

## **Aviation Underwriting**

### **Working Party Members**

Graham Lyons (Chairman)  
Philip Archer-Lock  
Colin Czapiewski  
Andrew English  
Victoria Hughes  
Jeff Sayers

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## **Summary of Paper**

The Introduction to the Paper summarises the conclusions from discussions held with Aviation underwriters including how rating is done in practice. The question that should be asked is "can actuaries contribute towards placing the rating of aviation on a more proficient basis".

A brief description of the classes of aviation business is given followed by "Underwriting Practice" which describes the slip system which is the main method used for writing Aviation insurance business.

Rating of Aviation insurance is described, firstly in general and then for the main classes giving the rating factors used by the underwriters. Space Risks and Personal Accident are each described in more detail as subjects deserving of special interest.

A study by Sigma is described which investigates the nature of Aviation insurance cycles and provides an econometric forecast. Formulae of rate levels for each of Liability and Hull business are derived.

The paper also includes discussion of the underwriting cycle, the accumulation risk and market statistics for 1994.

# Introduction

The title of this paper is "Aviation Underwriting". Last year's working party on Aviation produced a paper which gave an outline of the market and description of the main classes of business and outwards reinsurance, but very little on how Aviation is underwritten or how rates are determined. This paper was therefore intended to fill in these gaps. To this end we talked with a number of aviation underwriters to establish how rates are set. We were not able to find anyone who used any "scientific" basis for determining rates. The copious statistics obtainable from various organisations giving loss statistics and data related to various risk factors (numbers of aircraft, airline, passenger miles, etc) are not used by any of the underwriters we spoke to. Rates tend to be based on past experience of the insured, the previous rate charged, consideration of rating factors, how rates are changing in the market and the cost of reinsurance.

The members of the working party would like the discussions at the workshop sessions to concentrate on the rating process:

- 1) Has anyone experience of rating using market statistics?
- 2) Can actuaries contribute to the rating process?

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# **Classes of Aviation Business**

## **Airlines**

Generally this covers hull and liabilities of aircraft that can carry more than 50 passengers, although this is not a hard and fast rule. Aircraft are covered for loss or accidental damage and for reasonable expenses for emergency landings. Legal liability to third parties is covered for bodily injury and property damage claims.

## **Products**

This covers manufacturers, vendors and distributors of aircraft and aircraft parts against losses from their liability arising from bodily injuries or property damage caused by these products. Costs of investigation, defence and negotiation of settlements are included.

## **Airports and Refuelling**

This covers liability and security (refuelling is linked to products). Bodily injury and property damage is covered when caused by the services of the assured or any defect in the assured's property or machinery, or when property is left in the care of the assured.

## **Satellites**

Cover is given for launch, post separation and in orbit. Cover for launch is purchased well before the launch date, which may not be fixed, so there can be a long exposure period. This is sometimes dealt with by a portfolio transfer each year. Post separation deals with the movement to the pre-determined flight path and testing the controls of the satellite. In orbit covers the satellite in the pre-determined flight path.

## **General Aviation**

General Aviation - hulls and liabilities, aircraft able to carry less than 50 passengers.

## **Personal Accident**

Originated in aviation departments from the need for financial protection from the consequences of death or injury arising from flying. The policies written now often cover a much wider range of perils.

## Underwriting Practice

The following description of how Aviation insurance is written comes from Lord Diplock's definition in *American Airlines Inc vs Hope, House of Lords, 1974*.

"Contracts of insurance are placed at Lloyd's by a broker acting exclusively as agent for the assured. It is he who prepares the slip in which he indicates in the customary 'shorthand' the cover that the assured requires. He takes the slip in the first instance to an underwriter, ie. one who has a reputation in the market as an expert in the kind of cover required and whose lead is likely to be followed by other insurers in the market. If it is the first contract of insurance covering that risk in which a particular underwriter has acted as leading underwriter, it is treated as an original insurance. The broker and the leading underwriter go through the slip together. They agree on any amendments to the broker's draft and fix the premium. When agreement has been reached the leading underwriter initials the slip for his proportion of the cover and the broker then takes the initialled slip round the market to other insurers who initial it for such proportion of the cover as each is willing to accept. For practical purposes all the negotiations about the terms of the insurance and the rate of premium are carried on between the broker and the leading underwriter alone. Where, as is often the case, the slip gives to the assured options to cover additional aircraft or additional risks during the period of the cover it does so on terms to be agreed with the leading underwriter. This is indicated by the abbreviation 'tba L/U'.

"The slip contemplates its eventual replacement by a policy of insurance in the standard form in use at Lloyd's for aviation risks, but subject to such deletions and additions as are indicated in the slip. Such additions are generally clauses which themselves follow a standard form and are sufficiently identified in the slip by a reference to a description or a number but some may be specially tailored to the particular requirements of the assured. In the latter case if the slip is for an original insurance the actual clause is set out in the slip itself, although it may be only in abbreviated form".

"After the slip has been initialled by all the insurers it is retained by the broker. In due course, often after several months, he prepares the policy from the slip. In the case of an original insurance he generally agrees the wording of the policy with the leading underwriter before taking it to Lloyd's Policy Signing Office for signature".

"Almost invariably the slip provides that the wording of the policy is to be agreed by the leading underwriter. Where this is the case the leading underwriter may occasionally consent to some clause going into the policy which was not provided for by the slip, if in his judgement it would not affect the premium. So there is the possibility of minor variations being made in the contract of insurance when the terms of the policy are agreed."

The slip, by market agreement, must be prepared in a given format with the text under the following headings:

Type (of Risk)	Situation (geographical limits)
Form (policy wording to be used)	Conditions
Insured	Premium
Period	Brokerage
Interest	Information
Sum insured	

From this basic information and discussion with the broker the underwriter decides the rates and premiums at which he would be prepared to write the risk and dependent on the class of business, so the facts required to be shown under the various headings will alter.

## Rating Aviation Business

Normally in aviation insurance no proposal form is used, the usual procedure being the submission of a slip by brokers who handle the bulk of this type of business, and it is they who will provide the underwriter with the information he requires.

The underwriter will look at this information in the light of two main classifications:

- **Physical Hazard:** relating to the subject matter in question which can be ascertained from the information provided and the underwriter's knowledge of the type of aircraft or the applicable law involved.
- **Moral Hazard:** relating to the behaviour of the pilot and crew, the engineer in charge or the airline management.

Physical hazard can be assessed and rated accordingly. Moral hazard cannot, and therefore cannot be insured and so is dealt with by the application of conditions, warranties or exclusions to the policy. The object of rating is to produce a premium to cover the risk based on the theoretical probability for the events which may cause loss and having in mind the underwriter's expenses, the commission or brokerage he will be allowing and the need to accumulate both reserves against the future and/or other risks and a profit for shareholders or the syndicate's names.

For hull insurance and other material damage risks, the rate is given as a percentage of the insured value.

For Third Party Liability it is given usually as an in full amount though for bigger risks such as airlines it could well be an adjustable rate based on revenue miles flown.

Passenger Liability is an amount per seat calculated on the number of seats or alternatively, again as an adjustable rate on revenue passenger miles flown.

In the other categories discussed the rate is based on the information required to be given and can be either in full or adjusted on turnover as appropriate.



# Hull Business

The rate actually charged is generally a percentage of the aircraft value. An excess will also be held by the operator, which will be fixed at a stated level agreed at the date of commencement of the policy. The rating factors guide the underwriter in deciding upon both the level of this percentage and the amount of the excess to be charged.

## Rating Factors

The underwriter will try to base rates on the past experience of the assured (if available) but this is only used as a rough guide, due to the multitude of factors that alter from risk to risk.

The major factors to be taken into consideration, on a broad scale are as follows:

### ■ Large Airline Operators

- routes of the aircraft
- type and value of aircraft
- experience of pilot and crew, and
- experience of airline.

The basic factor comes down to good, indifferent or bad management.

### ■ Charter Operators: Small Airline Operators

Above factors plus:

- variety of aircraft types operated
- familiarity of pilot to aircraft, and
- airfield used, local conditions, and standards and equipment.

### ■ Industrial Aid Aircraft

- type of aircraft
- experience of pilot
- past record, and
- total flying time of aircraft.

### ■ Flying Clubs: Tuition flying

- type and value of aircraft
- pilot experience
- number of members in the club

- past experience of club
- geographical area used by club
- facilities at airfield, and
- experience of flying instructor.

The cover, the limits of liability and the excess held on the hull section of the policy, are also major rating factors.

### **Different Types of Risk Covered**

There are various types of aircraft that can be covered and they are looked at on an individual basis. The reason for this is that most of the risk factors for a risk are exclusive to that risk.

**Aeroplanes.** Size and value of aircraft will determine the individual excess held on each aircraft. The larger the value of the aircraft, the larger the excess held upon it. Seaplanes have the added risk of damage when moored due to the possibility of the aircraft sinking and hence becoming a total loss.

**Helicopters.** Generally attract high rates due to the historically bad experience of helicopter cover.

**Glider.** The material construction of the glider dictates the cost of repair, and hence is a rating factor. The method of launch and, again, proficiency of the pilot are all taken into consideration. Also, an additional hazard is the risk of damage in transit by road to and from the launch site and when collected after landing.

### **Other Types of Insurance**

Although there are the 'usual' covers available for an aircraft owner (hull, liability, cargo, etc) there also exist other covers, as is the case for marine insurance.

**Breach of Warranty Insurance.** Loans are raised to cover the initial cost of the aircraft. The creditors involved will ensure that they have a 'lien' held on the policy. The 'lien' ensures that the holder can take possession of the goods to compel satisfaction of rights. The lienholder will ensure that he/she is mentioned alongside the operator in the policy, in order to share the indemnity cover. However, should the original assured, ie. the aircraft operator, breach the policy, then although the lienholder has no part in this breach he will not be covered under the original policy. A breach of warranty insurance will cover the lienholder for this possible outcome.

**Loss of Use Insurance.** This covers the loss of earning power attributable to an aircraft being out of action. This insurance is paid when the aircraft is either awaiting or undergoing repairs following an accident. This is similar to Business Interruption insurance except a simple daily fee is paid which is agreed upon at the commencement of the risk. The waiting period and for how long the benefit is payable are major factors.

**Loss of Profits Insurance.** As 'loss of use insurance' but covering loss of profits.

**Deductible Insurance.** In effect, the underwriter will need the same basic information as for hull insurance, with the difference that the hull underwriter, when giving his terms, will have imposed the deductible whereas here the underwriter is being asked to give a price to reduce it to what the insured considers a more acceptable level.

**Loss of Licence.** Loss of licence cover relates to compensation to a pilot for loss of income if he fails a medical examination and loses his pilot's licence. For this form of cover the underwriter will insist on a completed proposal before offering terms. This asks for details of the type of licence, income and medical history of the pilot.

In the case of group schemes for a known airline risk, receipt of basic information as to claims experience and the numbers and ages of flight crew would enable indications of rating per age band to be given; this would still however be subject to receipt of individual proposals to set the terms for each individual relative to their medical condition.

# Liability

## Third Party - Public Liability

It is important for the underwriter to be aware of all the various aspects of the risk involved, but some of these aspects may not actually be directly incorporated into the rating process. They are useful for the underwriter to get a feel for the total exposure involved. For instance:

- knowing the total possible passenger capacity of an aircraft will give some measure of exposure
- knowing the type of regime that an insured operates (eg. Hague/Montreal/domestic), is essential in order that the insured carries at least minimum limits on his policy, and
- details of past total revenue passenger miles will help determine a minimum or deposit premium.

Rates are generally calculated at so much premium per thousand revenue passenger miles.

The 1929 Warsaw Convention set very low limits, reflecting the nature of air transport at the time with its limited finance and an acknowledged high personal risk. Subsequent international agreements have expanded that liability, but their application varies between countries. This can result in a situation in which different passengers on the same flight have tickets with differing liability.

## Products Legal Liability Insurance

Due to the long tail nature of this risk, cover is given on either a losses occurring or risks attaching basis. The risks attaching basis covers all aircraft built within the year of cover regardless of accident date.

# Reinsurance

Standard 'burning cost' methods are shown in order to calculate rates for excess of loss treaties, ie:

$$\text{Rate under treaty} = \frac{\text{Claims under treaty for last 5 years}}{\text{Ceding office premium income for last 5 years}} \times \text{grossing up factor}$$

The grossing up factor loads expenses and profit into the formula and is often taken as 100/70.

The excess of loss market seems to provide a balance of capacity. The excess of loss market can be split into a number of areas, with different marketing patterns at each level.

Original loss level:

- \$20m - \$100m

In 1984-85 and 1988-91 this area was priced well below burning cost, and contributed significantly to the lack of backbone shown by direct underwriters. Pricing is currently at, or slightly above, burning cost, with a very limited number of reinsurers. This therefore means that premium is normally a multiple of the indemnity and a number of free reinstatements are provided.

- \$100m - \$400m

This area has seen the effect of growing loss values, and therefore a number of reinsurers are moving upward and out of this band. However, capacity is still more than sufficient, especially since the leaders in this area will be looking to increase prices if at all possible.

Rates on line on this band vary considerably depending upon the level at which a particular layer attaches. The differential varies from 50% rate on line with reinstatement at \$100m to 20% on line excess of \$350m.

- \$400m - \$800m

This is arguably the most popular band in the current market. Some reinsurers are trying to increase their share at this level. While there is a feeling that exposure is gradually increasing, this area is one in which there is ample capacity. Rates on line currently in force at this level vary from 17.5%-8% with one reinstatement, or possibly two, at 100%.

Note: the above rates are given as an indication of recent underwriting but may now be out of date.

### **Final Numerical Evaluation of the Rate**

Extensive statistical details of aviation risks are not held and as the business is continuously changing, and hence producing new risks, underwriters coming to a final conclusion on the correct rate to charge, must use highly subject 'techniques'.

Useful statistics on aviation business are held by the International Union of Aviation Insurers, although these are only held on total losses or major claims.

# Space Risks and Commercial Satellite Insurance

The scope and structure of the cover available is constantly developing as is of course its subject matter. As a branch of insurance it is characterised by its total imbalance attributable to the small number of risks and huge sums insured.

These risks usually extend beyond the normal scope of cover of reinsurance treaties. Reinsurers, as with the direct insurers, undertake their own facultative risk assessments from extensive information presented as a proposal and arrive at their own decisions in each case.

The risks themselves divide into separate categories as follows:

**Erection "All Risks".** This covers the assembling and testing of launchers and satellites and their components. Testing includes functional testing, ie. testing under simulated conditions and may include static engine firings.

**Pre-Launch "All Risks".** This covers satellites and launchers whilst being transported from the manufacturer's premises to launch site, while being stored, assembled and prepared for launching. Cover ends not later than upon intentional engine firing. However, it may become effective again following an aborted launch (post-abort cover).

Cover is normally broken down into transit, storage and integration, usually with different sums insured and different rates applying to each phase.

**Launch "All Risks".** This covers launch, from time of ignition until the satellite reaches correct final orbit. It includes pre-operational tests and initial operations.

**In Orbit "All Risks".** This covers the operating phase.

**Agreed Values.** In all cases the sum insured is an Agreed Value based on the cost of a replacement launch, except that in the case of 'In Orbit' cover, as times goes by the sum insured is reduced to allow for the passing of the satellites original designed life.

**Losses Payable.** Total Loss occurs in the event of the satellite being physically destroyed or failing to become operative within an agreed period of time after launch. An insured loss also occurs in the event of the satellite only becoming partially serviceable or if technical problems rule out the achievement of the designed service life. Formulae are built into the wording to determine the appropriate percentage of the agreed value which underwriters will pay in the various circumstances, less any deductible that might have been imposed. It is accepted, particularly in communication satellites, that a certain amount of failure is almost inevitable and the insured usually has to face at least a certain number of transponder failures as a deductible.

**Premiums.** The actual assessment of premiums is based on the underwriter knowing and understanding the technology upon which all depends and being aware of the particular parameters of the specific risk he is rating.

For In Orbit insurance the most important criterion is the satellite's reliability as determined by the manufacturers. Moral hazard could play a part so 'In Orbit' policies are not issued for the whole of a satellite's designed service life but just for reasonable periods of time. Before renewal of any such policy there must be a thorough review of the existing technical position and an in-depth assessment of all malfunctions, temporary or otherwise, that have so far occurred.

**Liability Insurance.** This covers all third party legal liability claims that may arise from a satellite, its launch vehicle or parts thereof no matter against whom such claim is made. The policy, therefore, includes as joint insured the manufacturer, the launching state and all organisations rendering services during the launch and operation. Cover starts on the arrival of the satellite at launch site and ceases on expiry of the policy or upon complete destruction of the satellite and its launch vehicle.

**Warranty Insurance.** Those who buy equipment used in space flight obviously agree, before spending the huge sums required, a detailed specification with regard to its function and length of service life. They then usually pay an initial sum of cash 'up front' and then the balance of instalments as and when the agreed specifications are met. The manufacturers are interested in insuring against loss of these instalment payments under what is known as 'incentive payment insurance'.

Essentially, this type of cover is a performance guarantee and gets very close to being uninsurable. Expert evaluation of the risk, the contracts and specifications are required and the underwriters must be very clear on the question of moral hazard.

**Loss of Revenue Insurance.** This indemnifies the system owner/lessee against loss of revenue as a result of the failure of the satellite system. Only those losses of revenue should be insured which it can be proved would actually have been earned were it not for the failure of the system. It could be that the satellite was not being used to capacity but was still capable of fulfilling its tasks, or alternatively its tasks could be taken over by other satellites, so there may only be a minor loss. Again, as with all other aspects of this field of insurance, specialist knowledge of the craft, its specific functions and those of other craft in orbit is required to evaluate and underwrite the risk.



# Personal Accident

## Background

Personal Accident business written in aviation departments originated from the need for financial protection from the consequences of death or injury arising from flying. However, the policies written now often cover a much wider range of perils.

## Cover

The cover provided is usually in the form of a lump sum in the event of accidental death or injury, with the various levels of benefit defined in the policy. Cover may also be given for disability income benefits.

The period of cover may vary from annual policies to policies covering specific events, such as an air display or motor race.

There are normally exclusions for war and activities which are regarded as particularly hazardous, although it is possible to buy policies which specifically include such activities.

The cover may be offered on a particular individual or as a group scheme. In the case of aircraft operators, cover may also be on a 'seat' basis, where cover is given to whoever is occupying the seat at the time of accident.

## Underwriting/Pricing

The nature of the Personal Accident market is that it comprises a high volume of individual risks usually with relatively small individual risk size, although the sums insured for high worth individuals such as top sportsmen can be substantial and business is also written on a group basis. It might therefore be expected that the rating would be done using generalised linear modelling techniques taking account of various rating factors, as is now the norm for other personal lines business. However, whilst this is possible and done by the largest market writers, other underwriters believe that the data available to them are not sufficient for such a detailed analysis. This may be because much of the business written is on binders and line slips, with only summary data being made available to the underwriter, or because the underwriter only sees individual risk data for special cases for which the volume of comparable risks is regarded as giving sufficient experience to make a statistical analysis credible.

The premium to be charged will depend on the perils covered, level of benefits and period of the policy. There is also some variation in rates between territories. The main rating factors are the occupation of the assured and whether the policy is to cover any high risk activities, such as hang gliding or skiing. However, for some underwriters the majority of occupations would be covered at a standard rate. Occupations considered to be of higher risk attract

loadings on the standard rate, but it was suggested in some cases that these loadings were based more on what the market would tolerate than on any mathematical analysis of past experience.

Underwriters being asked to quote for personal accident cover for private flying would consider factors such as the pilot's experience, type of aircraft and equipment, where the aircraft is to be flown and for what purpose.

Group scheme rates may be experience adjusted on a burning cost basis.

## Current Situation

In the past decade, the worldwide volume of commercial air traffic has grown twice as rapidly as real Gross Domestic Produce (GDP). Although this growth rate will slacken in coming years, it will remain well above average: an overall rate of 1.7 times GDP is projected up to the year 2000, with traffic to and within the Far East region considered as holding the greatest potential. Because the volume of air traffic tends to reflect global economic trends, growth rates in the sector fluctuate more or less in parallel with those of the economy in general.

Covers in aviation insurance (which are expressed as fleet value for hull insurance and passenger kilometres for liability insurance) will reflect in large measure any fluctuations in traffic volume. However, this relationship does not extend to premium rates (the premium paid for a given cover): these show a much higher volatility than either the amounts covered or the "burn rate" (loss-to cover ratio).

There are reasons for such extreme price fluctuations specifically in the aviation insurance market: these are, on the one hand, "spillover" from the general insurance market, the financial markets and the overall economy, and on the other hand, a lack of transparency in the aviation insurance market, as well as the capacity adjustment costs associated with it. The spillover is due to composite insurance companies and reinsurers who tend to become active in the aviation insurance market at times when, with surplus capital at their disposal, they find that prices in their main areas of business are not particularly attractive. Conversely, when the general market promises better returns and capital is scarce, they retreat: aviation insurance thus takes on the character of a residual market. Insufficient information contributes significantly to the state of the aviation insurance market: as insurers underwrite only small shares, and as success for many aviation underwriters and brokers depend mainly on premium volume, there is a perception that rigorously correct premium rate calculation is scarcely worthwhile.

High premium rate volatility should not be expected to decrease substantially in the medium term: however, long-term contracts with prices oriented to loss histories should exert a smoothing effect.

To be successful in any cyclical market, the investor must commit his resources in a phase-conscious way. Ideally, the insurer should reduce his commitments during "soft" markets (phases of insufficient returns), and raise them in "hard" markets. However, the extent to which this should be done in order to reap the greatest benefit depends on the adjustment costs involved. In some cases, it may be more lucrative in the long term to accept losses in a soft market, as insurers who respond by curbing their business will be confronted with the difficult task of rebuilding at the beginning of the next hard-market phase.

A study by Sigma investigates the nature of aviation insurance cycles and provides an econometric forecast that can be used as a basis for defining a phase-oriented underwriting policy.

## Sigma Rating Model

In general terms, it can be said that the main factors influencing aviation insurance prices are loss experience, the global insurance cycle, financial market yields and shortages of capital in the aviation insurance market itself. The Sigma study briefly surveys each of these before proceeding to a consideration of how they may be quantified in a premium rate model.

The following is a summary of the factors considered in the Sigma model:

- Loss experience determining the long-term trend (Figure 5)
- Spillover effect from other branches
- Investment yields
- Deviations between effective and desired levels of capitalisation.

Lagged loss ratios are expected to influence rates because of the need by insurers to balance loss and premium volumes when actual losses deviate from expected losses. Regression of the hull rate logarithm shows a downward trend of 5.4% per annum which is incorporated in the model. Statistical evidence does not support assumptions of a rising trend in the liability burn rate.

The surplus in either US or British non-life markets can be used as a parallel indication for the aviation market. Price trends in aviation insurance parallel those in other markets, with turning points one or two years ahead because it is simpler and cheaper to vary commitments in the aviation market. Aviation insurance is characterised by short-term contracts, few long-term client relationships, low insurance costs in relation to clients' total costs and the lack of regulatory price approval procedures.

The long-term interest rate should be significant as an explanatory rate variable as rates are dependent on financial market performance.

A variable may be derived for available capacity by relating concrete capital data for aviation insurance to the accepted risk. Capacity is defined principally as the surplus or equity capital of the entire insurance market. Cycles are largely the result of capacity bottlenecks.

The data were not available to include the level of capitalisation for aviation insurance in the model. A proxy variable was used, MA(1), known in economic jargon as a "moving average of the first order" which estimates the logged deviation of the premium rates from their current values. Regression analysis of this variable shows that premium rates in any given year are positively correlated with those of the preceding year and use of the variable therefore effectively takes into account the previous year's capacity.

Based on the theoretical concepts presented, two single-equation models were estimated to explain the prices in the hull and liability business of aviation insurance. For the evaluation,

the study uses annual aviation insurance data from the years 1975-1995. The empirical results are presented schematically in Figures 3 and 4.

As shown in Figures 3 and 4, 1996 aviation insurance prices were predicted to fall below 1995 levels, with rates in hull insurance dipping more markedly than in liability. However, hull insurance prices should return to positive growth in 1997, whereas the liability rate will only turn the corner in 1998, a one-year lag. For 1995, all insurance branches (including aviation) are anticipating generally good results.

The forecast extends to the year 2000; however, prognoses after 1997/98 are subject to increasing uncertainty.

### **Sigma Empirical Equations of Regression**

Equation for the hull insurance premium rate:

$$\ln HR_t = 0.87 * \ln HR_{t-1} - 0.49 * \ln USSR_{t-1} + 0.48 * MA(1)$$

Basis of data: 21 observations, 1975-1995

Equation for the liability insurance premium rate (corrected for inflation):

$$\ln LR_t = 0.55 * \ln LR_{t-1} - 0.08 * \ln USI_t + 0.94 * MA(1)$$

Basis of data: 21 observations, 1975-1995

Where:	HR	premium rate, hull insurance
	LR	premium rate, liability insurance (corrected for inflation)
	HB	burn rate, hull insurance
	USSR	surplus of the US casualty and property market (corrected for inflation)
	USI	US interest rate (nominal, long term)
	MA(1)	proxy variable for capacity in the aviation market
	ln	natural logarithm

Note: Cointegration analyses were carried out for the variables in both equations, and in each case, long-term relationships were discovered.

## Cycles

Aviation insurance cycles are mainly the result of spillover from other markets; as such, they can only be avoided by alleviating cycles in those markets, or by doing away with the spillover mechanism itself. This second alternative would only be possible if the current information problems in the aviation insurance market could be solved, increasing transparency for all market participants.

The high degree of cyclicity in the aviation insurance market is costly. Drastic price fluctuations necessitate the investment of considerable effort to remain abreast of price developments and to plan intelligently. Also, negotiations with the airlines are particularly time-consuming due to the large amount of persuasion necessary. In periods of rising prices, the airlines ask why they should pay higher premiums despite the fact that the old premium rate had evidently been sufficient to cover the anticipated losses. When prices are falling, the airlines welcome the savings, but express doubts - not entirely unjustified - as to whether the low rate might not indeed be a dumping price: whether the promises of payment made at the time of the contract signing will indeed be honoured after a loss event. Finally, aviation insurance is subject to higher capital costs. As the "normal" volatility of claims experience and investment revenue is increased by the market's cyclical volatility, insurers are forced to demand a higher return.

Insurers could dampen fluctuations in aviation insurance prices by emphasising a long-term approach. It would be possible to distribute the cost for entering the aviation insurance market (personnel recruitment and training, client acquisition, etc) over a longer period, rather than writing the greater part off during the next soft market.

One instrument for accomplishing this is the long-term contract with prices defined on the basis of loss experience. Though the rates used in such contracts would fluctuate parallel to the burn rate they would be more stable than the prices observed to date, as these are subject to market aberrations (eg. too much or too little capacity). Chances for closing such contracts are particularly good when rates are sidestepping at about the middle of their range: in high premium rate periods, insurers would not be overly inclined to offer long-term contracts at favourable rates: while in times of low rates, almost no airline would opt for the comparatively expensive long-term contracts.

## Accumulation Risk

Consideration of the total airline insurance premium (of about \$1560m gross in 1994, excluding war risks) will show that this relatively modest premium covers enormous exposures; such as nearly \$400bn of aircraft hull values and the liability exposures from the carriage of passengers.

Both can produce huge accumulations. With a per passenger fatality liability cost of \$3m, and hull values of up to \$150m per wide body, a single major event could cost several billion dollars or many times the worldwide annual premium. Fortunately such a loss has not yet occurred, but a single airliner loss did cost nearly \$600m in 1985, which would be a much higher figure at today's levels.

The problem facing aviation insurers is the need to be able to meet large losses with a modest premium. Insurance companies try to limit their retained loss to a defined percentage of their total premiums. At the same time, their shareholder funds provide a solvency or safety margin to meet any undue loss experience. However, this margin is typically limited to between 50% and 125% of annual premiums.



## Market Statistics

In 1994, some 340,000 clients from the aeronautics and space sectors paid roughly \$5 billion in premiums to insure themselves against hull, liability and business interruption risks.

Table 1

Insured risk or sector	Gross premiums 1994 in \$m	No. of Insureds
Airlines	1,750	750
Aeronautical manufacturers	500	25,000
Airports, tank vehicles	175	750
Aerospace	525	250
Helicopters	360	3,000
General (private) aviation, USA	1,100	200,000
General aviation, other	500	110,000
War (additional coverage)	180	500
<b>Total, all insureds</b>	<b>5,090</b>	<b>339,750</b>

Over 50 % of total direct business derives from 460 major clients.

Table 2

Major airlines	1,500	200
Other major clients	1,210	260
<b>Total</b>	<b>2,710</b>	<b>460</b>

A considerable share of the direct premium volume is ceded: the direct market generates approximately \$2.1 billion in reinsurance premiums.

Table 3

Reinsurance instrument	Ceded premiums in 1994 in \$m	
Proportional reinsurance		1,500
XL		
to \$100 million	160	
\$100-500 million	120	
above \$500 million	100	
Gen. aviation, USA	70	
Retrocessions	150	
XL Total		600
Total: reinsurance and retrocessions		2,100

## Observations:

Table 1: Airlines account for more than a third of the direct premium volume

Table 2: Demonstrates the highly concentrated demand

Table 3: Proportional reinsurance predominates

Figure 1

### Airline Insurance: Hull Premiums and Claims

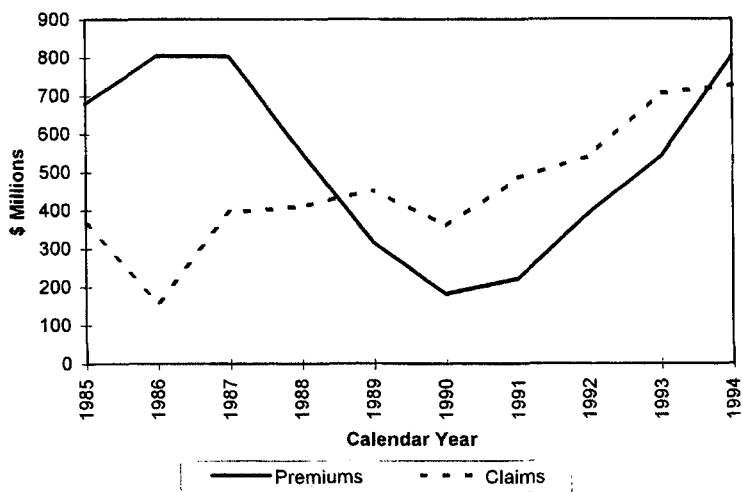
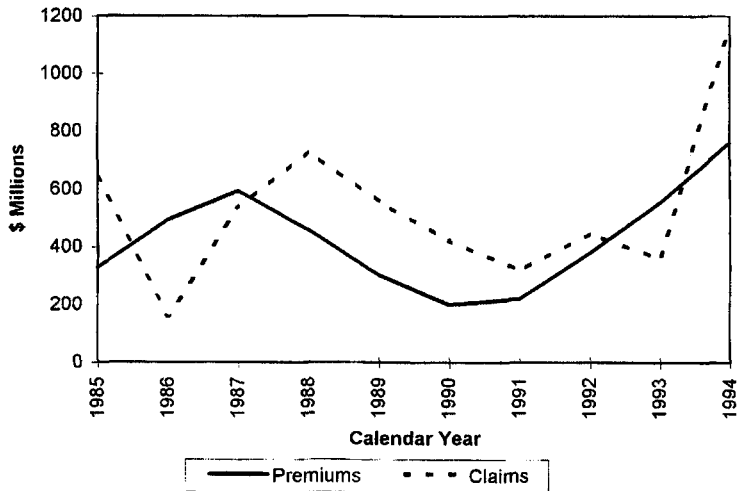
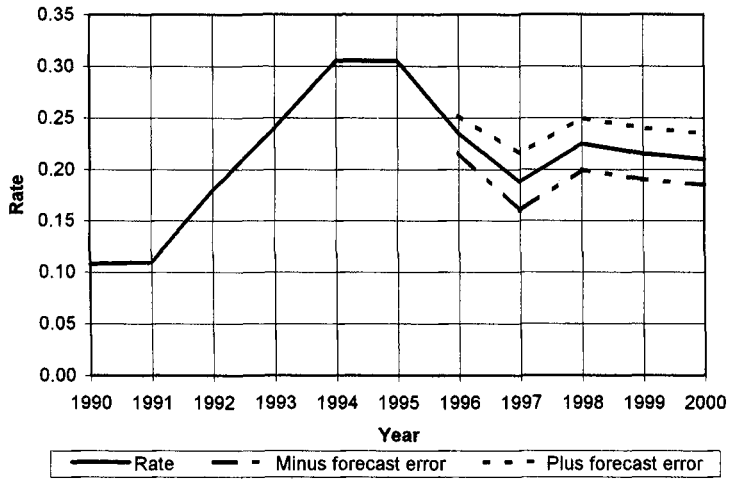


Figure 2

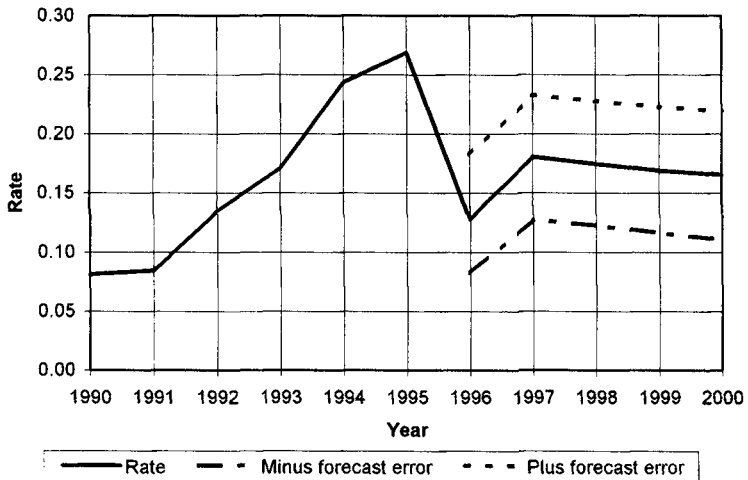
### Airline Insurance: Liability Premiums and Claims



**Figure 3 Liability Insurance Premium Rate**



**Figure 4 Hull Insurance Premium Rates**

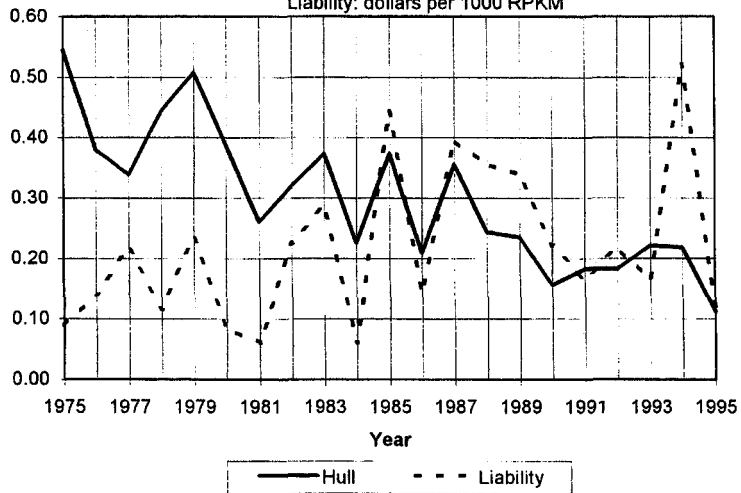


**Figure 5**

### Burn Rates

Hull: percent of insured value

Liability: dollars per 1000 RPKM



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