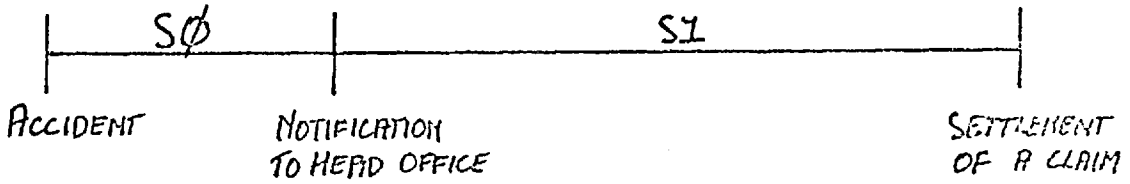
New Policies N	Renewal Rate K	Year at which Y_t 7,950 with Y_o = 500
1000	0	1
900	.1	1
800	.2	2
700	.3	2
600	.4	3
500	.5	4
400	.6	5
300	.7	7
200	.8	11
100	.9	22

Values of N and K to give Y^* = 1000

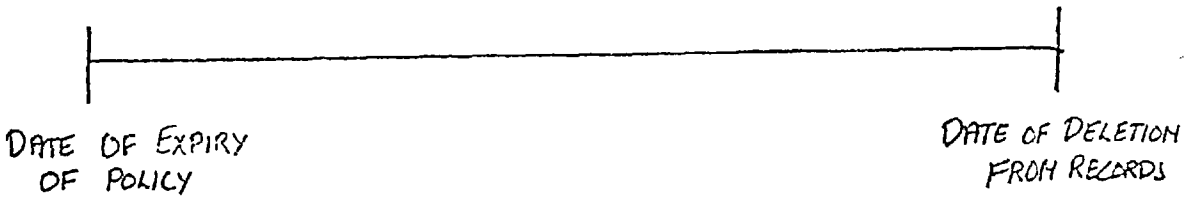
Table 8.1



DELAY : RECEIPT OF CASH



DELAY : CLAIM SETTLEMENT



DELAY: LAPSING POLICIES

FIG 8.2 DELAYS

and in all intermediate months

$$\frac{N_i P_{1i} + O_i P_{2i}}{12}$$

That is it is calculated on a 24ths basis on the actual amount of premiums written in each month.

8.2.4 Claims

If the occurrence of claims is assumed to be proportional to exposure then the distribution of the value of claims occurring month by month for the policies incepted in month i is shown diagrammatically in Fig 8.3.

This assumes that there is no variation in the probability of a claim during the life of a policy. For the model, the actual value of the claims is assumed to be known at inception of the policy and is given by C and V. A total of $£(N_i + O_i)C_i V_i$ will be paid out on claims for policies incepted in month i.

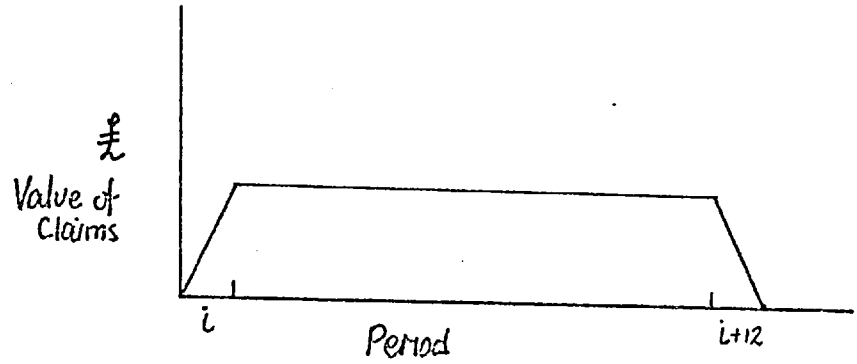
However a seasonal distribution can be superimposed upon the claim distribution, in the form of a seasonal index (Fig 8.4). Thus for policies incepted in month i, the value of claims in the months i+1 to i+10 is

$$\frac{(N_i + O_i)\ C_i V_i\ * \text{INDEX}_J}{12}$$

J = calendar month

INDEX_J is the proportion of the average amount of claims which actually occurs in a given month. It is important that the condition

$\sum_{J=1}^{12} \text{INDEX}_J = 12$ should hold, otherwise the total amount paid out in claims will be altered. The action of an index is only to affect the time of claims occurrence, not the amount. This can thus, for instance, allow for such things as an increase in claims during the winter months for motor vehciles due to worse road conditions.



Exposure of Policies incepted in a Month

FIG 8-3



Monthly Index

FIG 8.4

In month i a certain total number of claims will occur on all the policies then in force and a certain amount of money will be paid out eventually, on these claims.

Two distributions are associated with the settlement of these claims, SØ and S1 and are handled in a similar way to the delays on the receipt of cash, as is shown in Fig 8.2. SØ is the delay between an accident and its notification to Head Office (and the computer files) and S1 is the delay between notification and settlement of a claim.

At the end of the accounting year provision is made for claims which have been Incurred but not reported (IBNR). That is claims which are known on past experience to have occurred but which have not been notified due to the delay SØ. Provision is also made for claims outstanding. That is claims which are known about but which have not been settled due to the delay S1.

The delay SØ is typically 2 or 3 months but S1 can be up to some eight years. While the number of claims unsettled after as long a period as this is small, the value of each individual claim is generally large. The distribution of delay to settlement differs markedly from class to class with, for example theft being settled very quickly and employers liability taking a very long time. Where claims involve severe personal injuries it may take a long time both for the final effects of the injuries to become apparent and for the courts to settle on an amount of damages. Since the basis for damages is often taken as the loss in earnings, claims increase due to inflation the longer they are left unsettled. However in July 1974, it was ruled by the Court of Appeal in Young v Percival that future inflation should be ignored. For claims involving property, inflation directly affects the costs of reparation and replacement.

The shape of the distribution of notification to settlement of accidents is markedly different depending on whether it is based on the number of claims or the value of claims. The model is based on money and distribution S1 is in terms of money settled in each period. This is shown in Fig 8.5.

The total value of claims occurring in December, say, is notified in December and the following months under delay SØ. Those claims which are notified in December are actually settled in December and the following months, under delay S1. In Fig 8.5 the total of 'A' for January onwards gives the IBNR at the year end and the corresponding total for 'B' gives the OCR. The program handles claims in this way, having vectors for claims occurring, and the ones labelled A and B in Fig 8.5, on a monthly basis. Money is transferred from one vector to the next according to the delays.

8.2.5 Inflation

Inflation is incorporated in the model primarily by specifying rates of increase over time for the premiums and average claims amounts. However, the effect of inflation on outstanding claims can be simulated. That is the problem of under-reserving for claims due to inflation being greater than anticipated. This is done by supplying a monthly rate of inflation, being the difference between the actual rate, and that by implication allowed for in the original setting of the premiums. This is then applied to the distribution S1, inflating the proportions for each future month by the number of months of inflation.

The total of distribution S1 will now be more than 1. The program allows different rates of inflation to be specified at different periods. If a marker is set on the data card then the outstanding claims reserve will also be inflated, month by month, by the same amount as the delay S1.

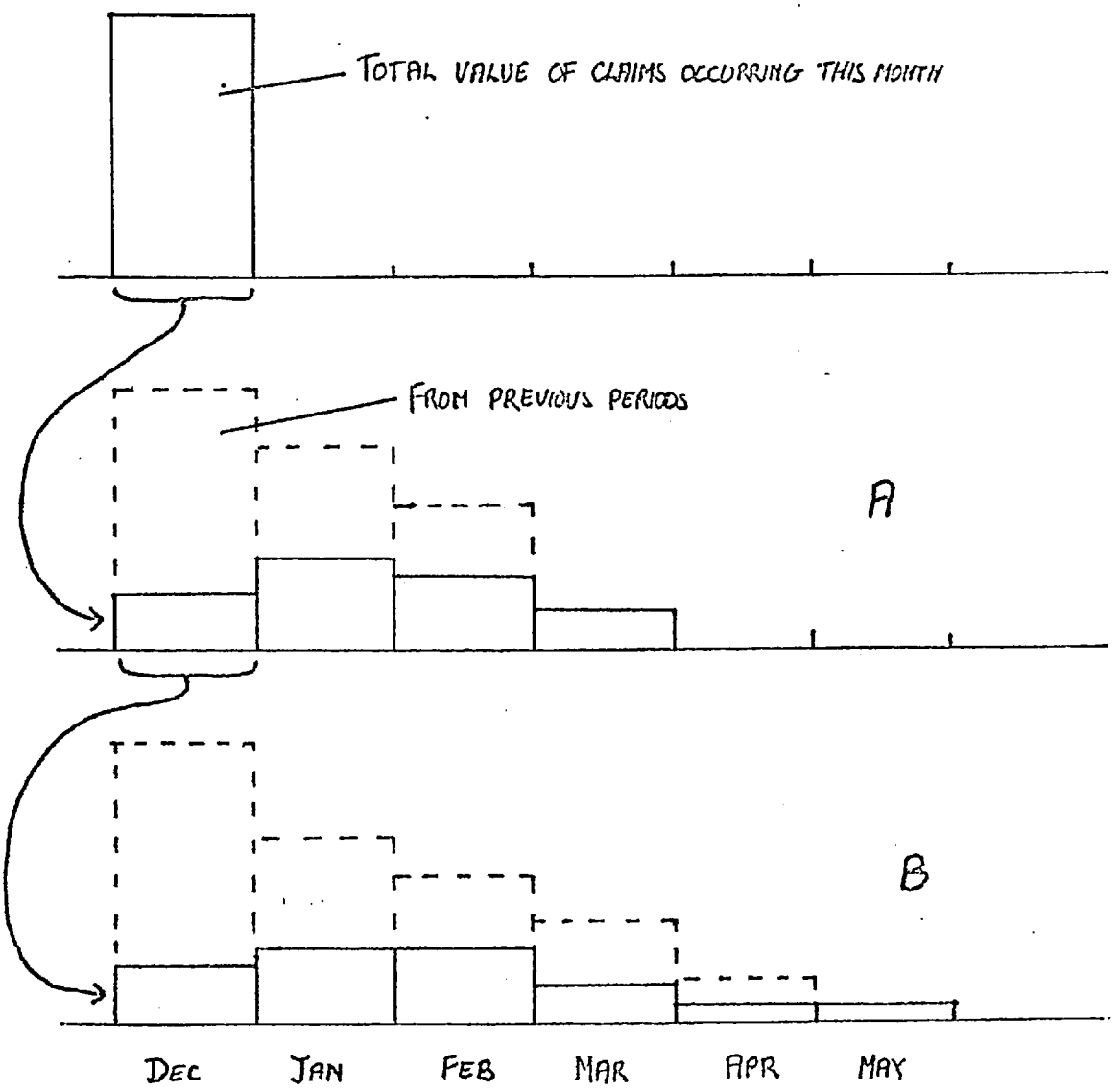

TOTAL VALUE OF CLAIMS OCCURRING THIS MONTH
FROM PREVIOUS PERIODS
A
B
DEC
JAN
FEB
MAR
APR
MAY

FIG 8.5

A scenario might be, then, that due to the underestimating of inflation the value of claims is increasing at 1% per month on the expected claims in a particular year. This is allowed for by, at the start of the year, increasing the OCR by 1% per month, compounded according to the month of actual settlement, and by increasing the delay S1 similarly. At the end of the year, if premiums have now caught up with inflation, delay S1 can be 'deflated' to its original value, but the amount in the OCR is the correct amount and it must not be similarly deflated. This process can be repeated for different rates of inflation. This does not entirely reflect actuality; however it is sufficiently close to enable the magnitude of the effect to be seen.

8.2.6 Commission

Commission is allowed as a percentage on the written premium. A delay in paying commission is incorporated in the same way as the other delays and this allows the commission component of the cash flow to be calculated.

8.2.7 Predebiting

As explained in Chapter 4 the Society operates a predebiting system in that all policies coming up for renewal are assumed to be renewed, until they are known to have lapsed. This means that a strain exists in the accounts due to a liability being allowed for which does not exist. This strain can be calculated from the model. A delay distribution is needed for the delay in lapsing policies and this operates in the same way as the other delays. It has been seen from the society's data that the average premium of a policy which is renewed is not the same as for one which is not renewed. Thus the average value of a lapsing premium has to be supplied to the program. The UPR strain caused by the predebiting system is printed in the yearly class summaries.

8.2.8 UPR

The UPR is calculated on several definitions, allowing the amount of the strains to be compared. Any amount by which the UPR is in excess of the amount necessary to cover future claims (and costs) covered by the reserves is considered as a strain. The main strain is that expenses of 20% of premiums only are allowed (by law) to be deducted before calculating the UPR, whereas the true expenses rate is usually considerably in excess of this figure.

The strain caused by the predebiting accounting system has already been mentioned.

A small negative strain occurs due to the accounting system not being able to take consideration of new policies until they are notified. Thus there is no allowance for policies which have been incepted but what have not been notified to head office.

These strains are all given in the printout of the results and are shown diagrammatically in Fig 8.6.

8.2.9 Cash Flow

The cash flow is calculated on a monthly class by class basis and is taken as the difference between cash received (from premiums) and cash outflows on commission and claims settled.

Expenses are not considered directly in this model, but are fed in as annual amounts (which could be obtained from the expenses model) which are used to produce the net cash flows.

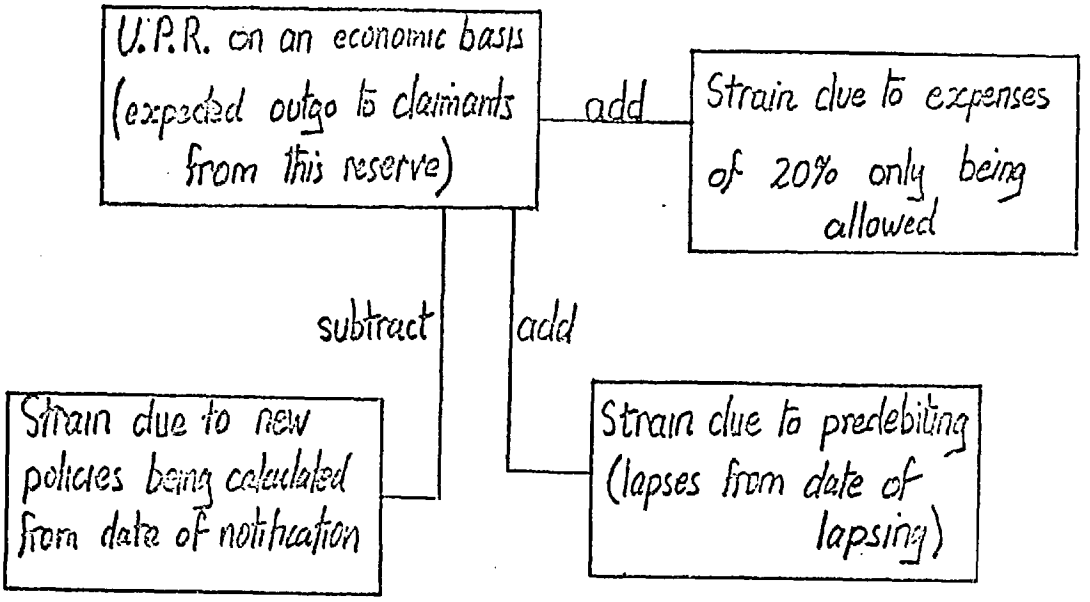


FIG 8·6 U.P.R. STRAINS

8.2.10 Investments

A single investment model is included. This allows proportions of all the assets to earn different rates of interest, reflecting the investments and earnings in fixed interest, equities, property and cash. A similar facility for borrowing money exists, although this in practice should not be needed.

8.2.11 Non-Pure Premium

Each month, for each class what is called the surplus is calculated. This is the difference between the written premium and the pure premium plus commission. That is the amount which is left over to go to expenses, free reserves, the strains of technical reserves and profit. The pure premium is calculated without allowing for any inflation what has not been included in the rate setting.

8.3 Conclusion

The model has been used to look at the effects of inflation on outstanding claims, the model having reproduced satisfactorily the figures produced from a hand-worked example. The greater power of the computer allows many more parameters to be rapidly changed and compared and this should enable a greater 'feel' for, and insight to, the problem to be achieved. In a manual analysis the time period has inevitably to be a year due to the complicated and extended arithmetic which has to be done. The monthly basis of the computer model provides much more accurate working and allows effects, which are lost in an annual analysis, to be discerned.

It is hoped, and indeed believed, that the model will provide a useful investigative tool for decision making.

CHAPTER 9

Future Work

Inevitably new ideas and approaches to the problem of corporate modelling for insurance companies will be developed. Just as a company changes to reflect the business environment so must the models change to maintain an accurate representation of the company. There would appear to be numerous areas for further work within the field of planning in insurance.

a) Refining the methods of data collection. The quality of the results from the models is only as good as the data used as a base. The company on which the models were based was unable to provide sufficient accurate data and much work has to be done to improve statistical collection methods. No doubt with the greater involvement of computers this will become easier. It would seem that this criticism of inadequate data is general throughout the industry.

b) Foreign business - A substantial amount of business is carried on overseas and this could usefully be incorporated. The main addition would require the handling of exchange rates and any different accounting procedures.

c) Long term business - A model of, or incorporating, the long term business of the society would be useful in completing the planning models for a composite insurer. The 1974 Insurance Companies Act requires the strict separation of assets belonging to the long term business from the other assets. The two types of business are substantially different and thus can be run completely separately except for consolidation at the highest level of a corporate model.

d) Other companies - Although many companies are marketing similar products the financial structure varies considerably, and a comparative study of insurance companies could prove useful.

e) Other countries - Britain is still the centre of world insurance, but naturally the environment for overseas business varies from country to country both due to national custom and legislation and a study of these could be interesting.

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ADDENDUM

a) The graphs in chapter 7, pages 70-85 show what is an unrealistically high profit margin, taking into account the very small underwriting profit which is normally earned on General Insurance. The large proportion of a company's profit is derived from interest earned on the reserves. The assumption that this interest earned on policyholders 'reserves' accrues to the benefit of the company is now challenged in many countries.

b) The claims settlement distribution is becoming available from information supplied on the statutory returns and this is open to public inspection.

c) Insurance is fundamentally a stochastic problem and can only to an extent be modelled satisfactorily by a deterministic model.

d) Ratios and measures such as the Outstanding Claims Reserve, the Unearned Premium Reserve and the Expenses Ratio which are in standard use by the industry are inadequate in describing a dynamic situation. The various components which make up the measure or ratio will b distorted to varying extents by, for instance, inflation.

e) A primary purpose of reinsurance is to smooth out fluctuations in the claims and hence the cash flow. The level of reinsurance is set with reference to the overall structure of the portfolio, the reserves and the anticipated profitability.

APPENDIX E.1

DATA CODES AND RUNNING

THE EXPENSES MODEL

Running the Expenses Model

For each year of the forecast unit costs and volumes or their proportionate changes on the previous year have to be supplied for each class of business, each Service Office and each type of work. Costs have to be assigned to all other cost centres either explicitly or again as proportionate changes on the previous year's values.

There are two subroutines which are used for reading in the data. Prime reads data which will basically remain in force for the duration of the run. Second reads data for each year of the run.
Within Prime and each call of Second the cards may be in any order, the correct use being identified by the use of a code. An optional comment is allowed on each card to make individual cards more easily identifiable.

The general format of the data cards is

code data optional comment

There are default values for most of the variables usually being values for which no effect occurs. Values are given in the program listing, or where applicable in the list of codes.

The data for PRIME and for each call of SECOND is terminated by a card with 999 in columns 1 - 3. Additionally, comment cards may be placed after the data for Prime and these will be printed out as a heading at the start of the results. These comment cards are terminated with a card with an asterisk in column 1, which must be present even if there are no comment cards.

Thus the sequence of data is:-

Data for PRIME run 1

999 terminator for PRIME

comment cards

* terminator for comment cards.

Data for SECOND - year 1

999 terminator for SECOND

. . .

. . .

. . .

. .

Data for SECOND - year N_1

Data for PRIME run 2

999 terminator for PRIME

comment cards

* terminator for comment cards.

Data for SECOND - year 1

. . .
. . .
. . .
. . .

.
.
.

Data for PRIME run N

.
.
.

Data for SECOND - year 1

.
.
.
.

Data for SECOND - year N_{11}

999 terminator for SECOND

In the first year, policy volumes and unit costs must be supplied to the program for each service office using the appropriate codes. Two categories of overheads are also allowed for at each service office. In subsequent years the new volumes have to be supplied and these can be either as proportionate changes on the volumes for the previous year, or new absolute values. The same thing applies to the unit costs. If either proportionate changes or absolute values are used a complete set must be supplied for all service offices, each class and each type of work. This is shown in the example in Appendix E.3. A sample coding sheet is supplied to aid the user for this in Fig E.1.1. Two of these sheets are needed for each service office for each year of the run - one for volumes and one for costs. The correct code is filled in the first column depending on whether absolute values or proportionate changes are being supplied. The number of the service office is the next value followed by the number of the class of business. The

YEAR _____ OFFICE _____

SERVICE OFFICE EXPENSES

VOLUMES / UNIT COSTS / PROPORTIONAL CHANGES IN UNIT COSTS / PROPORTIONAL CHANGES IN VOLUMES

DATE _____

CODE	OFFICE No.	CLASS	NEW	RENEWALS	CLAIMS	ALTERATIONS	CANCELLATIONS ⇒ LAPSES

		CODE	VALUE
OVERHEADS CATEGORY 1	Factor/amount	44/45	
OVERHEADS CATEGORY 2	Factor/amount	46/47	

FIG E·1·1

five data values are completed next and the whole line of numbers is punched onto the data card, with blanks as delimiters. The overheads (for the unit cost data sheet) are filled in at the bottom; code 44 and 46 for proportionate changes over the previous year and 45 and 47 for absolute values.

Any Head Office costs which are considered to be dependent on policy volumes can be treated as another service office in exactly the same way, if it deals with specific volumes of business. If a Head Office department costs depend on the total society volumes then the unit costs are entered (without volumes) after the highest number of service office and the number of these departments entered on card code 39. These are known as 'pseudo-service offices' and the costs will be calculated on total volumes.

The other costs, not being dependent on volumes, have to be supplied to the nodes of the tree structure using the data sheet in Fig E.1.2. All absolute costs must be assigned to a terminal node (i.e. one not with a label zero) although proportionate changes may be assigned to any node. Thus if all costs under a certain 2nd level node are to be changed by the same amount, this factor may be fed in once at the corresponding 2nd level node using the correct code. The updated values at the nodes will be preserved as the starting values for the following year although nodes can be added, deleted or changed in any year. A single card will consist of the code, three integers identifying the node and the (decimal) value. Names identifying cost centres representing the first or second level nodes can be supplied using either the built-in names (seen from the listing) or by entering them in Prime. The maximum number of cost centres in the tree structure and the number of service offices is limited by the size of the arrays used. All can be easily increased. As the program is listed the maximum number of service offices (plus pseudo service offices) is 20 and the number of classes of business is 15. In the tree structure costs, the

RUN NUMBER _____ YEAR _____

DATE _____

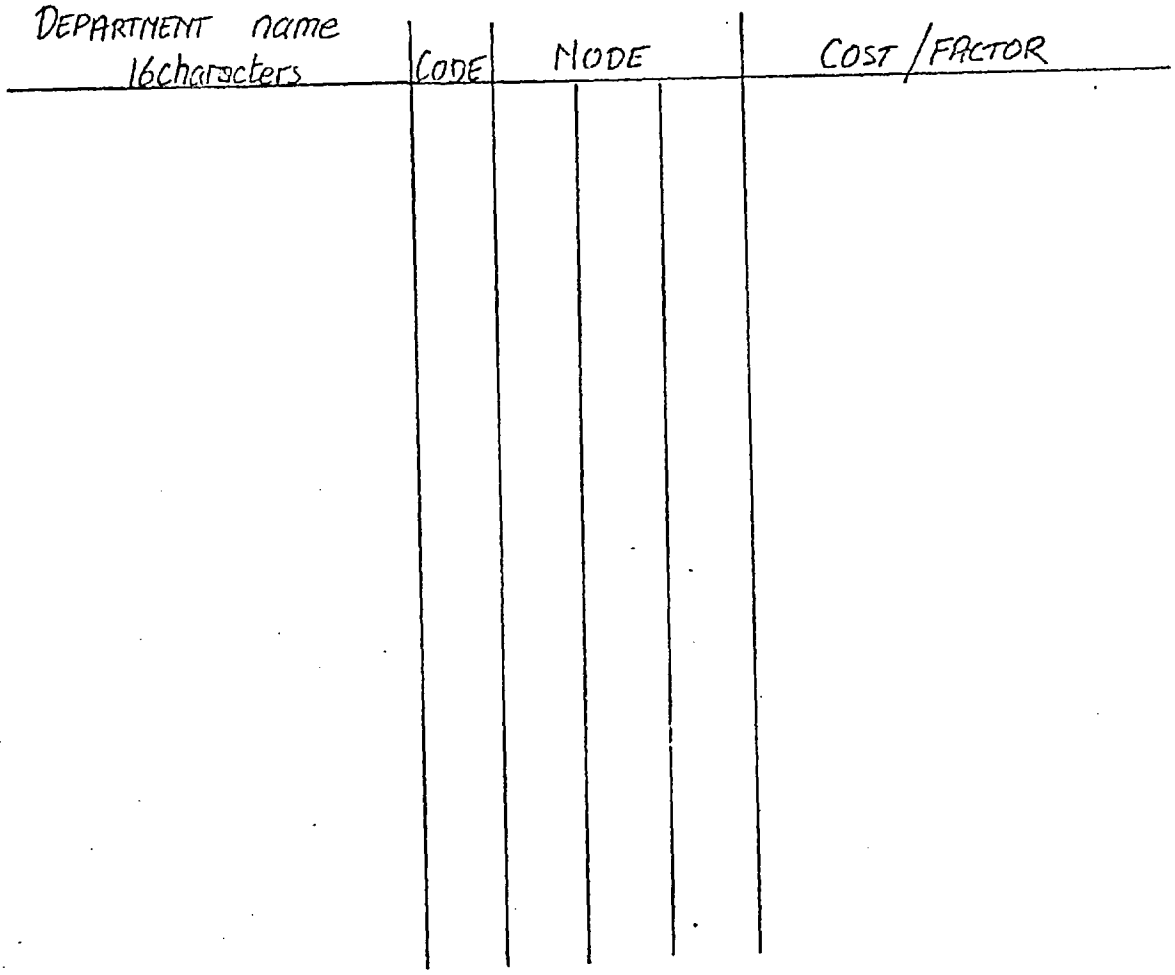


FIG E.1.2 EXPENSES MODEL

Tree Structure Costs

maximum number of first level nodes is 15, for each of these there can be up to 10 second level nodes and from each of these up to 4 terminal nodes.

The data for Prime can be set up using the data sheet in Fig E.1.3.

Results are produced of costs at each cost centre together with sub-totals. At the service offices costs are produced for each class for each type of work. Summaries are produced of the total costs for each class of business and for each service office as can be seen in the example in Appendix E.3.

RUN NUMBER _____ DATE _____

	CODE	DATA
First year for projection	1	
Number of years of projection	2	
Number of separate runs	5	
=0 if initial data is to be printed =1 otherwise	10	
New names for cost tree	11	Col 20
Start of service office (S.O.) and pseudo-service office names	12	
Assign names to nodes	15	

FIG E·1·3 Initial Data for Expenses Model

Data for Prime

I,J,K indicate integer values, SF indicates 5 decimal numbers

Code	default value or format	comment (use)
1	1973	base year for the forecasting of the model.
2	1	number of years of forecast.
5	1	number of runs.
10	1	= 1 data is printed out at the end of the program as it appears in the deck = 0 printing suppressed.
11	I,NAME (I)	This is used to define the names which can be associated with nodes in the tree structure of non-service office costs. A complete list of the names which are preset is given in the listing and this code allows names to be changed or new names included. I has a maximum value of 100. NAME is an alphanumeric string of up to 16 characters starting in column 20 of the card.
12	I,J	This points to locations in the array NAME. I is the element which is the start of the service office names. J is the element which is the start of the pseudo service office names.

Code	default value or format	comment (use)
15	I,J,K	This is used for assigning names to their corresponding position in the tree structure of non-service office costs. A list of preset assignations is given in the program listing. J,K is the node which will be called NAME (I). Should no assignment be specified either in the program or in the data then the title 'NO NAME' will appear at invocation.
999		The data for Prime is terminated by 999 on a card.

Additional comment cards may now be added and these will be printed out as a title at the start of the results.

* A card with an asterisk in column I terminates the comment cards, but must be present even if no comment cards are present.

Data for Second

Code	default or format	comment
20	0	If equal to 1 the volumes of policies at each service office by class and type will be printed out. If equal to 0 this is suppressed.
26	J,5F	This reads in the total society volumes for each type (1 - 5) of work for class J.

Code	default or format	comment
27	I,J,5F	This reads in the proportion of the total society volumes to be assigned to each service office I, for each class of business J. The 5 fields are the types of work.
28	I,4F	This reads in the proportion of the total society volumes to be assigned to each service office I. The 4 fields are for the classes of business. It assumes the same proportions of the total for each type of work at a given service office and class of business.
29	I,J,4F	Volumes of new policies, renewals lapses and cancellations at office I for class J. These will be used to calculate the proportions of the society total volumes for each type of work.
30	I,J,K,1F	This assigns the particular value F to the node B (I,J,K) of the tree of non-service office costs. The corresponding value of FAC is reset to 1. F is in £'000's.
31	I,J,K	This deletes the node B (I,J,K) from the tree of non-service office costs (resets it to zero). The corresponding value of FAC is reset to 1.

Code	default or format	comment
32	I,J	Deletes all the nodes below the node B (I.J,0) (resets them to zero) and resets all the corresponding values of FAC to 1.
35	I,J,K,1F	Assigns a value to the node FAC (I,J,K) of the tree of inflation factors associated with the tree B, of non-service office costs.
39	NCLASS NOFF NEXT I, J, K	This reads the number of classes of business, and the number of true service offices. The final value is the number of pseudo service offices. That is head office costs which are to be considered as dependent on total society policy volumes in the way that service offices are on their volumes.
40	I,J,5F	Similar in style to card 41 it is for inputting the factors by which this year's volumes are increased over last year's, for office I and class J. The 5 fields are the different types of work.
41	I,J,5F	These are the actual volumes of policies for office I and class J. The 5 fields are the different types of work, new policies, renewals, claims, alterations and cancellations and lapses.

Code	default or format	comment
42	I,J,5F	Similar in style to card 41, it is for inputting the unit costs of each type of policy for service office I and class J. The 5 fields are the different types of work. For pseudo service offices the values of I should follow consecutively after the highest value of I for a service office.
43	I,J,1.0,1.0,1.0,1.0,1.0	Similar in style to card 41, it is for inputting the factors by which this year's unit cost are increased over last years, for office I and class J. The 5 fields are the different types of work.
44	I,1.0	The amount by which the overheads of the first category at service office I are increased over those for the previous year.
45	I,1F	The actual amount of overheads of the first category at service office I, in £'000's.
46	I,1.0	The amount by which the overheads of the second category at service office I are increased over those for the previous year.
47	I,1F	The actual amount of overheads of the second category at service office 1, in £'000's.
999		The data for Second is terminated by 999 on a card in columns 1 - 3.

APPENDIX E.2

VARIABLES AND THEIR USE

EXPENSES MODEL

Variables and their Use

Expenses Model

Variable	Description	Dimension
AMALT	Total costs of handling alterations by service office.	(20)
AMCALP	Total costs of handling cancellations and lapses by service office.	(20)
AMCL	Total costs of handling claims by service office.	(20)
AMNEW	Total costs of handling new policies by service office.	(20)
AMREN	Total costs of handling renewals by service office.	(20)
AMTOT	Total costs of handling all type of work by service office.	(20)
B	The tree of non-service office type costs. The structure is shown in Fig 6.1.	(0:15,0:10,0:4)
BASEYR	The first year that the results are produced for e.g. 1974.	
BLANKET	A mask used to identify the end of the comment cards.	
CARD	Buffer for reading in data.	
CLACOST	The total variable costs by office/class of business.	(20,30)
CO	The unit cost of handling policies, matching matrices V and COFAC. office/class/type.	(30,15,5)
CODE	Data code.	
COFAC	The amount by which each element of the unit cost matrix CO, changes from the previous year. office/class/type.	(30,15,5)

Variable	Description	Dimension
FAC	The tree associated with B. Each node of B is changed from the value of the previous year by the factor in the corresponding element of FAC.	(0:15,0:10,0:4)
FLAG	Indicates how the policy volumes have been produced for the current year. =0 if actual volumes are read in by office/class/type. =1 if the society volumes by type/class are to be apportioned to individual offices by 'SPLIT'. =2 if the society volumes by type and class are to be apportioned to individual offices by 'SPLIT', but by assuming that the same proportions of the society total for each type of work hold for each office and class. =3 the volumes of new policies, renewals, lapses and cancellations have been fed in by office and class. This enables the proportions of new policies, renewals and cancellations and lapses to be calculated directly. The proportion of claims and alterations is taken to be the number of in force policies, i.e. $\text{new} + \text{renewals} - \text{lapses} - \frac{\text{cancellations}}{2}$	
FTOT	Total non-service office variable costs.	
GTOT	Total service office variable costs.	
I	Indicates whether a section of the tree structure B is used or not. =0 if node is used. =1 if node not used.	(0:15,0:10)

Variable	Description	Dimension
INDEX	Assigns elements of array NAME to a location at the first or second level of the tree structure B.	(0:15,0:10)
NAME	An array of names which are associated with various parts of the final printout. Each element is a 16 character string.	(0:100)
NB1	A pointer to a location in NAME where the names of the service offices start and follow consecutively.	
NB2	A pointer to a location in NAME where the names of the pseudo service offices start and follow consecutively.	
NCLASS	The number of classes of business.	
NEXT	The number of pseudo service offices, that is head office costs which are to be treated as dependent upon the total society volumes in the same way as service office costs.	
NOFF	The number of service offices.	
OVERFAC 1	The amount by which the first category of overheads at each service office is increased over the previous year.	(20)
OVERFAC 2	The amount by which the second category of overheads at each service office is increased over the previous year.	(20)
OVERH 1	The actual amount of the first category of overheads at each service office.	(20)
OVERH 2	The actual amount of the second category of overheads at each service office.	(20)
OVERTAT	Total pseudo-service office overhead costs.	
OVERTOT	Total service office overhead costs.	
RUNS	The total number of times the program is to be run.	

Variable	Description	Dimension
S	The total costs of handling policies by office/class/type.	(30,15,5)
SOCVOL	The volumes of business for the whole society type/class.	(5,4)
SPLIT	Matrix for assigning the total society volumes from SOCVOL to the appropriate service offices. The data is in the form of proportions of the total. Thus for each class and type the total value of SPLIT over all service offices should be 1. office/type/class.	(15,5,4)
SPLTGEN	The proportions of total society volumes split by office/class. This assumes the same proportions for all types of work.	(15,4)
TEST	If TEST = 0 then the data will be printed at the end of the run exactly as it appears in the deck. = 1 this print out is suppressed	
TIMES	A counter for the current run.	
V	The actual policy volumes by office/class/type.	(30,15,5)
VFAC	The amount by which the current year's policy volumes in matrix V are changed over the previous year. office/class/type.	(30,15,5)
VOLP	= 1 if the policy volumes are to be printed by office, class and type. = 0 if the policy volumes are not to be printed.	
YEARS	The number of years results are to be produced for.	

APPENDIX E.3

EXAMPLE DATA AND RESULTS

EXPENSES MODEL

```
2 3                                                    NO. YEARS OF FORECAST
10 1                                                   SUPPRESS PRINT OF DATA
11 91                        EXAMPLE NAME              CHANGE A NAME IN ARRAY NAME
12 45 71                                               BASE VALUES IN ARRAY NAME FOR S. O. NAMES
15 91 2 0                                              ASSIGN NAME%91< TO NODE %2,0<
999                                                    TERMINATOR FOR PRIME
DEMONSTRATION DATA              THESIS
-------------------------------------
*:                                                     TERMINATOR FOR COMMENT CARDS
20 1                                                   PRINT POLICY VOLUMES BY OFFICE
30 1 2 1 11.                                           TREE STRUCTURE COSTS   I,J,K,VALUE
30 1 2 2 21.                                           TREE STRUCTURE COSTS   I,J,K,VALUE
30 1 2 3 16.                                           TREE STRUCTURE COSTS   I,J,K,VALUE
30 1 2 4 23.                                           TREE STRUCTURE COSTS   I,J,K,VALUE
30 1 3 1 10.                                           TREE STRUCTURE COSTS   I,J,K,VALUE
30 2 1 1 271.                                          TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 1 1 174.                                         TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 2 1 76.                                          TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 2 2 45.                                          TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 2 3 14.                                          TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 3 1 141.                                         TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 3 2 27.                                          TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 3 3 56.                                          TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 4 1 34.                                          TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 4 2 75.                                          TREE STRUCTURE COSTS   I,J,K,VALUE
30 10 4 3 2.                                           TREE STRUCTURE COSTS   I,J,K,VALUE
39 4 1 0                                               NO. CLASSES  NO. S.O.   NO. PSEUDO-S. O.
41 1 1 13245 136452 10324 15374 45621                  POLICY VOLUMES BY----
41 1 2 13245 45327 54325 745621 64573                  OFFICE/CLASS/NEW/RENEWAL/CLAIMS/-------
41 1 3 245 45213 45127 198765 45123                    ALTERATIONS/CANCELLATIONS AND LAPSES
41 1 4 13574 131211 7546 132139 139481
42 1 1 1.5 2.1 0.7 6.0 6.6                             UNIT COSTS BY--------
42 1 2 3.2 2.6 0.4 3.9 3.9                             OFFICE/CLASS/NEW/RENEWAL/CLAIMS/-------
42 1 3 2.2 3.1 0.9 5.2 3.9                             ALTERATIONS/CANCELLATIONS AND LAPSES
42 1 4 5.7 3.6 2.1 5.7 9.1
45 1 56.                                               FIRST CATEGORY OF OVERHEADS
47 1 73.                                               SECOND CATEGORY OF OVERHEADS
999                                                    TERMINATOR FOR SECOND      YEAR 1
40 1 1 .9 .95 .99 1. 1.1                               VOLUME FACTORS
40 1 2 .9 .95 .99 1. 1.1                               VOLUME FACTORS
40 1 3 .9 .95 .99 1. 1.1                               VOLUME FACTORS
40 1 4 .9 .95 .99 1. 1.1                               VOLUME FACTORS
43 1 1 1.3 1.3 1.3 1.3 1.3                             UNIT COST FACTOR
43 1 2 1.3 1.3 1.3 1.3 1.3                             UNIT COST FACTOR
43 1 3 1.3 1.3 1.3 1.3 1.3                             UNIT COST FACTOR
43 1 4 1.3 1.3 1.3 1.3 1.3                             UNIT COST FACTOR
44 1 1.25                                              OVERHEAD FACTOR
46 1 1.3                                               OVERHEAD FACYOR
999                                                     TERMINATOR DOR SECOND YEAR 2
999                                                     TERMINATOR DOR SECOND YEAR 3
```

EXAMPLE DATA FOR EXPENSES MODEL

HEADING
DEMONSTRATION DATA THESIS
END OF HEADING

		EXPENSES FOR YEAR 1976 AMOUNTS IN L000 $	
			11.00
			21.00
			16.00
			23.00
(1, 2) M.S.A. CHARGES		71.00	
			10.00
(1, 3) UNDERWRITING		10.00	
HEAD OFFICE	81.00		
			271.00
(2, 1)		271.00	
EXAMPLE NAME	271.00		
			174.00
(10, 1) ACCOUNTS		174.00	
			76.00
			45.00
			14.00
(10, 2) M.S.A. CHARGES		135.00	
			141.00
			27.00
			56.00
(10, 3) PERSONNEL		224.00	
			34.00
			75.00
			2.00
(10, 4) OFF. SERVICES		111.00	
TOTAL OVERHEADS	644.00		

****
TOTAL G.I. U.K. 996000.00
****

OFFICE 1 LONDON NORTH

CLASS	1	2	3	4	5	6	7	8	9	10
NEW	19867.5	42384.0	539.0	77371.8						
RENEWALS	296549.1	117850.1	140160.3	472359.5						
CLAIMS	7226.8	21730.0	40614.3	15846.5						
ALTERATIONS	92244.0	2907921.0	1033577.9	753192.3						
CANCS+LAPS	301098.6	251834.6	175979.6	1269277.0						
	706985.9	3341719.0	1390870.0	2588047.0						

TOTAL COSTS		
NEW	140162.2	
RENEWALS	1016918.9	
CLAIMS	85417.6	
ALTERATIONS	4786934.0	
CANCS + LAPSES	1998189.0	
TOTAL	8027621.0	8027621.0
OVERHEADS		56000.0
OVERHEADS		73000.0
TOTAL COSTS		8156621.0

ANALYSIS OF GROUP SERVICE OFFICE COSTS BY CLASS OF BUSINESS

--OFFICE	1	2	3	4	5	6	7	8	9	10
MOTOR	706985.9									
PROP PRIVATE	3341719.0									
PROP COMMER	1390870.0									
MISC ACCIDENT	2583047.0									

--COSTS BY OFFICE	VARIABLE	OVERHEAD
1 LONDON NORTH	8027621.0	129000.0

--COSTS BY CLASS (VARIABLE) INCLUDING HEAD OFFICE VARIABLE COSTS

1	MOTOR	706985.9
2	PROP PRIVATE	3341719.0
3	PROP. COMMER	1390870.0
4	MISC. ACCIDENT	2583047.0

TOTAL SERVICE OFFICE VARIABLE COSTS	8027621.0
TOTAL SERVICE OFFICE OVERHEAD COSTS	129000.0
TOTAL HEAD OFFICE SO TYPE VARIABLE COSTS	0.0
TOTAL HEAD OFFICE SO TYPE OVERHEAD COSTS	0.0
TOTAL NON-SERVICE OFFICE COSTS	996000.0
TOTAL C.I.U.K. COSTS	9153621.0

VOLUMES OF POLICIES BY OFFICE

OFFICE 1 LONDON NORTH

CLASS

	1	2	3	4	5	6	7	8	9	10
NEW	13245.0	13245.0	245.0	13574.0						
RENEWALS	136452.0	45327.0	45213.0	131211.0						
CLAIMS	10324.0	54325.0	45127.0	7546.0						
ALTERATIONS	15374.0	745621.0	198765.0	132139.0						
CANCS+LAPS	45621.0	64573.0	45123.0	139481.0						

TOTAL SOCIETY VOLUMES

OFFICE 2

CLASS

	1	2	3	4	5	6	7	8	9	10
NEW	13245.0	13245.0	245.0	13574.0						
RENEWALS	136452.0	45327.0	45213.0	131211.0						
CLAIMS	10324.0	54325.0	45127.0	7546.0						
ALTERATIONS	15374.0	745621.0	198765.0	132139.0						
CANCS+LAPS	45621.0	64573.0	45123.0	139481.0						

APPENDIX E.4

LISTING OF THE

EXPENSES MODEL

SOURCE LISTING

```
STMT LEV NT

   1     0  PL1:      PROC  OPTIONS    (MAIN);
   2   1 0  PRIME: PROCEDURE;
                /*-------------------------------------DECLARATIONS-------------------------*/
   3   2 0  DCL (OVERH1(20),OVERH2(20),OVERFC1(20),OVERFC2(20),SOCVOL(5,4),
                SPLIT(15,5,4),SPLTGEN(15,4),V(30,15,5),S(30,15,5),VFAC(30,15,5),
                B(0:15,0:10,0:4),FAC(0:15,0:10,0:4),
                CO(30,15,5),COFAC(30,15,5)) BIN FLOAT EXTERNAL;
   4   2 0    DCL CARD CHAR(80),SUB CHAR(16) DEF(CARD) POSITION (20),
                BLANKET CHAR(1) DEF (CARD);
   5   2 0  DCL(FLAG,TEST,RUNS,I(0:15,0:10),INDEX(0:15,0:10),NB1,NB2)

                BIN FIXED(15) EXTERNAL;
   6-7 2 0  DCL NAME(0:100) CHAR(16) EXTERNAL;
   8   2 0  DCL(I1,I2,I3,I4,I5,I6,I7,I8,I9) BIN FIXED ,LAB(30)'LABEL;
   9   2 0  DCL CODE BIN FIXED(15),BASEYR BIN FIXED EXTERNAL;

                /*----------RESET MATRICES TO NON ACTIVE VALUES-------------------------*/

   9   2 0  DO I7=1 TO 4;
  10   2 1  DO I8=1 TO 15;
  11   2 2  SPLTGEN(I8,I7)=0.;
  12   2 2  DO I6=1 TO 5;
  13   2 3  SPLIT(I8,I6,I7)=0.;
  14   2 3  END;
  15   2 2  END;
  16   2 1  DO I6=1 TO 5;
  17   2 2  SOCVOL(I6,I7)=0.;
  18   2 2  END;
  19   2 1  END;

  20   2 0  DO I6=0 TO 15;
  21   2 1  DO I7=0 TO 10;
  22   2 2  DO I8=0 TO 4;
  23   2 3  FAC(I6,I7,I8)=1.;
  24   2 3  B(I6,I7,I8)=0.;
  25   2 3  END;
  26   2 2  INDEX(I6,I7)=0;
  27   2 2  I(I6,I7)=0;
  28   2 2  END;
  29   2 1  END;
  30   2 0    DO I4=1 TO 15;
  31   2 1  DO I3=1 TO 30;
  32   2 2  V(I3,I4,1)=0.;
  33   2 2  V(I3,I4,2)=0.;
  34   2 2  V(I3,I4,3)=0.;
  35   2 2  V(I3,I4,4)=0.;
  36   2 2  V(I3,I4,5)=0.;
  37   2 2  VFAC(I3,I4,1)=1.;
```

```
STMT LEV NT

   38     2    2   WFAC(I3,I4,2)=1.;
   39     2    2   WFAC(I3,I4,3)=1.;
   40     2    2   WFAC(I3,I4,4)=1.;
   41     2    2   WFAC(I3,I4,5)=1.;
   42     2    2   CO(I3,I4,1)=0.;
   43     2    2   CO(I3,I4,2)=0.;
   44     2    2   CO(I3,I4,3)=0.;
   45     2    2   CO(I3,I4,4)=0.;
   46     2    2   CO(I3,I4,5)=0.;
   47     2    2   COFAC(I3,I4,1)=1.;
   48     2    2   COFAC(I3,I4,2)=1.;
   49     2    2   COFAC(I3,I4,3)=1.;
   50     2    2   COFAC(I3,I4,4)=1.;
   51     2    2   COFAC(I3,I4,5)=1.;
   52     2    2   END;
   53     2    1   END;
   54     2    0   DO I4=1 TO 20;
   55     2    1   OVERFC1(I4)=1.;
   56     2    1   OVERFC2(I4)=1.;
   57     2    1   OVERH1(I4)=0.;
   58     2    1   OVERH2(I4)=0.;
   59     2    1   END;
                   /*----------------------SET INITIAL VALUES-----------------------------*/
                   /*---------------PRR NAMES ASSIGNED TO NODES OF COST TREE--------------*/

   60     2    0   INDEX(10,1)=1;
   61     2    0   INDEX(10,2)=16;
   62     2    0   INDEX(10,3)=2;
   63     2    0   INDEX(10,4)=3;
   64     2    0   INDEX(10,5)=5;
   65     2    0   INDEX(10,6)=4;
   66     2    0   INDEX(10,7)=6;
   67     2    0   INDEX(10,8)=7;
   68     2    0   INDEX(0,0)=40;

   69     2    0   INDEX(1,0)=34;
   70     2    0   INDEX(1,1)=100;
   71     2    0   INDEX(1,2)=16;
   72     2    0   INDEX(1,3)=17;
   73     2    0   INDEX(1,4)=18;
   74     2    0   INDEX(1,5)=19;
   75     2    0   INDEX(1,6)=20;
   76     2    0   INDEX(1,7)=21;
   77     2    0   INDEX(2,0)=4;
   78     2    0   INDEX(2,1)=100;
   79     2    0   INDEX(2,2)=4;
   80     2    0   INDEX(2,3)=14;
   81     2    0   INDEX(2,4)=15;
   82     2    0   INDEX(3,0)=1;
   83     2    0   INDEX(4,0)=19;
   84     2    0   INDEX(5,0)=24;
```

```
STMT LEV NT

   85     2  0   INDEX(3,1)=100;
   86     2  0   INDEX(4,1)=100;
   87     2  0   INDEX(5,1)=100;
   88     2  0   INDEX(5,2)=34;
   89     2  0   INDEX(6,0)=34;
   90     2  0   INDEX(6,1)=26;
   91     2  0   INDEX(6,2)=33;
   92     2  0   INDEX(6,4)=31;
   93     2  0   INDEX(6,5)=30;
   94     2  0   INDEX(6,6)=14;
   95     2  0   INDEX(6,7)=29;
   96     2  0   INDEX(6,8)=25;
   97     2  0   INDEX(6,9)=27;
   98     2  0   INDEX(7,1)=9;
   99     2  0   INDEX(7,2)=10;
  100     2  0   INDEX(7,3)=11;
  101     2  0   INDEX(7,4)=12;
  102     2  0   INDEX(7,5)=7;
  103     2  0   INDEX(7,0)=1;
  104     2  0   INDEX(8,0)=2;
  105     2  0   INDEX(9,0)=3;
  106     2  0   INDEX(8,1)=100;
  107     2  0   INDEX(9,1)=100;
  108     2  0   INDEX(10,0)=28;
  109     2  0   INDEX(10,1)=1;
  110     2  0   INDEX(11,1)=100;
  111     2  0   INDEX(12,1)=100;
  112     2  0   INDEX(13,1)=100;
  113     2  0   INDEX(15,0)=90;
  114     2  0   INDEX(15,1)=54;
  115     2  0   INDEX(15,2)=60;
  116     2  0   INDEX(15,3)=61;
  117     2  0   INDEX(15,4)=62;
  118     2  0   INDEX(15,5)=63;
  119     2  0   INDEX(15,6)=64;

                /*----------------------INITIAL NAMES FOR COST TREE----------------------*/
  120     2  0   NAME(0)='NO NAME';
  121     2  0   NAME(1)='ACCOUNTS';
  122     2  0   NAME(2)='PERSONNEL';
  123     2  0   NAME(3)='OFF. SERVICES';
  124     2  0   NAME(4)='PLANNING';
  125     2  0   NAME(5)='SECY. OFFICE';
  126     2  0   NAME(6)='INVESTMENTS';
  127     2  0   NAME(7)='GEN. OVERHEADS';
  128     2  0   NAME(8)='ESTATES';
  129     2  0   NAME(9)='MOTOR';
  130     2  0   NAME(10)='PROP. PRIVATE';
  131     2  0   NAME(11)='PROP. CONNER';
  132     2  0   NAME(12)='MISC. INCIDENT';
```

```
STMT LEV NT

 133    2   0   NAME(13)='ADMIN+ TRAINING';
 134    2   0   NAME(14)='STATISTICAL';
 135    2   0   NAME(15)='SYSTEMS';
 136    2   0   NAME(16)='M.S.A. CHARGES';
 137    2   0   NAME(17)='UNDERWRITING';
 138    2   0   NAME(18)='CLAIMS';
 139    2   0   NAME(19)='SURVEYORS-ENG';
 140    2   0   NAME(20)='UNDERWTG-ENG';
 141    2   0   NAME(21)='REGIONAL ADMIN';
 142    2   0   NAME(22)='G.I  PLANNING';
 143    2   0   NAME(23)='GI UK ACCOUNTS';
 144    2   0   NAME(24)='BUILD SOC COMM';
 145    2   0   NAME(25)='GEN SALES(GI) HO';
 146    2   0   NAME(26)='REG. OVERHEADS';
 147    2   0   NAME(27)='ADMIN';
 148    2   0   NAME(28)='TOTAL OVERHEADS';
 149    2   0   NAME(29)='PUBLICITY';
 150    2   0   NAME(30)='RECORDS';
 151    2   0   NAME(31)='TRAINING';
 152    2   0   NAME(32)='TYPISTS';
 153    2   0   NAME(33)='DEVELOPMENT';
 154    2   0   NAME(34)='HEAD OFFICE';
 155    2   0   NAME(35)='SERVICE OFFICE';
 156    2   0   NAME(36)='INSPECTORS';
 157    2   0   NAME(37)='SALES OFFICES';
 158    2   0   NAME(38)='GEN INSURANCE';
 159    2   0   NAME(39)='GEN SALES';
 160    2   0   NAME(40)='TOTAL G.I. U.K.';
 161    2   0   NAME(45)='LONDON NORTH';
 162    2   0   NAME(46)='SCOTLAND';
 163    2   0   NAME(47)='LONDON SOUTH';
 164    2   0   NAME(48)='MIDLAND WEST';
 165    2   0   NAME(49)='LEEDS';
 166    2   0   NAME(50)='MANCHESTER';
 167    2   0   NAME(51)='LIVERPOOL';
 168    2   0   NAME(52)='CITY';
 169    2   0   NAME(53)='WEST END';
 170    2   0   NAME(54)='SOUTH';
 171    2   0   NAME(55)='IPSWICH';
 172    2   0   NAME(56)='BELFAST';
 173    2   0   NAME(57)='BRISTOL';
 174    2   0   NAME(58)='PLYMOUTH';
 175    2   0   NAME(60)='MIDLANDS';
 176    2   0   NAME(61)='LONDON';
 177    2   0   NAME(62)='NORTH';
 178    2   0   NAME(63)='WEST';
 179    2   0   NAME(64)='CITY+WEST END';
 180    2   0   NAME(65)='BONUS';
 181    2   0   NAME(71)='GI UK NO YMSA';
 182    2   0   NAME(72)='NO MSA+SEC MIN';
```

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  183    2   0   NAME(81)='MOTOR';
  184    2   0   NAME(82)='PROP PRIVATE';
  185    2   0   NAME(83)='PROP. COMMER';
  186    2   0   NAME(84)='MISC. ACCIDENT';
  187    2   0   NAME(90)='SALES OFFICES';
  189    2   0   NAME(100)='                ';

  189    2   0   BASEYR=1973;
  190    2   0   YEARS=1;
  191    2   0   TEST=1;

                 /*--------------------READ NEXT DATA CARD---------------------------------*/
  192    2   0   L1:
                 GET FILE(SYSIN) EDIT(CARD) (A(80));
  193    2   0   IF TEST=0 THEN GOTO L2;
                 /*----------------------------PRINT DATA ONTO FILE DUM--------------------*/
  194    2   0   PUT FILE(DUM) EDIT(CARD) (SKIP,COLUMN(10),A(80));
  195    2   0   L2:
                 GET STRING(CARD) LIST(CODE);
                 /*--------------------TEST DATA FOR TERMINATOR--------------------------*/
  196    2   0   IF CODE=999 THEN GOTO L999;
  197    2   0   GOTO LAB(CODE);
  198    2   0   LAB(1): GET STRING(CARD) LIST(CODE,BASEYR);
  199    2   0                             GOTO L1;
  200    2   0   LAB(2):  GET STRING(CARD) LIST(CODE,YEARS);
  201    2   0                             GOTO L1;
  202    2   0   LAB(5): GET STRING(CARD) LIST(CARD,RUNS);
  203    2   0                             GOTO L1;
  204    2   0   LAB(10): GET STRING(CARD) LIST(CODE,TEST);
  205    2   0                             GOTO L1;
  206    2   0   LAB(11): GET STRING(CARD) LIST(CODE,I7);
  207    2   0   NAME(I7)=SUB;
  208    2   0                             GOTO L1;
  209    2   0   LAB(12):  GET STRING(CARD) LIST(CODE,NB1,NB2);
  210    2   0                             GOTO L1;
  211    2   0   LAB(15): GET STRING(CARD) LIST(CODE,I8,I6,I7);
  212    2   0   INDEX(16,I7)=I8;
  213    2   0                             GOTO L1;
  214    2   0    L999:

                 /*-----------------------------HEADING-------------------------------------*/
                 PUT FILE (SYSPRINT) EDIT('HEADING')(SKIP(2),COLUMN(10),A);
  215    2   0   L11:
                 GET FILE(SYSIN) EDIT (CARD) (A(80));
                 /*----------------------TEST FOR END OF HEADING-------------------------*/
  216    2   0    IF BLANKET='*' THEN GOTO L10;
  217    2   0   PUT FILE(SYSPRINT) EDIT (CARD) (SKIP,COLUMN(10),A(80));
  218    2   0      GOTO L11;
  219    2   0   L10:    PUT  FILE(SYSPRINT) EDIT('END OF HEADING')(SKIP,COLUMN(10),A);
  220    2   0   PUT SKIP(3);
```

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 221    2   0   PUT EDIT ('NUMBER OF YEARS OF FORECAST IS',YEARS,'BASEYEAR IS',BASEYR)
                (SKIP,A,F(4),X(10),A,F(6));
 222    2   0   RETURN;
 223    2   0   END PRIME;



                /*-------------------------------------------------------------------*/
 224    1   0   SECOND: PROCEDURE;
                /*-------------------------------DECLARATIONS------------------------*/
 225    2   0   DCL (TEMP,TEMP1,TEMP2,TEMP3,TEMP4) BIN FLOAT;
 226    2   0   DCL (NB1,NB2,FLAG,TEST,RUNS,I(0:15,0:10),INDEX(0:15,0:10),NCLASS,NOFF,
                NEXT,VOLP) BIN FIXED(15) EXTERNAL;
 227    2   0   DCL (OVERH1(20),OVERH2(20),OVERFC1(20),OVERFC2(20),SOCVOL(5,4),
                B(0:15,0:10,0:4),FAC(0:15,0:10,0:4),
                SPLIT(15,5,4),SPLTGEN(15,4),V(30,15,5),S(30,15,5),VFAC(30,15,5),
                CO(30,15,5),COFAC(30,15,5)) BIN FLOAT EXTERNAL;
 228    2   0   DCL CARD CHAR(80),LAB(50) LABEL,NAME(0:100) CHAR(16) EXTERNAL;
 229    2   0   DCL (I4,I5,I6,I7,I8,CODE) BIN FIXED;

 230    2   0   FLAG=0;
                /*--------------------READ NEXT DATA CARD------------------------------*/
 231    2   0   L1:
                GET FILE(SYSIN) EDIT(CARD) (A(80));
 232    2   0   IF TEST=0 THEN GOTO L2;
                /*-----------------------------PRINT DATA ONTO FILE DUM----------------*/
 233    2   0   PUT FILE(DUM) EDIT(CARD) (SKIP,COLUMN(10),A(80));
 234    2   0   L2:
                GET STRING(CARD) LIST(CODE);
                /*---------------------TEST DATA FOR TERMINATOR------------------------*/
 235    2   0   IF CODE=999 THEN GOTO L999;
 236    2   0   GOTO LAB(CODE);
                /*-------------------------------------------------------------------*/
 237    2   0   LAB(20):
                GET STRING(CARD) LIST(CODE,VOLP);
 238    2   0                                   GOTO L1;
 239    2   0   LAB(26):
                GET STRING(CARD) LIST(CODE,I6,SOCVOL(1,I6),SOCVOL(2,I6),SOCVOL(3,I6),
                SOCVOL(4,I6),SOCVOL(5,I6));
 240    2   0                                   GOTO L1;
 241    2   0   LAB(27):
                GET STRING(CARD) LIST(CODE,I6,I7,SPLIT(I6,1,I7),SPLIT(I6,2,I7),
                SPLIT(I6,3,I7),SPLIT(I6,4,I7),SPLIT(I6,5,I7));
 242    2   0   FLAG=1;
 243    2   0                                   GOTO L1;
 244    2   0   LAB(28):
                GET STRING(CARD) LIST(CODE,I6,SPLTGEN(I6,1),SPLTGEN(I6,2),
                SPLTGEN(I6,3),SPLTGEN(I6,4));
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 245    2   0   FLAG=2;
 246    2   0                                        GOTO L1;
 247    2   0   LAB(29);
                GET STRING(CARD) LIST(CODE,I6,I7,SPLIT(I6,1,I7),SPLIT(I6,2,I7),
                SPLIT(I6,3,I7),SPLIT(I6,4,I7));
 248    2   0   FLAG=3;
 249    2   0                                        GOTO L1;
 250    2   0   LAB(30);
                GET STRING(CARD) LIST(CODE,I6,I7,I8,B(I6,I7,I8));
 251    2   0   I(I6,I7)=1;
 252    2   0   FAC(I6,I7,I8)=1.;
 253    2   0                                        GOTO L1;
 254    2   0   LAB(31);
                GET STRING(CARD) LIST(CODE,I6,I7,I8);
 255    2   0   B(I6,I7,I8)=0.;
 256    2   0   FAC(I6,I7,I8)=1.;
 257    2   0                                        GOTO L1;
 258    2   0   LAB(32);
                GET STRING(CARD) LIST(CODE,I6,I7);
 259    2   0   DO I8=1 TO 4;
 260    2   1   B(I6,I7,I8)=0.;
 261    2   1    FAC(I6,I7,I8)=1.;
 262    2   1   END;
 263    2   0   I(I6,I7)=0;
 264    2   0                                        GOTO L1;
 265    2   0   LAB(35);
                GET STRING(CARD) LIST(CODE,I6,I7,I8,FAC(I6,I7,I8));
 266    2   0                                        GOTO L1;
 267    2   0   LAB(39);
                GET STRING(CARD) LIST(CODE,NCLASS,NOFF,NEXT);
 268    2   0                                        GOTO L1;
 269    2   0   LAB(40);
                GET STRING(CARD) LIST(CODE,I4,I3,VFAC(I4,I3,1),VFAC(I4,I3,2),VFAC(I4,I3,3),VAFC
                ,3),VFAC(I4,I3,4),VFAC(I4,I3,5));
 270    2   0                                        GOTO L1;
 271    2   0   LAB(41);
                GET STRING(CARD) LIST(CODE,I4,I3,V(I4,I3,1),V(I4,I3,2),V(I4,I3,3),V(I4,I3,4),
                I3,4),V(I4,I3,5));
 272    2   0                                        GOTO L1;
 273    2   0   LAB(42);
                GET STRING(CARD) LIST(CODE,I4,I3,CO(I4,I3,1),CO(I4,I3,2),CO(I4,I3,3),CO(I4,I3,4
                (I4,I3,4),CO(I4,I3,5));
 274    2   0                                        GOTO L1;
 275    2   0   LAB(43);
                GET STRING(CARD) LIST(CODE,I4,I3,COFAC(I4,I3,1),COFAC(I4,I3,2),
                COFAC(I4,I3,3),COFAC(I4,I3,4),COFAC(I4,I3,5));
 276    2   0                                        GOTO L1;
 277    2   0   LAB(44);
                GET STRING(CARD) LIST(CODE,I4,OVERFL(I4));
 278    2   0                                        GOTO L1;
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 279    2   0   LAB(45):
                GET STRING(CARD) LIST(CODE,I4,OVERH1(I4));
 280    2   0   OVERH1(I4)=OVERH1(I4)*1000.;
 281    2   0                                   GOTO L1;
 282    2   0   LAB(46):
                GET STRING(CARD) LIST(CODE,I4,OVERFC2(I4));
 283    2   0                                   GOTO L1;
 284    2   0   LAB(47):
                GET STRING(CARD) LIST(CODE,I4,OVERH2(I4));
 285    2   0   OVERH2(I4)=OVERH2(I4)*1000.;
 286    2   0                                   GOTO L1;
 287    2   0   L999:
                /*----------CHECK FOR VALID VALUES OF SPLIT----------*/
                IF FLAG NE 1 THEN GOTO L12;
 288    2   0   DO I7=1 TO 5;
 289    2   1   DO I8=1 TO NCLASS;
 290    2   2   TEMP=0.;
 291    2   2   DO I6=1 TO NOFF;
 292    2   3   TEMP=TEMP+SPLIT(I6,I7,I8);
 293    2   3   END;
 294    2   2   IF ABS(TEMP-1.) LT 0.01 THEN GOTO L13;
 295    2   2   PUT EDIT('DATA FOR APPORTIONMENT OF VOLUMES FOR CLASS',I8,' AND TYPE',I7,' IS I
                7,' IS INCORRECT   TOTAL IS ',TEMP)
                (SKIP,A,F(4),A,F(4),A,F(7,3));
 296    2   2   L13:
                END;
 297    2   1   END;

                /*----------------GENERATE ELEMENTS OF MATRIX SPLIT----------------*/
 298    2   0   L12:
                IF FLAG NE 2 THEN GOTO L14;
 299    2   0   DO I6=1 TO NCLASS;
 300    2   1   TEMP=0.;
 301    2   1   DO I7=1 TO NOFF;
 302    2   2   TEMP=TEMP+SPLTGEN(I7,I6);
 303    2   2   END;
 304    2   1   IF ABS(TEMP-1.) LT 0.01 THEN GOTO L20;
 305    2   1   PUT EDIT('DATA FOR APPORTIONMENT OF VOLUMES USING SPLTGEN AT CLASS',
                I6,' OFFICE ',I7,' TOTAL IS ',TEMP)
                (SKIP,A,F(4),A,F(4),A,F(7,3));
 306    2   1    L20:
                END;
 307    2   0   DO I6=1 TO NCLASS;
 308    2   1   DO I8=1 TO NOFF;
 309    2   2   DO I7=1 TO 5;
 310    2   3   SPLIT(I8,I7,I6)=SPLTGEN(I8,I6);
 311    2   3   END;
 312    2   2   END;
 313    2   1   END;
 314    2   0   L14:
```

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                    IF FLAG NE 3 THEN GOTO L15;
 315     2   0      FLAG=1;
 316     2   0      DO I8=1 TO NCLASS;
 317     2   1      TEMP1=0.;
 318     2   1      TEMP2=0.;
 319     2   1      TEMP3=0.;
 320     2   1      TEMP4=0.;
 321     2   1      DO I6=1 TO NOFF;
 322     2   2      TEMP1=TEMP1+SPLIT(I6,1,I8);
 323     2   2      TEMP2=TEMP2+SPLIT(I6,2,I8);
 324     2   2       TEMP3=TEMP3+SPLIT(I6,3,I8);
 325     2   2      TEMP4=TEMP4+SPLIT(I6,4,I8);
 326     2   2      TEMP=TEMP1+TEMP2-TEMP3-TEMP4/2.;
 327     2   2      END;
 328     2   1      DO I6=1 TO NOFF;
 329     2   2      SPLIT(I6,5,I8)=(SPLIT(I6,3,I8)+SPLIT(I6,4,I8))/(TEMP3+TEMP4);
 330     2   2      SPLIT(I6,3,I8),SPLIT(I6,4,I8)=(SPLIT(I6,1,I8)+SPLIT(I6,2,I8)-
                    SPLIT(I6,3,I8)-SPLIT(I6,4,I8)/2.)/TEMP;
 331     2   2      SPLIT(I6,1,I8)=SPLIT(I6,1,I8)/TEMP1;
 332     2   2      SPLIT(I6,2,I8)=SPLIT(I6,2,I8)/TEMP2;
 333     2   2      END;
 334     2   1      END;
 335     2   0      L15:
                    IF FLAG=0 THEN GOTO L16;
 336     2   0      DO I6=1 TO NCLASS;
 337     2   1      DO I7=1 TO NOFF;
 338     2   2      DO I8=1 TO 5;
 339     2   3      VFAC(I7,I6,I8)=1.;
 340     2   3      END;
 341     2   2      END;
 342     2   1      END;
 343     2   0      L16:
                    END SECOND;
                    /*-----------------------------------------------------------------*/


                    /*-----------------------------------DECLARATIONS------------------------------*/
 344     1   0      DCL (NB1,NB2,FLAG,TEST,RUNS,I(0:15,0:10),INDEX(0:15,0:10),NCLASS,NOFF,
                    NEXT,VOLP) BIN FIXED(15) EXTERNAL;
 345     1   0      DCL BASEYR BIN FIXED EXTERNAL;
 346     1   0      DCL NAME(0:100) CHAR(16) EXTERNAL;
 347     1   0      DCL (I1,I2,I3,I4,I5,I6,I7,I8,I9,NTOP,NB,IC,TIMES,YEARS) BIN FIXED(15);
 348     1   0      DCL (AMNEW(20),AMREM(20),AMCL(20),AMALI(20),AMCALP(20),AMTOT(20),FTOT,
                    CLACOST(20,30),OVERTAT,OVERTOT,TEMP2,GTOT) BIN FLOAT;
 349     1   0      DCL (OVERH1(20),OVERH2(20),OVERFC1(20),OVERFC2(20),SOCVOL(5,4),
                    B(0:15,0:10,0:4),FAC(0:15,0:10,0:4),
                    SPLIT(15,5,4),SPLTEEN(15,4),V(30,15,5),S(30,15,5),VFAC(30,15,5),
                    CO(30,15,5),COFAC(30,15,5)) BIN FLOAT EXTERNAL;
 350     1   0      OPEN FILE(SYSPRINT) LINESIZE(132) PAGESIZE(64);
 351     1   0      DCL DUM FILE PRINT;
```

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 352    1   0   RUNS=1;
 353    1   0   VOLP=0;

 354    1   0   DO TIMES=1 TO RUNS;
 355    1   1   CALL PRIME;

 356    1   1   DO I1=1 TO YEARS;
 357    1   2   CALL SECOND;
 358    1   2   PUT EDIT ('EXPENSES FOR YEAR',I1+BASEYR)(SKIP(6),COLUMN(30),A,F(7));
 359    1   2   PUT EDIT('AMOUNTS IN 1000 S')(SKIP,COLUMN(30),A);

                 /*------------RESET NON TERMINAL NODES TO ZERO-------------------------*/
 360    1   2   DO I6=1 TO 15;
 361    1   3   DO I7=1 TO 10;
 362    1   4   B(I6,I7,0)=0.;
 363    1   4   END;
 364    1   3   B(I6,0,0)=0.;
 365    1   3   END;
 366    1   2   B(0,0,0)=0.;

                 /*---------------CALC COSTS AT EACH NODE OF TREE-----------------------*/
 367    1   2   DO I6=1 TO 15;
 368    1   3   DO I7=1 TO 10;
 369    1   4   IF I(I6,I7)=0 THEN GOTO L7;
 370    1   4   DO I8=1 TO 4;
 371    1   5   B(I6,I7,I8)=B(I6,I7,I8)*FAC(I6,I7,I8)*FAC(I6,I7,0)*FAC(I6,0,0);
 372    1   5   B(I6,I7,0)=B(I6,I7,0)+B(I6,I7,I8);
 373    1   5   END;
 374    1   4   B(I6,0,0)=B(I6,0,0)+B(I6,I7,0);
 375    1   4   L7:
                 END;
 376    1   3   B(0,0,0)=B(0,0,0)+B(I6,0,0);
 377    1   3   END;


                 /*----------PRINT NON SERVICE OFFICE COSTS-------------------------------*/
 378    1   2   DO I6=1 TO 15;
 379    1   3   DO I7=1 TO 10;
 380    1   4   IF I(I6,I7)=0 THEN GOTO L8;
 381    1   4   DO I8=1 TO 4;
 382    1   5   IF B(I6,I7,I8) LT 0.01 THEN GOTO L9;
 383    1   5   PUT EDIT(B(I6,I7,I8))
                 (SKIP,COLUMN(40),F(12,2));
 384    1   5   L9:
                 END;
 385    1   4   PUT EDIT('(',I6,',',I7,')',NAME(INDEX(I6,I7)),B(I6,I7,0))
                 (SKIP,X(2),A,F(2),A,F(2),A,X(2),A(16),COLUMN(28),F(12,2));
 386    1   4   L8:
                 END;
 387    1   3   IF B(I6,0,0) LT 0.01 THEN GOTO L10;
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 388    1   3   PUT EDIT('-------')
                (SKIP,COLUMN(25),A);
 389    1   3   PUT EDIT(NAME(INDEX(I6,0)),B(I6,0,0))
                (SKIP,X(2),A(16),COLUMN(20),F(12,2));
 390    1   3   PUT EDIT('========')
                (SKIP,COLUMN(25),A);
 391    1   3   PUT SKIP(3);
 392    1   3   L10:
                END;
 393    1   2   PUT EDIT('**********************************')(SKIP,A);
 394    1   2   PUT EDIT(NAME(INDEX(0,0)),B(0,0,0)*1000.0)
                (SKIP,X(2),A(16),COLUMN(20),F(12,2));
 395    1   2   PUT EDIT('**********************************')(SKIP,A);

                /*-----------------------------SET UP INITIAL VALUES---------------------*/
 396    1   2   DO I4=1 TO NOFF+NEXT;
 397    1   3   AMREN(I4)=0.;
 398    1   3   AMNEW(I4)=0.;
 399    1   3   AMCL(I4)=0.;
 400    1   3   AMALT(I4)=0.;
 401    1   3   AMCALP(I4)=0.;
 402    1   3   END;

                /*------------CALCULATE SERVICE OFFICE VOLUMES-------------------------*/
 403    1   2   IF FLAG=0 THEN GOTO L1;
 404    1   2   DO I2=1 TO 5;
 405    1   3   DO I3=1 TO NCLASS;
 406    1   4   DO I4=1 TO NOFF;
 407    1   5    V(I4,I3,I2)=SOCVOL(I2,I3)*SPLIT(I4,I2,I3);
 408    1   5   END;
 409    1   4   END;
 410    1   3   END;
                /*-----------CALC SERVICE OFFICE COSTS---------------------------------*/
 411    1   2   L1:
                DO I3=1 TO NCLASS;
 412    1   3   DO I2=1 TO 5;
 413    1   4   V(NOFF+1,I3,I2)=0.;
 414    1   4   DO I4=1 TO NOFF;
 415    1   5   CO(I4,I3,I2)=CO(I4,I3,I2)*COFAC(I4,I3,I2);
 416    1   5   V(I4,I3,I2)=V(I4,I3,I2)*VFAC(I4,I3,I2);
 417    1   5   V(NOFF+1,I3,I2)=V(NOFF+1,I3,I2)+V(I4,I3,I2);
 418    1   5   S(I4,I3,I2)=V(I4,I3,I2)*CO(I4,I3,I2);
 419    1   5   END;
 420    1   4   END;
 421    1   3   END;
 422    1   2   DO I4=NOFF+1 TO NOFF+NEXT;
 423    1   3   DO I3=1 TO NCLASS;
 424    1   4   DO I2=1 TO 5;
 425    1   5   S(I4,I3,I2)=V(NOFF+1,I3,I2)*CO(I4,I3,I2);
 426    1   5   END;
```

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 427    1   4   END;
 428    1   3   END;

                /*------CALCULATE SERVICE OFFICE OVERHEADS-----------------------------*/
 429    1   2   DO I2=1 TO NOFF+NEXT;
 430    1   3   OVERH1(I2)=OVERH1(I2)*OVERFC1(I2);
 431    1   3   OVERH2(I2)=OVERH2(I2)*OVERFC2(I2);
 432    1   3   END;
                /*--------------PRINT RESULTS BY OFFICE-----------------------------------*/
 433    1   2   PUT EDIT('AMOUNTS IN L S')(SKIP(5),COLUMN(20),A);
 434    1   2   I4=0;
 435    1   2   IC=0;
 436    1   2   NB=NB1-1;
 437    1   2   NTOP=NOFF;
 438    1   2   L990:
                DO I9=1 TO NTOP;
 439    1   3   I4=I4+1;
 440    1   3   PUT EDIT('OFFICE',I4,NAME(NB+I9)) (PAGE,SKIP,COLUMN(40),A,F(4),X(3),A);
 441    1   3   DO I3=1 TO NCLASS;
 442    1   4   AMNEW(I4)=AMNEW(I4)+S(I4,I3,1);
 443    1   4   AMREN(I4)=AMREN(I4)+S(I4,I3,2);
 444    1   4   AMCL(I4)=AMCL(I4)+S(I4,I3,3);
 445    1   4   AMALT(I4)=AMALT(I4)+S(I4,I3,4);
 446    1   4   AMCALP(I4)=AMCALP(I4)+S(I4,I3,5);
 447    1   4   END;
 448    1   3   PUT EDIT('CLASS')(SKIP,COLUMN(8),A);
 449    1   3   PUT EDIT((I8 DO I8=1  TO 10))(SKIP(1),X(11),10(F(10)));
 450    1   3    IF NCLASS GT 10 THEN I8=10;
 451    1   3   ELSE  I8=NCLASS;
 452    1   3   PUT EDIT('NEW',(S(I4,I3,1) DO I3=1 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 453    1   3   PUT EDIT('RENEWALS',(S(I4,I3,2) DO I3=1 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 454    1   3   PUT EDIT('CLAIMS',(S(I4,I3,3) DO I3=1 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 455    1   3   PUT EDIT('ALTERATIONS',(S(I4,I3,4) DO I3=1 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 456    1   3   PUT EDIT('CANCS+LAPS',(S(I4,I3,5) DO I3=1 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 457    1   3   DO I3=1 TO I8;
 458    1   4   CLACOST(I4,I3)=S(I4,I3,1)+S(I4,I3,2)+S(I4,I3,3)+S(I4,I3,4)+S(I4,I3,5);
 459    1   4   END;
 460    1   3   PUT EDIT('-------------------------------------------------------------------
                ----------------------------------------------------')
                (SKIP,A);
 461    1   3   PUT EDIT((CLACOST(I4,I3) DO I3=1  TO I8))(SKIP,COLUMN(13),10(F(10,1)));
 462    1   3   PUT EDIT('=========================================================================
                ==========================================================')
                (SKIP,A);
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  463    1   3   IF NCLASS LT 11 THEN GOTO M1;
  464    1   3   PUT EDIT('CLASS')(SKIP,COLUMN(8),A);
  465    1   3   PUT EDIT((I8 DO I8=11 TO 20))(SKIP(1),X(11),10(F(10)));
  466    1   3   IF NCLASS GT 20 THEN I8=20;
  467    1   3   ELSE I8=NCLASS;
  468    1   3   PUT EDIT('NEW',(S(I4,I3,1) DO I3=11 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  469    1   3   PUT EDIT('RENEWALS',(S(I4,I3,2) DO I3=11 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  470    1   3   PUT EDIT('CLAIMS',(S(I4,I3,3) DO I3=11 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  471    1   3   PUT EDIT('ALTERATIONS',(S(I4,I3,4) DO I3=1 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  472    1   3   PUT EDIT('CANCS+LAPS',(S(I4,I3,5) DO I3=1 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  473    1   3   DO I3=10 TO I8;
  474    1   4   CLACOST(I4,I3)=S(I4,I3,1)+S(I4,I3,2)+S(I4,I3,3)+S(I4,I3,4)+S(I4,I3,5);
  475    1   4   END;
  476    1   3   PUT EDIT('-------------------------------------------------------------------
                  ----------------------------------------------------------')
                  (SKIP,A);
  477    1   3   PUT EDIT((CLACOST(I4,I3) DO I3=11 TO I8))(SKIP,COLUMN(13),10(F(10,1)));
  478    1   3   PUT EDIT('===================================================================
                  ==========================================================')
                  (SKIP,A);

  479    1   3   IF NCLASS LT 21 THEN GOTO M1;
  480    1   3   PUT EDIT('CLASS')(SKIP,COLUMN(8),A);
  481    1   3   PUT EDIT((I8 DO I8=21 TO 30))(SKIP(1),X(11),10(F(10)));
  482    1   3    I8=NCLASS;
  483    1   3   PUT EDIT('NEW',(S(I4,I3,1) DO I3=21 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  484    1   3   PUT EDIT('RENEWALS',(S(I4,I3,2) DO I3=21 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  485    1   3   PUT EDIT('CLAIMS',(S(I4,I3,3) DO I3=21 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  486    1   3   PUT EDIT('ALTERATIONS',(S(I4,I3,4) DO I3=1 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  487    1   3   PUT EDIT('CANCS+LAPS',(S(I4,I3,5) DO I3=1 TO I8))
                   (SKIP,A,COLUMN(13),10(F(10,1)));
  488    1   3   DO I3=20 TO I8;
  489    1   4   CLACOST(I4,I3)=S(I4,I3,1)+S(I4,I3,2)+S(I4,I3,3)+S(I4,I3,4)+S(I4,I3,5);
  490    1   4   END;
  491    1   3   PUT EDIT('-------------------------------------------------------------------
                  ----------------------------------------------------------')
                  (SKIP,A);
  492    1   3   PUT EDIT((CLACOST(I4,I3) DO I3=21 TO I8))(SKIP,COLUMN(13),10(F(10,1)));
  493    1   3   PUT EDIT('===================================================================
                  ==========================================================')
                  (SKIP,A);
```

```
STMT LEV NT

 494    1   3   M1:
                PUT EDIT('TOTAL COSTS')(SKIP(3),A);
 495    1   3   PUT EDIT('NEW',AMNEW(I4))(SKIP,A,COLUMN(18),F(13,1));
 496    1   3   PUT EDIT('RENEWALS',AMREN(I4))(SKIP,A,COLUMN(18),F(13,1));
 497    1   3   PUT EDIT('CLAIMS',AMCL(I4))(SKIP,A,COLUMN(18),F(13,1));
 498    1   3   PUT EDIT('ALTERATIONS',AMALT(I4))(SKIP,A,COLUMN(18),F(13,1));
 499    1   3   PUT EDIT('CANCS + LAPSES',AMCALP(I4))(SKIP,A,COLUMN(18),F(13,1));
 500    1   3   AMTOT(I4)=AMREN(I4)+AMNEW(I4)+AMCL(I4)+AMALT(I4)+AMCALP(I4);
 501    1   3    PUT EDIT('---------')(SKIP,COLUMN(23),A);
 502    1   3   PUT EDIT('TOTAL      ',AMTOT(I4),AMTOT(I4))(SKIP,A,2(F(19,1)));
 503    1   3   PUT EDIT('---------')(SKIP,COLUMN(23),A);
 504    1   3   PUT EDIT('OVERHEADS',OVERH1(I4))(SKIP,A,COLUMN(37),F(13,1));
 505    1   3   PUT EDIT('OVERHEADS',OVERH2(I4))(SKIP,A,COLUMN(37),F(13,1));
 506    1   3   PUT EDIT('---------')(SKIP,COLUMN(42),A);
 507    1   3   PUT EDIT('TOTAL COSTS',AMTOT(I4)+OVERH1(I4)+OVERH2(I4))
                (SKIP,A,COLUMN(31),F(19,1));
 508    1   3   PUT EDIT('=========')(SKIP,COLUMN(42),A);
 509    1   3   END;
 510    1   2    IF IC=0 THEN BEGIN;
 511    2   2   IC=1;
 512    2   2   NTOP=NEXT;
 513    2   2   NB=NB2-1;
 514    2   2   GOTO L990;
 515    2   2   END;

 516    1   2   PUT EDIT('ANALYSIS OF GROUP SERVICE OFFICE COSTS BY CLASS OF BUSINESS')(PAGE,CO
                (PAGE,COLUMN(10),A);
 517    1   2   PUT EDIT('--OFFICE',(I8 DO I8=1 TO 10))(SKIP(2),A,COLUMN(15),10(F(10)));
                ;
 518    1   2   IF NOFF GT 10 THEN I8=10;
 519    1   2   ELSE I8=NOFF;
 520    1   2   DO I5=1 TO NCLASS;
 521    1   3   PUT EDIT(NAME(80+I5),(CLACOST(I3,I5) DO I3=1 TO I8))(SKIP,A,X(2),10(F(10,1)));
                0,1)));
 522    1   3   END;
 523    1   2   IF NOFF LT 11 THEN GOTO M2;
 524    1   2   PUT EDIT('--OFFICE',(I8 DO I8=11 TO 20))(SKIP(2),A,COLUMN(15),10(F(10)));
                );
 525    1   2   I8=NOFF;
 526    1   2   DO I5=1 TO NCLASS;
 527    1   3   PUT EDIT(NAME(80+I5),(CLACOST(I3,I5) DO I3=11 TO I8))(SKIP,A,X(2),10(F(10,1)));
                10,1)));
 528    1   3   END;
 529    1   2   M2:
                PUT EDIT('--COSTS BY OFFICE','VARIABLE          OVERHEAD')(SKIP(3),A,COLUMN(24)
                LUMN(24),A);
 530    1   2   GTOT=0.;
 531    1   2   OVERTOT=0.;
 532    1   2   ITOT=0.;
```

```
STMT  LEV  NT

 533    1    2   NB=NB1-1;
 534    1    2   DO I3=1 TO NOFF;
 535    1    3   GTOT=GTOT+AMTOT(I3);
 536    1    3   PUT EDIT(I3,NAME(NB+I3),AMTOT(I3),OVERH1(I3)+OVERH2(I3))
                 (SKIP,F(2),COLUMN(5),A,F(11,1),X(9),F(11,1));
 537    1    3   END;
 538    1    2   NB=NB2-1;
 539    1    2   DO I3=1 TO NEXT;
 540    1    3   FTOT=FTOT+AMTOT(I3+NOFF);
 541    1    3   PUT EDIT(I3+NOFF,NAME(NB+I3),AMTOT(I3+NOFF),OVERH1(I3+NOFF)+OVERH2(I3+NOFF))
                 OFF))
                 (SKIP,F(2),COLUMN(5),A,F(11,1),X(9),F(11,1));
 542    1    3   END;
 543    1    2   PUT SKIP(2);
 544    1    2   PUT EDIT('--COSTS BY CLASS (VARIABLE) INCLUDING HEAD OFFICE VARIABLE COSTS')
                 STS')(SKIP,A);
 545    1    2   DO I3=1 TO NCLASS;
 546    1    3   TEMP2=0.;
 547    1    3   DO I5=1 TO NOFF+NEXT;
 548    1    4   TEMP2=TEMP2+CLACOST(I5,I3);
 549    1    4   END;
 550    1    3   PUT EDIT(I3,NAME(80+I3),TEMP2)(SKIP,F(2),COLUMN(5),A,F(10,1));
 551    1    3   END;

 552    1    2   PUT SKIP(2);
 553    1    2   OVERTOT=0.;
 554    1    2   DO I5=1 TO NOFF;
 555    1    3   OVERTOT=OVERTOT+OVERH1(I5)+OVERH2(I5);
 556    1    3   END;
 557    1    2   DO I5=1 TO NEXT;
 558    1    3   OVERTAT=OVERTAT+OVERH1(I5+NOFF)+OVERH2(I5+NOFF);
 559    1    3   END;
 560    1    2    PUT EDIT('TOTAL SERVICE OFFICE VARIABLE COSTS',GTOT)
                 (SKIP(4),A,COLUMN(42),F(11,1));
 561    1    2   PUT EDIT('TOTAL SERVOCE OFFICE OVERHEAD COSTS',OVERTOT)
                 (SKIP(1),A,COLUMN(42),F(11,1));
 562    1    2   PUT EDIT('TOTAL HEAD OFFICE SO TYPE VARIABLE COSTS',FTOT)
                 (SKIP(1),A,COLUMN(42),F(11,1));
 563    1    2   PUT EDIT('TOTAL HEAD OFFICE SO TYPE OVERHEAD COSTS',OVERTAT)
                 (SKIP(1),A,COLUMN(42),F(11,1));
 564    1    2   PUT EDIT('TOTAL NON-SERVICE OFFICE COSTS',B(0,0,0)*1000.)
                 (SKIP(1),A,COLUMN(42),F(11,1));
 565    1    2   PUT EDIT('----------')(SKIP,COLUMN(43),A);
 566    1    2   PUT EDIT('TOTAL G.I. U.K. COSTS',B(0,0,0)*1000.+OVERTAT+FTOT+OVERTOT+GTOT)
                 OT)
                 (SKIP(1),A,COLUMN(42),F(11,1));
 567    1    2   PUT EDIT('==========')(SKIP,COLUMN(43),A);

 568    1    2   IF VOLP=0 THEN GOTO L700;
                 /*----------------PRINT VOLUMES BY OFFICE-----------------------------*/
```

```
STMT LEV NT

569    1   2   PUT EDIT('VOLUMES OF POLICIES BY OFFICE') (SKIP(5),A);
570    1   2   NB=NB1-1;
571    1   2   NTOP=NOFF;
572    1   2   IC=0;
573    1   2   I4=0;
574    1   2   L880:
               DO I9=1 TO NTOP;
575    1   3   I4=I4+1;
576    1   3   PUT EDIT('OFFICE',I4,NAME(NB+I9))(PAGE,SKIP,COLUMN(40),A,F(4),X(3),A);
577    1   3   PUT EDIT('CLASS')(SKIP,COLUMN(8),A);
578    1   3   PUT EDIT((I8 DO I8=1 TO 10))(SKIP(2),X(11),10(F(10)));
579    1   3    IF NCLASS GT 10 THEN I8=10;
580    1   3   ELSE I8=NCLASS;
581    1   3   PUT EDIT('NEW',(V(I4,I3,1) DO I3=1 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
582    1   3   PUT EDIT('RENEWALS',(V(I4,I3,2) DO I3=1 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
583    1   3   PUT EDIT('CLAIMS',(V(I4,I3,3) DO I3=1 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
584    1   3   PUT EDIT('ALTERATIONS',(V(I4,I3,4) DO I3=1 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
585    1   3   PUT EDIT('CANCS+LAPS',(V(I4,I3,5) DO I3=1 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
586    1   3   PUT EDIT('-------------------------------------------------------------------
               ----------')
               (SKIP,A);
587    1   3   IF NCLASS LT 11 THEN GOTO N1;
588    1   3   PUT EDIT('CLASS')(SKIP,COLUMN(8),A);
589    1   3   PUT EDIT((I8 DO I8=11 TO 20))(SKIP(2),X(11),10(F(10)));
590    1   3   IF NCLASS GT 20 THEN I8=20;
591    1   3   ELSE I8=NCLASS;
592    1   3   PUT EDIT('NEW',(V(I4,I3,1) DO I3=11 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
593    1   3   PUT EDIT('RENEWALS',(V(I4,I3,2) DO I3=11 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
594    1   3   PUT EDIT('CLAIMS',(V(I4,I3,3) DO I3=11 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
595    1   3   PUT EDIT('ALTERATIONS',(V(I4,I3,4) DO I3=1 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
596    1   3   PUT EDIT('CANCS+LAPS',(V(I4,I3,5) DO I3=1 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
597    1   3   PUT EDIT('-------------------------------------------------------------------
               ----------')
               (SKIP,A);
598    1   3   IF NCLASS LT 21 THEN GOTO N1;
599    1   3   PUT EDIT('CLASS')(SKIP,COLUMN(8),A);
600    1   3   PUT EDIT((I8 DO I8=21 TO 30))(SKIP(2),X(11),10(F(10)));
601    1   3   I8=NCLASS;
602    1   3   PUT EDIT('NEW',(V(I4,I3,1) DO I3=21 TO I8))
                 (SKIP,A,COLUMN(13),10(F(10,1)));
```

```
STMT LEV NT

 603    1   3   PUT EDIT('RENEWALS',(V(I4,I3,2) DO I3=21 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 604    1   3   PUT EDIT('CLAIMS',(V(I4,I3,3) DO I3=21 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 605    1   3   PUT EDIT('ALTERATIONS',(V(I4,I3,4) DO I3=1 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 606    1   3   PUT EDIT('CANCS+LAPS',(V(I4,I3,5) DO I3=1 TO I8))
                  (SKIP,A,COLUMN(13),10(F(10,1)));
 607    1   3   N1:
                PUT EDIT('-------------------------------------------------------------------------
                ----------------------------------------------------------')
                (SKIP,A);
 608    1   3   END;
 609    1   2   IF IC=1 THEN GOTO L700;
 610    1   2   IC=1;
 611    1   2   NTOP=1;
 612    1   2   N8=99;
 613    1   2   PUT EDIT('TOTAL SOCIETY VOLUMES')(SKIP(3),A);
 614    1   2   PUT EDIT('**********************')(SKIP,A);
 615    1   2   GOTO L860;
 616    1   2   L700:
                PUT EDIT ('.....................................................................
                ..........................................................')(SKIP,A);
 617    1   2   END;
 618    1   1   END;
 619    1   0   END PL1;
```

APPENDIX F.1

DATA CODES AND RUNNING

THE PREMIUM/CLAIMS MODEL

Data Structure for the Premium/Claims model

There are two subroutines which are used for reading in the data. PRIME reads data which will basically remain in force for the duration of the run. SECOND reads data for all the years for one class of business only. Thus there is one block of data for SECOND for each class.

The sequence is:-

Data for PRIME run 1.

Data for SECOND - class 1

.
.
.
.

Data for SECOND - class N_1

Data for PRIME run 2

Data for SECOND - class 1

.
.
.

.
.
.
.

Data for PRIME run M

Data for SECOND - class 1

.
.
.
.

Data for SECOND - class N_M

Within 'PRIME' and each call of 'SECOND' the cards, may in general be in any order, the correct use being identified by a code. Data in SECOND, however, must be in chronological order for each parameter, although not necessarily in consecutive order. An optional comment is allowed on each card to make individual cards more easily identifiable.

The general format of the data cards is

<code> <data> <optional comment>

There are default values for most of the parameters and the data can be set up to investigate certain aspects of the business with the other parameters 'lying idle'. If any data is incomplete or invalid (e.g. distributions do not sum to 1) then usually warning messages will be printed out, but this does not in general prevent the program running. Care should be taken, however, as spurious results may occur if the data is not complete. Care should also be taken not to exceed the time limits of the program. As listed it is capable of running up to 20 years. However there are also restrictions on the delay distributions. They must not exceed 12 periods, except for the delay from notification to settlement of a claim which may extend up to 96 periods. Additionally the total number of years of the run plus the number of years in the delay from notification to settlement of a claim must not exceed 25 years. To extend the number of years of the run, all the arrays which are dimensioned up to 240 and also those dimensioned up to 300 should be increased by the requisite number of extra periods. Also the arrays dimensioned up to 20 should be increased by the number of years. For the delay distributions, the individual delay distribution arrys should be adjusted by the required number of periods (also CDEL if altering AT0 or AT1). If increasing AS1 (settlement of claims delay) care should be taken that the number of years of the run plus the delay does not exceed 25 years.

Below is a check list for the main data, although the list of data codes should be referred to for a complete list.

2) - 5) are required for each period.

		default
1)	policies falling due in year 1	0
2)	new policies incepted	0
3)	lapse rate	1
4)	maintenance rate	1
5)	average value of a new premium	0
6)	average value of a renewal premium	0
7)	average value of a claim	0
8)	average value of a lapsed premium	0
9)	claims per policy	0
10)	rate of commission	0
11)	delay in paying commission	immediate
12)	delay inception to notification	immediate
13)	delay notification to receipt of cash	immediate
14)	delay accident to notification	immediate
15)	delay notification to settlement	immediate
16)	relative frequency by month Jan - Dec	uniform
17)	delay in lapsing policies	immediate

Coding sheets are given of Figs F.1.1 and F.1.2 to aid the user. One sheet of F.1.1 is needed for each class and one sheet of F.1.2 for each class for each year. A flow diagram is given in Fig F.1.3 which shows the interactions of the parameters. A logic diagram is not included as there are very few decision branches in the program and the comment cards should be sufficient, with the commentary, to understand the program.

RUN NUMBER _____ CLASS _____

DATE _____

VARIABLE	CODE	PERIODS	0	1	2	3	4	5	6	7	8	9	10	11
accident – notification	80													
notification – settlement	81													
Year 2	81													
Year 3	81													
inception – notification	83													
notification – receipt of cash	84													
PAYING COMMISSION	86													
RELATIVE EXPOSURE	85													
LAPSING POLICIES	87													
RATE of COMMISSION %	49													

FIG F·1·1 PREMIUM/CLAIMS DATA SHEET – DELAYS

RUN NUMBER _____ CLASS _____ YEAR _____

DATE _____

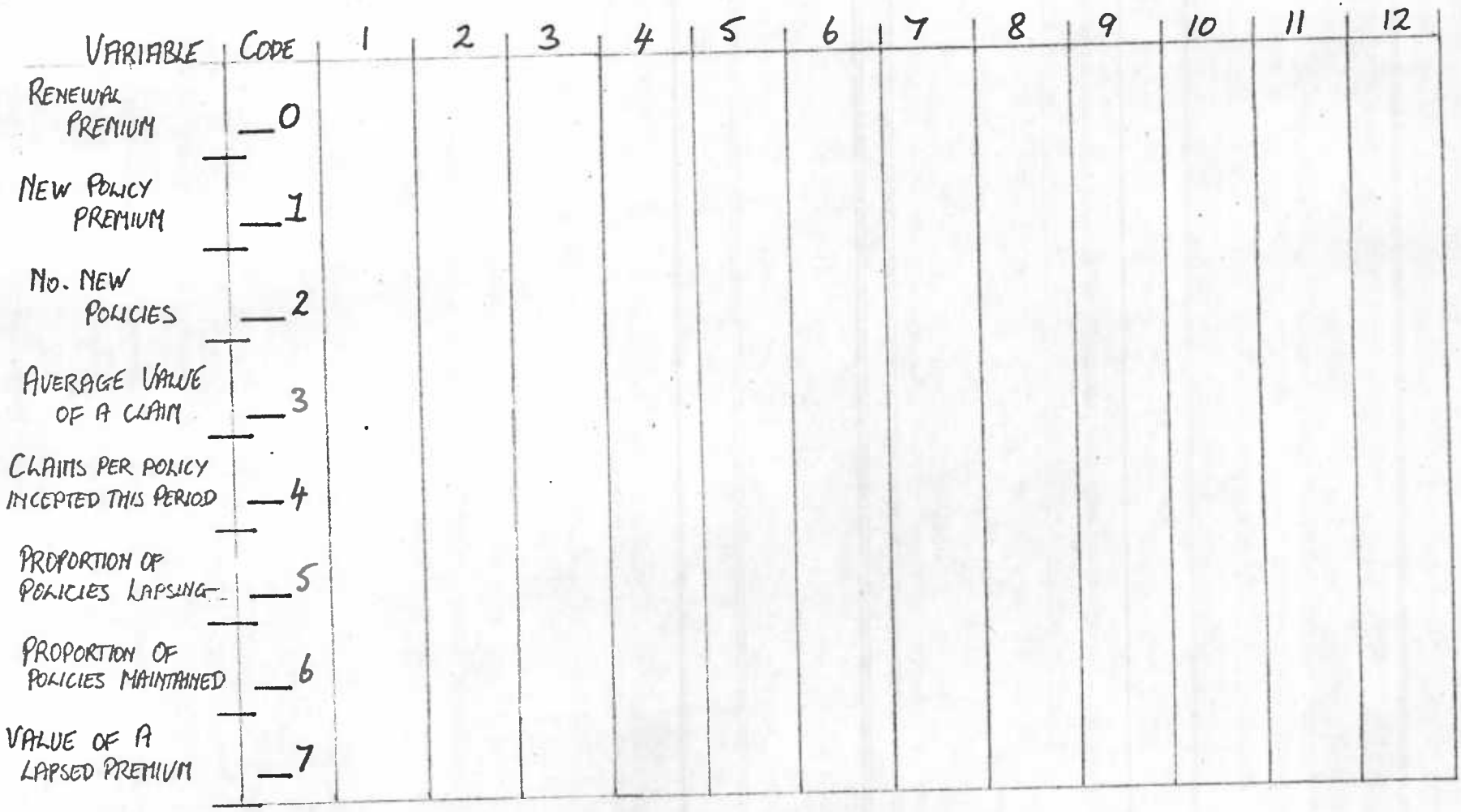
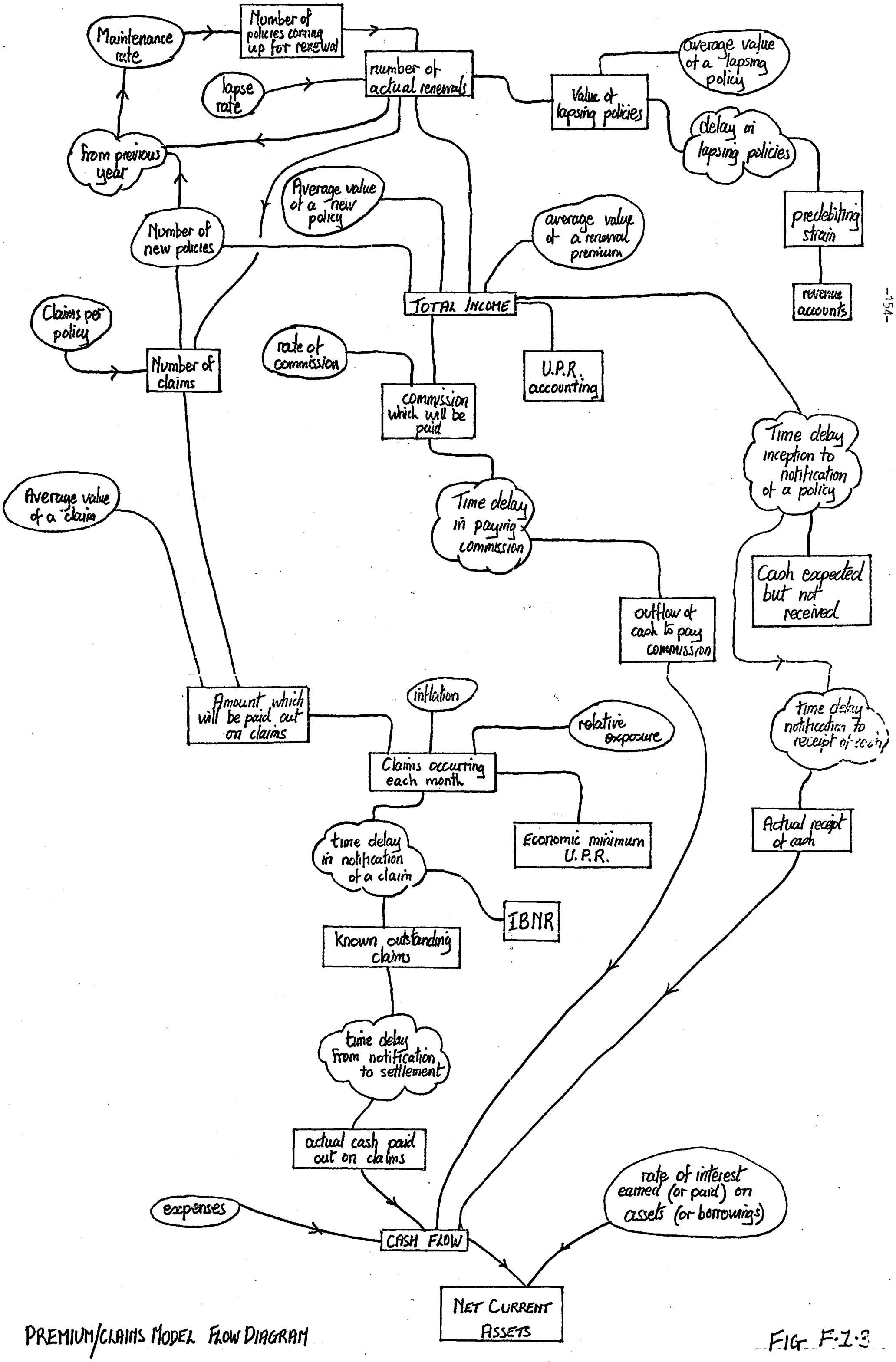


FIG F·1·2 PREMIUM/CLAIMS



PREMIUM/CLAIMS MODEL FLOW DIAGRAM

FIG F.1.3

Data Codes for Premium/Claims model

Data for Prime

Code	Default value or format	Comment (use)
1	1974	Base year for the forecasting of the model
2	4	Number of years of forecasting
4	1	Number of classes
5	1	Number of runs
13	N,NF	Expenses for the next N years. (There can be more than one card each with the same format, in chronological order)
14	N,(F1,F2),(F1,F2)...	N is the number of different interest rates received on positive cash balances. F1 and F2 are read as a series of N pairs of numbers. F1 is the proportion of the total balance receiving a rate of interest per period of F2%
15	N,(F1,F2),(F1,F2)...	N is the number of different interest rates charged on negative cash balances (borrowed money). F1 and F2 are read as a series of N pairs of numbers. F1 is the proportion of the total balance being charged a rate of interest per period of F2%. (In reality a negative balance should not occur, insolvency having been reached [illegible]

Code	Default value or format	Comment (use)
16	0.	The total amount of claims outstanding (including IBNR) for all classes of business at the start of the run (used for producing the accounts)
17	N,(F,I,J),(F,I,J)...	A series of N sets of numbers for changing the rate of actual inflation over the perceived rate at the time policy rates were set. I is the period the next change occurs at. F is the amount of the difference calculated compound per month starting from month I + 1. No difference is given by a value of 1.0, which will have the effect of eliminating any previous change. Successive changes are calculated from the ratio of the current value of F to the previous value of F to get the correct change. J is a Mag. = 1 then the claims outstanding are changed by the rate, compounded according to the month of settlement, and the delay distribution from notification to settlement is changed, compounded by month = 0 then only the delay distribution is affected.

Code	Default value or format	Comment (use)
20	1,1,1,0,0,0	A series of flags suppressing various parts of the printout 1st parameter. = 1 prints out information about the parameters at the start of each class and each run = 0 printing suppressed 2nd parameter. = 1 the data is printed out at the end of the results as it appears in the deck = 0 printing suppressed 3rd parameter. = 1 monthly cash flows and yearly surpluses are printed out = 0 printing suppressed 4th parameter. = N printing of the first type of accounts (as published) is suppressed for the first N years 5th parameter. = N printing of the second type of accounts (earned premium basis) is suppressed for the first N years 6th parameter. = N printing of the third type of accounts (economic minimum) is suppressed for the first N years
999		Terminator for PRIME

Data for Second

Code	Default value or format	Comment(use)
20	1,1,1,0,0,0	The same as code 20 in Prime
21		A dummy card - has no effect but can be useful for identifying blocks of data

The cards from 30 to 48, inclusive, are for setting up initial values which would have come from business from years previous to the start of the run

30	6(0.)	The money which will be received in the first six periods on business already written
31	6(0.)	The same as card 30, but for periods seven to twelve
32	6(0.)	The same as card 30, but for periods thirteen to eighteen
33	6(0.)	The amount of claims occurring in the first six periods on policies already written
34	6(0.)	The same as card 33 but for periods seven to twelve
35	6(0.)	The amounts of claims which have occurred, and which will be notified in the first six periods (i.e. notification of IBNR).

Code	Default value or format	Comment (use)
36	6(0.)	The same as card 35 but for periods seven to twelve
37	6(0.)	Claims outstanding by month of settlement, periods one to six The following cards contain the same data, for different periods
38	6(0.)	periods seven to twelve
39	6(0.)	periods thirteen to eighteen
40	6(0.)	periods nineteen to twenty-four
41	6(0.)	periods twenty-five to thirty
42	6(0.)	periods thirty-one to thirty-six
45	6(0.)	Commission which is due to be paid in periods one to six
46	6(0.)	The same as card 45, but for periods seven to twelve
49	0.	Rate of commission, per cent

The following cards specify the basic data for the program and actual values have to be supplied either explicitly or implicitly. The program detects if a complete set is not specified and prints out warning messages. Inconsistent or incomplete data will not necessarily result in termination of the program.

The three codes refer to different ways of inputting the data

code	category
50 60 70	The average amount of a premium on a renewal policy, in each period (POPOL)
51 61 71	The average amount of a premium on a new policy, in each period (PPOL)
52 62 72	The number of new policies incepted on each period (NPOL)
53 63 73	The average value of a claim in each period (VCL)
54 64 74	The number of claims which will occur on each policy incepted or renewed in each period (CCL)
55 65 75	The fraction of policies which fall due for renewal in each month but are not renewed i.e. the lapse rate (LAPRT)
56 66 76	The proportion of policies which run for a full year i.e. the maintenance ratio = 1 - cancellation ratio (MAINTRT)
57 67 77	The average value of a lapsed premium (premiums debited) (LAPVAL)

While the data in SECOND may ostensibly be in any order, the data for these categories must be in chronological order.

Code	Default value or format	Comment (use)
50 51 52 53 54 55 56 57	N,NF	Actual values for the next N periods
60 61 62 63 64 65 66 67	F	A change of factor F is made on the data for the corresponding period in the previous year for a whole year. e.g. new policies (Jan 75) = F * new policies (Jan 74) This cannot be used for the data for the first year
70 71 72 73 74 75 76 77	N,F1,F2	If N=0 then each period remaining in the analysis is changed by a factor F2 on the previous period where F1 is the first data item in the sequence If N≠0 then the above happens but only for one year

Code	Default value or format	Comment (use)
80	N,NF	The delay distribution from accident to notification (total of the data items = 1.) There may only be one card
81	N,NF	The delay distribution from notification to settlement of a claim (total of the data items for all cards = 1.) There may be more than one data card each of a similar format.
83	N,NF	The delay distribution from inception of a policy to notification (total of the data items = 1.) There may only be one card
84	N,NF	The delay distribution from notification to receipt of cash (total of the data items = 1.) There may only be one card
85	12(1.)	This allows an uneven claims experience during a year. The values run from January to December and the total must = 12.
86	N,NF	The delay distribution in paying commission (total of the data items = 1.) There may only be one card
87	N,NF	The delay distribution in lapsing policies (total of the data items = 1.) There may only be one card

Code	Default value or format	Comment (use)
90	N,N(0.)	The number of policies falling due in the first year is needed by the program, and this allows them to be supplied. There may be any number of cards, with N items on each card
999		The data for SECOND is terminated by this code
		Comment cards may now be inserted and there will be printed at the start of this class as a heading
*		Terminator for the comment cards, which must be present.

APPENDIX F.2

VARIABLES AND THEIR USE

PREMIUM/CLAIMS MODEL

Variables and their Use

Premium/Claims model

Variable	Description	Dimension
ANCOM	The total commission paid each year.	(0:20)
ANWRITP	The total written premiums each year.	(0:20)
AS0	Delay distribution of accident to notification.	(0:11)
AS1	Delay distribution of notification of an accident to final settlement.	(0:95)
AT0	Delay distribution of inception of a policy to notification.	(0:11)
AT1	Delay distribution of notification to receipt of cash for a policy.	(0:11)
BANK	Value of the total assets (excluding interest earned in the current period).	
BASEYR	Base year from which the projections are made.	
BLANKET	Mask for identifying the end of the heading cards.	
CA	Local variable.	
CARD	Buffer for reading in data.	
CASHNOT	The amount of cash which is notified in each month as being due.	(240)
CASHREC	The amount of cash which is received in each month.	(240)
CCL	The claims ratio for each period (claims per policy incepted).	(240)
CDEL	The combined delay distribution of AT0 and AT1.	(0:12)
CFLAG	A flag. = 1 if the change in the rate of inflation over perceived inflation is to be applied to the outstanding claims, as well as the claim settlement distribution.	(10)

Variable	Description	Dimension
	= 0 if the change is not applied to the outstanding claims.	
CFLOW	Total cash inflow for this class this year.	
CHARG	Interest charges payable, per cent per period on proportions of borrowed money.	(5)
CLAFAC	The rates per month of actual inflation relative to inflation perceived when premium rates were set. CLAFAC(0) is set internally equal to 1, i.e. actual and perceived inflation are the same initially.	(0:10)
CLAFACP	The periods at which changes in the rate of inflation over perceived inflation occur.	(10)
CLMLIA	Value of claims which occur in each month for this class.	300
CLMO	Value of claims which are notified in each month for this class.	300
CLM1	Value of claims which are settled in each month for this class.	300
CLOUT	Total amount of outstanding claims at the end of each year for all classes.	(0:20)
CLPD	Total amount of claims paid each year for all classes.	(0:20)
CODE	For identifying the data on input.	
COM	Delay distribution in paying commission.	(0:6)
COMMIS	Commission paid each period.	(240)
DUM	File for holding the printout of the data.	
EARNPREM	Earned premium for each period calculated from the date of inception.	(240) (240)
ECONTEMP	The minimum amount required to pay claims on unearned premiums (not allowing for any inflation not allowed for in rate setting) for this class this period.	

Variable	Description	Dimension
EXCESS	The excess of the written premium for this period over commission and claims which will eventually be paid on these policies.	
EXPO	Relative variation of claims during the year due to seasonal factors.	(12)
EXPYR	The expenses (excluding commission) for each year.	(20)
FACTOR	Local variable.	
FLOW	Cash flow in each period for this class (cash received less claims settled less commission).	(240)
FLOWTOT	Cash flow in each period for all classes of business,	(240)
I	Local counter.	
IBNR	Claims incurred but not reported for this class this year.	
ICLASS	The current class of business.	
INC	The amount of investment income, or interest paid this period.	
INT	Interest earned per cent per period on proportions of assets.	(5)
LAB	Labels for data codes.	(0:100)
LAPDEL	Delay distribution in lapsing policies.	(0:6)
LAPRT	The proportion of policies falling due in each period which lapse.	(240)
LAPVAL	Average value of a premium which lapses in each month.	(240)
MAINTRT	Proportion of policies incepted in each month which remain in force for the whole year.	(240)
NCANC	The number of policies incepted in each month which are cancelled.	(240)

Variable	Description	Dimension
NCLA	A counter for the next change in rate of inflation.	
NCLASS	Number of classes of business.	
NCOM	Number of elements of delay distribution in paying commission.	
NETFLOW	Cash flow, after allowing for expenses, for all classes this period.	
NEWMON	Money received each period on new business.	(240)
NLAPDEL	Number of elements of delay distribution in lapsing policies.	
NPOL	Number of new policies incepted in each period.	(240)
NRATE1	The number of different rates of interest earned.	
NRATE2	The number of different rates of interest charged.	
NSO	Number of elements in delay distribution of accident to notification.	
NS1	Number of elements in delay distribution of notification to settlement of a claim.	
NTO	Number of elements in delay distribution of inception to notification of a policy.	
NT1	Number of elements in delay distribution of notification to receipt of cash.	
OCR	The amount of outstanding claims at the end of this year.	
OFF1	A flag =0 initial headings are not printed =1 initial headings are printed.	
OFF2	A flag =0 data is not printed out at the end of the run =1 data is printed out at the end of the run.	

Variable	Description	Dimension
OFF3	A flag =0 Table of excess of premiums over claims and commission for each year is not printed =1 This table is printed.	
OFF5	A flag The first set of accounts (published) are not printed for the first OFF5 years.	
OFF6	A flag The second set of accounts (30ths basis from date of inception) are not printed for the first OFF6 years.	
OFF7	A flag The third set of accounts (economic minimum) are not printed for the first OFF7 years.	
OPOL	Number of old policies which are renewed in each period.	(240)
PDUE	Number of policies falling due for renewal in each period.	(240)
PERCOM	Rate of commission.	
PERIOD	The current period of the simulation.	
PERS	The number of periods in each year.	
POPOL	Average amount of a renewed policy premium in each period.	(240)
PPOL	Average amount of a new policy premium in each period.	(240)
PROP1	The proportions of invested money which earn interest at the rates of interest in the corresponding vector INT.	(5)
PROP2	The proportions of borrowed money which are charged interest at the rates of interest in the corresponding vector CHARG.	(5)
PSEUDEP	The earned premiums in each month calculated from PSEUDNP.	(240)

Variable	Description	Dimension
PSEUDUPR	The unearned premium reserve calculated on a 24ths basis from PSEUDWP.	
PSEUDWP	The apparent written premium each period of policies falling due for renewal and which will eventually be lapsed over those notified this period as lapsing.	(240)
PSUPR	The total unearned premium reserve for each year calculated from PSEUDWP.	(0:20)
RENLAP	The amount, each month, of money received from new business and the value of policies falling due for renewal and which are eventually renewed.	(240)
RUNS	Number of independent runs of the model.	
SURP	The excess, for all classes, of the written premium for each period over commission and claims which will eventually be paid on these policies.	(240)
TEMP	Local Variable.	
TEMP1	Local Variable.	
TEMP2	Local Variable.	
TEMP24	The unearned premium reserve for this class this year calculated according to the definition for UPR24.	
TEMPCAN	The total number of cancellations which will occur sometime on policies incepted this year.	
TEMPNEW	Total number of new policies for this class this year.	
TEMPREN	Total number of renewed policies for this class this year.	
TIMES	Counter for the current run.	
TOTCASH	The total cash received this year.	
TOTCL	The total amount of claims settled this year.	

Variable	Description	Dimension
TOTEXP	The total amount of cash notified as being due but not yet received at the end of this year.	
NOTNOT	The total amount of cash due but not yet notified, at the end of this year.	
TOTWRIT	The total written premium for this class this year.	
UPR	The unearned premium reserve on a 24ths basis from the date of inception.	
UPRCALC	The total unearned premium reserve for each year calculated on a 24ths basis from the date of inception.	(0:20)
UPRECON	The total minimum amount required to pay claims on unearned premiums (not allowing for any inflation not allowed for in the rate setting) for all classes each year.	(0:20)
UPR24	The total unearned premium reserve each year calculated on a 24ths basis for new business from the date of receipt of money and renewals from the date of falling due for renewal.	(0:20)
VCL	Average value of a claim occurring on policies incepted in each period.	(240)
WRITP	The written premium in each period.	(300)
YEARS	Number of years of simulation.	

APPENDIX F.3

EXAMPLE DATA AND RESULTS

PREMIUM/CLAIMS MODEL

Output for premium/claims model

Results are produced for each period of the simulation, and totals and supporting figures are produced at the end of each year.

The following is a list of the column headings and their meaning for the results produced each period:-

Heading		Description	Variable
Year	:	The current year of the simulation	
Period	:	The current period of the simulation	
No. Cancs.	:	The number of policies incepted this month which will be cancelled during the year for which the policy is in force	NCANC(i)
Lapse Value	:	The average premium amount attributable to those policies falling due this period but which will eventually be lapsed	LAPVAL(i)
Lapsed Premium	:	The excess of the total premiums on those policies falling due this period, but which will not be renewed over the total value of lapsed policies notified this period	PSEUDWP(i)
New Premium	:	The average amount of premium on a new policy incepted this month	PPOL(i)
No. New Policies	:	The number of new policies incepted this month	NPOL(i)

Heading		Description	Variable
Renewal Premium	:	The average premium paid on a policy falling due for renewal this month and which will eventually be renewed	POPOL(i)
Renewed Policies	:	The total number of policies falling due for renewal and which will eventually be renewed	OPOL(i)
Written Premium	:	The total written premium this month (incepted this month)	WRITP(i)
Claims Settled	:	Money paid out on claims this month	CLM1(i)
Claims/Policy	:	Average number of claims occurring on each policy incepted this month	CCL(i)
Claim Value	:	The average amount of a claim which will occur on the policies incepted this month	VCL(i)
Commission	:	Commission paid out this month	COMMIS(i)
Cash Received	:	Cash actually received this period	CASHREC(i)
Cash Flow	:	The Cash Flow on this class this period	FLOW(i)
Surplus	:	The excess of the written premium over the total commission and claims which will eventually be paid out on this month's policies	EXCESS

An example of the results produced at the end of each year is given in Fig F.3.1. The letter subscripts refer to the notes below:

a) The year

b) Total number of cancellations which will occur on policies incepted this year

c) The outstanding claims reserve at the end of the year

d) The reserve for incurred but not reported claims

e) The total of c) and d)

f) Total number of new policies incepted this year

g) Total number of policies falling due for renewal this year and which are eventually renewed

h) Total written premium for the year

j) Total money paid out in claims this year

k) The exact UPR calculated on a 24ths basis on the true written premium each month (for 30ths basis multiply by .8)

l) The UPR calculated on a 24ths basis on new policies from the date of debit and renewed policies from date of falling due for renewal

m) The UPR calculated on a 30ths basis on new policies from the date of debit and renewed policies from date of falling due for renewal (i.e. (l) * .8)

n) The amount which must be added to 1) to give the UPR according to the accounting convention:-

New policies from date of debit

plus Renewals from date of renewal

less lapses from date of lapse

o) Since the model is deterministic it is possible for the program to calculate the minimum amount of reserving required to cover all the claims occurring on unearned premiums and this is called the economic UPR - it shows the amount of under or over reserving, using the accounting methods

p) Total cash received

q) Total cash due at the end of the year

r) Net cash flow for the year on this class (claims less commission less claims paid)

```
4  1                                   CLASSES OF BUSINESS
2  3                                   NUMBER OF YEARS
13  3  10000  10000  10000             EXPENSES
14  1  1.   .1
15  1  1.   .1
20  1  1  1  2  2  2                   PRINT OUT RESULTS
999                                    TERMINATOR FOR PRIME
111                                    DUMMY
449  10.                               RATE OF COMMISSION
500  6  50.  50.  50.  50.  50.  50.   RENEWAL PREMIUM FIRST YEAR
500  6  50.  50.  50.  50.  50.  50.   RENEWAL PREMIUM FIRST YEAR
510  6  60.  60.  60.  60.  60.  60.   NEW PREMIUM FIRST YEAR
510  6  60.  60.  60.  60.  60.  60.   NEW PREMIUM FIRST YEAR
520  6  100  100  100  100  100  100     NO. NEW POLICIES FIRST YEAR
520  6  100  100  100  100  100  100     NO. NEW POLICIES FIRST YEAR
530  6  150.  150.  150.  150.  150.  150.  CLAIM AMOUNT FIRST YEAR
530  6  150.  150.  150.  150.  150.  150.  CLAIM AMOUNT FIRST YEAR
600  1.2                               RENEWAL PREMIUM FACTOR INCREASE OVER LAST YEAR
600  1.2                               RENEWAL PREMIUM FACTOR INCREASE OVER LAST YEAR
610  1.2                               NEW PREMIUM FACTOR INCREASE OVER LAST YEAR
610  1.2                               NEW PREMIUN FACTOR INCREASE OVER LAST YEAR
620  1.1                               NEW POLICY VOLS FACTOR INCREASE LAST YEAR
620  1.1                               NEW POLICY VOLS FACTOR INCREASE LAST YEAR
630  1.25                              CLAIMS AMOUNT FACTOR INCREASE OVER LAST YEAR
630  1.25                              CLAIMS AMOUNT FACTOR INCREASE OVER LAST YEAR
740  0  .1  1.                        CLAIMS/POLICY
750  0  0.5  1.                       LAPSE RATE
760  0  1.  1.                       MAINTENANCE RATE
770  0  40  1.01                      LAPSED PREMIUM
900  2  0.  1.                       DELAY ACCIDENT TO NOTIFICATION
910  2  0.  1.                       DELAY NOTIFICATION TO SETTLEMENT
930  2  0.  1.                       DELAY INCEPTION TO NOTIFICATION
940  2  0.  1.                       DELAY NOTIFICATION TO RECEIPT OF CASH
950  3  0.  .7  .3                   DELAY PAYING COMMISSION
970  2  0.  1.                       DELAY IN LAPSING POLICIES
900  6  5  5  5  5  5  5             POLICIES FALLING DUE IN FIRST YEAR
900  6  5  5  5  5  5  5             POLICIES FALLING DUE IN FIRST YEAR
999                                    TERMINATOR FOR SECOND --CLASS ONE
THESIS DATA      EXAMPLE
*                                      TERMINATOR FOR COMMENT CARDS
```

EXAMPLE DATA FOR PREMIUM/CLAIMS MODEL

NUMBER OF CLASSES IN THIS RUN IS 1
NUMBER OF YEARS OF FORECAST IS 3 EACH OF 12 PERIODS BASEYEAR IS 1974

FRONTSHEET
THESIS DATA EXAMPLE
END FRONTSHEET

OPTIONS AND PARAMETER VALUES IN FORCE AT THE START OF THIS RUN

DELAY DISTRIBUTIONS		0	1	2	3	4	5	6	7	8	9	10	11
ACCIDENT TO NOTIFICATION	S0	0.000	1.000										
NOTIFICATION TO SETTLEMENT	S1	0.000	1.000										
INCEPTION OF POLICY TO NOTIFICATION	T0	0.000	1.000										
NOTIFICATION TO RECEIPT OF CASH	T1	0.000	1.000										
RELATIVE EXPOSURE JAN-DEC		1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LAPSING UNRENEWED POLICIES		0.000	1.000										
PAYING COMMISSION	COM	0.000	0.700	0.300									

RATE OF COMMISSION IS 10.0

YEAR	PERIOD	NO. CANCS	LAPSE VALUE	LAPSED PREMIUM	NEW PREMIUM	NO.NEW POLICIES	RENEWAL PREMIUM	RENEWED POLICIES	WRITTEN PREMIUM	CLAIMS SETTLED	CLAIMS/ POLICY	CLAIM VALUE	COMMISSION	CASH RECEIVED	CASH FLOW	SURPLUS
1	1	0.0	40.0	100.0	60.0	100.0	50.0	2.5	6125	0	0.100	150	0.0	0	0	3975
1	2	0.0	40.4	1.0	60.0	100.0	50.0	2.5	6125	0	0.100	150	428.7	0	-429	3975
1	3	0.0	40.8	1.0	60.0	100.0	50.0	2.5	6125	64	0.100	150	612.5	6125	5448	3975
1	4	0.0	41.2	1.0	60.0	100.0	50.0	2.5	6125	192	0.100	150	612.5	6125	5320	3975
1	5	0.0	41.6	1.0	60.0	100.0	50.0	2.5	6125	320	0.100	150	612.5	6125	5192	3975
1	6	0.0	42.0	1.0	60.0	100.0	50.0	2.5	6125	448	0.100	150	612.5	6125	5064	3975
1	7	0.0	42.5	1.1	60.0	100.0	50.0	2.5	6125	577	0.100	150	612.5	6125	4936	3975
1	8	0.0	42.9	1.1	60.0	100.0	50.0	2.5	6125	705	0.100	150	612.5	6125	4808	3975
1	9	0.0	43.3	1.1	60.0	100.0	50.0	2.5	6125	833	0.100	150	612.5	6125	4680	3975
1	10	0.0	43.7	1.1	60.0	100.0	50.0	2.5	6125	961	0.100	150	612.5	6125	4552	3975
1	11	0.0	44.2	1.1	60.0	100.0	50.0	2.5	6125	1089	0.100	150	612.5	6125	4423	3975
1	12	0.0	44.6	1.1	60.0	100.0	50.0	2.5	6125	1217	0.100	150	612.5	6125	4295	3975
*: 1(a)		0(b)				1200(f)		30(g)	73500(h)	6406(i)	UPR(CALC)	36750(k)		61250 p	48290 r	*
*:	OCR	1345(c)						UPR(ECON	9225 o		UPR 24THS	35750	CASHDUE	12250 q		*
*:	IBNR	1473(d)		2819(e)				UPR STRAIN	10.5 n		UPR (30THS)	28600 m				*
2	1	0.0	45.1	2198.4	72.0	110.0	60.0	51.3	10995	1345	0.100	188	612.5	6125	4167	6872
2	2	0.0	45.5	23.1	72.0	110.0	60.0	51.3	10995	1473	0.100	188	953.4	6125	3698	6872
2	3	0.0	46.0	23.3	72.0	110.0	60.0	51.3	10995	1599	0.100	188	1099.5	10995	8296	6872
2	4	0.0	46.4	23.6	72.0	110.0	60.0	51.3	10995	1723	0.100	188	1099.5	10995	8172	6872
2	5	0.0	46.9	23.8	72.0	110.0	60.0	51.3	10995	1847	0.100	188	1099.5	10995	8048	6872
2	6	0.0	47.4	24.0	72.0	110.0	60.0	51.3	10995	1971	0.100	188	1099.5	10995	7925	6872
2	7	0.0	47.8	24.3	72.0	110.0	60.0	51.3	10995	2095	0.100	188	1099.5	10995	7801	6872
2	8	0.0	48.3	24.5	72.0	110.0	60.0	51.3	10995	2219	0.100	188	1099.5	10995	7677	6872
2	9	0.0	48.8	24.8	72.0	110.0	60.0	51.3	10995	2342	0.100	188	1099.5	10995	7553	6872
2	10	0.0	49.3	25.0	72.0	110.0	60.0	51.3	10995	2466	0.100	188	1099.5	10995	7429	6872
2	11	0.0	49.8	25.3	72.0	110.0	60.0	51.3	10995	2590	0.100	188	1099.5	10995	7305	6872
2	12	0.0	50.3	25.5	72.0	110.0	60.0	51.3	10995	2714	0.100	188	1099.5	10995	7182	6872
*: 2		0				1320		615	131940	24385	UPR(CALC)	65970		122200	85254	*
*:	OCR	2838						UPR(ECON	18141		UPR 24THS	65650	CASHDUE	21990		*
*:	IBNR	2962		5799				UPR STRAIN	238.5		UPR (30THS)	52520				*
3	1	0.0	50.8	1517.7	86.4	121.0	72.0	80.6	16259	2838	0.100	234	1099.5	10995	7058	9908
3	2	0.0	51.3	40.9	86.4	121.0	72.0	80.6	16259	2962	0.100	234	1468.0	10995	6565	9908
3	3	0.0	51.8	41.4	86.4	121.0	72.0	80.6	16259	3094	0.100	234	1625.9	16259	11539	9908
3	4	0.0	52.3	41.8	86.4	121.0	72.0	80.6	16259	3236	0.100	234	1625.9	16259	11397	9908
3	5	0.0	52.9	42.2	86.4	121.0	72.0	80.6	16259	3378	0.100	234	1625.9	16259	11255	9908
3	6	0.0	53.4	42.6	86.4	121.0	72.0	80.6	16259	3520	0.100	234	1625.9	16259	11114	9908
3	7	0.0	53.9	43.0	86.4	121.0	72.0	80.6	16259	3662	0.100	234	1625.9	16259	10972	9908
3	8	0.0	54.5	43.5	86.4	121.0	72.0	80.6	16259	3804	0.100	234	1625.9	16259	10830	9908
3	9	0.0	55.0	43.9	86.4	121.0	72.0	80.6	16259	3945	0.100	234	1625.9	16259	10688	9908
3	10	0.0	55.5	44.3	86.4	121.0	72.0	80.6	16259	4087	0.100	234	1625.9	16259	10546	9908
3	11	0.0	56.1	44.8	86.4	121.0	72.0	80.6	16259	4229	0.100	234	1625.9	16259	10404	9908
3	12	0.0	56.7	45.2	86.4	121.0	72.0	80.6	16259	4371	0.100	234	1625.9	16259	10262	9908
*: 3		0				1452		967	195113	43126	UPR(CALC)	97556		184594	122631	*
*:	OCR	4513						UPR(ECON	28353		UPR 24THS	97134	CASHDUE	32519		*
*:	IBNR	4655		9167				UPR STRAIN	323.7		UPR (30THS)	77707				*

FIG F.3.1

WRITTEN PREMIUM FOR EACH YEAR

YEAR	1	73500
YEAR	2	131940
YEAR	3	195113

YEAR	PERIOD	CASH FLOW	EXPENSES	NET CASH FLOW	INTEREST	INVESTMENTS
1	1	0	833	-833	-83	-833
1	2	-429	833	-1262	-218	-2179
1	3	5448	833	4615	222	2218
1	4	5320	833	4487	693	6927
1	5	5192	833	4359	1198	11979
1	6	5064	833	4231	1741	17407
1	7	4936	833	4103	2325	23251
1	8	4808	833	3974	2955	29550
1	9	4680	833	3846	3635	36352
1	10	4552	833	3718	4371	43705
1	11	4423	833	3590	5167	51666
1	12	4295	833	3462	6029	60294
2	1	4167	833	3334	6966	69658
2	2	3698	833	2865	7949	79488
2	3	8296	833	7463	9490	94900
2	4	8172	833	7339	11173	111728
2	5	8048	833	7215	13012	130116
2	6	7925	833	7091	15022	150219
2	7	7801	833	6967	17221	172208
2	8	7677	833	6844	19627	196273
2	9	7553	833	6720	22352	222620
2	10	7429	833	6596	25148	251478
2	11	7305	833	6472	28310	283097
2	12	7182	833	6348	31776	317755
3	1	7058	833	6224	35576	355755
3	2	6565	833	5732	39706	397063
3	3	11539	833	10706	44747	447475
3	4	11397	833	10564	50279	502796
3	5	11255	833	10422	56349	563487
3	6	11114	833	10280	63012	630115
3	7	10972	833	10138	70326	703265
3	8	10830	833	9997	78359	783588
3	9	10688	833	9855	87180	871802
3	10	10546	833	9713	96869	968694
3	11	10404	833	9571	107513	10751133
3	12	10262	833	9429	119207	1192075

EXCESS OF PREMIUM OVER CLAIMS AND COMMISSION FOR EACH YEAR

1975	47700.00
1976	82464.50
1977	118894.06

APPENDIX F.4

LISTING OF THE PREMIUMS/CLAIMS MODEL

SOURCE LISTING

```
STMT LEV NT

   1       0  PL1:       PROC  OPTIONS    (MAIN);
              /*       VARIABLES USED                                          */
              /* NCLASS  = NUMBER OF CLASSES OF BUSINESS                       */
              /*       TOTWRIT= TOTAL VALUE OF PREMIUMS WRITTEN DURING YEAR */
              /*       TOTCL= TOTAL VALUE OF CLAIMS SETTLED DURING YEAR  */
               /*      TOTCASH= TOTAL CASH RECEIVED DURING YEAR */
              /*       CFLOW= CASH FLOW IN CURRENT PERIOD  */
              /*       PERS= NO. OF PERIODS PER YEAR IN SIMULATION  */
              /*       YEARS= NO. OF YEARS OF SIMULATION  */
              /*       WRITPREM=  VALUE OF PREMIUMS WRITTEN IN CURRENT PERIOD  */
              /*       EARNPREM=  VALUE OF PREMIUMS EARNED IN EACH PERIOD  */
              /*       CASHDUE=  CASH EXPECTED TO BE RECEIVED IN EACH PERIOD  */
              /*       CLMSET= AMOUNT PAID OUT IN EACH PERIOD TO SETTLE CLAIMS  */
              /*    RPOL =AVERAGE AMOUNT OF A RENEWED PREMIUM IN EACH PERIOD */
              /* PPOL  = AVERAGE AMOUNT  OF A NEW PREMIUM     */

              /*                                                              */
              /*--------------------------------------------------------------*/
   2    1  0  PRIME: PROCEDURE;
              /*--------------------DECLARATIONS------------------------------*/
   3    2  0  DCL (M,N,I11) BIN FLOAT;
   4    2  0  DCL (PROP1(5),PROP2(5),INT(5),CHARG(5),EXPYR(20)) BIN FLOAT EXTERNAL;
   5    2  0  DCL (OFF1,OFF2,OFF3,OFF5,OFF6,OFF7,PERS,YEARS,NCLASS,
              RUNS,NRATE1,NRATE2,BASEYR) BIN FIXED EXTERNAL;
   6    2  0  DCL (CLAFAC(10),CFLAG(10)) BIN FIXED EXTERNAL;
   7    2  0   DCL CARD CHAR(80),CODE BIN FIXED(15),LAB(30) LABEL;
              /*-----SET INITIAL VALUES AND DEFAULT VALUES-------------------*/
   8    2  0  OFF1=1;
   9    2  0  OFF2=1;
  10    2  0  OFF3=1;
  11    2  0  OFF5=0;
  12    2  0  OFF6=0;
  13    2  0  OFF7=0;
  14    2  0  I11=0;
  15    2  0  BASEYR=1974;
  16    2  0  YEARS=4;
  17    2  0  PERS=12;
  18    2  0  NCLASS=1;
  19    2  0  NRATE1=0;
  20    2  0  NRATE2=0;
  21    2  0  CLAFAC(0)=1.;
  22    2  0  DO N=1 TO 10;
  23    2  1  CLAFAC(N)=1.;
  24    2  1  CLAFACP(N)=0;
  25    2  1  END;
  26    2  0  UPR24(0)=0.;
```

```
STMT LEV NT

  27    2   0   DO N=1 TO 20;
  28    2   1   EXPYR(N)=0.;
  29    2   1   UPR24(N)=0.;
  30    2   1   END;
  31    2   0   L1:
                  /*--------------------READ NEXT DATA CARD-------------------------------*/
                  GET FILE(SYSIN) EDIT (CARD) (COL(1),A(80));
  32    2   0   IF OFF2=0 THEN GOTO L2;
                  /*---------------------------PRINT DATA ONTO FILE DUM-----------------*/
  33    2   0   PUT FILE(DUM) EDIT(CARD) (SKIP,COLUMN(10),A(80));
  34    2   0   L2:
                  GET STRING(CARD) LIST(CODE);
                  /*---------------------TEST DATA FOR TERMINATOR-------------------------*/
  35    2   0   IF CODE=999 THEN GOTO  L999;
  36    2   0   GOTO LAB(CODE);
  37    2   0   LAB(1): GET STRING(CARD) LIST(CODE,BASEYR);
  38    2   0                                  GOTO L1;
  39    2   0   LAB(2):  GET STRING(CARD) LIST(CODE,YEARS);
  40    2   0                                  GOTO L1;
  41    2   0   LAB(3): GET STRING(CARD) LIST(CODE,PERS);
  42    2   0                                  GOTO L1;
  43    2   0   LAB(4): GET STRING(CARD) LIST(CODE,NCLASS);
  44    2   0                                  GOTO L1;
  45    2   0   LAB(5): GET STRING(CARD) LIST(CODE,RUNS);
  46    2   0                                  GOTO L1;
  47    2   0   LAB(13):
                  GET STRING(CARD) LIST(CODE,N,(EXPYR(I11+M) DO M=1 TO N));
  48    2   0   I11=I11+N;
  49    2   0                                  GOTO L1;
  50    2   0   LAB(14):
                  GET STRING(CARD) LIST(CODE,NRATE1,(PROP1(M),INT(M) DO M=1 TO NRATE1));
  51    2   0                                  GOTO L1;
  52    2   0   LAB(15):
                  GET STRING(CARD) LIST(CODE,NRATE2,(PROP2(M),CHARG(M) DO M=1 TO NRATE2));
                  ;
  53    2   0                                  GOTO L1;
  54    2   0   LAB(16):
                  GET STRING(CARD) LIST(CODE,CLOUT(0));
  55    2   0                                  GOTO L1;
  56    2   0   LAB(17):
                  GET STRING(CARD) LIST(CODE,N,(CLAFAC(M),CLAFACP(M),CFLAG(M) DO M=1 TO N));
                  ));
  57    2   0                                  GOTO L1;
  58    2   0   LAB(20):
                  GET STRING(CARD) LIST(CODE,OFF1,OFF2,OFF3,OFF5,OFF6,OFF7);
  59    2   0                                  GOTO L1;
                  /*----------------------DATA READING COMPLETE--------------------------*/
  60    2   0   L999:
                   /*-------------CHECK EXPENSES DATA HAVE BEEN READ IN FOR ALL YEARS--*/
                  IF YEARS NE I11 THEN
```

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STMT LEV NT

                PUT EDIT('EXPENSES ONLY INPUT UP TO END OF YEAR ',I11)
                (SKIP(2),A,F(5));
                /*-----------------------PRINT HEADING IF REQUIRED--------------------*/
  61    2   0   IF OFF1=0 THEN RETURN;
  62    2   0   PUT EDIT('NUMBER OF CLASSES IN THIS RUN IS ',NCLASS)(SKIP,COLUMN(10),A,F(5));
                F(5));
  63    2   0   PUT EDIT('NUMBER OF YEARS OF FORECAST IS',YEARS,'  EACH OF',PERS,'  PERIODS')(S
                IODS','BASEYEAR IS',BASEYR)(SKIP,A,F(4),A,F(4),A,X(10),A,F(6));
  64    2   0    RETURN;
  65    2   0   END PRIME;
                /*--------------------------------------------------------------------*/

  66    1   0   SECOND: PROCEDURE;
                /*--------------------DECLARATIONS------------------------------------*/
  67    2   0   DCL CARD CHAR(80),CODE BIN FIXED(15),LAB(20:100) LABEL;
  68    2   0   DCL (CASHREC(240),PPOL(240),NPOL(240),VCL(240),CCL(240),LAPRT(240),
                OPOL(240),MAINTRT(240),PDUE(240),LAPVAL(240),POPOL(240),CLMLIA(300),
                UPR24(0:20),PERCOM,NCANC(240),EXPO(12),LAPDEL(0:6),COM(0:6),
                AS0(0:11),AS1(0:95),AT0(0:11),AT1(0:11)) BIN FLOAT EXTERNAL;
  69    2   0   DCL (I0,I1,I2,I3,I4,I5,I6,I7,I8,I10,I11,N,M) BIN FIXED;
  70    2   0   DCL (OFF1,OFF2,OFF3,OFF5,OFF6,OFF7,PERS,YEARS,
                NS0,NS1,NT0,NT1,NCOM,NLAPDEL) BIN FIXED EXTERNAL;
  71    2   0   DCL (FACTOR,TEMP) BIN FLOAT;

                /*-----SET INITIAL VALUES AND DEFAULT VALUES--------------------------*/
  72    2   0   DO N=1 TO 12;
  73    2   1   EXPO(N)=1.;
  74    2   1   PDUE(N)=0.;
  75    2   1   END;
  76    2   0   DO N=1 TO 240;
  77    2   1   LAPVAL(N)=0.;
  78    2   1   LAPRT(N)=1.;
  79    2   1   NPOL(N)=0.;
  80    2   1   MAINTRT(N)=1.;
  81    2   1   POPOL(N)=0.;
  82    2   1   CASHREC(N)=0.;
  83    2   1   END;
  84    2   0   NS0=0;
  85    2   0   NS1=0;
  86    2   0   NT0=0;
  87    2   0   NT1=0;
  88    2   0   NCOM=0;
  89    2   0   NLAPDEL=0;
  90    2   0   I0=0;
  91    2   0   I1=0;
  92    2   0   I2=0;
  93    2   0   I3=0;
  94    2   0   I4=0;
  95    2   0   I5=0;
  96    2   0   I6=0;
```

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STMT LEV NT

  97    2   0    I10=0;
  98    2   0   I11=0;
  99    2   0   PERCON=0.;
 100    2   0   L1:
                 /*-------------------READ NEXT DATA CARD-------------------------------*/
                 GET FILE(SYSIN) EDIT(CARD) (COL(1),A(80));
 101    2   0   IF OFF2=0 THEN GOTO L2;
                 /*-----------------------------PRINT DATA ONTO FILE DUM-----------------*/
 102    2   0   PUT FILE(DUM) EDIT (CARD) (SKIP,COLUMN(10),A(80));
 103    2   0   L2:
                 GET STRING(CARD) LIST(CODE);
                 /*---------------------TEST DATA FOR TERMINATOR-------------------------*/
 104    2   0   IF CODE=999 THEN GOTO  L999;
                 /*-------------------------TEST FOR INVALID CODE----------------------*/
 105    2   0   IF CODE LT 20 OR CODE GT 100 THEN  BEGIN;
 106    3   0   PUT EDIT('VALUE OF CODE IS NOT VALID. THIS CARD IS IGNORED. THE VALUE IS
                 S',CODE)(SKIP,A,F(12,2));
 107    3   0   PUT SKIP;
 108    3   0   PUT EDIT('THE CARD CONTAINS',CARD)(A,A(80));
 109    3   0                                   GOTO L1;
 110    3   0   END;
 111    2   0   GOTO LAB(CODE);

 112    2   0   LAB(20):
                 GET STRING(CARD) LIST(CODE,OFF1,OFF2,OFF3,OFF5,OFF6,OFF7);
 113    2   0                                   GOTO L1;
 114    2   0   LAB(21):   GOTO L1;       /*DUMMY*/
                 /*-----------------------------30 SERIES---------------------------------*/
 115    2   0   LAB(30):
                 GET STRING(CARD) LIST(CODE,(CASHREC(I6) DO I6=1 TO 6));
 116    2   0                                   GOTO L1;
 117    2   0   LAB(31):
                 GET STRING(CARD) LIST(CODE,(CASHREC(I6) DO I6=7 TO 12));
 118    2   0                                   GOTO L1;
 119    2   0   LAB(32):
                 GET STRING(CARD) LIST(CODE,(CASHREC(I6) DO I6=13 TO 18));
 120    2   0                                   GOTO L1;
 121    2   0   LAB(33):
                 GET STRING(CARD) LIST(CODE,(CLMLIA(I6)  DO I6=1 TO 6));
 122    2   0                                   GOTO L1;
 123    2   0   LAB(34):
                 GET STRING(CARD) LIST(CODE,(CLMLIA(I6)  DO I6=7 TO 12));
 124    2   0                                   GOTO L1;
 125    2   0   LAB(35):
                 GET STRING(CARD) LIST(CODE,(CLNO(I6) DO I6=1 TO 6  ));
 126    2   0                                   GOTO L1;
 127    2   0   LAB(36):
                 GET STRING(CARD) LIST(CODE,(CLNO(I6) DO I6=7 TO 12 ));
 128    2   0                                   GOTO L1;
 129    2   0   LAB(37):
```

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STMT LEV NT

                GET STRING(CARD) LIST(CODE,(CLM1(I6) DO I6=1 TO 6  ));
 130    2  0                                  GOTO L1;
 131    2  0   LAB(38):
                GET STRING(CARD) LIST(CODE,(CLM1(I6) DO I6=7 TO 12 ));
 132    2  0                                  GOTO L1;
 133    2  0   LAB(39):
                GET STRING(CARD) LIST(CODE,(CLM1(I6) DO I6=13 TO 18));
 134    2  0                                  GOTO L1;
 135    2  0   LAB(40):
                GET STRING(CARD) LIST(CODE,(CLM1(I6) DO I6=19 TO 24));
 136    2  0                                  GOTO L1;
 137    2  0   LAB(41):
                GET STRING(CARD) LIST(CODE,(CLM1(I6) DO I6=25 TO 30));
 138    2  0                                  GOTO L1;
 139    2  0   LAB(42):
                GET STRING(CARD) LIST(CODE,(CLM1(I6) DO I6=31 TO 36));
 140    2  0                                  GOTO L1;

                /*---------------------------40 SERIES---------------------------------*/
 141    2  0   LAB(45):
                GET STRING(CARD) LIST(CODE,(COMMIS(I6) DO I6=1 TO 6));
 142    2  0                                  GOTO L1;
 143    2  0   LAB(46):
                GET STRING(CARD) LIST(CODE,(COMMIS(I6) DO I6=7 TO 12));
 144    2  0                                  GOTO L1;
 145    2  0   LAB(49): GET STRING(CARD) LIST(CODE,PERCOM);
 146    2  0                                  GOTO L1;
                /*---------------------------50 SERIES---------------------------------*/
 147    2  0   LAB(50):
                GET STRING(CARD) LIST(CODE,I7,(POPOL(I0+I6) DO I6=1 TO I7));
 148    2  0   I0=I0+I7;
 149    2  0                                  GOTO L1;
 150    2  0   LAB(51):
                GET STRING(CARD) LIST(CODE,I7,(PPOL(I1+I6)  DO I6=1 TO I7));
 151    2  0   I1=I1+I7;
 152    2  0                                  GOTO L1;
 153    2  0   LAB(52):
                GET STRING(CARD) LIST(CODE,I7,(NPOL(I2+I6)  DO I6=1 TO I7));
 154    2  0   I2=I2+I7;
 155    2  0                                  GOTO L1;
 156    2  0   LAB(53):
                GET STRING(CARD) LIST(CODE,I7,(VCL(I3+I6) DO I6=1 TO I7));
 157    2  0   I3=I3+I7;
 158    2  0                                  GOTO L1;
 159    2  0   LAB(54):
                GET STRING(CARD) LIST(CODE,I7,(CCL(I4+I6) DO I6=1 TO I7));
 160    2  0   I4=I4+I7;
 161    2  0                                  GOTO L1;
 162    2  0   LAB(55):
                GET STRING(CARD) LIST(CODE,I7,(LAPRT(I5+I6) DO I6=1 TO I7));
```

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STMT LEV NT

 163    2   0   I5=I5+I7;
 164    2   0                                   GOTO L1;
 165    2   0   LAB(56):
                GET STRING(CARD) LIST(CODE,I7,(MAINTRT(I10+I6) DO I6=1 TO I7));
 166    2   0   I10=I10+I7;
 167    2   0                                   GOTO L1;
 168    2   0   LAB(57):
                GET STRING(CARD) LIST(CODE,I7,(LAPVAL(I11+I6) DO I6=1 TO I7));
 169    2   0   I11=I11+I7;
 170    2   0                                   GOTO L1;
                /*----------------------------60 SERIES---------------------------------*/
 171    2   0   LAB(60):
                GET STRING(CARD) LIST(CODE,FACTOR);
 172    2   0   DO M=1 TO PERS;
 173    2   1   I0=I0+1;
 174    2   1   POPOL(I0)=POPOL(I0-PERS)*FACTOR;
 175    2   1   END;
 176    2   0                                   GOTO L1;
 177    2   0   LAB(61):
                GET STRING(CARD) LIST(CODE,FACTOR);
 178    2   0   DO M=1 TO PERS;
 179    2   1   I1=I1+1;
 180    2   1   PPOL(I1)=PPOL(I1-PERS)*FACTOR;
 181    2   1   END;
 182    2   0                                   GOTO L1;
 183    2   0   LAB(62):
                GET STRING(CARD) LIST(CODE,FACTOR);
 184    2   0   DO M=1 TO PERS;
 185    2   1   I2=I2+1;
 186    2   1   NPOL(I2)=NPOL(I2-PERS)*FACTOR;
 187    2   1   END;
 188    2   0                                   GOTO L1;
 189    2   0   LAB(63):
                GET STRING(CARD) LIST(CODE,FACTOR);
 190    2   0   DO M=1 TO PERS;
 191    2   1   I3=I3+1;
 192    2   1   VCL(I3)=VCL(I3-PERS)*FACTOR;
 193    2   1   END;
 194    2   0                                   GOTO L1;
 195    2   0   LAB(64):
                GET STRING(CARD) LIST(CODE,FACTOR);
 196    2   0   DO M=1 TO PERS;
 197    2   1   I4=I4+1;
 198    2   1   CCL(I4)=CCL(I4-PERS)*FACTOR;
 199    2   1   END;
 200    2   0                                   GOTO L1;
 201    2   0   LAB(65):
                GET STRING(CARD) LIST(CODE,FACTOR);
 202    2   0   DO M=1 TO PERS;
 203    2   1   I5=I5+1;
```

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STMT LEV NT

 204    2   1   LAPRT(I5)=LAPRT(I5-PERS)*FACTOR;
 205    2   1   END;
 206    2   0                                   GOTO L1;
 207    2   0   LAB(66):
                GET STRING(CARD) LIST(CODE,FACTOR);
 208    2   0   DO M=1 TO PERS;
 209    2   1   I10=I10+1;
 210    2   1   MAINTRT(I10)=MAINTRT(I10-PERS)*FACTOR;
 211    2   1   END;
 212    2   0                                   GOTO L1;
 213    2   0   LAB(67):
                GET STRING(CARD) LIST(CODE,FACTOR);
 214    2   0   DO M=1 TO PERS;
 215    2   1   I11=I11+1;
 216    2   1   LAPVAL(I11)=LAPVAL(I11-PERS)*FACTOR;
 217    2   1   END;
 218    2   0                                   GOTO L1;
                /*---------------------------70 SERIES---------------------------------*/
 219    2   0   LAB(70):
                GET STRING(CARD) LIST(CODE,M,POPOL(I0+1),FACTOR);
 220    2   0   IF M=0 THEN N=PERS*YEARS-1-I0; ELSE N=PERS-1;
 222    2   0   DO M=1 TO N;
 223    2   1   I0=I0+1;
 224    2   1   POPOL(I0+1)=POPOL(I0)*FACTOR;
 225    2   1   END;
 226    2   0   I0=I0+1;
 227    2   0                                   GOTO L1;
 228    2   0   LAB(71):
                GET STRING(CARD) LIST(CODE,M,PPOL(I1+1),FACTOR);
 229    2   0   IF M=0 THEN N=PERS*YEARS-1-I1; ELSE N=PERS-1;
 231    2   0   DO M=1 TO N;
 232    2   1   I1=I1+1;
 233    2   1   PPOL(I1+1)=PPOL(I1)*FACTOR;
 234    2   1   END;
 235    2   0   I1=I1+1;
 236    2   0                                   GOTO L1;
 237    2   0   LAB(72):
                GET STRING(CARD) LIST(CODE,M,NPOL(I2+1),FACTOR);
 238    2   0   IF M=0 THEN N=PERS*YEARS-1-I2; ELSE N=PERS-1;
 240    2   0   DO M=1 TO N;
 241    2   1   I2=I2+1;
 242    2   1   NPOL(I2+1)=NPOL(I2)*FACTOR;
 243    2   1   END;
 244    2   0   I2=I2+1;
 245    2   0                                   GOTO L1;
 246    2   0   LAB(73):
                GET STRING(CARD) LIST(CODE,M,VCL(I3+1),FACTOR);
 247    2   0   IF M=0 THEN N=PERS*YEARS-1-I3; ELSE N=PERS-1;
 249    2   0   DO M=1 TO N;
 250    2   1   I3=I3+1;
```

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STMT LEV NT

 251    2   1   VCL(I3+1)=VCL(I3)*FACTOR;
 252    2   1   END;
 253    2   0   I3=I3+1;
 254    2   0                                   GOTO L1;
 255    2   0   LAB(74):
                GET STRING(CARD) LIST(CODE,M,CCL(I4+1),FACTOR);
 256    2   0   IF M=0 THEN N=PERS*YEARS-1-I4; ELSE N=PERS-1;
 258    2   0   DO M=1 TO N;
 259    2   1   I4=I4+1;
 260    2   1   CCL(I4+1)=CCL(I4)*FACTOR;
 261    2   1   END;
 262    2   0   I4=I4+1;
 263    2   0                                   GOTO L1;
 264    2   0   LAB(75):
                 GET STRING(CARD) LIST(CODE,M,LAPRT(I5+1),FACTOR);
 265    2   0   IF M=0 THEN N=PERS*YEARS-1-I5; ELSE N=PERS-1;
 267    2   0   DO M=1 TO N;
 268    2   1   I5=I5+1;
 269    2   1   LAPRT(I5+1)=LAPRT(I5)*FACTOR;
 270    2   1   END;
 271    2   0   I5=I5+1;
 272    2   0                                   GOTO L1;
 273    2   0   LAB(76):
                GET STRING(CARD) LIST(CODE,M,MAINTRT(I10+1),FACTOR);
 274    2   0   IF M=0 THEN N=PERS*YEARS-1-I10; ELSE N=PERS-1;
 276    2   0   DO M=1 TO N;
 277    2   1   I10=I10+1;
 278    2   1   MAINTRT(I10+1)=MAINTRT(I10)*FACTOR;
 279    2   1   END;
 280    2   0   I10=I10+1;
 281    2   0                                   GOTO L1;
 282    2   0   LAB(77):
                GET STRING(CARD) LIST(CODE,M,LAPVAL(I11+1),FACTOR);
 283    2   0   IF M=0 THEN N=PERS*YEARS-1-I11; ELSE N=PERS-1;
 285    2   0   DO M=1 TO N;
 286    2   1   I11=I11+1;
 287    2   1   LAPVAL(I11+1)=LAPVAL(I11)*FACTOR;
 288    2   1   END;
 289    2   0   I11=I11+1;
 290    2   0                                   GOTO L1;
                /*----------------------------80 SERIES-----------------------------------*/
 291    2   0   LAB(80): GET STRING(CARD) LIST(CODE,NS0,(AS0(I6) DO I6=0 TO NS0-1));
 292    2   0                                   GOTO L1;
 293    2   0   LAB(81): GET STRING(CARD) LIST(CODE,M,(AS1(N) DO N=NS1 TO NS1+M-1));
 294    2   0   NS1=NS1+M;
 295    2   0                                   GOTO L1;
 296    2   0   LAB(83): GET STRING(CARD) LIST(CODE,NT0,(AT0(I6) DO I6=0 TO NT0-1));
 297    2   0                                   GOTO L1;
 298    2   0   LAB(84): GET STRING(CARD) LIST(CODE,NT1,(AT1(I6) DO I6=0 TO NT1-1));
 299    2   0                                   GOTO L1;
```

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STMT LEV NT

 300    2   0   LAB(85): GET STRING(CARD) LIST(CODE,(EXPO(I6) DO I6=1 TO PERS));
 301    2   0                                  GOTO L1;
 302    2   0   LAB(86): GET STRING(CARD) LIST(CODE,NCOM,(COM(I6) DO I6=0 TO NCOM-1));
 303    2   0                                  GOTO L1;
 304    2   0   LAB(87):
                GET STRING(CARD) LIST(CODE,NLAPDEL,(LAPDEL(I6) DO I6=0 TO NLAPDEL-1));
 305    2   0                                  GOTO L1;
                /*------------------------------90 SERIES------------------------------*/
 306    2   0   LAB(90) :
                GET STRING(CARD) LIST(CODE,I7,(PDUE(I6+I8) DO I6=1 TO I7));
 307    2   0   I8=I8+I7;
 308    2   0                                  GOTO L1;
 309    2   0   L999:

                /*------------------------------HEADING---------------------------------*/
                PUT FILE (SYSPRINT) EDIT('FRONTSHEET')(SKIP(2),COLUMN(10),A);
 310    2   0   DCL BLANKET CHAR(1) DEF CARD;
 311    2   0   L11:
                GET FILE(SYSIN) EDIT (CARD) (A(80));
 312    2   0    IF BLANKET='*' THEN GOTO L10;
 313    2   0   PUT FILE(SYSPRINT) EDIT (CARD) (SKIP,COLUMN(10),A(80));
 314    2   0      GOTO L11;
 315    2   0   L10:     PUT  FILE(SYSPRINT) EDIT('END FRONTSHEET')(SKIP,COLUMN(10),A);


                /*------------------NO. OF POLICIES RENEWED IN FIRST YEAR-------------*/
 316    2   0   DO I6=1 TO PERS;
 317    2   1   OPOL(I6)=PDUE(I6)*(1.-LAPRT(I6));
 318    2   1   END;
 319    2   0   DO I6=PERS+1 TO PERS*YEARS;
                /*---NO. OF POLICIES FALLING DUE FOR RENEWAL IN EACH PERIOD----------*/
 320    2   1   PDUE(I6)=(NPOL(I6-PERS)+OPOL(I6-PERS))*MAINTRT(I6-PERS);
 321    2   1   NCANC(I6-PERS)=(NPOL(I6-PERS)+OPOL(I6-PERS))*(1.0-MAINTRT(I6-PERS));
                /*-------------NO. OF POLICIES RENEWED IN EACH PERIOD-----------------*/
 322    2   1   OPOL(I6)=PDUE(I6)*(1.-LAPRT(I6));
 323    2   1   END;
 324    2   0   DO I6=PERS*YEARS-11 TO PERS*YEARS;
 325    2   1   NCANC(I6)=(NPOL(I6)+OPOL(I6))*(1.0-MAINTRT(I6));
 326    2   1   END;

                /*-----------CHECK THAT PERIOD DATA IS COMPLETE-----------------------*/

 327    2   0   M=12*YEARS;
 328    2   0   IF I0 NE M THEN
                PUT EDIT('NOT ENOUGH DATA FOR RENEWED POLICY VALUE DATA, LAST PERIOD SPECIFIED
                ECIFIED IS ',I0)(SKIP(3),A,F(7));
 329    2   0   IF I1 NE M THEN
                PUT EDIT('NOT ENOUGH DATA FOR POLICY PREMIUM VALUE DATA, LAST PERIOD SPECIFIED
                ECIFIED IS ',I1)(SKIP(3),A,F(7));
 330    2   0   IF I2 NE M THEN
```

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                PUT EDIT('NOT ENOUGH DATA FOR POLICY VOLUME DATA, LAST PERIOD SPECIFIED IS
                 IS ',I2) (SKIP(3),A,F(7));
 331    2   0   IF I3 NE M THEN
                PUT EDIT('NOT ENOUGH DATA FOR CLAIM VALUE, LAST PERIOD SPECIFIED IS',I3)(SK
                )(SKIP(3),A,F(7));
 332    2   0   IF I4 NE M THEN
                PUT EDIT('NOT ENOUGH DATA FOR CLAIM FREQUENCY DATA, LAST PERIOD SPECIFIED IS
                ED IS',I4)(SKIP(3),A,F(7));
 333    2   0   IF I5 NE M THEN
                PUT EDIT('NOT ENOUGH DATA FOR LAPSE RATES, LAST PERIOD SPECIFIED IS ',I25)(
                5)(SKIP(3),A,F(7));
 334    2   0   IF I8 NE 12 THEN
                PUT EDIT ('NOT ENOUGH DATA FOR NUMBER OF POLICIES FALLING DUE IN FIRST YEAR,
                 YEAR, LAST PERIOD SPECIFIED IS',I8)(SKIP(3),A,F(7));
 335    2   0   IF I10 NE M THEN
                PUT EDIT('NOT ENOUGH DATA FOR MAINTENANCE RATES, LAST PERIOD SPECIFIED IS',I5)
                IS',I10)
                (SKIP(3),A,F(7));
 336    2   0   IF I11 NE M THEN
                PUT EDIT('NOT ENOUGH DATA FOR VALUES OF LAPSED PREMIUMS, LAST PERIOD SPECIFIED
                ECIFIED IS',I11)
                (SKIP(3),A,F(7));
 337    2   0   PUT SKIP(2);

                /*----CHECK THAT DISTRIBUTIONS ARE SPECIFIED--IF NOT SET DEFAULT-----*/
 338    2   0    IF NS0=0 THEN BEGIN;
 339    3   0   PUT EDIT ('DISTRIBUTION S0 NOT SPECIFIED')(SKIP,A);
 340    3   0   AS0(0)=1.;
 341    3   0   NS0=1;
 342    3   0   END;
 343    2   0    IF NS1=0 THEN BEGIN;
 344    3   0   PUT EDIT ('DISTRIBUTION S1 NOT SPECIFIED')(SKIP,A);
 345    3   0   AS1(0)=1.;
 346    3   0   NS1=1;
 347    3   0   END;
 348    2   0    IF NT0=0 THEN BEGIN;
 349    3   0   PUT EDIT ('DISTRIBUTION T0 NOT SPECIFIED')(SKIP,A);
 350    3   0   AT0(0)=1.;
 351    3   0   NT0=1;
 352    3   0   END;
 353    2   0    IF NT1=0 THEN BEGIN;
 354    3   0   PUT EDIT ('DISTRIBUTION T1 NOT SPECIFIED')(SKIP,A);
 355    3   0   AT1(0)=1.;
 356    3   0   NT1=1;
 357    3   0   END;
 358    2   0   IF NLAPDEL=0 THEN BEGIN;
 359    3   0   PUT EDIT ('DISTRIBUTION DELAY IN LAPSING NOT SPECIFIED')(SKIP,A);
 360    3   0   LAPDEL(0)=1.;
 361    3   0   NLAPDEL=1;
 362    3   0   END;
```

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 363    2   0   IF NCOM=0 THEN BEGIN;
 364    3   0   PUT EDIT('DISTRIBUTION COM OF DELAY IN PAYING COMMISSION NOT SPECIFIED
                ')(SKIP,A);
 365    3   0   COM(0)=1.;
 366    3   0   NCOM=1;
 367    3   0   END;
 368    2   0   PUT SKIP(2);
 369    2   0   NS0=NS0-1;
 370    2   0   NS1=NS1-1;
 371    2   0   NT0=NT0-1;
 372    2   0   NT1=NT1-1;
 373    2   0   NCOM=NCOM-1;
 374    2   0   NLAPDEL=NLAPDEL-1;
                /*----------------------PRINT OUT INITIAL DATA IF REQUIRED------------*/
 375    2   0   IF OFF1=0 THEN GOTO L3;
 376    2   0   PUT EDIT('OPTIONS AND PARAMETER VALUES IN FORCE AT THE START OF THIS RUN')
                N')          (SKIP(5),A);
 377    2   0    PUT EDIT('DELAY DISTRIBUTIONS',(I6 DO I6=0 TO 11))
                (SKIP(3),COLUMN(10),A,COLUMN(37),12 F(6));
 378    2   0   PUT EDIT('ACCIDENT TO NOTIFICATION','S0',(AS0(I6) DO I6=0 TO NS0))
                (SKIP(2),A,COLUMN(37),A,12(F(6,3)));
 379    2   0   IF NS1 GT 11 THEN I7=11 ;
 380    2   0   ELSE I7=NS1;
 381    2   0   PUT EDIT('NOTIFICATION TO SETTLEMENT','S1',(AS1(I6) DO I6=0 TO I7))
                (SKIP,A,COLUMN(37),A,12(F(6,3)));
 382    2   0   IF NS1 LT 12 THEN GOTO A1;
 383    2   0   IF NS1 GT 23 THEN N=23; ELSE N=NS1;
 385    2   0   PUT EDIT('YEAR TWO   ',(AS1(N) DO N=12 TO N))
                (SKIP,A,COLUMN(39),12 (F(6,3)));
 386    2   0   IF NS1 LT 24 THEN GOTO A1;
 387    2   0   IF NS1 GT 35 THEN N=35; ELSE N=NS1;
 389    2   0   PUT EDIT('YEAR THREE ',(AS1(N) DO N=24 TO N))
                (SKIP,A,COLUMN(39),12 (F(6,3)));
 390    2   0   IF NS1 LT 36 THEN GOTO A1;
 391    2   0   IF NS1 GT 47 THEN N=47; ELSE N=NS1;
 393    2   0   PUT EDIT('YEAR FOUR  ',(AS1(N) DO N=36 TO N))
                (SKIP,A,COLUMN(39),12 (F(6,3)));
 394    2   0   IF NS1 LT 48 THEN GOTO A1;
 395    2   0   IF NS1 GT 59 THEN N=59; ELSE N=NS1;
 397    2   0   PUT EDIT('YEAR FIVE  ',(AS1(N) DO N=48 TO N))
                (SKIP,A,COLUMN(39),12 (F(6,3)));
 398    2   0   IF NS1 LT 60 THEN GOTO A1;
 399    2   0   IF NS1 GT 71 THEN N=71; ELSE N=NS1;
 401    2   0   PUT EDIT('YEAR SIX   ',(AS1(N) DO N=60 TO N))
                (SKIP,A,COLUMN(39),12 (F(6,3)));
 402    2   0   IF NS1 LT 72 THEN GOTO A1;
 403    2   0   IF NS1 GT 83 THEN N=83; ELSE N=NS1;
 405    2   0   PUT EDIT('YEAR SEVEN ',(AS1(N) DO N=72 TO N))
                (SKIP,A,COLUMN(39), 12(F(6,3)));
 406    2   0   IF NS1 LT 84 THEN GOTO A1;
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 407    2   0   N=NS1;
 408    2   0   PUT EDIT('YEAR EIGHT ',(AS1(M) DO M=84 TO N))
                (SKIP,A,COLUMN(39), 12(F(6,3)));
 409    2   0   A1:
                PUT EDIT('INCEPTION OF POLICY TO NOTIFICATION','TO',(ATO(I6) DO I6=0 TO NTO))
                 NTO));
                (SKIP,A,COLUMN(37),A,12(F(6,3)));
 410    2   0   PUT EDIT('NOTIFICATION TO RECEIPT OF CASH','T1',(AT1(I6) DO I6=0 TO NT1))
                ));
                (SKIP,A,COLUMN(37),A,12(F(6,3)));
 411    2   0   PUT EDIT('RELATIVE EXPOSURE JAN-DEC',(EXPO(I6) DO I6=1 TO PERS))
                (SKIP,A,COLUMN(39),12(F(6,3)));
 412    2   0   PUT EDIT('LAPSING UNRENEWED POLICIES',(LAPDEL(I6) DO I6=0 TO NLAPDEL))
                (SKIP,A,COLUMN(39),12(F(6,3)));
 413    2   0   PUT EDIT('PAYING COMMISSION','COM',(COM(I6) DO I6=0 TO NCOM))
                (SKIP,A,COLUMN(36),A,12 (F(6,3)));
 414    2   0   PUT EDIT('RATE OF COMMISSION IS',PERCOM)(SKIP(2),A,F(8,1));
 415    2   0   L3:
                PUT SKIP(3);

                /*------CHECK THAT DISTRIBUTIONS ARE P.D.F.--------------------------*/
 416    2   0   TEMP=0.;
 417    2   0   DO M=0 TO NS0;
 418    2   1   TEMP=TEMP+AS0(M);
 419    2   1   END;
 420    2   0   IF ABS(TEMP-1.) GT 0.001 THEN
                PUT EDIT('DISTRIBUTION S0 IS NOT A VALID PROB. DIST. FUNCTION')
                (SKIP,A);
 421    2   0   TEMP=0.;
 422    2   0   DO I6=0 TO NS1;
 423    2   1   TEMP=TEMP+AS1(I6);
 424    2   1   END;
 425    2   0   IF ABS(TEMP-1.) GT 0.001 THEN
                PUT EDIT('DISTRIBUTION S1 IS NOT A VALID PROB. DIST. FUNCTION')
                (SKIP,A);
 426    2   0   TEMP=0.;
 427    2   0   DO I6=0 TO NT0;
 428    2   1   TEMP=TEMP+AT0(I6);
 429    2   1   END;
 430    2   0   IF ABS(TEMP-1.) GT 0.001 THEN
                PUT EDIT('DISTRIBUTION T0 IS NOT A VALID PROB. DIST. FUNCTION')
                (SKIP,A);
 431    2   0   TEMP=0.;
 432    2   0   DO I6=0 TO NT1;
 433    2   1   TEMP=TEMP+AT1(I6);
 434    2   1   END;
 435    2   0   IF ABS(TEMP-1.) GT 0.001 THEN
                PUT EDIT('DISTRIBUTION T1 IS NOT A VALID PROB. DIST. FUNCTION')
                (SKIP,A);
 436    2   0   TEMP=0.;
```

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 437    2   0   DO I6=1 TO 12;
 438    2   1   TEMP=TEMP+EXPO(I6);
 439    2   1   END;
 440    2   0   IF ABS(TEMP-12.) GT 0.001 THEN
                PUT EDIT ('DISTRIBUTION OF EXPOSURE IS NOT VALID')(SKIP,A);
 441    2   0   TEMP=0.;
 442    2   0   DO I6=0 TO NCOM;
 443    2   1   TEMP=TEMP+COM(I6);
 444    2   1   END;
 445    2   0   IF ABS(TEMP-1.) GT 0.001 THEN
                PUT EDIT('DISTRIBUTION COM IS NOT A VALID PROB. DIST FUNCTION')(SKIP,A);
                ;
 446    2   0   TEMP=0.;
 447    2   0   DO I6=0 TO NLAPDEL;
 448    2   1   TEMP=TEMP+LAPDEL(I6);
 449    2   1   END;
 450    2   0   IF ABS(TEMP-1.) GT 0.001 THEN
                PUT EDIT('DISTRIBUTION LAPDEL IS NOT A VALID PROB. DIST. FUNCTION')
                (SKIP,A);
                /*--COMBINE COMMISSION PERCENT AND DELAY IN PAYING COMMISSION--------*/
 451    2   0   DO I6=0 TO NCOM;
 452    2   1   COM(I6)=COM(I6)*PERCOM/100.0;
 453    2   1   END;
 454    2   0   END SECOND;

                /*-------------------------------------------------------------------*/
                /*-------------------------------------------------------------------*/
                /*-----------------------------MAIN PROGRAM--------------------------*/
                /*-------------------------------------------------------------------*/

                /*--------------------DECLARATIONS-----------------------------------*/
 455    1   0   DCL DUM FILE PRINT;
 456    1   0   DCL (I1,I2,I3,I4,N,M,NCLA,I,PERIOD,TIMES) BIN FIXED(31);
 457    1   0   DCL (SURP(240),PPOL(240),NPOL(240),VOL(240),CCL(240),UPRECON(0:20),
                OPOL(240),PDUE(240), CASHNOT(240),POPOL(240),CLNLIA(300),UPR24(0:20),
                CASHREC(240),WRITP(300),NCANC(240),LAPVAL(240),PERCOM,ANCON(0:20),
                EXPO(12),EXPYR(20),CLAFAC(0:10),LAPDEL(0:6),COM(0:6),CLPD(0:20),
                PROP1(5),PROP2(5),CHARG(5),INT(5),CLOUT(0:20),ANWRITP(0:20),
                AS0(0:11),AS1(0:95),ATO(0:11),ATI(0:11)) BIN FLOAT EXTERNAL;
 458    1   0   DCL (CA,EXCESS,CFLOW,TOTWRIT,TOTCL,TOTCASH,TOTNOT,CLNO(300),
                PSUPR(0:20),UPRCALC(0:20),TEMP,TEMP1,TEMP2,TEMP24,IBNR,UPR,OCR,INC,
                CONNIS(240),RENLAP(240),NEWNOM(240),CPSL(0:12),FLOW(240),CLN1(300),
                TEMPCAN,TEMPNEW,TEMPREN,ECONTEMP,PSEUDUPR,EARNPREM(240),PSEUDUP(240),
                PSEUDEP(240),FLOWTOT(240),TOTEXP,BANK,NETFLOW) BIN FLOAT;
 459    1   0   DCL (OFF3,OFF5,OFF6,OFF7,ICLASS,NS0,NS1,NT0,NT1,NCOM,NCLASS,NLAPDEL,
                CLAFACP(10),CFLAG(10),
                RUNS,PERS,YEARS,BASEYR,NRATE1,NRATE2) BIN FIXED EXTERNAL;
                /*                                                              */
                /*-----------SET INITIAL AND DEFAULT VALIES AT START OF EACH RUN-----*/
 460    1   0   RUNS=1;
```

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 461    1   0   OPEN FILE(SYSPRINT) LINESIZE(132) PAGESIZE(64);
 462    1   0   DO TIMES=1 TO RUNS;
 463    1   1   DO N=1 TO 240;
 464    1   2   SURP(N)=0.;
 465    1   2   FLOWTOT(N)=0.;
 466    1   2   END;
 467    1   1   DO N=0 TO 20;
 468    1   2   PSUPR(N)=0.;
 469    1   2   ANWRITP(N)=0.;
 470    1   2   UPRCALC(N)=0.;
 471    1   2   ANCOM(N)=0.;
 472    1   2   CLPD(N)=0.;
 473    1   2   CLOUT(N)=0.;
 474    1   2   UPRECON(N)=0.;
 475    1   2   END;
 476    1   1   PUT SKIP(10);
                 /*------------------------------START NEXT CLASS---------------------*/
 477    1   1   CALL PRIME;
 478    1   1   DO ICLASS=1 TO NCLASS;
                 /*------------SET INITIAL AND DEFAULT VALIES AT START OF EACH CLASSS--*/
 479    1   2         PERIOD=0;
 480    1   2   NCLA=1;
 481    1   2   DO N=1 TO 240;
 482    1   3   PSEUDUP(N)=0.;
 483    1   3   PSEUDEP(N)=0.;
 484    1   3   COMMIS(N)=0.;
 485    1   3   NEWMOM(N)=0.;
 486    1   3   CASHREC(N)=0.;
 487    1   3   CASHNOT(N)=0.;
 488    1   3   EARNPREM(N)=0.;
 489    1   3   CLM0(N)=0.;
 490    1   3   CLM1(N)=0.;
 491    1   3   CLMLIA(N)=0.;
 492    1   3         END;
 493    1   2   DO N=241 TO 300;
 494    1   3   CLM0(N)=0.;
 495    1   3   CLM1(N)=0.;
 496    1   3   CLMLIA(N)=0.;
 497    1   3   END;
 498    1   2   CALL SECOND;
                 /*---------------CALCULATE COMBINED DELAY FOR RECEIPT OF CASH--------*/
 499    1   2   DO I3=0 TO NT0+NT1;
 500    1   3   CDEL(I3)=0.;
 501    1   3   END;
 502    1   2   DO I3=0 TO NT0+NT1;
 503    1   3   DO I4=0 TO I3;
 504    1   4   IF I4 GT NT0 OR I3-I4 GT NT1 THEN GOTO S1;
 505    1   4   CDEL(I3)=CDEL(I3)+AT0(I4)*AT1(I3-I4);
 506    1   4   S1: END; END;
 507    1   2   PUT SKIP(3);
```

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 509    1   2  PUT EDIT('YEAR','PER','NO.','LAPSE','LAPSED','NEW','NO.NEW','RENEWAL','RENEWED'
                 RENEWED','WRITTEN','CLAIMS','CLAIMS/','CLAIM  ','COMMISSION','CASH', 'C
                 ASH','SURPLUS')
                 (SKIP,A,X(1),A,X(2),A,X(3),A,X(2),A,X(4),A,X(4),A,X(2),A,X(1),A,X(2),A,X(2),A,X
                 X(2),A,X(1),A,X(2),A,X(0),A,X(2),A,X(3),A,X(4),A);
 510    1   2  PUT EDIT('IOD','CANCS','  VALUE','PREMIUM','PREMIUM','POLICIES','PREMIUM','POLI
                 M','POLICIES','PREMIUM','SETTLED','POLICY','VALUE','RECEIVED','FLOW')
                 (SKIP,X(5),11(A,X(1)),X(2),A,X(11),A,X(2),A);
                 /*                                                              */
 511    1   2       DO I1=1 TO YEARS BY 1;
 512    1   3   TOTWRIT=0.0;
 513    1   3    TOTCL=0.0;
 514    1   3     TOTCASH=0.0;
 515    1   3       CFLOW=0.0;
 516    1   3  TEMPREN=0;
 517    1   3  TEMPNEW=0;
 518    1   3  TEMPCAN=0;
                 /*-----------------------CALCULATE WRITTEN PREMIUM----------------------*/
 519    1   3       DO I2=1 TO PERS BY 1;
 520    1   4       PERIOD=PERIOD+1;
                 /*-------------CALCULATE EFFECT OF INFLATION ON CLAIMS DISTRIBUTION---*/
 521    1   4   IF CLAFAC(NCLA) ME PERIOD THEN GOTO L15;
 522    1   4  IF CFLAG(NCLA)=1 THEN BEGIN;
 523    2   4  TEMP1=CLAFAC(NCLA)/CLAFAC(NCLA-1);
 524    2   4  TEMP=TEMP1;
 525    2   4  DO N=1 TO NS1;
 526    2   5  AS1(N)=AS1(N)*TEMP;
 527    2   5   CLM1(PERIOD+N)=CLM1(PERIOD+N)*TEMP;
 528    2   5  TEMP=TEMP*TEMP1;
 529    2   5  END;
 530    2   4  END; ELSE BEGIN;
 532    2   4  TEMP=0.;
 533    2   4  DO N=0 TO NS1;
 534    2   5  TEMP=TEMP+AS1(N);
 535    2   5  END;
 536    2   4  TEMP=1./TEMP;
 537    2   4  DO N=0 TO NS1;
 538    2   5  AS1(N)=AS1(N)*TEMP;
 539    2   5  END; END;
 541    1   4  NCLA=NCLA+1;
 542    1   4  L15:
                 WRITP(PERIOD)=NPOL(PERIOD)*PPOL(PERIOD)+OPOL(PERIOD)*POPOL(PERIOD);
 543    1   4  TOTWRIT=TOTWRIT+WRITP(PERIOD);

                 /*------------CALC VALUE OF LAPSES NOTIFIED----------------------------*/
 544    1   4  TEMP=LAPVAL(PERIOD)*(PDUE(PERIOD)-OPOL(PERIOD));
                 /*----------------------CALCULATE WHEN THESE LAPSES ARE NOTIFIED-------*/
 545    1   4  DO I3=0 TO NLAPDEL;
 546    1   5  PSEUDWP(PERIOD+I3)=PSEUDWP(PERIOD+I3)+TEMP*LAPDEL(I3);
 547    1   5  END;
```

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                /*----AMOUNT OF DISTORTION DUE TO PREDEBITING=VALUE OF LAPSING OCC---*/
                /*-----URRING - VALIE OF LAPSES NOTIFIED-------------------------------*/
 548    1   4   PSEUDWP(PERIOD)=TEMP-PSEUDWP(PERIOD);
                /*---------POSITIVE IF OVERESTIMATED-------------------------------------*/
 549    1   4   TEMP=PSEUDWP(PERIOD)/PERS;
 550    1   4   PSEUDEP(PERIOD)=PSEUDEP(PERIOD)+TEMP/2.0;
 551    1   4   DO I3=PERIOD+1 TO PERIOD+PERS-1;
 552    1   5   PSEUDEP(I3)=PSEUDEP(I3)+TEMP;
 553    1   5   END;
 554    1   4   PSEUDEP(PERIOD+PERS)=PSEUDEP(PERIOD+PERS)+TEMP/2.0;

                /*-------CALC MONEY ACTUALLY RECEIVED IN NEW BUSINESS------------------*/
 555    1   4   TEMP=PPOL(PERIOD)*NPOL(PERIOD);
 556    1   4   DO I3=0 TO NT0+NT1;
 557    1   5   NEWMON(I3+PERIOD)=NEWMON(I3+PERIOD)+TEMP*CDEL(I3);
 558    1   5   END;
 559    1   4   RENLAP(PERIOD)=POPOL(PERIOD)*OPOL(PERIOD)+NEWMON(PERIOD);
                 /*-------------CALCULATE COMMISSION-------------------------------------*/
 560    1   4   DO I3=0 TO NCOM;
 561    1   5   COMMIS(PERIOD+I3)=COMMIS(PERIOD+I3)+WRITP(PERIOD)*COM(I3);
 562    1   5   END;
                /*------CALCULATE EARNED PREMIUM---------------------------------------*/
 563    1   4   TEMP=WRITP(PERIOD)/PERS;
 564    1   4   EARNPREM(PERIOD)=EARNPREM(PERIOD)+TEMP/2.0;
 565    1   4   DO  I3=PERIOD+1 TO PERIOD+PERS-1;
 566    1   5   EARNPREM(I3)=EARNPREM(I3)+TEMP;
 567    1   5    END;
 568    1   4   EARNPREM(PERIOD+PERS)=EARNPREM(PERIOD+PERS)+TEMP/2.0;
                /*                                                                    */
                /*----CALCULATE CASH EXPECTED BUT NOT NOTIFIED-------------------------*/
 569    1   4   DO I3=0 TO NT0;
 570    1   5   CASHNOT(PERIOD+I3)=CASHNOT(PERIOD+I3)+WRITP(PERIOD)*AT0(I3);
 571    1   5   END;
                /*-----------CALCULATE CASH NOTIFIED BUT NOT RECEIVED-----------------*/
 572    1   4   DO I3=0 TO NT1;
 573    1   5   CASHREC(PERIOD+I3)=CASHREC(PERIOD+I3)+CASHNOT(PERIOD)*AT1(I3);
 574    1   5   END;
                /*                                                                    */
                /*-----------------CALCULATE CLAIM LIABILITY-------------------------*/
 575    1   4    CA=(NPOL(PERIOD)+OPOL(PERIOD))*CCL(PERIOD)*VCL(PERIOD)/PERS;
 576    1   4   CLMLIA(PERIOD)=CLMLIA(PERIOD)+CA*EXPO(I2)/2.0;
 577    1   4       DO I3=1 TO PERS-1;
 578    1   5   M=I2+I3;
 579    1   5   IF M GT 12 THEN M=M-12;
 580    1   5   I4=PERIOD+I3;
 581    1   5   CLMLIA(I4)=CLMLIA(I4)+CA*EXPO(M);
 582    1   5   END;
 583    1   4   CLMLIA(PERIOD+PERS)=CLMLIA(PERIOD+PERS)+CA*EXPO(I2)/2.0;

                /*-------------CALCULATE VALUE OF CLAIMS KNOWN UNDER SO----------------*/
```

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STMT LEV NT

 584    1   4   DO I3=0 TO NS0;
 585    1   5   CLM0(PERIOD+I3)=CLM0(PERIOD+I3)+CLMLIA(PERIOD)*AS0(I3);
 586    1   5   END;

                /*----------------CALCULATE VALUE OF CLAIMS SETTLED UNDER S1----------*/
 587    1   4   DO I3=0 TO NS1;
 588    1   5   CLM1(PERIOD+I3)=CLM1(PERIOD+I3)+CLM0(PERIOD)*AS1(I3);
 589    1   5   END;

                /*-------------------CALCULATE CASH FLOW--------------------------------*/
 590    1   4    FLOW(PERIOD)=CASHREC(PERIOD)-CLM1(PERIOD)-COMMIS(PERIOD);
 591    1   4   CFLOW=CFLOW+FLOW(PERIOD);
 592    1   4   FLOWTOT(PERIOD)=FLOWTOT(PERIOD)+FLOW(PERIOD);
                /*                                                                   */

                /*--------------------CALCULATE TOTAL NON-PURE PREMIUM-----------------*/
 593    1   4   EXCESS=WRITP(PERIOD)-CA*PERS-WRITP(PERIOD)*PERCOM/100.;

 594    1   4   PUT EDIT(I1,I2,NCANC(PERIOD),LAPVAL(PERIOD),PSEUDWP(PERIOD),PPOL(PERIOD)
                ),NPOL(PERIOD),PSPOL(PERIOD),OPOL(PERIOD),WRITP(PERIOD),CLM1(PERIOD),CCL(PERIOD
                L(PERIOD),VCL(PERIOD),COMMIS(PERIOD),CASHREC(PERIOD),FLOW(PERIOD),EXCESS/
                S)
                (SKIP,F(3),F(3),7 F(8,1),2 F(8),X(2),F(6,3),F(7),X(2),F(7,1),X(2),2 F(8),X(3)
                ),X(2),F(8));
 595    1   4   SURP(PERIOD)=EXCESS+SURP(PERIOD);
 596    1   4   TEMPCAN=TEMPCAN+NCANC(PERIOD);
 597    1   4   TEMPNEW=TEMPNEW+NPOL(PERIOD);
 598    1   4   TEMPREN=TEMPREN+OPOL(PERIOD);
 599    1   4    ANCOM(I1)=ANCOM(I1)+COMMIS(PERIOD);
 600    1   4     END;      /*  PERS  */
                /*                                                                   */
                /*                                                                   */
                /*---------CALCULATE POSITION AT YEAR END-------------------------------*/

 601    1   3   TEMP24=0.;
 602    1   3    PSEUDUPR=0.;
 603    1   3   OCR=0.0;
 604    1   3   UPR=0.0;
 605    1   3   IBNR=0.;
 606    1   3   TOTNOT=0.;
 607    1   3   TOTEXP=0.;
 608    1   3   ECONTEMP=0.;
 609    1   3   ANWRITP(I1)=TOTWRIT+ANWRITP(I1);
                /*                                                                   */
                /*-----------CALCULATE I.B.N.R. AT YEAR END-----------------------------*/
 610    1   3   DO I3=1 TO NS0;
 611    1   4   IBNR=CLM0(PERIOD+I3)+IBNR;
 612    1   4   END;
                /*---------------------CALCULATE O.C.R. AT YEAR END-------------------*/
 613    1   3   DO I3=1 TO NS1;
```

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 614    1   4   OCR=OCR+CLM1(PERIOD+I3);
 615    1   4   END;
                /*                                                          */
                /*-----------CALCULATE U.P.R. AT YEAR END-------------------------*/
 616    1   3     DO I3=1 TO PERS;
 617    1   4   PSEUDUPR=PSEUDUPR+PSEUDEP(PERIOD+I3);
 618    1   4    UPR=UPR+EARNPREM(PERIOD+I3);
 619    1   4   TOTEXP=TOTEXP+CASHREC(PERIOD+I3);
 620    1   4   TOTNOT=TOTNOT+CASHNOT(PERIOD+I3);
 621    1   4   ECONTEMP=ECONTEMP+CLMLIA(PERIOD+I3);
 622    1   4         END;
                /*--CALC TOTAL CLAIMS SETTLED AND TOTAL CASH RECEIVED----------------*/
 623    1   3   DO I3=PERIOD-PERS+1 TO PERIOD;
 624    1   4   TOTCL=TOTCL+CLM1(I3);
 625    1   4    TOTCASH=TOTCASH+CASHREC(I3);
 626    1   4   END;
 627    1   3    CLPD(I1)=CLPD(I1)+TOTCL;
                /*---------CALCULATE U. P. R. BY 24 TH'S RULE-------------------------*/
 628    1   3   DO I3=1 TO 12;
 629    1   4   I4=PERIOD-12+I3;
 630    1   4    TEMP24=TEMP24+RENLAP(I4)*FLOAT(2*I3-1)/24.0;
 631    1   4   END;
                /*--------------------CALCULATE U. P. R. BY 30 TH'S RULE----------------*/
 632    1   3    PUT EDIT('**********************************************************************
                **********************************************************
                *') (SKIP,A);
 633    1   3   PUT EDIT('*',I1,TEMPCAN,TEMPNEW,TEMPREN,TOTWRIT,TOTCL,'UPR(CALC)',UPR,TOTCASH,T
                OTCASH,CFLOW,'*')
                (SKIP,A,F(2),F(9),X(22),F(10),X(6),F(10),F(10),F(8),X(2),A,F(8),X(4),F(11),F(8)
                11),F(8),COLUMN(132),A);
 634    1   3   PUT EDIT('*','OCR',OCR,'UPR(ECON',ECONTEMP,'UPR 24THS',TEMP24,
                'CASHDUE',TOTNOT+TOTEXP,'*')
                (SKIP,A,X(5),A,F(9),COLUMN(56),A,F(8),COLUMN(79),A,F(10),COLUMN(99),A,F(7), OLU
                (7),COLUMN(132),A);
 635    1   3   PUT EDIT('*','IBNR',IBNR,OCR+IBNR,'UPR STRAIN',PSEUDUPR,'UPR (30THS)',
                TEMP24*0.8,'*')
                (SKIP,A,X(4),A,F(9),F(12),X(25),A,F(9,1),COLUMN(79),A,F(8),COLUMN(132),A);
                A);
 636    1   3    PUT EDIT('**********************************************************************
                **********************************************************
                *') (SKIP,A);
                /*                                                          */
                /*----------------------------STORE YEARLY TOTALS-----------------------*/
 637    1   3   CLOUT(I1)=CLOUT(I1)+OCR+IBNR;
 638    1   3   UPRECON(I1)=UPRECON(I1)+ECONTEMP;
 639    1   3   PSUPR(I1)=PSUPR(I1)+PSEUDUPR;
 640    1   3   UPRCALC(I1)=UPRCALC(I1)+UPR;
 641    1   3   UPR24(I1)=UPR24(I1)+TEMP24;
 642    1   3   END;                        /*--END YEARS---*/
 643    1   2   END;                      /*---END CLASSES---*/
```

```
STMT LEV NT

                  /*-------------------------------------------------------------------*/
  644   1   1     PUT EDIT('WRITTEN PREMIUM FOR EACH YEAR')
                  (SKIP(2),A);
  645   1   1     DO M=1 TO YEARS;
  646   1   2     PUT EDIT('YEAR',M,ANWRITP(M))(SKIP(1),A,F(5),X(4),F(12));
  647   1   2     END;
                  /*--------------------PRINT NET CASH FLOW-----------------------------*/
  648   1   1      IF OFF3=1 THEN BEGIN;
  649   2   1     PUT EDIT(' YEAR  PERIOD  CASH FLOW  EXPENSES  NET CASH FLOW  INTEREST  INVESTME
                   INVESTMENTS') (SKIP(3),A);
  650   2   1     BANK=0.;
  651   2   1     PERIOD=0;
  652   2   1     DO N=1 TO YEARS;
  653   2   2     TEMP=EXPYR(N)/PERS;
  654   2   2     DO N=1 TO PERS;
  655   2   3     PERIOD=PERIOD+1;
  656   2   3     NETFLOW=FLOWTOT(PERIOD)-TEMP;
  657   2   3     BANK=BANK+NETFLOW;
                  /*-------------------------------CALC INTEREST-----------------------*/
  658   2   3     INC=0.;
  659   2   3     IF BANK GT 0. THEN BEGIN;
                  /*-------------------------INTEREST EARNED ON ASSETS-----------------*/
  660   3   3     DO I3=1 TO NRATE1;
  661   3   4     INC=INC+BANK*PROP1(I3)*INT(I3);
  662   3   4     END; END;
  664   2   3     ELSE BEGIN;
                  /*---------------------------INTEREST PAID ON BORROWINGS-------------*/
  665   3   3     DO I3=1 TO NRATE2;
  666   3   4     INC=INC+BANK*PROP2(I3)*CHARG(I3);
  667   3   4     END; END;
  669   2   3     PUT EDIT(M,N,FLOWTOT(PERIOD),TEMP,NETFLOW,INC,BANK)
                  (SKIP(1),F(6),F(6),F(10),F(10),F(15),F(13),F(10));
  670   2   3     BANK=BANK+INC;
  671   2   3     END;
  672   2   2     END; END;
  674   1   1     IF OFF3=1 THEN BEGIN;
                  /*--------PRINT PREMIUM SURPLUS FOR EACH YEAR IF REQUIRED-------------*/
  675   2   1     I3=0;
  676   2   1     PUT EDIT('EXCESS OF PREMIUM OVER CLAIMS AND COMMISSION FOR EACH YEAR')
                  (SKIP(3),A);
  677   2   1     DO I1=1 TO YEARS;
  678   2   2     EXCESS=0.;
  679   2   2     DO I2=1 TO PERS;
  680   2   3     I3=I3+1;
  681   2   3     EXCESS=EXCESS+SURP(I3);
  682   2   3     END;
  683   2   2     PUT EDIT(I1+BASEYR,EXCESS)(SKIP,F(7),F(19,2));
  684   2   2     END; END;

  626   1   1     TEMP1,TEMP2=0.;
```

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                /*------PRINT OUT PUBLISHED REVENUE ACCOUNTS (FICTITIOUS)-----------*/
  687    1   1  DO I1=OFF5+1 TO YEARS;
  688    1   2  PUT EDIT('REVENUE ACCOUNTS (AS PUBLISHED) FOR YEAR ENDING 31ST DEC',
                I1+BASEYR)(SKIP(5),COLUMN(40),A,F(6));
  689    1   2  PUT EDIT('PREMIUMS',ANNRITP(I1)/1000.)
                (SKIP(3),COLUMN(5),A,COLUMN(45),F(8,1));
  690    1   2  TEMP1=(PSUPR(I1)-PSUPR(I1-1)+UPR24(I1)-UPR24(I1-1))*0.008;
  691    1   2  PUT EDIT('LESS INCREASE IN UPR',TEMP1)(SKIP,X(5),A,COLUMN(45),F(8,1));
  692    1   2  PUT EDIT('---------')(SKIP,COLUMN(46),A);
  693    1   2  TEMP1=ANNRITP(I1)/1000.-TEMP1;
  694    1   2  PUT EDIT(TEMP1)                (SKIP,COLUMN(55),F(8,1));
  695    1   2  PUT EDIT('LESS: CLAIMS PAID',CLPD(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(35),F(8,1));
  696    1   2  PUT EDIT('LESS CLAIMS O/S BEGINNING',CLOUT(I1-1)/1000.)
                (SKIP,COLUMN(10),A,COLUMN(35),F(8,1));
  697    1   2  PUT EDIT('PLUS CLAIMS O/S AT END',CLOUT(I1)/1000.)
                (SKIP,COLUMN(10),A,COLUMN(35),F(8,1));
  698    1   2  PUT EDIT('---------')(SKIP,COLUMN(36),A);
  699    1   2  TEMP2=(CLPD(I1)-CLOUT(I1-1)+CLOUT(I1))/1000.;
  700    1   2  PUT EDIT('CLAIMS INCURRED',TEMP2)
                (SKIP,COLUMN(10),A,COLUMN(45),F(8,1));
  701    1   2  PUT EDIT('COMMISSION',ANCOM(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(45),F(8,1));
  702    1   2  PUT EDIT('EXPENSES',EXPYR(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(45),F(8,1));
  703    1   2  PUT EDIT('---------')(SKIP,COLUMN(46),A);
  704    1   2  TEMP2=TEMP2+ANCOM(I1)/1000.+EXPYR(I1)/1000.;
  705    1   2  PUT EDIT(TEMP2) (SKIP,COLUMN(55),F(8,1));
  706    1   2  PUT EDIT('---------')(SKIP,COLUMN(56),A);
  707    1   2  PUT EDIT(TEMP1-TEMP2)(SKIP,COLUMN(55),F(8,1));
  708    1   2  PUT EDIT('=========')(SKIP,COLUMN(56),A);
  709    1   2  END;

                /*------PRINT OUT MANAGEMENT REVENUE ACCOUNTS (FICTITIOUS)-----------*/
  710    1   1  DO I1=OFF6+1 TO YEARS;
  711    1   2  PUT EDIT('REVENUE ACCOUNTS (INTERNAL, ACCOUNTING) FOR YEAR ENDING 31ST DEC.',
                DEC',
                I1+BASEYR)(SKIP(5),COLUMN(40),A,F(6));
  712    1   2  PUT EDIT('PREMIUMS',ANNRITP(I1)/1000.)
                (SKIP(3),COLUMN(5),A,COLUMN(45),F(8,1));
  713    1   2  TEMP1=(UPRCALC(I1)-UPRCALC(I1-1))*0.009;
  714    1   2  PUT EDIT('LESS INCREASE IN UPR',TEMP1)(SKIP,X(5),A,COLUMN(45),F(8,1));
  715    1   2  PUT EDIT('---------')(SKIP,COLUMN(46),A);
  716    1   2  TEMP1=ANNRITP(I1)/1000.-TEMP1;
  717    1   2  PUT EDIT(TEMP1)                (SKIP,COLUMN(55),F(8,1));
  718    1   2  PUT EDIT('LESS: CLAIMS PAID',CLPD(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(35),F(8,1));
  719    1   2  PUT EDIT('LESS CLAIMS O/S BEGINNING',CLOUT(I1-1)/1000.)
                (SKIP,COLUMN(10),A,COLUMN(35),F(8,1));
```

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 720    1   2   PUT EDIT('PLUS CLAIMS O/S AT END',CLOUT(I1)/1000.)
                (SKIP,COLUMN(10),A,COLUMN(35),F(8,1));
 721    1   2   PUT EDIT('---------')(SKIP,COLUMN(36),A);
 722    1   2   TEMP2=(CLPD(I1)-CLOUT(I1-1)+CLOUT(I1))/1000.;
 723    1   2   PUT EDIT('CLAIMS INCURRED',TEMP2)
                (SKIP,COLUMN(10),A,COLUMN(45),F(8,1));
 724    1   2   PUT EDIT('COMMISSION',ANCOM(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(45),F(8,1));
 725    1   2   PUT EDIT('EXPENSES',EXPYR(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(45),F(8,1));
 726    1   2   PUT EDIT('---------')(SKIP,COLUMN(46),A);
 727    1   2   TEMP2=TEMP2+ANCOM(I1)/1000.+EXPYR(I1)/1000.;
 728    1   2   PUT EDIT(TEMP2) (SKIP,COLUMN(55),F(8,1));
 729    1   2   PUT EDIT('---------')(SKIP,COLUMN(56),A);
 730    1   2   PUT EDIT(TEMP1-TEMP2)(SKIP,COLUMN(55),F(8,1));
 731    1   2   PUT EDIT('=========')(SKIP,COLUMN(56),A);
 732    1   2   END;

                /*-----PRINT OUT  REVENUE ACCOUNTS (ECONOMICALLY CORRECT)-----------*/

 733    1   1   DO I1=OFFZ+1 TO YEARS;
 734    1   2   PUT EDIT('REVENUE ACCOUNTS (ECONOMIC BASIS) FOR YEAR ENDING 31ST DEC.',
                I1+BASEYR)(SKIP(5),COLUMN(40),A,F(6));
 735    1   2   PUT EDIT('PREMIUMS',ANNRITP(I1)/1000.)
                (SKIP(3),COLUMN(5),A,COLUMN(45),F(8,1));
 736    1   2   TEMP1=(UPRECON(I1)-UPRECON(I1-1))*0.001;
 737    1   2   PUT EDIT('---------')(SKIP,COLUMN(46),A);
 738    1   2   TEMP1=ANNRITP(I1)/1000.-TEMP1;
 739    1   2   PUT EDIT(TEMP1)                (SKIP,COLUMN(55),F(8,1));
 740    1   2   PUT EDIT('LESS: CLAIMS PAID',CLPD(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(35),F(8,1));
 741    1   2   PUT EDIT('LESS CLAIMS O/S BEGINNING',CLOUT(I1-1)/1000.)
                (SKIP,COLUMN(10),A,COLUMN(35),F(8,1));
 742    1   2   PUT EDIT('PLUS CLAIMS O/S AT END',CLOUT(I1)/1000.)
                (SKIP,COLUMN(10),A,COLUMN(35),F(8,1));
 743    1   2   PUT EDIT('---------')(SKIP,COLUMN(36),A);
 744    1   2   TEMP2=(CLPD(I1)-CLOUT(I1-1)+CLOUT(I1))/1000.;
 745    1   2     PUT EDIT('CLAIMS INCURRED',TEMP2)
                (SKIP,COLUMN(10),A,COLUMN(45),F(8,1));
 746    1   2   PUT EDIT('COMMISSION',ANCOM(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(45),F(8,1));
 747    1   2   PUT EDIT('EXPENSES',EXPYR(I1)/1000.)
                (SKIP,COLUMN(5),A,COLUMN(45),F(8,1));
 748    1   2   PUT EDIT('---------')(SKIP,COLUMN(46),A);
 749    1   2   TEMP2=TEMP2+ANCOM(I1)/1000.+EXPYR(I1)/1000.;
 750    1   2   PUT EDIT(TEMP2) (SKIP,COLUMN(55),F(8,1));
 751    1   2   PUT EDIT('---------')(SKIP,COLUMN(56),A);
 752    1   2   PUT EDIT(TEMP1-TEMP2)(SKIP,COLUMN(55),F(8,1));
 753    1   2   PUT EDIT('=========')(SKIP,COLUMN(56),A);
 754    1   2   END;
```

APPENDIX G.1

DATA CODES AND RUNNING

THE SOLVENCY MODEL

Running the Solvency Model

The built-in values are intended to be used for the five year running-in period, as described in the text, in order that a steady state situation is built up. These may however be altered by using the appropriate data codes and placing these cards immediately after the comment cards. For the main run the required values are supplied in a similar way using the same set of codes.

The claims delay distribution must be on the first two cards. The distribution is of the form of the percentage of claims occurring in a month which are settled in each subsequent month, starting from the current month. These are followed by optional comment cards which are terminated by a card with an asterisk in column 1, which must be present even if there are no comment cards. Both sets of data cards are terminated by a card with 999 in columns 1 - 3.

The sequence is thus:-

Card 1 claims distribution

2 " "

3 comment cards

.
.
.

* terminator for comment cards

.

data for running-in period

.

.

999 data terminator

.

data for main run

.

.

999 data terminator

Data Codes for the Solvency Model

Code	Default value or Format	Comment (Use)
2	5	Number of years of run after running-in period.
7	6000.	Capital at the start of the run.
8	30.	The percentage of the capital in the form of shares (on which dividends are paid).
10	0.	Dividend percent paid on shares.
11	60.	Money paid on claims on £100 of written premium.
12	12.	Money paid on commission on £100 of written premium.
13	3.	Money paid on reinsurance on £100 of written premium.
14	0.	Rate of interest earned on cash balance (investments).
15	25.	Expenses on each £100 of written premium.
19	0.	Rate of tax percent.
20	1.	Rate at which the written premium changes on the previous month.

APPENDIX G.2

VARIABLES AND THEIR USE

SOLVENCY MODEL

Variables and their Use

Solvency Model

Variable	Description	Dimension
BIT	A flag = 0 if in running-in period = 1 if not in running-in period.	
BLANKET	A mask used to identify the end of the comment cards.	
CAPITAL	The capital employed each year.	(0:24)
CAPSTA	The capital at the start of the run.	
CARD	Buffer for reading in data.	
CASH	Cash balance at the end of the year (excluding CAPSTA).	
CL	Claims as a proportion of the written premium.	
CLAM	Claims paid in each period.	(300)
CLDIS	Claims settlement distribution by period.	(0:40)
CLOUT	Claims outstanding at year end.	
CLPD	Claims paid during year.	
CODE	Data code.	
COMM	Commission as a proportion of the written premium.	
DIVI	Dividends paid during year.	
EP	Premiums earned in each period.	(0:300)
EXP	Expenses as a proportion of the written premium.	
EXPTOT	Total expenses this year.	
FACTOR	Change in written premium per month.	
FUNDS	Capital employed this year.	
INT	Rate of interest earned on investments.	
INTAX	Taxable income this year.	
INVIN	Investment income this year.	

Variable	Description	Dimension
MONEY	Money left from transactions this year.	
N	Local counter.	
NCL	Number of periods in claims distribution.	
PERIOD	Counter for current period.	
PROSHARE	Proportion of the initial capital on which dividends are paid.	
RDIVI	Rate of dividends paid.	
REIN	Reinsurance costs as a proportion of the written premium.	
RRA	Rate of return on capital for each year.	(24)
RTAX	Rate of tax.	
R3	The total of claims outstanding and UPR (30ths basis) for each year.	(24)
SOLA	Solvency margin for each year.	(24)
TAX	Tax this year.	
TEMP	Local variable.	
TEXP	Total expenses this year.	
T1	Local variable.	
UPRREAL	UPR calculated after deductions for expenses and commission.	
UPRSTAT	UPR calculated on a 30ths basis.	
WP	Written premium each period.	(0:300)
WPREAL	Written premium each period after deduction of expenses and commission.	(300)
WPTOT	Total written premium this year.	
YEARS	Number of years of run.	

APPENDIX G.3

EXAMPLE DATA AND RESULTS

SOLVENCY MODEL

```
19          1  .3  .5  .7  .9 1.1 1.3 1.7 2.1 2.5 3.1 3.5 4.2 4.6 4.6 5.1 5.5 5.5 5.5
12 5.5 6.2 6.2 6.2 6.2 5.5 4.7 3.8 3.5 2.2 1.4 1.0 1.0  CLAIMS DISTRIBUTION
THESIS EXAMPLE
OPTIONAL COMMENT CARDS
999                                 TERMINATOR FOR COMMENT CARDS
2  4                                TERMINATOR FOR CHANGING RUNNING IN VALUES
10  55.                             NUMBER OF YEARS OF RUN AFTER RUNNING-IN
11  60.                             RATE OF DIVIDEND
12  10.                             CLAIMS PER 100 WRITTEN PREMIUM
13   5.                             COMMISSION PER 100 WRITTEN PREMIUN
14  15.                             REINSURANCE PER 100 WRITTEN PREMIUM
15  27.                             RATE OF INTEREST
19  55.                             EXPENSES PER 100 WRITTEN PREMIUM
20   1.                             RATE OF TAX
999                                 RATE OF CHANGE OF WRITTEN PREMIUM PER MONTH
                                    TERMINATOR FOR DATA VALUES FOR MAIN RUN
```

EXAMPLE DATA FOR SOLVENCY MODEL

PERIOD	WRITTE PREMIUM	STATUTORY W.P.	REALISTIC W.P.	EXPENSES
73	1000.00	800.00	630.00	270.00
74	1000.00	800.00	630.00	270.00
75	1000.00	800.00	630.00	270.00
76	1000.00	800.00	630.00	270.00
77	1000.00	800.00	630.00	270.00
78	1000.00	800.00	630.00	270.00
79	1000.00	800.00	630.00	270.00
80	1000.00	800.00	630.00	270.00
81	1000.00	800.00	630.00	270.00
82	1000.00	800.00	630.00	270.00
83	1000.00	800.00	630.00	270.00
84	1000.00	800.00	630.00	270.00

POSITION AT END OF YEAR 7

OUTSTANDING CLAIMS	10303.5	10503.5
UPR(REALISTIC)	3700.0	
UPR(STATUTORY)		4800.0
INCOME	12000.0	
LESS		
CLAIMS PAID	7199.9	
TOTAL EXPENSES	3240.0	
COMMISSION	1000.0	
REINSURANCE COST	600.0	
MONEY LEFT FROM THIS YEARS ACTIVITIES	-239.3	
INTEREST EARNED	3054.4	
INCREASE IN OCR AND UPR(STATUTORY)	0.0	
TAXABLE INCOME	2814.5	
TAX	1548.0	
MONEY LEFT THIS YEAR AFTER TAX	1266.5	
DIVIDENDS PAID	930.0	
RETURN ON CAPITAL EMPLOYED		44.3
CAPITAL EMPLOYED AT END OF YEAR		6355.9
CASH AT END OF YEAR	14639.7	
SOLVENCY MARGIN		44.5

APPENDIX G.4

LISTING OF THE

SOLVENCY MODEL

```
 1      0  PL1: PROCEDURE OPTIONS (MAIN);
           /*----------------------------SOLVENCY MODEL----------------------------*/
           /*---------------------------------DECLARATIONS-------------------------*/
 2   1  0  DCL (UPREAL(300),CLAM(300),WP(0:300),CLDIS(0:40),EP(0:300),CLPD,
           INT,INTAX,TAX,CLOUT,UPRSTAT,UPRREAL,TEXP,FUNDS,RTAX,INVIN,RDIVI,EXP,
           R3(0:24),PROSHARE,FACTOR,PRA(24),SOLA(24),CAPITAL(24),
           TEMP,T1,WPTOT,EXPTOT,MONEY,CASH,DIVI,CL,COMM,REIN,CAPSTA) BIN FLOAT;
 3   1  0  DCL CARD CHAR(80);
 4   1  0  DCL BLANKET CHAR(1) DEF (CARD);
 5   1  0  DCL LAB(20) LABEL;
 6   1  0  DCL (N,NCL,BIT,I8,YEARS,CODE,PERIOD,I1,I2,I6) BIN FIXED;

           /*------READ IN CLAIMS SETTLEMENT DISTRIBUTION (AS A PERCENTAGE)-----*/
 7   1  0  NCL=0;
 8   1  0  DO I1=1 TO 2;
 9   1  1  GET FILE (SYSIN) EDIT (CARD) (A(80));
10   1  1  GET STRING(CARD) LIST(N,(CLDIS(I6) DO I6=NCL TO NCL+N-1));
11   1  1  DO I6=NCL TO NCL+N-1;
12   1  2  CLDIS(I6)=CLDIS(I6)/100.;
13   1  2  END;
14   1  1  NCL=NCL+N;
15   1  1  END;

16   1  0  ON ENDFILE(SYSIN) GOTO L998;
17   1  0  L997:
           /*-----------------------------------SET INITIAL VALUES--------------*/
           BIT=0;
18   1  0  I1=0;
19   1  0  INT=0.;
20   1  0  FACTOR=1.;
21   1  0  YEARS=5;
22   1  0  RTAX=0.;
23   1  0  RDIVI=0.;
24   1  0  DIVI=0.;
25   1  0  CASH=0.;
26   1  0  CAPSTA=6000.;
27   1  0  PROSHARE=0.3;
28   1  0  WP(0)=1000.;
29   1  0  R3(0)=0.;
30   1  0  PERIOD=0;
31   1  0  DO I6=1 TO 24;
32   1  1  PRA(I6)=0.;
33   1  1  END;
34   1  0  DO I6=1 TO 300;
35   1  1  CLAM(I6)=0.;
36   1  1  EP(I6)=0.;
37   1  1  END;
```

```
STMT LEV NT

                CL=0.6;
                COMM=0.12;
                REIN=0.03;
                EXP=0.25;

   42    1  0   L11:
                /*------------------------------READ NEXT COMMENT CARD-----------------------*/
                GET FILE(SYSIN) EDIT(CARD) (A(80));
                /*------------------------------TEST FOR COMMENT TERMINATOR------------------*/
   43    1  0   IF BLANKET='*' THEN GOTO L10;
   44    1  0   PUT FILE(SYSPRINT) EDIT(CARD) (SKIP,COLUMN(10),A(80));
   45    1  0   GOTO L11;
   46    1  0   L10:


                L1:
                /*------------------------------READ NEXT DATA CARD--------------------------*/
                 GET FILE(SYSIN) EDIT (CARD) (A(80));
   47    1  0   GET STRING(CARD) LIST(CODE);
                /*------------------------------TEST FOR DATA TERMINATOR---------------------*/
   48    1  0   IF CODE=999 THEN GOTO L999;
   49    1  0    GOTO LAB(CODE);
   50    1  0   LAB(2):  GET STRING(CARD) LIST(CODE,YEARS);
   51    1  0                              GOTO L1;
   52    1  0   LAB(7): GET STRING(CARD) LIST(CODE,CAPSTA);
   53    1  0                              GOTO L1;
   54    1  0   LAB(8): GET STRING(CARD) LIST(CODE,PROSHARE);
   55    1  0   PROSHARE=PROSHARE/100.;
   56    1  0                              GOTO L1;
   57    1  0   LAB(10): GET STRING(CARD) LIST(CODE,RDIVI);
   58    1  0   RDIVI=RDIVI/100.;
   59    1  0                              GOTO L1;
   60    1  0   LAB(11): GET STRING(CARD) LIST(CODE,CL);
   61    1  0   CL=CL/100.;
   62    1  0                              GOTO L1;
   63    1  0   LAB(12): GET STRING(CARD) LIST(CODE,COMM);
   64    1  0   COMM=COMM/100.;
   65    1  0                              GOTO L1;
   66    1  0   LAB(13): GET STRING(CARD) LIST(CODE,REIN);
   67    1  0   REIN=REIN/100.;
   68    1  0                              GOTO L1;
   69    1  0   LAB(14): GET STRING(CARD) LIST(CODE,INT);
   70    1  0   INT=INT/100.;
   71    1  0                              GOTO L1;
   72    1  0   LAB(15): GET STRING(CARD) LIST(CODE,EXP);
   73    1  0   EXP=EXP/100.;
   74    1  0                              GOTO L1;
   75    1  0   LAB(16):
                GET STRING(CARD) LIST(CODE,STAX);
```

```
STMT LEV NT

   75    1  0   RTAX=RTAX/100.;
   77    1  0                                  GOTO L1;
   78    1  0   LAB(20): GET STRING(CARD) LIST(CODE,FACTOR);
   79    1  0   GOTO L1;
   80    1  0   L999:     /* END OF DATA INPUT SECTION                    */

                /*---------------------------PRINT OUT DATA-----------------------------------*/
                PUT EDIT('SOLVENCY  MODEL')(SKIP,COLUMN(50),A);
   81    1  0   IF BIT=0 THEN GOTO SETUP;
   82    1  0   PUT EDIT('NUMBER OF YEARS OF RUN',YEARS)(SKIP,A,COLUMN(45),F(8,1));
                /*---------PRINT OUT DISTRIBUTION OF CLAIMS...ACCIDENT TO NOTIFICATION*/
   83    1  0   PUT EDIT('DISTRIBUTION OF CLAIMS')(SKIP,COLUMN(70),A);
   84    1  0   IF NCL-1 GT 19 THEN N=19 ; ELSE N=NCL-1;
   86    1  0   PUT EDIT((I6 DO I6=0 TO N))
                (SKIP(2),20 F(6,0));
   87    1  0    PUT EDIT((CLDIS(I6)*100. DO I6=0 TO N))
                (SKIP,20 F(6,1));
   88    1  0   IF NCL LT 20 THEN GOTO L2;
   89    1  0   N=NCL-1;
   90    1  0   PUT EDIT((I6 DO I6=20 TO N))
                (SKIP(2),20 F(6,0));
   91    1  0   PUT EDIT((CLDIS(I6)*100. DO I6=20 TO N))
                (SKIP,20 F(6,1));
   92    1  0   L2:
                /*------CHECK FOR VALID CLAIMS DISTRIBUTION-------------------------------*/
                TEMP=0.;
   93    1  0   DO I6=0 TO NCL-1;
   94    1  1   TEMP=TEMP+CLDIS(I6);
   95    1  1   END;
   96    1  0    TEMP=TEMP*100. ;
   97    1  0   PUT EDIT('CLAIMS DISTRIBUTION TOTAL IS',TEMP) (SKIP(2),A,F(8,1));
   98    1  0   PUT EDIT('RATE OF INTEREST',INT*100.)
                (SKIP,A,COLUMN(45),F(8,2));
   99    1  0   PUT EDIT('RATE OF TAX PER CENT',RTAX*100.)
                (SKIP,A,COLUMN(45),F(8,2));
  100    1  0   PUT EDIT('RATE OF DIVIDEND',RDIVI*100.)
                (SKIP,A,COLUMN(45),F(8,2));
  101    1  0   PUT EDIT('FOR EACH £100 OF PREMIUM')(SKIP(2),A);
  102    1  0   PUT EDIT('CLAIMS',CL*100.)
                (SKIP,A,COLUMN(22),F(7,1));
  103    1  0    PUT EDIT('POLICY EXPENSES',EXP*100.)
                (SKIP,A,COLUMN(22),F(7,1));
  104    1  0   PUT EDIT('COMMISSION',COMM*100.)
                (SKIP,A,COLUMN(22),F(7,1));
  105    1  0   PUT EDIT('REINSURANCE',REIN*100.)
                (SKIP,A,COLUMN(22),F(7,1));

                /*----------------------SET INITIAL VALUES-------------------------------*/
                /*-----------------------------------------------------------------------*/
  106    1  0   SETUP:
```

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                  DO I9=1 TO YEARS;
  107    1    1    I1=I1+1;
  108    1    1    PUT EDIT('PERIOD  WRITTE PREMIUM   STATUTORY W.P.  REALISTIC W.P.
                  EXPENSES')(SKIP(2),A);
  109    1    1    DO I2=1 TO 12;
  110    1    2    PERIOD=PERIOD+1;
  111    1    2    UP(PERIOD)=UP(PERIOD-1)*FACTOR;
  112    1    2    TEXP=UP(PERIOD)*EXP;
  113    1    2    UPREAL(PERIOD)=UP(PERIOD)*(1.-COMM)-TEXP;
  114    1    2    T1=UP(PERIOD)*CL/12.;
                  /*-------------------CALCULATE EARNED PREMIUM-------------------------------*/
  115    1    2    EP(PERIOD)=EP(PERIOD)+T1/2.;
  116    1    2    EP(PERIOD+12)=EP(PERIOD+12)+T1/2.;
  117    1    2    DO I6=1 TO 11;
  118    1    3    EP(PERIOD+I6)=EP(PERIOD+I6)+T1;
  119    1    3    END;
                  /*------CLAIMS SETTLED IN FUTURE PERIODS AND OCCURRING THIS PERIOD----*/
  120    1    2    DO I6=0 TO NCL-1;
  121    1    3    CLAM(PERIOD+I6)=CLAM(PERIOD+I6)+EP(PERIOD)*CLDIS(I6);
  122    1    3    END;
  123    1    2    PUT EDIT(PERIOD,UP(PERIOD),UP(PERIOD)*0.8,UP(PERIOD)*(1.-COMM)-TEXP,TEXP)
                  P2
                  (SKIP,F(7),F(12,2),3F(16,2));
  124    1    2    END;  /*PERIOD  */
                  /*                                                                      */
                  /*---------------END OF YEAR CALCULATIONS-------------------------------*/
  125    1    1    UPRSTAT=0.;
  126    1    1    UPREAL=0.;
  127    1    1    UPTOT=0.;
  128    1    1    EXPTOT=0.;
  129    1    1    CLOUT=0.;
  130    1    1    CLPD=0.;
                  /*------------------------------------------------------------------------*/
                  /*-----------------------------CLAIMS OUT STANDING------------------------*/
  131    1    1    DO I6=1 TO NCL-1;
  132    1    2    CLOUT=CLOUT+CLAM(PERIOD+I6);
  133    1    2    END;
                  /*                                                                      */
  134    1    1    DO I6=1 TO 12;
  135    1    2    UPTOT=UPTOT+UP(PERIOD-12+I6);
                  /*-----------CALCULATE REALISTIC U.P.R.-----------------------------------*/
  136    1    2    UPREAL=UPREAL+FLOAT(I6*2-1)*UPREAL(PERIOD-12+I6)/24.;
                  /*---------CALCULATE STATUTORY U. P.R.----------------------------------*/
  137    1    2    UPRSTAT=UPRSTAT+FLOAT(I6*2-1)*UP(PERIOD-12+I6)/24.;
                  /*-----------------------CALCULATE CLAIMS PAID----------------------------*/
  138    1    2    CLPD=CLPD+CLAM(PERIOD-12+I6);
  139    1    2    END;
  140    1    1    UPRSTAT=UPRSTAT*0.8;
  141    1    1    A3(I1)=CLOUT+UPRSTAT;
  142    1    1    EXPTOT=UPTOT*EXP;
```

```
STMT  LEV NT

 143    1   1   MONEY=WPTOT-EXPTOT-WPTOT*(COMM+REIN)-CLPD;
 144    1   1   INVIN=(CAPSTA+CASH)*INT;
 145    1   1   INTAX=MONEY-R3(I1)*R3(I1-1)+INVIN;
 146    1   1   IF INTAX LT 0 THEN INTAX=0.;
 147    1   1   TAX=RTAX*INTAX;
 148    1   1   DIVI=RDIVI*CAPSTA*PROSHARE;
 149    1   1   CASH=CASH+MONEY-TAX-DIVI+INVIN;
 150    1   1   FUNDS=CAPSTA+CASH-CLOUT-UPRREAL;
 151    1   1   CAPITAL(I1)=FUNDS;
 152    1   1   PRA(I1)=INTAX*100./FUNDS;
 153    1   1   SOLA(I1)=(FUNDS+UPRREAL-UPRSTAT)/WPTOT*100.;
                /*-------------------------------------------------------------------*/
                /*-----------------------PRINT OUT END OF YEAR RESULTS---------------*/
 154    1   1   PUT EDIT('POSITION AT END OF YEAR',I1)(SKIP(2),A,F(4));
 155    1   1   PUT EDIT('--------------------------')(SKIP,A);
 156    1   1   PUT EDIT('OUTSTANDING CLAIMS',CLOUT,CLOUT)
                (SKIP,A,COLUMN(40),2F(15,1));
 157    1   1   PUT EDIT('UPR(REALISTIC)',UPRREAL)
                (SKIP,A,COLUMN(40),1F(15,1));
 158    1   1   PUT EDIT('UPR(STATUTORY)',UPRSTAT)
                (SKIP,A,COLUMN(55),2F(15,1));
 159    1   1   PUT EDIT('--------           --------')
                (SKIP,COLUMN(48),A);
 160    1   1   PUT EDIT('.....')(SKIP,A);
 161    1   1   PUT EDIT('INCOME',WPTOT)
                (SKIP,A,COLUMN(40),F(15,1));
 162    1   1   PUT EDIT('LESS')(SKIP,A);
 163    1   1   PUT EDIT('CLAIMS PAID',CLPD)
                (SKIP,A,COLUMN(40),F(15,1));
 164    1   1   PUT EDIT('TOTAL EXPENSES',EXPTOT)
                (SKIP,A,COLUMN(40),F(15,1));
 165    1   1   T1=WPTOT*COMM;
 166    1   1   PUT EDIT('COMMISSION',T1)
                (SKIP,A,COLUMN(40),F(15,1));
 167    1   1   T1=WPTOT*REIN;
 168    1   1   PUT EDIT('REINSURANCE COST',T1)
                (SKIP,A,COLUMN(40),F(15,1));
 169    1   1   PUT EDIT('.....')(SKIP,COLUMN(48),A);
 170    1   1   PUT EDIT('MONEY LEFT FROM THIS YEARS ACTIVITIES',MONEY)
                (SKIP,A,COLUMN(40),F(15,1));
 171    1   1   PUT EDIT('INTEREST EARNED',INVIN)
                (SKIP,A,COLUMN(40),F(15,1));
 172    1   1   PUT EDIT('INCREASE IN UCR AND UPR(STATUTORY)',R3(I1)-R3(I1-1))
                (SKIP,A,COLUMN(40),F(15,1));
 173    1   1   PUT EDIT('--------')
                (SKIP,COLUMN(48),A);
 174    1   1   PUT EDIT('TAXABLE INCOME',INTAX)
                (SKIP,A,COLUMN(40),F(15,1));
 175    1   1   PUT EDIT('TAX',TAX)
```

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                (SKIP,A,COLUMN(40),F(15,1));
 176     1   1  PUT EDIT('--------')
                (SKIP,COLUMN(48),A);
 177     1   1  PUT EDIT('MONEY LEFT THIS YEAR AFTER TAX',MONEY+INVIN-TAX)
                (SKIP,A,COLUMN(40),F(15,1));
 178     1   1  PUT EDIT('******','--------')
                (SKIP,A,COLUMN(48),A);
 179     1   1  PUT EDIT('DIVIDENDS PAID',DIVI)
                (SKIP,A,COLUMN(40),F(15,1));
 180     1   1  PUT EDIT('RETURN ON CAPITAL EMPLOYED',RRA(I1))
                (SKIP,A,COLUMN(48),F(15,1));
 181     1   1  PUT EDIT('........')(SKIP,COLUMN(48),A);
 182     1   1  PUT EDIT('CAPITAL EMPLOYED AT END OF YEAR',FUNDS)
                (SKIP,A,COLUMN(40),F(15,1));
 183     1   1  PUT EDIT('........')(SKIP,COLUMN(48),A);
 184     1   1  PUT EDIT('CASH AT END OF YEAR',CASH)
                (SKIP,A,COLUMN(40),F(15,1));
 185     1   1  PUT EDIT('SOLVENCY MARGIN',SOLA(I1))
                (SKIP,A,COLUMN(48),F(15,1));
 186     1   1  END;          /* OF YEAR      */
 187     1   0  IF BIT = 1 THEN GOTO L16;
 188     1   0  BIT=1;
                /*----------------------------END OF RUNNUNG IN PERIOD------------------*/
 189     1   0  GOTO L1;
                /*----------------------------END OF SIMULATION-------------------------*/
 190     1   0  L16:
                /*----------------------------PRINT SUMMARY OF RESULTS------------------*/
                PUT FILE(SYSPRINT) PAGE;
 191     1   0  PUT EDIT('SOLVENCY MODEL')(SKIP,COLUMN(50),A);
 192     1   0  PUT EDIT('DIVIDEND',RDIVI*100.)
                (SKIP(1),A,COLUMN(20),F(5,1));
 193     1   0  PUT EDIT('INTEREST',INT*100.)
                (SKIP(1),A,COLUMN(20),F(5,1));
 194     1   0  PUT EDIT('TAX',RTAX*100.)
                (SKIP(1),A,COLUMN(20),F(5,1));
 195     1   0  PUT EDIT('CLAIMS',CL*100.)
                (SKIP(1),A,COLUMN(20),F(5,1));
 196     1   0  PUT EDIT('COMMISSION',COMM*100.)
                (SKIP(1),A,COLUMN(20),F(5,1));
 197     1   0  PUT EDIT('REINSURANCE',REIN*100.)
                (SKIP(1),A,COLUMN(20),F(5,1));
 198     1   0  PUT EDIT('POL EXP',EXP*100.)
                (SKIP(1),A,COLUMN(20),F(5,1));
 199     1   0  PUT EDIT('DISTRIBUTION OF CLAIMS')(SKIP,COLUMN(20),A);
 200     1   0  IF NCL-1 GT 19 THEN N=19 ; ELSE N=NCL-1;
 202     1   0   PUT EDIT((CLDIS(I6)*100. DO I6=0 TO N))
                (SKIP,20 F(6,1));
 203     1   0  IF NCL LT 20 THEN GOTO A2;
 204     1   0  N=NCL-1;
 205     1   0  PUT EDIT((CLDIS(I6)*100. DO I6=20 TO N))
```

```
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                (SKIP,20 F(6,1));
 206    1  0    A2:
                PUT EDIT('-------------------------------------------------------------
                ----------------------------------------------------------')
                (SKIP(1),A);
 207    1  0    PUT EDIT('I          I          I          I          I          I          I          I
                    I          I          I          I          I')
                (SKIP,COLUMN(19),A);
 208    1  0    PUT EDIT('ACTUAL SOLN',(SOLA(I1) DO I1=5 TO YEARS+5))
                (SKIP(1),A,COLUMN(11),24(F(8,1)));
 209    1  0    PUT EDIT('ACTUAL RCAP',(RRA(I1) DO I1=5 TO YEARS+5))
                (SKIP(1),A,COLUMN(11),24(F(8,1)));
 210    1  0    PUT EDIT('ACTUAL CAPE',(CAPITAL(I1) DO I1=5 TO YEARS+5))
                (SKIP(1),A,COLUMN(11),24(F(8,1)));
 211    1  0    PUT EDIT('I          I          I          I          I          I          I          I
                    I          I          I          I          I')
                (SKIP,COLUMN(19),A);
 212    1  0    PUT EDIT('-------------------------------------------------------------
                ----------------------------------------------------------')
                (SKIP(1),A);
 213    1  0    PUT FILE(SYSPRINT) PAGE;
 214    1  0    GOTO L997;
 215    1  0    L998:
                END PL1;
```

APPENDIX H

Program Notes

All the computer programs were written in PL1 as this was used for the company's in-house computing. The college machine used was an IBM 360/65I, on which the programs were developed and they were successfully transferred to the company's own 370/145. The programs were developed using the IBM checkout compiler which provides good diagnostic facilities, and later run under the optimising compiler, which although taking much longer to compile, produces more efficient coding and consequently reduces the run time. The compiler used at Legal and General was PL1(F), running under VSI. Small differences in the compilers were resolved to allow the programs to run under any of the compilers.

The control cards required depend very much on the individual operating system being used. The College machine used MFT2 with MASP and the sequence of control cards is shown in Fig H.1.

The parameters on the EXEC.... card indicate various options to the compiler and can be changed according to the respective programmers manuals (ref 10,11). The language reference manual is given in ref 12.

The files which are used by the program are 'SYSIN' for data input and 'SYSOUT' for printing results. Another file called 'DUM' is used for storing the printout of the initial data and this has to be assigned to the line printer as shown in Fig H.1.

For all the data cards the delimiter is a blank (space).

The compile and run times for the three models are given here as an indication of times, however these will vary depending on the exact

compiler and machine used. The degree of complexity of the data will also affect the run times for the expenses and, especially, the premium/claims model.

		Expenses 2 years	Premium/Claims 1 class 15 years	Solvency 20 years
compile	optimiser	112	130	35
	checkout	18	22	7
run	optimiser	7	10	5
	checkout	38	45	20

Approximate Run and Compile Times in Seconds

The by now virtual standardisation of the American spelling of program has been used in the text when referring to a computer program.

```
jobcard
// EXEC PL1OP,PARM.C='CS(B,48),NX,NA,NAG,NOP'
//C.SYSIN DD *
    :
program
    :
/*
//L.SYSIN DD *
/*
//G.DUM DD SYSOUT=A,DCB=BLKSIZE=1596
//G.SYSIN DD *
    :
data
    :
/*
```

Control Cards for PL1 Optimising Compiler at University College

```
jobcard
// EXEC PL1CK,PARM.C='CS(B,48),STEP(200000,9000),NA'
//G.SYSCIN DD *
    :
program
    :
/*
//G.DUM DD SYSOUT=A,DCB=BLKSIZE=1596
//G.SYSIN DD *
    :
data
    :
/*
```

Control Cards for PL1 Checkout Compiler at University College

FIG H·1