A comparison of Aviation Insurance to the rest of the General Insurance Sector in Kenya

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Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

OCHWADA IMAAN NASUBO

8/12/17

This research project has been submitted for examination with my approval as the Supervisor.

DR. LUCY MUTHONI

8/12/17

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Abstract

With the popularity of insurance cover booming in Kenya, individuals are scrambling to acquire insurance policy to protect their property, health and loved ones in the event of their death. The premium amount charged for a given cover differs from one insurance type to another due to the difference in risk factors. For Example, for motor insurance, the make, model, year and history of the car affect the premium. For fire, the items worth at the time of cover is a risk factor. For aviation, the type of aircraft, the experience of the pilot as well as the business involved (passenger/cargo).

This study's objective is to determine if aviation insurance is as risky as perceived and its comparison to other forms of general insurance. We aim to see how other forms of general insurance perform and how aviation insurance performs relative to that.

Keywords: Aviation risk, general insurance risk, underwriting, risk management

1. Introduction

Since the first passenger flight by Wilbur Wright in 1908, aviation has been a booming industry leading to the growth of other sectors. Industries affected are missiles and drones in defense, satellites in technology and space travel, exploration by unmanned space vehicles and telescopes and many other fields, as explained in McDonnell (2011). Apart from defense, space travel, and other scientific-related applications, aviation was also considered as a commercial venture by many investors. This led to commercial aviation which grew at an alarming rate as people sought faster and safer means of traveling. This allegation is supported by the International Air Transport Association (IATA) 2016 study, which predicts near doubling of air travelers in the next 19 years. The prediction is based on a 3.7% annual Compound Average Growth Rate (CAGR) noted in the release of the latest update to the association's 20-Year Air Passenger Forecast, IATA (2016). This study revealed that with the number of passengers anticipated to increase, there is also a need for a higher number of aircrew.

Increased air business has the undesired effect of greater risk in that there is a general view that aviation is very risky, given the anticipated claim amounts in the event of adversity. This is because most air accidents prove to be fatal with probabilities of aircraft, aircrew, passengers and/or cargo's survival is on the lower side. However, air accidents are the lowest recorded per annum over road, sea, and rail, thus, making it safer than any other form of transportation, as shown by Savage (2013).

Determination of risk and premium of any policy is determined by the underwriting section of insurance companies. With various models and programs, this may easily be achieved.

1.1. Problem Statement

There is little or no research in Kenya to show if aviation insurance is as risky as perceived and the reasons as to why it performs the way it does compare to its other general insurance counterparts. This study aims to compare a risky business, aviation insurance, and less risky ones. We will investigate the underwriting and risk management practice of both occupations and the outcome of the underwriting and risk practices.

1.2. Research Questions

1) Are Kenya's insurance industry's underwriting and risk management practices for aviation insurance different from other General Insurance business classes?
2) Is the aviation insurance industry more risky than other general insurance business?

1.3. Research Objectives

1) To determine if Kenya's insurance industry's underwriting and risk management practices for aviation insurance and other forms of general insurance differ.
2) To determine if the aviation industry is riskier than other general insurance business.

1.4. Significance of Study

1) The study will highlight the changes in premiums versus the claims and the growth rate to show the trends over the specified period.
2) The study aims at increasing the amount of literature and information pertaining underwriting and management of risks associated with aviation.
3) The results of this study will show how well aviation insurance is doing with respect to its counterparts.

2. Literature Review

2.1. History of aviation Insurance

Aviation insurance according to (Wells & Chadbourne, 1992) first cropped up in the early 20th century with the first ever aviation underwriting taking place under Lloyd's of London in 1911. This, however, did not last very long as poor weather conditions above an airstrip led to many plane crashes and damage that led to huge claims and after that, the insurer grew weary of aviation risk. After that however in 1924 new aviation insurers came up but in specialty meaning aviation insurance was all they took up. Soon after, the 1929 Warsaw Convention agreement made clear the terms of liability for any air carriage. This was the start of regulation for Aviation Insurance.

2.2. Types of Aviation Insurance

Aviation insurance is a cover that revolves around air transportation especially the operation of the aircraft. Unlike other forms of transportation, aviation insurance is divided so as to cater for all possible liabilities on their own (Gesell, 1993; Margo, Posner, Marland, & Chrystal, 2014; Wells & Chadbourne, 1992).

2.2.1. Public Liability Insurance

As per the name of this cover, it manages the liabilities that arrive at the event that an accident happens and those outside or does not operate the aircraft come at a loss. It is also called third-party liability. Like motor vehicle third party insurance, it does not cover the aircraft itself nor what or who was aboard it (Gesell, 1993).

2.2.2. Passenger Liability Insurance

This insurance aims to cover the passengers of the aircraft in a loss occurring event. It is usually sold on a seat to seat basis meaning it covers the exact number of passengers on the aircraft instead of the entire aircraft (Gesell, 1993).

2.2.3. Combined Single Limit

It is a combination of the two above mentioned types of cover. However, it has one maximum limit for both. This cover does come with an advantage in that it provides ease in liability payment in that in the event both or one occurs, claims will still be paid (Mo, 2003).

2.2.4. Ground Risk Hull Insurance

This covers damage that may occur while the aircraft is on the ground. It only covers the insured aircraft in the event of say weather damage like flooding, damage caused by other aircraft or damage caused by people like vandalism or theft of the aircraft or its parts (Mo, 2003).

2.2.5. In-flight Insurance

The last form covers the insured aircraft while it is airborne or during ground operations like taxying, takeoff, landing, ascent, decent or while it is at cruising altitude. This also includes when the plane is parking. The plane should basically be in motion for this cover to apply. Because of there are more risks to the aircraft while it is in motion, the premiums for this are higher than it's not in motion counterpart (Margo et al., 2014).

2.2.6. Loss of Use Insurance

This is an insurance cover that protects the owner in the event that the aircraft is not in operation while it is undergoing repairs or maintenance (Margo et al., 2014).

2.2.7. Loss of License

This is a cover for pilots in the event that they may no longer fly due to circumstances like poor or ill health or if he/she loses his license to fly. This only applies if this is the pilot's source of income (Lin & Chang, 2008). To protect the insurer, the complete details of the pilot will be required including medical history and the type of license issued to the pilot.

Group schemes for this are present to an airline but it also requires that past information on their flight crew be disclosed including claims experience.

2.3. Risks involved with aviation insurance and aviation underwriting

According to (lyons, et al., 1996), in aviation underwriting, exclusive to the airline industry, the underwriter considers two things:

- Physical Hazard: This is actual parts of the policy such as the type of plane and its age and condition.
- Moral Hazard: This is the intangible mainly the labor involved with the maintenance of the aircraft and its operation. This would include pilots and crew and the engineer in charge of the plane's maintenance. For this their mental and physical health is taken into consideration.

Looking at the risks associated with aircraft separately:

- Smaller planes versus larger aircraft: The larger the aircraft calls for larger excess because of the damage a larger plane can do and the increased number of passengers on board the flight. Larger aircrafts also tend to be more expensive with the Airbus A380 costing above USD 430 million.
- Type of plane: Sea aircraft experience a sinking risk that planes on land do not experience and helicopters have a relatively poor history with air disasters that they fetch a higher premium than its fixed-wing counterpart.
- The material of construction: Some planes use high-cost material that makes their premium rates than those that use lesser cost materials.
- Method of launch: some aircraft are launched from others like gliders and most planes propel themselves off the ground. The premiums and risks involved differ greatly.
- Finally, the experience and skill of the pilot: younger more inexperienced pilots tend to be riskier than their counterparts who may have the experience and skill to save the aircraft in the event that a disaster strikes (Eichenberger, 2011; Gesell, 1993; Margo et al., 2014).

According to Richardson (1930) aviation is one of many industries that have inadequate or doubtful information and confusion about the practice. Underwriters depend on information to be able to calculate the premiums of the various policyholders. In this case, the rest of general

insurance is easily explained without technicality and thus will have a lower risk premium based on this factor. To help out with this risk, insurers pay premiums to reinsurers to spread out the risk involved with those policies.

With all on how risky this class of business is, air transportation is known to be one of the safest forms of transport in the world. A good case study would be of the year 2016 where there were 16 fatal air crashes with 268 fatalities against the 3.7 billion air passengers in the same year (International Air Transport Association, 2017). According to (Reed, 2016), the United States alone had no fatal crashes at all. This means that if the premiums are based on these statistics, then aviation insurance should have low premiums. In this study, we hope to analyze data on general insurance and aviation insurance and establish if indeed, aviation is a riskier business than other general business.

2.4. Aviation Insurance versus other General Insurance business

When it comes to aviation insurance, a lot of processes are involved before an insurer actually accepts a policy into the contract. The best way for an aircraft owner to obtain the best insurer for themselves is through an insurance broker. Insurance brokers are businesses that seek cover on behalf of the client, unlike insurance agents that seek to sell insurance on behalf of the insurance company. The brokers in the aviation insurance industry assist the policy seeker through all the procedures involved while getting a commission. They will acquire all the information insurers deem necessary and then send it off to them (Lin & Chang, 2008). The broker will then receive underwriters' feedback on the level of risk that this potential policyholder has and chooses the best fit for the aircraft owner

In other general insurance field, the broker isn't a huge player in the processes with companies having the ability to directly approach a client or vice versa or using other sales means such as the tied salesforce.

2.5. Recent developments in aviation insurance

There have been some issues cropping up including over insuring aircraft by insurers. This occurs when an insurer charges higher premiums than what is required. This may not seem a big issue at

first but the danger lies with how the insurer will handle the situation when a claim occurs. Because the insurer may end up repairing an aircraft that should be written off (Mo, 2003).

Another rising issue is the coverage of contract pilots when the staff that should be covered should be on the company's payroll. According to brokers, it is safer to specify that the company has contract pilots from the very beginning. Another choice could be to hire pilots that have cover from an agency that they work for (Flouris, Hayes, Pukthuanthong□Le, Thiengtham, & Walker, 2009).

The world is currently experiencing political instability and with technological developments, ground to air missiles, hijacking amongst other things are high possibilities. Because of these occurrences, aviation insurers have a war exclusion clause (War, Hi-Jacking, and other Perils Exclusion Clause) that protects them from making payments in the event that damage or hull loss happens to an aircraft with war being the primary contributing factor (Flouris et al., 2009).

3. Methodology

This part outlines the population, sampling methods, research design, and data analysis methods.

3.1. Population

The population of this study is all the companies in the Kenyan general insurance industry.

3.2. Sampling

We used a sample that would provide information from the recent past dating back six years for the quantitative data and for the questionnaire, simple random sampling was used.

3.3. Research design

The research design is the blanket strategy that will be used to bring the different components of the study together to bring out the desired outcome. In this case, the study is descriptive and quantitative in nature. We would like to see if the current risk 'stigma' associated with aviation is deserved or if it is a misconception. This design has been selected because the variables involved cannot be influenced by the researcher (Kothari, 2004).

3.4. Data Collection and Procedure

3.4.1. Sources of Data

The source of data in this study is both primary and secondary. It was generated in two forms: questionnaires submitted to insurers, and industry data from the Insurance Revenue Authority.

3.4.2. Data Collection Method

The method used to collect the primary data is questionnaires. These questionnaires were sent to insurance-based respondents to fill, with both open-ended and close-ended questions. The secondary data which comprised of overall industry data on claims and premiums amongst other variables were provided by the Kenya Reinsurance Ltd.

3.5. Data Analysis Methods

In this part, we aim to use models to determine the credibility of the premium with respect to the claims made in those periods. It also aims to show how loss ratios work in comparing two or more types of business on their performance.

3.5.1. Empirical Bayes Credibility Theory

3.5.1.1. Introduction

To calculate a premium that takes into account both the premium and the claims, we are going to use Credibility Theory. Credibility theory is used to quantify how unique a particular outcome will be compared to an outcome deemed as typical. It was developed originally as a method to calculate the risk premium by combining the individual risk experience with the class risk experience.

In Bayesian credibility, a probability is assigned to each class. Then the likelihood of an experience is calculated for each experience. Next, the likelihood of that experience is determined by all the given classes. Finally, one can determine the probability of the class given the probability of experience.

When the premium charged under full credibility is not an appropriate reflection of the actual premium, an alternative remedy is a partial credibility.

Under partial credibility the premium is a weighted average of the past experience X and the manual premium,

$$\mu = M > 0 \tag{3.1}$$

$$P_c = zX + (1 - z)\mu \tag{3.2}$$

Where:

Z a number between zero and one is called the credibility factor

P_c is the credibility premium

X Observed Premium

μ Experience

Note that when $Z = 1$, the partial credibility coincides with full credibility. The attractive features of the credibility premium formula are its simplicity and, provided X and μ are obviously reasonable alternatives, the ease with which it can be explained to a lay person.

3.5.1.2. The Model

The EBCT is one of two methods to estimate the credibility premium of Z. The other method is known as classical Bayesian credibility theory. We use EBCT method because it is not restricted to the two models as used in the Bayesian credibility theorem, the Poisson/Gamma and the Normal/Normal. This, therefore, gives room to be able to estimate Z without making the assumption that it has to fall under either of those distributions. The model is as shown below:

$$E(P) = (1 - Z)E[m(\theta)] + ZX_i \quad (3.3)$$

$$Z = \frac{n}{n+E[s^2(\theta)]/var[m(\theta)]} \quad (3.4)$$

$$X_i = \sum_{j=1}^{n} \frac{X_{ij}}{n} \quad (3.5)$$

Where:

$E(P)$ is the Credibility Premium

$E[m(\theta)]$ is the average (over the distribution of θ) of the values of $m(\theta)$ for different value of θ. Its estimator is $\bar{X}$

$E[s^2(\theta)]$ is the average variability of values from year to year for a single risk. Its estimator is: $N^{-1}\sum_{i=1}^{N}(n - 1)^{-1}\sum_{j=1}^{n}(X_{ij} - \bar{X}_i)^2$ (3.6)

$Var[m(\theta)]$ is the variability of average data values for different risk and its estimator is:

$$(N - 1)^{-1}\sum_{i=1}^{N}(\bar{X}_i - \bar{X})^2 - (Nn)^{-1}\sum_{i=1}^{N}(n - 1)^{-1}\sum_{j=1}^{n}(X_{ij} - \bar{X}_i)^2 \quad (3.7)$$

Z is the credibility value

X_i is the average experience values (premiums)

θ is the risk parameter

3.5.2. Loss Ratio Comparison

The loss ratio of a company is how much claims they are paying out with respect to the size of premiums they are receiving. It is a means in which the insurer and all involved with it can analyze the profitability of the company. The lower the figure computed from the formula, the better the company is performing.

It is given by

$$loss\ ratio = \frac{claims\ paid + additional\ expenses}{premiums\ paid}$$

The loss ratios provided by the IRA will be compared to that of the global Aviation Insurance Market.

Under this we will compare the ratios at face value to each other and then to the global ratios to see if they mirror each other.

3.5.3. Frechet Distance

We will further use Frechet Distance calculations to assist in comparing claims curves all classes of business present in the IRA data. Frechet distance is a measure of the similarity between curves that takes into account the location and order of the points along the curves. Let S be a metric space. A curve A in S is a continuous map from the unit interval into S, i.e. $A: [0,1] \rightarrow S$. A parameterization α of $[0,1]$ is a continuous, non-decreasing, surjection $\alpha: [0,1] \rightarrow [0,1]$. Let A and B be two given curves in S. Then, the Frechet distance between A and B is defined as the infimum over all reparameterizations α and β of $[0,1]$ of the maximum over all $t \in [0,1]$of the distance in S between $A(\alpha(t))$ and $B(\beta(t))$. In mathematical notation, the Frechet distance $F(A,B)$ is defined by:

$$F(A,B) = \underbrace{inf}_{\alpha,\beta}\ \underbrace{max}_{t\in[0,1]}\ \{d(A(\alpha(t)), B(\beta(t))\} \tag{3.8}$$

Where d is the distance function of S.

In this analysis, the loss ratios of the classes of business in general insurance will be compared to aviation insurance to determine which has the greatest difference from it. And which is the most similar overall.

4. Data Analysis

4.1. Questionnaire Report

The questionnaire provided qualitative information from insurance companies pertaining the differences in underwriting outcomes for both aviation insurance and other classes. This questionnaire was made available to respondents via Google Forms.

Also from the questionnaire, 85.7% of the respondents agreeing that aviation is riskier than any other class. They gave reasons like the travel factor that left them vulnerable to the risks of the geographical location at that given time such natural disasters and conflict with one referencing the Iran Air plane that was shot down by the American Navy during the Iranian war. They also say that although the accidents are of low frequency, the outcomes are mostly fatal with claims being definite in the event. The 14.3% that said aviation is not riskier than the other classes gave reason being their accident frequency is extremely low. One respondent, however mentioned that aviation is not necessarily riskier but their conditions of work and the value of aircraft and cargo make it riskier business.

64.3% of respondents agree that aviation premium determination is different from that of other classes. Their reasoning was because the according to them it is because of;

- High premium loadings especially for personal accident cover where an aircraft accident leads to a definite claim
- The claims from aviation are sure to be higher than that of other business and needs to be reflected in their premium
- Their sum assured is also bound to be higher for aviation business than other forms of business
- Aviation has higher exposure risk

Respondents mentioned the following factors that would contribute to aviation risk determination:

- Aircraft Make
- Aircraft Model

- Claims history
- Maintenance
- Type of courier (cargo, passenger or both)
- Destinations
- Flight crew experience
- Number of flights within a specific duration

4.2. EBCT Excel Analysis

For the EBCT analysis, Microsoft Excel software was used to make a model incorporating all the elements of the theorem.

Aviation Statistics						
	Years					
	2016	2015	2014	2013	2012	2011
Premiums	1476801000	1484892000	1.201E+09	1.13E+09	7.91E+08	6.24E+08
Premium Var Calc	8.60259E+17	8.7533E+17	4.242E+17	3.34E+17	5.84E+16	5.52E+15
Claims	-69815000	-12888000	-5915000	-1.5E+07	-4377000	-4559000
Claims Var Calc	3.83302E+17	3.1605E+17	3.083E+17	3.19E+17	3.07E+17	3.07E+17
Retention	3.1	1.9	0.5	1.8	4.9	0.5
Outward Reinsurance	1433232000	1513491000	1.277E+09	1.12E+09	7.56E+08	6.73E+08
Net Earned Premiums	44137000	39020000	26351000	8261000	26029000	3449000

Table 1: Individual values to Mean-Variance

This table shows the calculation to find the variance between the individual values x_i and the mean of the individual values.

The claims were taken to be negative values to show that they are a cash outflow and not a cash inflow. With this, it only affects the mean of the individual values and the individual variance as it is dependent on the mean.

EBCT Analysis				
	Row Mean	Sum of Row Variance	Row Mean - Mean	Row Variance to Mean
Premium	1117381500	2.55798E+18	568082250.00	3.22717E+17
Claims	18783000	1.93953E+18	-530516250	2.81447E+17
Mean of all values	549299250			
Totals:	1136164500	4.49751E+18		6.04165E+17
N	2			
n	6			

Table 2: Summation Table

In this table, the variables N and n are depicted in the final formula. The N is the number of risks involved in the analysis and n the number of years.

From the above table:

$\sum_{j=1}^{n}(X_{ij} - \bar{X}_{\iota})^2$: 4.49751E+18

$\sum_{i=1}^{N}(\bar{X}_i - \bar{X})^2$: 6.04165E+17

Finally, we can use the values obtained to find the credibility premium with the Z value.

Calculations	
E[m(θ)]	549299250
E[S^2(θ)]	4.49751E+17
Var[m(θ)	5.29206E+17
Z value	0.875930427
1 – Z	0.124069573
Credibility Premium	1046899778
Actual Premium vs Credibility Premium	70481722.36

Table 3: EBCT values

From the calculations, we can see that Z has a strong value at 0.8827 which took the credibility premium to a similar value as well. The difference was quite severe at KES 70.48 million, however, Insurance is a profit making business and an assumption is that the value is gross earned premiums. The net earned premiums average over the six years is KES 24.54 million. It should, however, be noted that this computation does not include the expenses that the insurer pays out such as commissions, administration and fund management expenses, and taxes. It is thus safe to say that

the underwriting practices of the aviation industry are correct and that the losses are due to extremely high levels of uncertainty and the very big claim sizes in comparison to their other industry counterparts.

4.3. Comparison using ratios

4.3.1. Aviation versus other classes of general business

Aviation showed highly fluctuating loss ratios but as mentioned in the review, aviation insurance is risky. This is shown in the huge graph jumps from year to year.

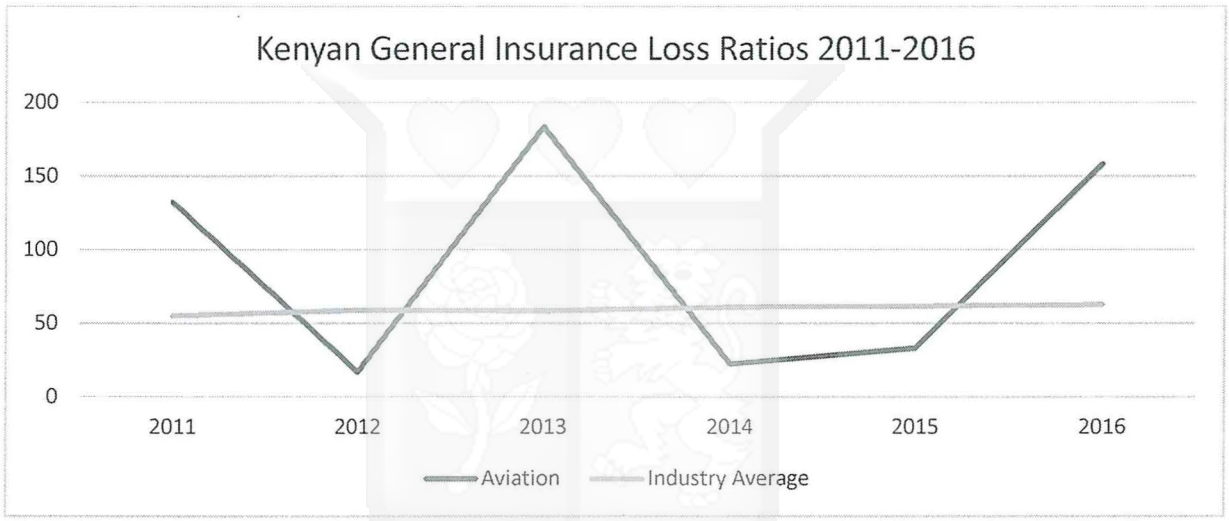

Figure 1: Kenyan Aviation Industry vs Industry Average Loss Ratios 2011-2016

Compared to the other classes of General Insurance business, Aviation Insurance is risky due to the huge shifts but the jumps are sometimes significantly lower than the industry averages of that year including 2012, 2014 and 2015.

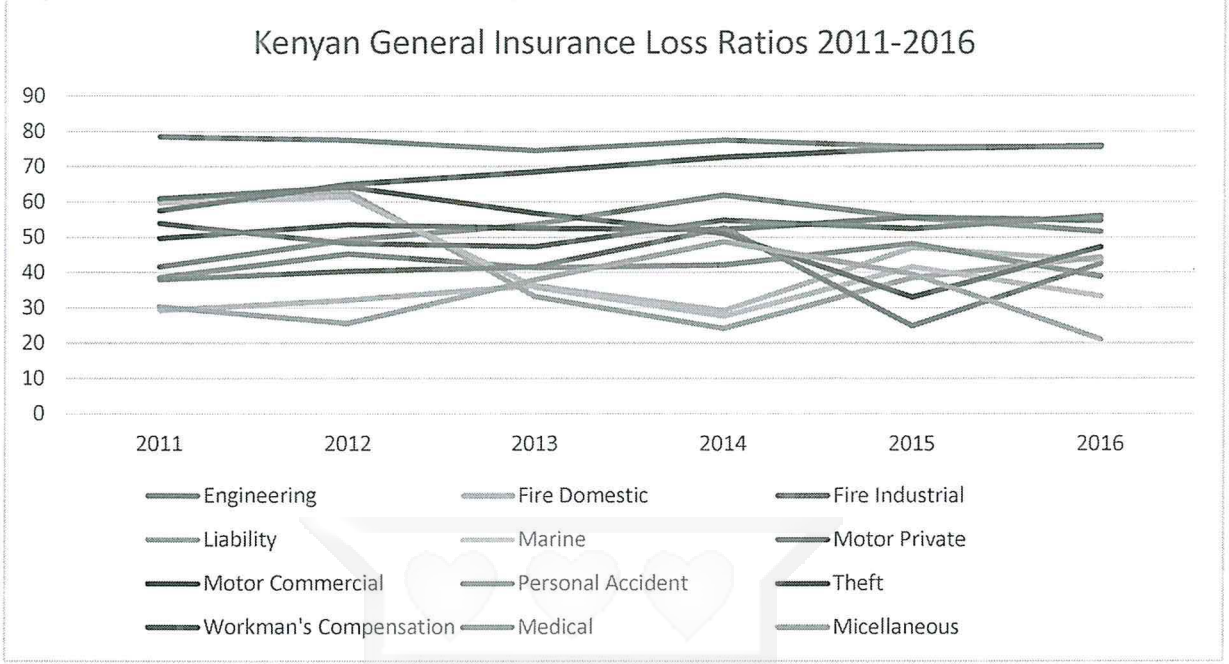

Figure 2: Kenyan General Insurance Business Loss Ratios 2011-2016

The graph shows relatively stable loss ratios for all other classes of business with no major hikes or dips relative to Aviation Insurance. The changes all seem to happen gradually.

4.3.2. Comparison to Global Loss Ratios for the Industry

To see if the loss ratios in the Kenyan Aviation Industry are following normal global trends and shifts, a comparison has to be conducted.

When the two graphs are put side by side, the Kenyan curve does not at all follow that of the global loss ratios.

For Kenyan graph, refer to figure 1.

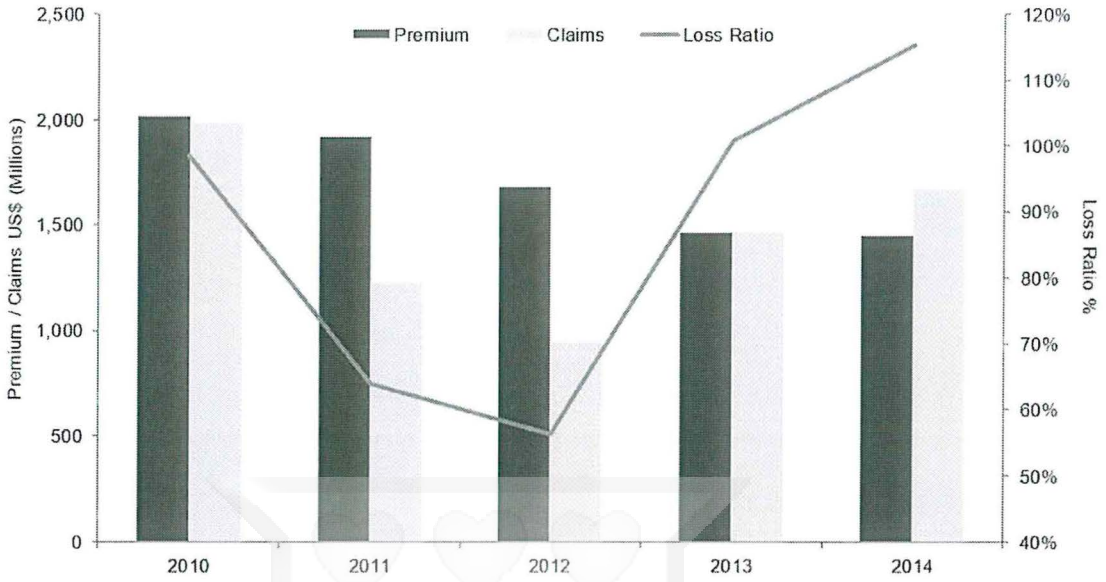

Figure 3: Global Aviation Industry Loss Ratios 2010-2014 (Source: The Willis Airline Insight)

When the globe experienced hikes in 2013, Kenya experienced it with the world at a higher level. Similarly, in 2012 when the world experience a low ratio, so did Kenya. However, during the years 2011 and 2014 the loss ratios moved in polar opposite directions.

Just like the Kenyan market we notice that the global market is also highly volatile.

4.4. Frechet Distance

The Frechet Distance was carried out to compare Aviation Insurance to all other classes of General Insurance with the following result (in descending order):

Medical:	173.4334
Motor Private:	179.3729
Theft:	190.9383
Motor Commercial:	193.3513
Wiba:	193.6074

Engineering:	198.723
Public Liability:	206.9355
Personal Accident:	209.4603
Fire Industrial:	211.1607
Marine:	211.3814
Fire Domestic:	214.1464
Miscellaneous:	226.128

From the analysis, it is seen that the closest of the General Insurance Classes to Aviation Insurance is Medical Insurance and the furthest is Fire Domestic (after Miscellaneous). Similarity in this case taking into account its characteristics and attributes.

5. Conclusion

5.1. Conclusion

In conclusion to the analysis carried out, it is noted that indeed the aviation industry is a volatile one. In the event that it performs well, profits are handsome but in the event that there are major claims of large sizes, then the insurer may end up paying for the claims above the premium.

Answering the research questions:

Kenya's underwriting and risk management practices are not biased and are conducted justly and yes, the Aviation Insurance business is a very risky one compared to all other forms of business in the General Insurance Sector.

5.2. Recommendations

The aviation insurance industry is highly volatile but relating the outcomes to certain events that could possibly affect it would be highly helpful by providing literature for future research.

Appendix

Industry Questionnaire

Questionnaire (Industry based)

Thank you for accepting to check out our questionnaire.

We carrying out a research titled: "Underwriting and Management of Aviation Risk in Kenyan Insurance Industry." In order for us to succeed in carrying out this study, we need you to kindly fill the attached form so as to enable us to conduct statistical analysis of perception versus fact.

1. a) Full name (Surname, First, Other)

b) Job title

c) Department?

d) Company?

2. (i) Does your company provide any insurance services to the aviation industry?

(ii) If the answer to the question above is yes, kindly list them.

(iii) If the answer is no, how do you handle aviation business who seek insurance from you?

3. a) In your view, would you consider aviation insurance to be riskier other classes of General Insurances?

b) Explain your answer to question 3a) above.

4. What do you put into consideration when determining the riskiness of a potential client?

5. a) Would you say that there is a big difference between the premium paid by the aviation insurance and other classes due to perceived increased risk?

b) Kindly explain your answer above.

R Codes for Frechet Distance

```
Aviation<-c(132.2,16.8,183.3,22.4,33,158.2)

Aviation

Engineering<-c(41.6,49.3,53.7,61.9,55.5,51.6)

Engineering

Fire_Domestic<-c(29.3,32.2,36.3,29.2,47.1,43.4)

Fire_Domestic

Fire_Commercial<-c(38.6,45.3,41.3,42.1,48.2,38.9)

Fire_Commercial

Public_Liability<-c(60.3,62.8,33.2,24.2,38.5,44.3)

Public_Liability

Marine<-c(59.7,61.5,35.9,27.6,41.6,33.3)

Marine

Motor_Private<-c(57.5,65,68.5,72.7,75.1,75.8)

Motor_Private

Motor_Commercial<-c(49.7,53.6,52.5,52.2,55.7,54.7)

Motor_Commercial

Personal<-c(38,40.4,41.6,52.6,24.9,42.5)

Personal

Medical<-c(78.5,77.5,74.5,77.5,75.6,75.6)
```

```
Medical

Theft<-c(61,64.2,56.8,51,33.1,47.2)

Theft

WIBA<-c(53.9,48.2,47.3,54.8,52.4,56)

WIBA

Miscellaneous<-c(30.3,25.6,37.9,48.7,39.6,21.1)

Miscellaneous

data<-matrix(Aviation,1)

data1<-matrix(Engineering,1)

data2<-matrix(Fire_Domestic,1)

data3<-matrix(Fire_Commercial,1)

data4<-matrix(Public_Liability,1)

data5<-matrix(Marine,1)

data6<-matrix(Motor_Private,1)

data7<-matrix(Motor_Commercial,1)

data8<-matrix(Personal,1)

data9<-matrix(Medical,1)

data10<-matrix(Theft,1)

data11<-matrix(WIBA,1)

data12<-matrix(Miscellaneous,1)
```

```
dEngineering<-Frechet(data,data1)

dEngineering

dFire_Domestic<-Frechet(data,data2)

dFire_Domestic

dFire_Commercial<-Frechet(data,data3)

dFire_Commercial

dPublic_Liability<-Frechet(data,data4)

dPublic_Liability

dMarine<-Frechet(data,data5)

dMarine

dMotor_Private<-Frechet(data,data6)

dMotor_Private

dMotor_Commercial<-Frechet(data,data7)

dMotor_Commercial

dPersonal<-Frechet(data,data8)

dPersonal

dMedical<-Frechet(data,data9)

dMedical

dTheft<-Frechet(data,data10)

dTheft
```

```
dWIBA<-Frechet(data,data11)

dWIBA

dMiscellenous<-Frechet(data,data12)

dMiscellenous
```

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