

UNIVERSITY OF GHANA

**IMPACT OF EXTREME EVENTS ON THE INSURANCE MARKET IN
GHANA**

BY

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DECLARATION

I hereby declare that this thesis is a record of an original work done by me and the results embodied in this thesis have not been submitted in whole or part to any other university or institute for the award of any degree.

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CERTIFICATION

We hereby certify that this thesis was prepared from the candidate's own work and supervised in accordance with guidelines on supervision of thesis laid down by the University of Ghana.

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ABSTRACT

The study examines how the frequent occurrence and severity of extreme events affect the demand, supply and the profitability of insurance companies in Ghana. Secondary data collected from NIC, NADMO, Ghana Statistical Service and Open Data Initiative on eight classes of business as well as thirteen life and non-life companies over the period 2007 – 2016 was analysed using a panel regression method.

The results indicated that the unexpected frequency of extreme events negatively affected both the demand and supply of insurance but had no influence on insurers' profitability. Also, the unexpected severity of extreme events significantly decreased the profitability of life insurers but had no effect on non-life insurers.

Therefore other avenues, such as public awareness and education can be explored in order to increase insurance demand and ensure the availability and affordability of insurance to all. Insurers are also encouraged to consistently assess the exposures of their investments, capital and reserves to extreme events.

Keywords and phrases: extreme events, panel regression, profitability, reserves, severity, vulnerability

DEDICATION

I dedicate this work to my parents, Mr. Daniel Yamoah and Mrs. Esther Yamoah, and Mr. Ebenezer Nyarko Kumi.

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LIST OF ABBREVIATION

AIC	Akaike Information Criteria
AMS	American Meteorological Society
BIC	Bayesian Information Criterion
CR	Claims Ratio
CRED	Centre for Research on the Epidemiology of Disasters
CSIL	Cambridge Institute for Sustainability Leadership
ERM	Extreme Risk Management
EVT	Extreme Value Theory
EY	Ernst & Young
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Reduction and Recovery
GSS	Ghana Statistical Service
HHI	Herfindahl-Hirschman Index
IFC	International Financial Corporation
IFRC	International Federation of Red Cross
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
NADMO	National Disaster Management Organisation
OFDA	Office of Foreign Disaster Assistance
OLS	Ordinary Least Square
ROA	Return On Asset
ROE	Return On Equity
ROI	Return On Investment
TT-DEWCE	Task Team on the Definition of Extreme Weather and Climate Events

UNDP	United Nations Development Programme
UNEP FI	United Nations Environment Programme Finance Initiative
WMO	World Meteorological Organisation
WTP	Willingness To Pay

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Extreme events have long been the focus of atmospheric sciences and have raised considerable concern of the public, policy makers and scientists because of their significant social and economic impacts. According to Stephenson (2008), extreme events are relatively difficult to define even though they are generally easy to recognize. However, Stephenson (2008) defines extreme events as events that have extreme values of certain important meteorological variables, such as, large amount of precipitation (e.g. flood), high wind speeds (e.g. cyclones) and high temperatures (e.g. heat waves). Task Team on the Definition of Extreme Weather and Climate Events (TT-DEWCE) (2016) further defines an extreme event as any event with high economic loss. Extreme event is also seen as a severe event with low probability of incidence but potentially high associated sicknesses, mortality or economic loss (Siri, Newell, Proust, & Capon, 2016). Extreme events include not only meteorological (extreme temperature, floods), but climatological (drought, famine), geological (earthquakes), epidemiological (epidemic), and anthropogenic (terrorism, fire) events. Various processes give rise to extreme events and according to Stephenson (2008), the movement of a weather system into a new spatial location or into a different time period and the simultaneous coincidence of several non-extreme conditions can cause extreme events. Also, slower disparities in the climate system causing persistence or frequent recurrence of weather can lead to recurring extremes.

Extreme events cause both direct and indirect damages to economies and individuals. Direct damages can be seen as the loss of life, injury, damages to raw materials, capital and other fixed assets as a result of these events. Indirect damages include loss of productivity and

income due to the destruction of resources (Cavallo & Noy, 2009). Droughts, floods, windstorms, extreme temperatures, wildfires and epidemics have caused about 8,835 disasters, 1.94 million deaths and US\$ 2.4 trillion of economic losses globally from 1970 to 2012 (WMO, 2014).

The frequency of extreme weather events rose from 38 in 1980 to 174 events in 2014 globally which is more than 400 percentage increase (Müller-Fürstenberger & Schumacher, 2015).

The rise in the severity and occurrence of extreme events can be attributed to urbanization of the population, growing population intensity and assets in risky areas, and the possible impact of climate change (global warming) (Kunreuther & Michel-Kerjan, 2009; Cummins & Mahul, 2009). Increase losses from extreme events for the past 20 years have made developing countries particularly helpless since they depend highly on agriculture, lack adequate resources to prepare and respond effectively to emergency (Courbage & Mahul, 2013).

According to the report from the UNDP (2013), Ghana's main exposure to extreme events is flooding, epidemics, wildfires and drought. Ghana has experienced 29 disasters over a 30 year-period from 1980 to 2010. Of the 29 disasters, 14 were epidemics, 13 were floods and there was one each of drought and wildfire (Disaster and Risk Profile:Preventionweb, 2017).

In 1983 Ghana experienced a drought which affected 12.5 million people. In June 1995, the entire city of Accra was flooded leaving about 70 people dead. Again, in 2007 the Upper East, Northern, Upper West, and some parts of the Western regions experienced massive floods causing the death of about 56 people and affecting about 332,600 people (Boah-Mensah, 2017). The most recent disaster which hit the country hardest was the June 3rd, 2015 flood and fire disaster. More than 200 lives and several properties were destroyed as a result of the disaster (Boah-Mensah, 2017).

1.2 Statement of the Problem

Insurance is one of the main ways in which societies currently deal with the risks of extreme hazards, such as windstorms and floods as well as the losses associated with them (UNEP FI, 2014; Linnerooth-Baye & Mechler 2009). According to Coomber (2006), insurance price and diversify risk faced by the society, and its capital base is used to partially absorb the impact of unavoidable shocks. There are various ways in which insurance provides assistance for the loss of assets, incomes and lives due to extreme events. Right after a disaster, individuals are indemnified and restored back to their original financial position before the loss. This aids in protecting the livelihood of individuals and preventing business interruptions. Also, government is able to finance the loss associated with these events and avoid fiscal deficits (Schäfer, Waters, Kreft, & Zissener, 2016; Linnerooth-Baye & Mechler, 2009). Though the global losses from a disastrous event cannot be prevented by insurance, by paying a small amount of premium those at risk can be protected against a large loss which can adversely affect their finances (Kunreuther & Michel-Kerjan, 2007).

The Intergovernmental Panel on Climate Change has predicted an increase in the risks associated with extreme events as the global mean temperature rises (IPCC, 2014). This is likely to cause a significant surge in losses in the coming years, increasing the vulnerability of developing countries to extreme events and so, the role of insurance is very crucial. However, insurance is practically very low in developing countries even though they bear a greater percentage of the burden, in terms of both casualties and direct economic damages (Linnerooth-Bayer & Mechler, 2007; Lester, 2009; Cavallo & Noy, 2009). Cummins and Mahul (2009) in their book made known that developed economies mostly use compulsory insurance to cover about 40 percent of the direct losses from natural disasters. On the contrary, less than 10 percent of these losses are covered by insurance in middle-income countries and less than 5 percent in low-income countries.

Due to the lack of insurance cover, rebuilding after an extreme event may be delayed and may negatively impact economic growth in developing countries in the long run. To ease their burdens, governments of developing countries, such as Ghana, are promoting insurance as one of the key ways of financing extreme events risks (Ghana National Climate Change Policy, 2012). Currently, insurance markets in developing economies are growing rapidly even though they account for only about 16 percent of the global insurance market (International Financial Corporation, 2016). The question therefore is, whether extreme events can affect the growth and sustainability of the insurance market especially in developing countries, and if so, what mechanisms of demand and supply reactions comprise the effect. Furthermore, how will extreme events affect the industry's ability to cover future losses? A study by Turner and Deng (2015) shows that a striking risk of high intensity from a major event could raise risk awareness and therefore increase insurance demand. On the supply side, the depletion of capital reserves by a major loss can intensify competition among insurers, prompting some to exit the market. The remaining insurers raises their premiums, with the hope of recouping some of their losses, which ultimately becomes higher than what policyholders are prepared to pay. This could affect the supply of insurance for people and their properties (Herweijer, Ranger, & Ward, 2009). Although insurance connects the world through risk-sharing agreement, the major objective of insurance companies is to make profits for shareholders. However, the growing exposures and intensities of risk due to extreme events increases insurers' capital requirements and challenge their profitability and insurability (Coomber, 2006). Insurance companies keep reserves, capital and financial assets to pay claims as and when they occur. Insurers invest part of their capital in equities and property, in many cases, and they may be negatively affected by extreme events due to climate change. Also, an upsurge of extreme events may cause regulatory capital required to

increase. Assets are also likely to fall in value as the liabilities and capital requirements are rising and this may eventually affect the profitability of insurers (Maynard, 2008).

Therefore, analyzing the insurability of risk (supply of) and demand for insurance, especially in developing countries like Ghana, post extreme events and their influence on the profitability of insurers is necessary to develop a broad picture of the extreme event risk problem and evaluate feasible solutions.

1.3 Purpose of Study

The study provides some understanding of the risks associated with extreme events since developing solutions also require a comprehensive understanding of how they affect the operations of the insurance industry in order to employ efficient systems for monitoring and estimating these events so that resilient societies can be built.

1.4 Research Objectives

The main objective of this study is to examine the impact of extreme events on the insurance market in Ghana.

The specific objectives include:

- i. Determine how extreme events affect demand for insurance.
- ii. Determine the effects of extreme events on insurability of risk.
- iii. Examine the impacts of extreme events on the profitability of the Ghanaian insurance firms.

1.5 Research Questions

Based on the research objectives above, this study seeks to answer the following research questions:

- i. How does extreme events affect the patronage of insurance in Ghana?
- ii. What are the effects of extreme events on the supply of the various classes of insurance business?
- iii. What are the impacts of extreme events on the profitability of the Ghanaian insurance firms?

1.6 Significance of Study

The significance of the study can be seen along the following lines: research, practice and policy. In research, academic work on extreme events and the Ghanaian insurance industry hardly exists. The literature on extreme events focuses on mainly developed countries and hence this study will enable insurance companies in developing countries to examine the threats of the risks of extreme events they are exposed to in order to better manage them.

For practice, the study will help management of insurance companies to formulate strategies to mitigate against risks posed by extreme events so that they can be adopted for their efficiency in financial operations. It will provide insight to management and other stakeholders on how the industry has been damaged and help inform their future decision making in terms of response and recovery.

For policy significance, the study will provide feedback on policies that can protect both shareholders capital and society from risks posed by these extreme events. This research will help policymakers enhance their understanding on the behavior and reaction of customers to

losses which will enable them implement better policies to increase insurance coverage and overall protection for these events prior to their occurrence.

1.7 Scope and Limitation of Study

The study will focus on extreme events that have occurred in Ghana within the past ten years. This study shall be limited by time since one academic year will not be enough to fully explore every angle of this title as the researcher would so desire.

Also, due to cost factors, the sample may be biased since the insurance companies chosen may be due to proximity. There exists also the constraint of unavailability of existing literature on the subject in Ghana. There is also the possibility that some of the insurance companies would withhold some information since the information required for the study is quite sensitive.

The researcher shall also limit this study to only insurance companies, even though the study could have covered the entire insurance industry.

1.8 Thesis Structure

The rest of the study is organized as follows; Chapter two presents the review of relevant literature on the nature and risk of extreme events as well as their impact on the Ghanaian insurance market. Chapter three focuses on the methodological approach for addressing the research questions, the sampling techniques and sampling size, data collection instrument and method, data processing and mode of analysis of variables. The fourth chapter includes the data presentation, analysis and discussion of findings. Finally, chapter five contains the summary of the study, conclusion and recommendations for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the concepts of extreme events, the risk associated with extreme events and their impacts in various economies. The role of insurance in managing extreme risk and economic growth are also discussed in this chapter. The section provides a summary of relevant literature and states out other methodologies and framework that were used by other studies in assessing extreme risk and its impact on insurance demand and supply as well as the profitability of insurers.

2.2 The Concept of Extreme Events

2.2.1 Nature of Extreme Events

Extreme events, also known as catastrophes, are events characterized by a low frequency but high severity. When such an event occurs, it deviates shortly from normality affecting a large number of people (Ciumas & Coca, 2015; Siri, Newell, Proust, & Capon, 2016). According to WMO (2014) extreme events can be defined as events which are rare at a particular place or events with high impacts. Not all extreme events will have impacts on the human system since the human impacts will depend on the exposure, vulnerability and the extent of adaptation of the society to the particular extreme events (Goodess, 2013).

Extreme events can also lead to extreme conditions or impacts, either by crossing a critical threshold in a social, ecological, or physical system, or by occurring simultaneously with other events. The threshold for defining an extreme event vary from location to another. This is because what is considered extreme in one location can be considered as being within the normal range in another locality (TT-DEWCE, 2016). According to Stephenson (2008)

extreme events do not arise spontaneously but rather they evolve continuously from less extreme events and they stop evolving to become even more extreme events. This is known as the evolutionary principle. Extreme events are multidimensional in nature and as such have a variety of attributes such as the rate of occurrence, intensity or magnitude, temporal duration and timing, and multivariate dependencies. This makes it difficult to completely describe extreme events by a single number or a unique definition (Stephenson, 2008).

Although some current events have resulted in huge loss of life, better preparedness, construction, and emergency response have reduced losses from certain extreme events, while consequences from other event categories such as annual earthquake casualties have remained stable (Siri, Newell, Proust, & Capon, 2016). The degree of exposure of economies depends on the geographical location, natural resource capital, seasonality and exposure of population, infrastructure, political and institutional mechanisms, and coping and adaptive capacity (Mirza, 2003).

2.2.2 Categories of Extreme Events

Extreme events (both natural and man-made) can be categorized into meteorological, climatological, geological, epidemiological, and anthropogenic events.

2.2.2.1 Meteorological Events

Extreme events that are categorized as meteorological include extreme temperatures (heat and cold waves), tornados and flooding from extreme rainfall or storm surges. Heat waves, according to the American Meteorological Society (AMS) Glossary of Meteorology, is defined as a period of abnormally and uncomfortably hot and high humid weather. Heat wave is also defined by WMO as a period of few days to several weeks of warm air due to high temperatures. Persistent exposure to high temperatures can cause heat cramps, heat exhaustion, and heat stroke (Molloy & Mihaltcheva, 2013). Cold waves also occurs when

there is a sudden fall in temperature within a short period leading to the cooling of the air and accompanied by hazardous weather, like frost and snow (TT-DEWCE, 2016). A flood on the other hand, is an overflow of a huge amount of water onto land that is normally dry. Heavy rains, fast melting of snow, or the breaking of dams can lead to the occurrence of floods. Globally, floods are the most common natural hazard. They cause the third highest damages after storms and earthquakes. Over 90% of the total economic loss globally between 1970 and 2004 was caused by storms and floods (Kunreuther & Michel-Kerjan, 2009). Floods have led to water-borne diseases, mental health problems such as anxiety as well as death from drowning. The elderly, children and women are the most vulnerable to weather-related events (Molloy & Mihaltcheva, 2013).

2.2.2.2 Climatological Events

According to Khandekar (2013) extreme climatic events are a central part of the earth's climate system and such events are generated by large-scale atmosphere-ocean circulation systems and their complex interaction with local and regional weather patterns. Exposure of human and natural systems increases the impacts of climatic extreme events (IPCC, 2013). Climatological events includes droughts, famines and naturally occurring fires. Drought is the absence or shortage of water due to abnormally low rainfall and dry weather over a prolonged period. Drought is difficult to detect initially since it happens slowly and steady unlike other extreme events, such as floods, and hurricanes, which are easily identified when they occur (TT-DEWCE, 2016). Mostly, droughts results from scarcity of water due to rainfall. It is mostly seen in areas where rainfall is unpredictable, and differs significantly in its seasonal distribution (Mohammed & Rahman, 1998). According to Molloy and Mihaltcheva (2013), droughts causes more than half of all deaths as a result of natural hazards. Drought conditions reduce water availability and destroy agricultural crops (and hence reduced food availability leading to under nutrition). Wildfires which are mostly caused by high temperatures and

droughts are worsened by climate change. Naturally occurring fires can lead to heat stress, injuries such as accidents, burns, and death.

2.2.2.3 Geological Events

Geological events arise as a result of a change of the earth either on or below its surface. Extreme geological events have led to the death of huge number of people and severely affected economies in the past several thousand years (Korup & Clague, 2009). Geological events includes earthquakes, tsunamis and volcanoes. An earthquake is the trembling or shaking of the earth's surface. It is caused by a sudden release of stress along a fracture in the crust of the earth which causes the crust to shift. The greatest number of deaths and infrastructural damage has been caused by earthquakes. In the past 4000 years, earthquakes have caused an estimated minimum of 11 million fatalities (Sena & Michael, 2006; Korup & Clague, 2009). Volcanic eruptions occurs when lava and gas are discharged from a volcanic vent. Volcanoes cause population movements as large number of people are forced to flee the moving lava flow (International Federation of Red Cross, 2017). Geological events (except volcanoes) are normally not predictive, unlike weather events where modern weather tracking gives many days warning (Sanders, 2005).

2.2.2.4 Epidemiological Events

An epidemiological event is an event which lead to a sudden severe outbreak of a disease. Epidemiological events could be biological or occur due to other events such as floods, earthquakes and droughts (Adivar & Selen, 2013). Epidemiological events cause the occurrence of more cases of disease than would be expected in a community or region during a given period (Sena & Michael, 2006). One cause of epidemics is population movement. During and after catastrophes such as floods, earthquakes and volcanoes, people may be forced to move to safer places. These people may lack access to good food, water and health

facilities and could lead to poor nutrition which will weaken their immune system and make them vulnerable to diseases such as malaria and diarrhea. Also, an outbreak of disease may occur when large numbers of dead bodies are present in an area which has affected by an extreme event (Watson, Gayer, & Connolly, 2007). Epidemiological events includes infectious disease epidemics such as influenza, tuberculosis and Hepatitis B; and allergen-associated events (Siri, Newell, Proust, & Capon, 2016). Children are particularly vulnerable to epidemics because they have a larger skin surface-to-body mass ratio, depend on others for their care and have partially developed immune system.

2.2.2.5 Anthropogenic Events

Anthropogenic can be defined as any activity that is caused or influenced by humans. Hence, anthropogenic events are extreme events caused by human actions or negligence. Anthropogenic events are mostly unpredictable, can spread across geographical areas, may be unpreventable and may have limited physical damage but long-term effect (Sena & Michael, 2006). These events can be broadly classified into technological events such as chemical and nuclear disasters; anthropogenic fires and extreme pollution events; and sociological events such as war and terrorism (Jha, 2010).

The illegal threat or use of violence to promote political ambitions is known as terrorism (Cunningham, 2003). Terrorism causes fear, panic, death and can disrupt the psychological and economic growth of the society (Richards, Burstein, Waeckerle, & Hutson, 1999). Nuclear disaster events is mainly caused by nuclear power plants. Nuclear power plants use the heat generated from nuclear fission in a contained environment to convert water to steam, which powers generators to produce electricity. When an accident occurs at a nuclear power plant, the body may be exposed to radiation from the cloud. Radioactive materials may also be inhaled and digested by the body due the particles being deposited on the ground. This can cause serious illness or death. Anthropogenic fires and pollution may be triggered as

secondary events after the occurrence of certain meteorological and geological events such as earthquakes and floods (Sena & Michael, 2006).

2.3 Extreme Value Theory

Extreme Value Theory (EVT) looks at how extreme values behave randomly in a process. Extreme events in real data can be generally identified in two ways. The first way is to observe the maximum or highest number taken by a variable in successive periods. The collection of these observations make up extreme values. This is also known as the block maxima method. The second approach, also known as the threshold method, looks at how the observations exceeds a given threshold. All observations that exceeds the threshold constitute extreme events (Gilli & Kellezi, 2006). Data with seasonality, such as hydrological data, is usually analysed with the block maxima method. However, recent applications of extreme theory prefer the threshold method because of its efficient use of data (Gilli & Kellezi, 2006). Fisher and Tippett (1928) suggested Gumbel, Frechet and negative Weibull distributions to model the maxima of a random variable in a single process. Later, a generalized extreme value distribution developed by Jenkinson (1955) combined all three distributions into one.

2.3.1 Applications of Extreme Value Theory

Extreme Value Theory has been applied in areas such as modern science, finance, insurance and engineering. In engineering, high magnitudes of wind was estimated using EVT in order to design bridges and buildings which could withstand the extreme winds (Coles, 2001). Extreme Value Theory (EVT) was also applied in public health to predict future extreme epidemiological events such as influenza and Pneumonia. In Taiwan, Nadarajah and Shiau (2005) applied extreme value theory to flood data to investigate extreme floods and also determine whether the volume and peak of floods vary with time and duration.

In insurance and other financial institutions, EVT has been used to predict the occurrence of catastrophic losses such as large credit default (Embrechts, Resnick, & Samardnitsky, 1999). Again, the theory was used to predict the occurrence of drought, heat waves, heavy rainfall and other extreme weather events. The theory was also employed to estimate the magnitude of long return period earthquakes (Al-Abbasi & Fahmi, 1985).

2.4 Risk of Extreme Events

According to Gencer (2013), risk is the possibility that something bad or harmful will happen due to interactions between natural or human-induced hazards and vulnerable conditions. It is also the probability and degree of an adverse outcome such as a loss or danger. Risk comprises of hazard and vulnerability of people and structures. A hazard is a specific situation, activity or condition that increases the probability of the occurrence of loss arising from a peril whilst vulnerability can be explained as the degree of exposure of a community to the influence of hazards and the ability (or lack thereof) of the exposure unit to cope, recover, or adapt (Linnerooth-Bayer, Mace, & Verheyen, 2003; Gencer, 2013).

An interaction between the external risk factor and the internal risk factor results in extreme risk or vulnerability. The risk and damages of extreme events depend heavily on socioeconomic factors, and also the number and severity of extreme events (Molloy & Mihaltcheva, 2013; Linnerooth-Bayer, Mace, & Verheyen, 2003). IPCC in their report has confirmed that severe events together with basic socio-economic trends (such as population growth and unplanned urbanization) are capable of stressing economies and businesses by declining the value of business assets and diminishing investment viability (UNEP FI, 2002).

2.4.1 The Frequency and Intensity of Extreme Events

Every year, extreme events cause both direct and indirect losses hindering both economic and social development (WMO, 2014). Losses experienced can be in the form of damages to assets, loss of jobs, business interruptions and decline in revenues from taxes. About 11000 extreme weather events occurred between 1996 and 2015 leading to the death of more than 528 000 people and economic loss of US\$3.08 billion worldwide. The severity and frequency of these events are projected to be two-to-three times higher by 2030 and four-to-five times higher by 2050 (Kreft, Eckstein, & Melchior, 2016). Windstorms, floods, droughts, and other climate-related hazards contributes to about three-quarters of all recent economic losses as stated by the United Nations International Strategy for Disaster Reduction (ISDR). Frequency provides information about the increasing nature of extreme events. Risks from extreme events are difficult to manage since there are not sufficient empirical information and they are not accurately predictable. Intensity or severity on the other hand, is the measure of the extent and the magnitude of the loss after an event. Severity depends on the characteristics of an event as well as the exposure and vulnerability of the systems it impacts (TT-DEWCE, 2016; Sakshi, 2009; Stephenson, 2008)). Globally, the number of extreme events has increased from about 400 per year to about 1,000 in the last 31 years supporting the fact that extreme events and total losses are rising faster than population, or economic growth (WMO, 2014).

In Africa, the number and intensity of droughts and floods have increased over the past 30 years. Ly, Traore, Alhassane, & Sarr (2013) estimated that there will be great evaporation in Africa as a result of increased temperatures since saturation vapor pressure increases exponentially with temperature according to the Claudius–Clapeyron relationship. This may affect the rainfall pattern and increase the risk of flooding. Hence, it was found that the number of flood events have increased on average from less than 2 per year before 1990 to more than 8 or 12 on average per year during the 2000s.

2.4.2 Influence of Socio-economic Factors on Extreme Events Losses

The observed rising loss of extreme events are highly influenced by socioeconomic and demographic factors. Migration of populations to flood and fire-prone areas, increasing reliance on vulnerable electric power grids, and rising material wealth are part of the reason for the increasing vulnerability of economies to extreme events. According to Kunreuther and Michel-Kerjan (2007), the degree of urbanization is one of the main socio-economic factor that influences the loss trend of extreme events. In 2000, about 6 billion people which consist of 50% of the world's population lived in urban areas and the United Nations has predicted an increase to about 8.3 billion people (60%) by the year 2025. Most of them will reside close to regions prone to extreme events (Courbage & Stahel, 2012). Increasing poverty and inequality, failures in governance, crowded living conditions and the location of residential areas close to hazardous industry or in places exposed to natural hazard increases the risk of urban areas to extreme events (GFDRR, 2010). Extreme events are expected to destroy a greater number of homes and commercial buildings today than if a similar event had occurred in the 1990s. This means that the intensity of exposure is increased as result of urbanization and population growth. (Gencer, 2013).

Most cities in least developed countries are unable to expand properly and accommodate the rapid population growth in urban areas. There are many reasons that makes urban areas in most developing countries vulnerable to extreme events. Firstly, the population density, rapid industrialization and accumulation of hazardous materials in heavily populated areas makes urban areas particularly those in developing countries at risk to extreme events. A given event will affect larger populations in urban areas because the people are clustered in a limited area (Siri, Newell, Proust, & Capon, 2016). Secondly, ecological imbalance such as shortage of appropriate drainage systems, resident buildings on waterways and insufficient planning have made some urban areas vulnerable to floods. In others, deforestation has led to hillside

erosion, making people vulnerable to landslides triggered by heavy rains. Thirdly, poor design and construction of buildings is a major challenge faced by urban areas. Architects, engineers, and skilled workmen in most of developing countries have limited knowledge in the design and construction of earthquake-resistant structures of buildings. The collapse of many buildings under construction is mainly caused by poor construction and weak buildings (Allotey, Arku, & Amponsah, 2010).

Other demographic factors such as age, income and sex also contributes to this trend. Children and older people are highly exposed to risks of extreme events. Children have small body size that makes them vulnerable to drowning in floods and prone to develop hypothermia (lowered body temperature) during heat waves. Their bodies are weak and they have underdeveloped immune system which increases their inability to fight infectious diseases which are brought by these events. For many elderly people, their physical movement are mostly restricted and they may rely on others to move them around. These and other conditions may influence their exposure to indirect effects of stress and shock after these events (Molloy & Mihaltcheva, 2013).

2.5 Impact of Extreme Events on Economies

A population's capacity to respond to and recover from an extreme event depends on the losses incurred as well as the global environment of affected location (Prelicean & Boscoianu, 2010). Extreme events have and continue to affect people in every continent. Globally, more than two million people lost their lives between 1980 and 2012 due to weather, climatological and geophysical events. Over the past 55 years, about 93 percent of all catastrophes is as a result of weather-related events (Mills, Roth, & Lecomte, 2005). The highest number of deaths (94%) between 1970 and 2012 in Europe was as a consequence of

extreme temperatures. Hydro meteorological and climatic events caused the greatest loss in terms of lives and economic damage in North and Central America. Hurricane Mitch in 1998 affected Honduras and Nicaragua and caused 17 932 deaths, Hurricane Fifi in 1974 affected Honduras which led to 8 000 deaths and Hurricane Katrina in 2005 resulted in US\$ 146.9 billion in losses. Two (2) million homes, 40 oil rigs and 150 offshore oil platforms were destroyed by hurricanes Katrina, Rita and Wilma in 2005 (Sturm & Oh, 2010; WMO, 2014).

The exposure of poorer developing countries to extreme event risks is high, though the absolute monetary losses are much higher in richer countries. Also, financial hardship and loss of life after an extreme event is far more prevalent particularly in developing countries (Kreft, Eckstein, & Melchior, 2016; Molloy & Mihaltcheva, 2013). According to Hallegatte, Dumas, and Hourcade (2010), extreme events affects the developing world in two folds. Firstly, a rise in the number and severity of extreme events will put pressure on the budgets of developed countries hence less resources will be available to assist other developing countries. Secondly, the governments of developing countries will be forced to use available resources to deal with the losses of extreme events rather than productive and growth-enhancing projects. As the number of extreme events increases than the capacity of developing countries to rebuild decreases and could cause them to remain in a constant state of reconstruction.

From 1970–2012, there have been loss of 915 389 lives and economic damages of US\$ 789.8 billion as a result of extreme events in Asia. The highest number of death (76%) was as a result of storms, while the greatest economic loss (60%) was due to floods (WMO, 2014). Africa is susceptible to all kinds of intense and frequent natural and man-made hazards. A study by Mohammed and Rahman (1998) reveals that the regions most affected are the African Horn, West and South Africa. Mozambique, Ethiopia, Ghana, Chad and Sudan were seen to be the most hazard-prone countries since they recorded the highest losses. Lack of

disaster-resistant infrastructure, high dependence on agriculture, inferior disaster preparedness and recovery, and other factors make developing countries much more vulnerable to extreme events. Ly, Traore, Alhassane and Sarr (2013) confirmed this by examining the evolution of climate extremes in the West African Sahel. They observed a general warming trend since the 1960s which means a higher demand on domestic energy consumption for cooling, a higher evaporation rate from water bodies and irrigated crops, and a lower performance of agricultural crops and livestock. Also, increased occurrence of extreme rainfall events such as heavy downpours leads to more tenuous infrastructure and production systems.

Thus, the threat posed by extreme events is more serious in developing countries than they appear since most huge social and human costs of extreme events such as loss of human lives, cultural heritage, and ecosystem services are not accounted for in the macroeconomic data. The reason being that such losses are difficult to value and monetize (Mirza, 2003).

2.6 Extreme Risk Management

Extreme Risk Management (ERM) is a dynamic process that requires continuous modifications, specialized decision making and interaction at different levels (Prelicean & Boscoianu, 2010). Extreme risk management involves a number of stages and these are: the preparedness to mitigate extreme risk effects; the response to deal with the physical impacts and the new risk factors created; short term recovery activities to restore vital support systems and long term tasks to bring economic framework back; and prevention and mitigation to minimize the likelihood and effect of future events (Prelicean & Boscoianu, 2010).

ERM is an integral part of country risk management and as such World Bank Group plays an active role in assisting countries with building effective risk management systems as these

events have a disproportionately adverse impact on the poor (Sakshi, 2009). The soar in the risks associated with extreme events threatens livelihoods, human lives and health. Moreover, socio-economic growth and development is severely weakened (Golnaraghi, Surminski, & Schanz, 2016). As the occurrence and severity of extreme events increases, management of risk from extreme events will become increasingly important for society. Extreme risk management will increase the safety and resistance of economies and communities, reduce economic, social and environmental losses, and also reduce the funds used up to finance losses associated with extreme events. This will promote investment and the affordability of insurance to the society (UNEP FI, 2014).

Managing extreme events involves risk identification and assessment, mitigation and adaptation activities, and the transfer of the risks that cannot be eliminated or reduced through risk-sharing mechanisms (Courbage & Stahel, 2012). Society can cope and manage risk from extreme events through the collaborating efforts of insurance, customers as well as the government bodies. The scientific community and the government can support the insurance industry by providing technological innovations and tools, raising awareness through public education and regulations as well as investing in preparedness and management of extreme events (Golnaraghi, Surminski, & Schanz, 2016).

The susceptibility of critical infrastructure (e.g. energy, food and agriculture, water, transportation and health) to extreme events has become a crucial concern of many leaders of the society. This is because the destruction or interruptions of these infrastructure could cause major harm to the welfare of the population due to the direct and indirect economic impacts of extreme events (Golnaraghi, Surminski, & Schanz, 2016). The government plays a key role as an insurer of last resort and risk manager for many types of climate, weather and other event losses. Systems and frameworks are introduced by governments on various state levels to deal with the risk of extreme events and strengthen resilience. For example specialized

agencies such as the African Risk Capacity Project and the African Adaptation Initiative have been set in Africa to strengthen resilience to extreme events, to lessen the risk fatalities, and to support member states through capacity building (Kreft, Eckstein, & Melchior, 2016).

2.6.1 Insurance as a Tool for Risk Management

Following a damaging episode of extreme event, societies turn to insurance companies to help them rebuild because the insurance industry helps protect society, fosters innovation and supports economic development through risk prevention, risk reduction and by sharing risks over many shoulders. When individuals purchase insurance, it shows that their common interest is to reduce their own loss and others who have suffered similar losses (UNEP FI, 2014; Sturm & Oh, 2010). The insurance industry's primary business is to understand, manage and carry various type of risks such as property risks, disability and natural disasters. Individuals and firms protect themselves against infrequent but extreme losses by paying a fee (premium) which is far lower than the financial loss. Using the law of large numbers, insurance companies are able to accurately predict the risks they carry and also estimate the right premium. (Lester, 2009).

Life and non-life or general contracts are the two main contracts in insurance. Material and financial risks are insured under non-life insurance contracts which are normally renewed annually. Life insurance contracts covers the risks associated with the life of an individual. It can be for short periods (for example, accidental death) or very long periods (for example, whole of life) (Guerineau & Sawadogo, 2015).

The sharing and transfer of risk through insurance can assist the recovery to catastrophes and improve the resilience of society to extreme events. This is becoming more significant as the frequency and losses from these events have increased over the last few decades (Schuster, 2013). For insurance to perform its role as an instrument for the management of risk from

extreme events, insurers should price premiums so that they accurately reflect risk which will signal how safe or exposed policyholders are, and also ensure equity and affordability of premiums especially for those in hazard prone areas (Kunreuther, 2017).

2.6.2 Insurance and Economic Growth

Insurance promotes economic growth by improving the conditions for investment and promoting a more proficient blend of activities. Insurance offers protection against uncertain but severe losses by providing payments periodically to people affected. This income smoothing effect helps to avoid excessive and costly bankruptcies and facilitates lending to businesses. Also, insurance accessibility promotes higher productivity and growth by assisting risk averse individuals and entrepreneurs to undertake activities which are risky but has higher returns (Brainard, 2008). The investment behaviour of smallholder farmers and crop insurance was studied by Karlan, Osei, Osei-Akoto and Udry (2014) in Ghana. The results revealed that, there was a significant growth in the investment on the farms of smallholder farmers who have crop insurance than those who do not. On the investment side, life insurers with their sizeable reserves and predictable premiums can assist in the role of providing capital to infrastructure and other long term investments as well as competent oversight to these investments (Brainard, 2008).

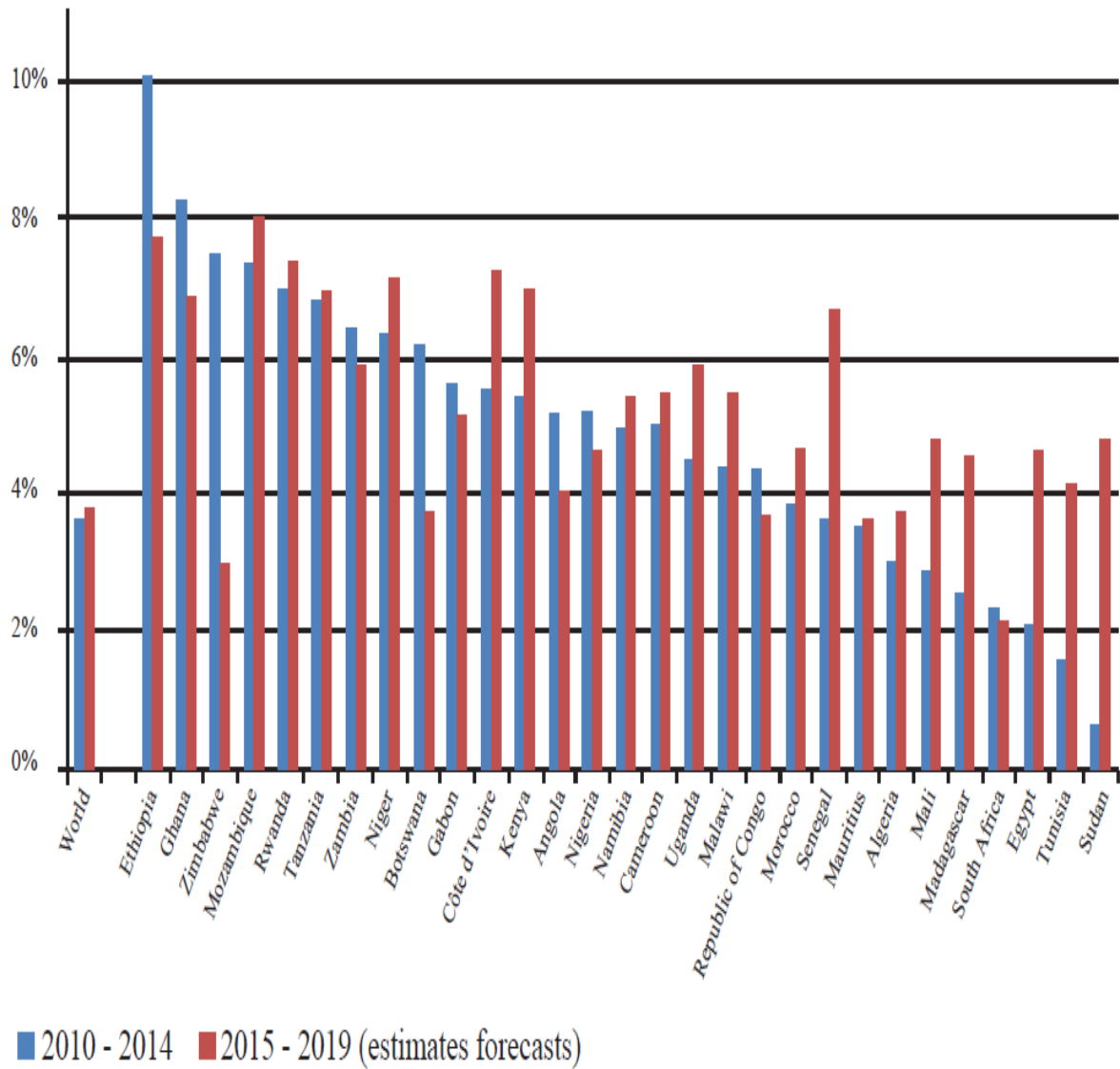
According to Warner, Yuzva, Zissener, Gille, Voss, and Wanczeck (2013), a study conducted by the World Bank finds that after a large weather-related catastrophic event, countries with high insurance penetration experience a growth in Gross Domestic Product (GDP) whilst low insurance penetration countries suffer from a negative GDP deviation. Moreover, low insurance penetration countries may need other growth factors to boost GDP growth otherwise their GDP could continue to dwindle for a long period.

2.6.3 The Insurance Market

The insurance market is a very competitive industry which is mostly controlled by supply and demand (Lester, 2009). The insurance market provides insurance coverage to individuals and business firms who are vulnerable to natural and manmade catastrophes as well as other risks (Cummins & Mahul, 2009).

According to Brainard (2008), rising incomes, macroeconomic stability, and financial deepening are the key drivers of insurance market growth. In the paper, Brainard posited that as individuals become richer, the demand for insurance coverage to protect their wealth also increases. Again, as the economy expands, it becomes more economical to provide insurance and therefore less operational cost leads to higher returns. Insurance market development is also determined by the level of growth of related markets, including sales of cars and other consumer durables, business establishments, residential and commercial mortgage markets, disposable income, and commercial and trade transactions.

There is massive expansion of the insurance industry in the developing world because of rising economies like China and India. The economies in Sub-Saharan Africa have been constantly ranked among the world's fastest growing economies since 2010. As such, the World Bank predicted a rise from 4.6% to 5.1% regional GDP growth by 2017 (EY, 2016).



Source: IMF, World Economic Outlook October 2015

Figure 2.1: Real GDP Growth, 31 Largest African Economies (2010-2019, Compound Annual Growth Rates, in %)

The growth in GDP may lead to rising incomes and growing affluence which will increase the number of people who can afford insurance as consumer spending on items, such as cars, smart mobile phones and health care expands (EY, 2016; Schanz, Alms, & Company, 2016).

An effective and viable insurance system requires a risk that is quantifiable, distributed, and affordable. Again there should be an insurable population aware of risk they are exposed to, willing to insure and can afford the necessary premiums. Finally, it requires a solvent insurer that is willing and able to pay claims; and has enough capital and reserve to cover any abnormally large losses (Lamond & Penning-Rowsell, 2014). An individual's willingness to pay (WTP) for insurance may be influenced by the premium, his income, his level of risk aversion and risk perception (Ranger & Surminski, 2011). Arshad, Amjath-Babu, Kächele and Müller (2016) examined the drivers of the willingness to pay for crop insurance against extreme weather event in Pakistan. The study revealed that the WTP depends on the age, education, family size, land ownership, source of income, irrigation availability, exposure to previous extreme events, and access to extension and credit services.

All in all, a well-functioning insurance markets should result in better pricing of risk, greater efficiency in the overall allocation of capital and mix of economic activities, and higher productivity (Brainard, 2008).

2.7 Empirical Findings on the Impact of Extreme Events on the Insurance Market

2.7.1 Insurance Demand and Extreme Events

Demand shows the quantity of a given product consumers are willing and able to buy at a given price. Individuals and firms may purchase insurance for various reasons. One reason may be that the law requires them to do so. For example, in Ghana, the third-party motor insurance policy, workers' compensation insurance as well as insurance against the hazards

of collapse, fire, earthquake, storm and flood in respect of all commercial buildings, both complete and those still under construction are compulsory. Also, workers' compensation insurance is required by law in all states of America (World Bank, 2013). Another reason could be that insurance is used to finance risks incurred by firms to protect them from bankruptcy. Hence, the insurance company bears the risk exposed to the firm (Michel-Kerjan, Raschky, & Kunreuther, 2015).

Insurance demand is influenced by several factors which have been revealed in many studies. These factors include political, psychological, economic (income, inflation and interest rate) and social (age and sex) issues (Ciumas & Coca, 2015). Other external factors influencing the demand for insurance include climate change, globalization, variations to financial market regulation, and global population growth (Ranger & Surminski, 2011). Using a panel model on a sample data between 2000 and 2012, Yuan and Jiang (2015) examined the determinant of insurance demand for life, nonlife and both life and non-life in China. The results pointed out that level of education, children and elderly dependency ratio, and development of social security pension, influenced life insurance demand whilst inflation influenced nonlife insurance demand. Both life and nonlife insurance demand was affected by the level of income, insurance market development and degree of marketization.

In Ghana, a study was done by Peprah, Koomson and Forson (2017) using a binary logit estimation on the GLSS6 data. Their finding showed that the patronage of insurance depends on poverty and employment status. It was observed that poor people have a lower probability of purchasing insurance, with locational influence being more evident for the poor in the rural areas. Moreover, regular income workers in the formal sector demand insurance than self-employed. Furthermore, those who reside in small cities and rural areas have a higher demand for insurance than people in urban areas. Fofie (2016) adds to this literature by exploring and assessing the Social, Economic and Demographic (SED) factors that are likely

to influence the patronage of insurance in Ghana using a probit econometric model. They found that SED characteristics is a major factor affecting insurance demand in Ghana. It was observed that these SED variables influences the factors that prevent people from patronizing insurance policies. One major cause for the low patronage of insurance was lack of knowledge on insurance due to lack of education and public awareness.

In general, the risk perceptions of individuals may change after the occurrence of extreme events and hence demand for insurance and mitigation mechanism may increase if individuals learn from these events. Ranger and Surminski (2011) suggest that as the risks from extreme events keep rising, insurance demand could be increased in places where losses were more recurrent. Several studies have been done on the demand for insurance after an extreme event. Michel-Kerjan and Kousky (2010) who analyzed the US National Flood Insurance Program portfolio, found that people opted for higher coverage and premium payments after major foods in Florida in 2004.

Individuals who view insurance as an investment from which they expect a return in the form of claims payments following an event rather than a protective measure should one suffer a loss, are likely to ignore potential disasters and overreact to recent ones (Kunreuther, 2017). This could cause an increase in the purchase of insurance only after the occurrence of extreme events and then demand for insurance would be seen as more reactive than proactive. A study by Dumm, Eckles, Nyce and Volkman-Wise (2017) revealed a rise in insurance demand and supply after a loss however, this demand decreases as more time elapses from when the loss occurred. This is consistent with the theory that individuals normally tend to amplify their sense of loss they are exposed to, only after a disaster occurs. Gallagher (2012) shared this view by finding that US flood insurance demand significantly increased immediately in areas affected by the flood but falls shortly afterwards. In Ghana, Ackah and

Owusu (2012) found in their study that most informal sector workers do not take-up insurance as a precautionary measure.

Dlugolecki and Hoekstra (2006) posited some barriers to demand for insurance against extreme events which include poor perception of risk exposure, high price of insurance (premiums) and lack of efficiency on the part of insurers in the payment of claims. Also, expectation of public and political responses as well as international aid reduces insurance demand (Lamond & Penning-Rowsell, 2014; Ranger & Surminski, 2011).

2.7.2 Insurability of risk (Supply of Insurance)

The affordability and accessibility of insurance are potential source of economic development, peace of mind and security in a society.

In order to guarantee their financial survival in case of catastrophic losses, according to Linnerooth-Bayer, Mace and Verheyen (2003), two conditions must be met before insurers will be prepared to insure an uncertain event. These conditions are;

- i. The ability of the insurer to identify and evaluate the probability of the occurrence of the event and the degree of risk presented. This can be done with the aid of historical data or scientific analyses.
- ii. The ability of the insurer to set premiums for each proposed insured. This requires an understanding and assessment of each potential customer's risk and the coverage to offer. Afterwards, a premium is charged to reflect the risk exposure in order to make a reasonable profit.

The first step to ensure insurability of risk is the identification of risk. To identify risk, the occurrence of specific events and the intensity of loss caused by these events are estimated (Courbage & Stahel, 2012). Insurance is mostly used to cover high-frequency, low-severity

events, which are statistically independent of each other and have probability distributions that are reasonably stationary over time. For such events, the premiums and reserves required to meet insurers' liabilities and ensure solvency can be accurately calculated. On the other hand, insurers hardly insure events such as catastrophes due to their high intensity but low frequency. This is because the historical data on such events may be insufficient or not available, making the assessment and modelling of the risk very challenging. Insurance markets poorly respond to huge catastrophes. They restrict the supply of insurance and raise the price of insurance as a way of responding to large or extreme events (Cummins, 2006; Courbage & Stahel, 2012).

Once risks have been identified, insurers must be able to estimate the premiums to be paid by each policyholder to ensure coverage. However, due to the severity of losses from extreme events, premiums can increase more than policyholders can pay. According to Ranger and Surminski (2011), extreme events could make the availability and affordability of insurance very difficult as a result of increasingly correlated losses within short intervals. Insurers may withdraw from certain areas and classes of business or, experience a higher rate of insolvency when faced with risks from extreme events.

Insurability of risk is affected by both external and internal factors. Internal factors include the amount of capital, ambiguity of risk, correlated risk, adverse selection and moral hazard. The role of reinsurers, insurance commissioners, rating agencies, modeling firms and investors constitute the external factors (Golnaraghi, Surminski, & Schanz, 2016).

The impact of extreme events on the insurability of risk have been examined by several researchers. Chen, Doerpinghaus, Lin and Yu (2008) examined the effects of 9/11 terrorist attack on the insurance industry in the U.S. and found that firm type, loss estimates, reinsurance use, and tax position influences premium increase after an extreme event whilst firm type, loss estimates, financial strength, underwriting risk, and reinsurance were key

determinants of insurance supply reductions after extreme events. Mills, Roth and Lecomte (2005) also revealed in their studies that extreme events may increase insurance claims and costs translating into higher premiums and deductibles, lowered limits, and broader coverage restrictions. This is supported by Yi (2013) who evaluated the market competition, demand and supply of the insurance market in Texas using a sample data from 1995-2011. The results indicated that insurance companies adapt to excessive losses from catastrophic risk by raising their premiums whilst others go insolvent and leave the market.

Maynard (2008) adds to this literature by asserting that increase in extreme events may worsen the level of losses which may make the price of insurance to be so high that policyholders may not be able to afford. Insurers may decide to maintain insurance coverage or remove cover totally from the market in order to maintain solvency and shareholder returns. For instance, after the Atlantic hurricane season in 2004 and 2005, reinsurance premiums rose dramatically which became economically infeasible for insurers in that region. Some insurers declined the underwriting of new policies in the state, dropped existing customers and left the market (Sturm & Oh, 2010). Other insurers such as Poe Financial Group, South Florida's second-largest insurer of homes, condos and apartments, had to pay more than US\$2 billion in claims after Hurricane Wilma and as such was declared insolvent in 2006 (Linnerooth-Baye & Mechler, 2009)

Insurers are mostly faced with the challenge of pricing insurance and the amount of coverage to offer as they renew their policies annually. This is because of their inability to differentiate between systematic changes in climate and random weather patterns in the short run (Kunreuther & Michel-Kerjan, 2007). To ensure coverage, premiums must be calculated through actuarial processes and be affordable to consumers. However, this situation may be affected in the case of extreme events (Mills, Roth, & Lecomte, 2005).

2.7.3 Profitability of insurance companies

One important factor that determines insurers' performance and healthiness is profitability (Dorofti & Jakubik, 2015). Insurance companies' primary goal is to generate profits or worth for their shareholders even though insurance assist in linking the world through risk-sharing measures (Akotey, Sackey, Amoah, & Manso, 2013). There are numerous approaches to measure insurer's profitability. Some of these methods include Return on Equity (ROE), Return on Investment (ROI) and Return on Assets (ROA). Others include technical profitability ratio and sales profitability ratio. ROA indicates how profitable a company is relative to its total assets and it measures the efficiency of management in using a company assets to generate profit. ROE shows how much profit the company generate from its shareholders equity (NIC, 2016). ROI is also an indicator which assesses a company's efficiency in allocating capital to profitable investments. This indicator shows how well a company uses its funds to generate higher returns. Technical profitability ratio assesses the effectiveness of the core insurance activities of the insurance company whilst sales profitability ratio associates net income before taxes obtained by the insurance company with gross written premium. ROA and ROE are normally used to measure profitability. This is because they are readily accessible, rely on public data and are calculated in accordance to strict, prudent accounting rules (Dorofti & Jakubik, 2015).

Insurers' profitability can be looked at from two perspectives according to Akotey, Sackey, Amoah and Manso (2013). Firstly, profitability can viewed from both internal and external factors. The internal factors comprises of the insurer's-specific characteristic whilst the external factors is made up of both industry and macroeconomic variables. Secondly, insurers' profitability can be perceived at the micro, meso and macro levels of the economy. The micro level measures the impact of variables such as size, capital, efficiency, age, and

ownership structure on profitability. The meso and macro levels look at the influence of support-institutions and macroeconomic factors, respectively, on profitability.

Mwangi and Murigu (2015) examined the determinants of the profitability of non-life insurance companies in Kenya. Employing multiple linear regression for the period 2009-2012, they found that leverage, equity capital and management competence index positively affected profitability whilst size and ownership structure negatively affected profitability.

Alhassan, Addisson, and Asamoah (2015) examined the impact of the regulatory-driven market structure on firm pricing behaviour on insurance markets in Ghana. They identified underwriting risk, leverage and inflation as major factors influencing the profitability of both life and non-life markets.

An insurer's capital enables him to pay for greater-than-expected losses thus, the capital required is proportional to the risk accepted. The more risk an insurer wishes to take, the more capital he needs to support the additional coverage it offers against that risk (Dlugolecki & Hoekstra, 2006). A study by Darkwah, Asare-Kumi, Nortey, and Baidoo (2016) reveals that working capital management is the cause of profitability of Ghanaian insurance companies. Using a sample of 10 insurance companies listed on the Ghana Stock Exchange between 2008 and 2014, they found out that Cash Conversion Cycle, Debt Ratio, Current Ratio, Sales Growth Rate and Accounts Collection Period are the main factors that affect working capital management which ultimately affects the profitability of these companies.

Using cross-country aggregate data of 30 European countries over eight years (2005-2012), Dorofti and Jakubik (2015) explored the relationship between the macroeconomic environment and insurers' profitability. Their results revealed that low interest rates (both nominal and real) negatively affect insurance profitability through lower investment income. Moreover, high inflation, low economic growth and poor equity market performance negatively influenced the performance of insurers.

Extreme events, such as natural disasters, present various challenges to insurers because of their uncertainty and associated great losses. Some of the challenges posed by extreme events include unexpected changes in claims pattern coupled with difficulty in adjusting premiums and reserve to maintain profitability (Mills, Roth, & Lecomte, 2005). Insurance companies keep reserves, capital and financial assets to pay claims as and when they occur. Insurers invest part of their capital in equities and property, in many cases. These assets may be negatively affected by extreme events causing them to fall in value. Large and unexpected losses lead to huge claim payments which reduce insurers' and reinsurers' capital and reserves (Maynard, 2008). Evaluating the financial performance of life insurers by using ten life insurance companies in Ghana between 2000 and 2010, Akotey et al. (2013) revealed that life insurers have been incurring underwriting losses due to overtrading, high claims payments and high managerial expenses and that have negatively affected their financial performance. This means that the increase in extreme events will increase claims which will lead to more underwriting losses and consequently affect the financial profitability of firms in the insurance industry in coming decades.

According to Cummins (2006) keeping capital and reserves to finance losses arising from extreme events such as floods and earthquakes is absurd and inefficient on the part of the insurance industry. This is because extreme events can seriously affect the insurance industry by affecting the profitability and overall performance of insurers and also affecting the ability of the industry to cover future losses. Furthermore, this effect will be higher in developing countries since developed economies have a stronger insurance market than developing countries.

Benali and Feki (2017) investigated how natural disasters affect the profitability of Property/Casualty insurers in the United States (U.S) for the period between 2008 and 2012 using a panel data analysis. Their findings were that loss ratio, unexpected number and losses

of disasters negatively affected profitability of insurers' while premium to surplus ratio and volume of capital positively influenced profitability.

However, according to Ranger and Surminski (2011), growing levels of extreme events risk could decrease the willingness of an individual to pay due to the increase in the premium. Also, the willingness to pay could increase due to the increasing level of perceived risk. The effect on profitability therefore depends on the price sensitivity of both actual and potential policyholders. If policyholders are less sensitive to prices, the increase in premiums may fully reflect the increase in risk, so profitability will increase; but if they are more sensitive, or the market is especially competitive, the increase in premium may be greater than the increased risk would imply, leading to reduced profitability (CISL, 2016).

2.8 Extreme Events and Insurance in Ghana

2.8.1 Extreme Events in Ghana

Ghana is situated in one of the world's most complex climatic regions, affected by tropical storms, and the influence of Atlantic Ocean and the Sahel. The country stretches from a densely populated low-lying coastal zone, to the sparingly populated northern regions in the savannah zone (GFDRR, 2017). Ghana is ranked among the 10 fastest-growing national economies in annual World Bank reports (EY, 2016). There has been a substantial population growth and expansion in Accra (Ghana's capital) in the last three decades. The average population growth in the city ranges between 5% and 8% with the natural growth rate accounting for 2.8-3.2% of growth, and rural-urban migration accounting for the rest (Allotey, Arku, & Amponsah, 2010).

Ghana's main exposure to extreme event is flood and epidemics. Others include pest infestations wildfires and drought, which normally occurs in the Northern part of the country.

Ghana is also vulnerable to earthquakes with the Greater Accra region being the most dangerous (Allotey, Arku, & Amponsah, 2010; GFDRR, 2017). Flood is a regular problem in some parts of the country as well as tornadoes and tidal waves. Ghana has also experienced wildfire disasters and epidemics (World Bank, 2013).

There has been a gradual and apparent temperature rise and a fall in rainfall in all agro-ecological zones in the country between 1960 and 2000 according to the Ghana Meteorological Agency (Twum, 2014). In 1983 Ghana experience a drought which affected 12.5 million people. In 2010, after a period of drought damaging the initial harvest in the White Volta River Basin, floods affected hundreds of thousands of people and destroyed many of their livelihoods. In June that same year, floods caused more than a 1,000 homes to be destroyed and 5,000 people to be displaced, with a total of 24 deaths and millions of dollars in property losses in Tema. These floods demonstrated how extreme events can reverse development investments (GFDRR, 2017).

According to the Centre for Research on the Epidemiology of Disasters (CRED), an event is considered as a disaster if at least 10 people are reported dead or at least 100 people are affected. In Ghana, an event is considered extreme if it affects at least 2000 people or kill at least 50 people according to the National Disaster Management Organisation (NADMO). The table below shows some of the extreme events which have occurred in the country.

Table 2.1: Some Extreme Events in Ghana from 1900 to 2016

Year	Event	Affected	Death
1918	Pandemic (Influenza)	560000	100000
Jun-39	Earthquake	4800	23

1983	Drought	12500000	150
1984	Epidemic	5670	103
1991	Flood	200000	0
1995	Flood	700000	145
1999	Northern Flood	324602	52
May-01	Technological	120	127
Jun-01	Flood	144025	11
2005	Flood	350000	20
2007	Northern Flood	332600	56
Jun-10	Swedru Flood	3000	42
Oct-10	Flood	280000	70
Oct-10	Northern Flood	6000	35
Nov-10	Afram Plains Flood	2800	0
Nov-11	Accra Flood	43087	14
2012	Cholera Outbreak	9548	100
2013	Flood (Rainstorm)	25000	17
2014	Cholera Outbreak	23622	190

Jun-15	Flood and Fire	46370	250
2016	Flood	41033	89

Source: OFDA/CRED, Ghana Open Data and NADMO.

According to the 12th edition of the Global Climate Risk Index, Ghana's economic, social and infrastructural sectors are negatively impacted by extreme events. In the northern parts of the country, severe drought and flooding have reduced agricultural productivity and damaged properties and investments. In southern Ghana, sea level rise and other extreme weather events have led to loss of lives, displaced communities and low economic activities, especially fishing (Kreft, Eckstein, & Melchior, 2016). The incidence of extreme events hinders the development of the nation. Flooding, for example threatens roads and transport, education, energy supply, food and agriculture, water and sanitation, and health. Also, prolonged dry seasons and flooding increases urban migration as people in the north drift to the South to make a living. These migrants are exposed to new vulnerabilities on the streets and heighten the pressure on existing over-stretched urban services (Ghana National Climate Change Policy, 2012).

More people are exposed to the risk of extreme events in Ghana because of current development and demographic changes. This is as a result of rapid urbanization, increasing rural poverty, and declining ecosystems. Others include a high dependence on natural resources in rural areas, lack of secure livelihoods and limited informal and formal social safety nets. A study by Asante and Amuakwa-Mensah (2015) predicted a high temperature and low rainfall in Ghana in the years 2020, 2050 and 2080. This would increase sea-surface temperatures and will have extreme effects on fishery as well as rooted crops such as cassava. Also, diseases such as measles, diarrheal cases, guinea worm infestation, malaria, cholera, cerebro-spinal meningitis and other water related diseases will increase.

2.8.2 The Ghanaian Insurance Industry

Insurance started in Ghana around 1924 during the colonial era when Royal Guardian Enterprise, currently known as Enterprise Insurance Company Limited was established. In 1955, the first local private insurance company called Gold Coast Insurance Company was started, followed by the establishment of State Insurance Company in 1962. By 1971, eleven more companies were added. In 2008, there were 17 life insurance and 22 non-life insurance companies licensed in Ghana. Previously, underwriters were able to offer both life and non-life insurance products, but the 2006 Insurance Act stipulated that companies were no longer allowed to operate in both segments of the industry and mandated that these composite companies separate by December 2007. This law was passed so that companies could specialise in one area, gaining the expertise necessary for the industry to expand. Initially, the industry was regulated under the Insurance Law 1989 (PNDC Law 227). However, it is now regulated under the Insurance Act 2006 (Act 724) by the NIC (Boady, Dwomo-Fokuo, Boakye, & Frimpong, 2014).

There are basically eight (8) main classes of business written on the Ghanaian insurance market. These are motor class of business, fire/theft and property, marine, liability, engineering, personal and general accident, life/health and bonds/travel (NIC, 2016). The motor insurance, which is the umbrella for a number of product lines including the compulsory third party policy, dominates the non-life insurance business.

Statistics shows that only one out of every 10 Ghanaian has an insurance policy and only one in 20 has health insurance. However, the insurance market in Ghana remains one of the fastest growing markets in Africa. The insurance industry in Ghana grew at a compound annual growth rate of 30.4% between 2009 and 2013, as compared with other African countries, such as Chad, 2.3%; Ivory Coast, 3.9%; Cameroon, 9.4%; and Uganda, 18.8% and as such, Oxford Economics anticipates the size of the insurance market to reach US\$600

million in 2018, compared to US\$400 million in 2014 (EY, 2016). Although the insurance industry is growing rapidly, insurance penetration, defined as the contribution of total insurance premiums to gross domestic product, remains low. This can be attributed to certain factors such as high start-up costs, transaction costs, the lack of insurance knowledge, the complex nature of insurance products, and low willingness and ability to pay by the policyholders (Warner et al., 2013).

While the expansion of the overall economy has slowed considerably in recent years, it remains positive and is expected to accelerate by 2020. As Ghana's middle class grows along with the economy, the demand for insurance is expected to increase (Timetric, 2014). Also, the favorable regulatory and business environments can accelerate the expansion of insurance market (EY, 2016).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter considers the methods that were used in the data collection for the research. It deals with the research design, the population of study, sampling and sampling procedure, instruments and procedures for data collection and the methods used to analyse the data obtained from the research.

3.2 Research Design

This study used a descriptive research design as well as a quantitative inferential statistical analysis design to identify, analyse and describe impact of extreme events on insurance demand, supply and insurers' profitability in Ghana. This research design included procedures through which the relationship among the variables involved in the research problem was explored and analyzed with minimum error (Nenty, 2009). The descriptive nature of the research design also allowed the independent variables to reflect the true state of the situation without any interference. It also helped in describing the characteristics of the variables being studied.

3.2.1 Quantitative Research Methodology

Quantitative research methodology was used to systematically investigate and measure the relationship between extreme events and the insurance market. Quantitative research was best for this research because it plainly and particularly specified both the independent and the dependent variables used in the analysis. It also followed the original set of research

objectives, reducing the influence of the researcher and assisting in deriving independent conclusions (Kealey & Protheroe, 1996).

Furthermore, this research method allowed for longitudinal measures of successive performance of research subjects as well as capturing heterogeneity and variance by making it easy to collect information about great numbers of research subjects (Kelly, 2006; Matveev, 2002).

3.2.2 Inferential Statistical Analysis

Inferential statistical analysis research design used in this study allowed new or already published data to draw conclusions or predict a future effect or phenomenon about how extreme events affect the demand, supply and profitability of insurance companies based on information obtained from the sample. Also, the link between the explanatory and explained variables in the study was examined by inferential design since inferential statistical analysis looks at correlations and causations. Correlation mainly indicates the relationship between two variables, mostly the explanatory and explained variables whilst causation shows how the explanatory variables affect the explained variables.

3.3 Research Population and Sample

The population chosen for this research was the Ghanaian insurance industry. This consists of 24 life insurance companies, 27 non-life companies, 3 reinsurance companies, 78 broking companies, 2 loss adjusters, 1 oil and gas company, 2 contact offices and 6,000 insurance agents as at June 2016, as reported by the NIC. The sample, which is the selected portion of the population that is being studied, comprised 13 life and 13 non-life insurance companies in Ghana. This sample was chosen due to availability of data and their role in the supply and demand for insurance in the country.

3.4 Sampling Procedure

In selecting the sample for this research, purposive sampling method was employed. Purposive sampling is a method of sampling where the sample is selected in a strategic way so that those sampled are relevant to the research questions (Bryman, 2012). This type of sampling procedure was suitable for the study because of the specific objectives to achieve at the end of the study. Insurance companies in the Ghanaian insurance sector were considered and chosen for the study because of their role in providing insurance services directly to customers.

3.5 Data Collection

Generally, data collected may be classified as primary or secondary data. For this study, secondary data on the history of extreme events was used to identify trends and prone areas from historical data of extreme events, and the variation of cost and effect following an extreme event. Secondary data was used because it was cost effective, time saving and convenient. Also, it allowed access to high quality larger datasets that involve larger samples and contain substantial breadth which gives a more representative of the target population and allow for greater validity and more generalizable findings (Johnston, 2014).

The sources of secondary data analyzed was from annual reports and financial statements of insurance companies from National Insurance Commission (NIC). The occurrence, economic and social cost of catastrophes in Ghana was obtained from NADMO, OFDA/CRED and Ghana Open Data Initiative. Others were obtained from books, journal articles, related thesis and the internet. The population and income data was from the Ghana Statistical Service (GSS).

3.6 Method of Analysis

In order to achieve the objectives of this study, multiple regression with panel data analysis was used. Multiple regression showed the relationship between each dependent variable and the independent variables. In the study, multiple regression analysis aided in knowing how the dependent variable varies as a result of a change in the independent variables and also figuring out how the explanatory variables influenced the explained variable (Jeon, 2015).

The study covered a period from 2007 - 2016. Extreme events in this study was limited to events caused by nature such as flood, epidemic and earthquake which are prevalent in Ghana.

3.6.1 Panel Data Analysis

Panel data analysis is a method of studying a particular subject within multiple sites, periodically observed over a defined time frame (Yaffee, 2003). A panel is a cross-section or group of people who are surveyed periodically over a given time span. Hence, observations in panel data involve at least two dimensions; a cross-sectional dimension, indicated by subscript i , and a time series dimension, indicated by subscript t . There are two types of panel data namely balanced and unbalanced panel data. Balanced panel data has equal number of observations for each individual (cross-section), while unbalanced panel data does not contain equal number of observations for each individual (Akbar, Imdadullah, Aman Ullah, & Aslam, 2011).

Panel data analysis bequeaths regression analysis with both a spatial and temporal dimension. The spatial dimension refers to a set of cross-sectional units of observation such as countries, firms, or individuals. The temporal dimension refers to periodic observations of a set of variables characterizing these cross-sectional units over a particular time span (Hsiao, 2007).

There are several types of panel data analytic models. There are constant coefficients models, fixed effects models, and random effects models. The constant coefficient model, also known

as the pooled regression model, has constant coefficients for both intercepts and slopes. In the case that there is neither significant spatial or temporal effects, all of the data is pooled together and an ordinary least squares regression model is run. The fixed effects models have constant slopes but different intercepts according to the cross-sectional (group) unit or according to time, constant slopes but the intercept varies over country as well as time, and different slopes and intercept. Random effects model, also known as the error components model, has different intercept terms which are constant over time with the relationships between the explanatory and explained variables assumed to be the same both cross-sectionally and temporally. However, the intercepts for each cross-sectional unit are assumed to arise from a common intercept plus a random variable that varies cross-sectionally but is constant over time (Brooks, 2008).

Mostly, to determine the best model among these three types of models for your analysis, significance test with an F test, Hausman Specification Test, Breusch-Pagan Lagrange Multiplier test are conducted (Akbar, Imdadullah, Aman Ullah, & Aslam, 2011).

3.6.2 Frequency versus Severity

Extreme events were captured in two ways. They were looked at from their frequencies and severity. Blockbuster events represented the most severe major extreme events in the country. They were not fully estimated by the insurers and as such were expected to have a major effect on insurance pricing (Born & Viscusi, 2006). Unexpected frequency was a variable introduced in the study to capture the frequent number of unexpected events. When extreme events are anticipated, underwriting performance of insurers may not be affected since it will be reflected in the premiums. However, extreme events may adversely affect insurers underwriting performance when the number is unexpected (Born & Viscusi, 2006).

3.6.3 Demand for Insurance

The purchase of insurance allows an individual to reduce the financial risks from the loss or damage to his goods as well as his income generation capacity (Carvalho & Afonso, 2017).

3.6.3.1 Empirical Model

In this study, demand for insurance was measured as insurance density (insurance expenditure per capita). Insurance density is an important indicator to evaluate the insurance market's current state and potential growth. Adopting the econometric style of Fier and Carson (2015), the regression model took the form:

$$Demand_{it} = \beta_0 + \theta_i + \beta_1 Unexpfreq_{t-1} + \beta_2 Blockbuster_{t-1} + \beta_3 Income_{t-1} + \beta_4 HHI_{it-1} + \beta_5 Death_{it-1} + \rho_t + \varepsilon_{it}$$

where;

- i. Demand: Aggregate demand for insurance, measured as ratio of gross written premiums to total population.
- ii. Unexpfreq: unexpected frequency of extreme events; 1 if the actual number of extreme events experienced is greater than the median number of extreme events over the study period, 0 otherwise (Benali & Feki, 2017).
- iii. Blockbuster: unexpected severity of extreme events; 1 if there is an extreme event in a year with a loss among the highest 30% of all losses in the entire period of study, 0 otherwise (Born & Viscusi, 2006).
- iv. Income: the gross national income per capita
- v. HHI: Herfindahl-Hirschman Index to account for the level of concentration within a market.
- vi. Death: the number of death attributed to an extreme event

- vii. i : Class of insurance business; $i = 1, \dots, 8$
- viii. t : time period; $t = 2007, \dots, 2016$
- ix. θ : state fixed effects
- x. ρ : time fixed effects
- xi. ε : error term

3.6.3.2 Variables Description

Income: This variable controls the effect of the gross national income per capita on the demand of insurance. From literature, the relation between income and insurance demand is ambiguous. According to Bryan, Proctor, and Stoklosa (2015) and Zietz (2003), a positive relation exist between insurance demand and gross national income per capita. They posited that the national income per capita better captures the ability of the individual to pay for specific goods, such as insurance premiums and hence individuals who earn higher income can afford to purchase insurance for their health and the education of their children as well as their properties. However, Ciumas and Coca (2015) observed that income had a negative relationship with the demand for insurance. The possible reason being that individuals consider it unnecessary to protect themselves from risk when they have certain level of welfare or income.

Herfindahl-Hirschman Index (HHI): This variable measures the extent of competition within the market. The extent of competition within a market can directly affect premiums as well as the quantity of coverage available. Higher value indicates a decrease in competition and an increase of market power.

Death: Total number of death after an extreme event can affect the decision to purchase insurance.

3.6.4 Insurability of Risk (Supply of Insurance)

Premiums reflect both the price of insurance as well as the quantity of insurance. Extreme events have diverse effect on insurance premiums. These events may raise the price of insurance, increasing the total premiums, for any given number of policies written (Born & Viscusi, 2006). However, extreme events may also restrict the quantity of insurance available due to high claims payment and cause some firms to exit the market leading to a reduction in total premium volumes (Ranger & Surminski, 2011).

3.6.4.1 Empirical Model

In this study, supply was measured using the supply density. Extreme events can have impact on insurance pricing which will largely influence the quantity of insurance offered by insurers to the society. The effect of extreme events on the supply of insurance, adapted from Born and Viscusi (2006), is represented by the equation;

$$Supply_{it} = \beta_0 + \delta_i + \beta_1 Unexpfreq_{t-1} + \beta_2 Blockbuster_{t-1} + \beta_3 CR_{it} + \beta_4 Reins_{it} + \omega_t + \varepsilon_{it}$$

where;

- i. Supply: Aggregate supply of insurance, measured as the natural log of the ratio of gross premiums to the number of insurers.
- ii. Unexpfreq: unexpected frequency of extreme events; 1 if the actual number of extreme events experienced is greater than the median number of extreme events over the study period, 0 otherwise (Benali & Feki, 2017).
- iii. Blockbuster: unexpected severity of extreme events; 1 if there is an extreme event in a year with a loss among the highest 30% of all losses in the entire period of study, 0 otherwise. (Born & Viscusi, 2006)

- iv. CR: Claims Ratio
- v. Reins: Amount of reinsurance ceded to a reinsurance company
- vi. i : Class of insurance business; $i = 1, \dots, 8$
- vii. t : time period; $t = 2007, \dots, 2016$
- viii. δ : state fixed effects
- ix. ω : time fixed effects
- x. ε : error term

3.6.4.2 Variables Description

Claims Ratio: This ratio measures the efficiency of insurers in paying claims. Claims ratio is also known as underwriting risk and a higher ratio is an indication that premiums collected are not adequate to pay claims and other expenses (Berhe & Kaur, 2017).

Reinsurance: The transfer of insurance from a primary insurer to another insurer (reinsurer) provides the finances needed by the primary insurer, aside his capital and reserve, to take in more risk by increasing the primary insurer's coverage (Prelipcean & Boscoianu, 2010). If extreme event losses exceed the retention limit of the insurer, the reinsurer comes in and make up for the difference (Benali & Feki, 2017).

3.6.5 Profitability of Insurance Companies

One important goal of financial management is to always seek to maximize the owner's or shareholders wealth (Ortyński, 2016). This is because for companies especially insurance companies to be sustainable in the competitive globalized environment, they need to earn profit. Also, without profit insurers will find it difficult to attract outside capital so as to meet their objectives (Berhe & Kaur, 2017).

3.6.5.1 Empirical Model

In this study, profitability was measured by return on asset (ROA). ROA is used to measure profitability because it captures the fundamentals of business performance in a holistic way, looking at both income statement performance and the assets required to run a business (Malik, 2011). Examining the impact of extreme events on the profitability of the insurance companies, the model used by Benali and Feki (2017) was replicated as follows;

$$ROA_{it} = \beta_0 + \alpha_i + \beta_1 Unexpfreq_t + \beta_2 Blockbuster_t + \beta_3 PremSurp_{it} + \beta_4 Size_{it} + \beta_5 ExpRatio_{it} + \beta_7 PremGrw_{it} + \gamma_t + \varepsilon_{it}$$

where;

- i. ROA: Return on Asset
- ii. Unexpfreq: unexpected frequency of extreme events; 1 if the actual number of extreme events experienced is greater than the median number of extreme events over the study period, 0 otherwise (Benali & Feki, 2017).
- iii. Blockbuster: unexpected severity of extreme events; 1 if there is an extreme event in a year with a loss among the highest 30% of all losses in the period of study, 0 otherwise (Born & Viscusi, 2006).
- iv. PremSurp: Premiums-to-surplus ratio
- v. Size: Size of the firm
- vi. ExpRatio: Expenses Ratio
- vii. PrewGrw: Premium Growth
- viii. i : Insurance Company; $i = 1, \dots, 13$
- ix. t : time period; $t = 2007, \dots, 2016$

- x. α : state fixed effects
- xi. γ : time fixed effects
- xii. ε : error term

3.6.5.2 Variables Description

PremSurp: Premium to surplus ratio measures the financial strength of the insurance company and the insurer's ability to absorb above average losses (Benali & Feki, 2017).

Size: The size of company mostly measures the total assets or market share of an insurer. It also captures the capacity of insurers for dealing with adverse market fluctuations (Berhe & Kaur, 2017).

Expense Ratio (ExpRatio): This ratio measures the percentage of premium that insurers use for paying all the cost to provide adequate coverage as required by the policy which includes acquiring, writing and servicing insurance and reinsurance. A high ratio signifies that, the insurer is inefficient in discharging its insurance obligations and this could affect the overall profitability of the insurance company (NIC, 2016).

Premium Growth (PremGrw): the growth in premiums collected over the years may positively affect insurance company's profitability. The growth in premiums may signify higher rate of market penetration and better performance of an insurer as found by Ullah, Faisal, and Zuhra (2016). However, Kim, Anderson, Amburgey and Hickman (1995) in their study observed that swift increase in premiums is a major cause of insurer insolvency because companies may be obsessed with growth and can neglect other important objectives.

3.7 Variables Construction and Expected Signs

Tables 3.1 and 3.2 show the dependent and independent variables used in the study, how they were measured and their expected signs.

Table 3.1: Definition of Dependent Variables

DEPENDENT VARIABLES	DEFINITIONS
Demand	Gross Premiums/Total Population
Supply	Natural log of Gross Premiums/Number of Insurers
Return on Asset (ROA)	Net financial result/Total Assets

Table 3.2: Definition of Independent Variables and Expected Signs

INDEPENDENT VARIABLES	DEFINITIONS	EXPECTED SIGN
Unexpected Frequency (Unexpfreq)	Unexpected Frequency of extreme event	+/-
Blockbuster	Unexpected Severity of extreme event	+/-
Income	Gross income per capita	+/-
Market Concentration (HHI)	Sum of the square of the market share	+
Death	Natural log of the number of death attributed to an extreme event	+

Claims Ratio (CR)	Claims incurred/Premiums earned	+/-
Reins	Amount of Reinsurance	+
PremSurp	Premiums-to-surplus ratio	+
Size of the firm (Size)	Natural log of total assets	+
Expense Ratio (ExpRatio)	Ratio of underwriting expenses to net premium	+/-
Premium Growth (PremGrw)	Changes in premium earned relative to prior year	+

3.8 Limitations to the Methodology

One limitation was the difficulty in finding secondary data for the insurance companies due to the sensitive nature of information required as well as the competitive nature of the industry. However, the researcher had to go to the regulatory body of the insurance industry (NIC) to get the needed information since all insurance companies are mandated to send a copy of their financial report to NIC.

Also, secondary data on extreme events for Ghana was minimal. The researcher had to resort to interviews with the staff of NADMO in order to get adequate information to carry out the study.

CHAPTER FOUR

DATA ANALYSIS, ESTIMATION AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the results of the study. The study sought to examine the effect of extreme events on insurance demand and supply and their impact on the profitability of insurance firms in Ghana. Data on the frequency, severity and death as a result of extreme events were examined to determine whether they have an impact on the insurance market in Ghana. The study further examined whether other demographic variables such as income and market concentration have impact on the demand, supply and profitability of insurance in Ghana. Also, variables such as claims ratio, premium to surplus ratio, size, expense ratio and premium growth obtained from thirteen life and general insurance companies were examined to assess how they affect the profitability of both life and non-life insurance firms in Ghana.

The chapter begins with a description of each data set using summary statistics. This is followed by the pre-tests such as the multicollinearity and Hausman test to determine the right regression model to use. Other diagnostic test are performed to confirm the appropriateness of the model and the chapter ends with a discussion of the results. The study used STATA software for all the analysis.

4.2 Extreme Events and Demand for Insurance

4.2.1 Descriptive Statistics

Table 4.1 presents the summary statistics for both the explained and the explanatory variables. The mean, standard deviation, minimum and maximum values for all variables used are displayed.

Table 4.1: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Demand	80	4.0416	5.8144	0.0186	30.446
Unexpfreq _{t-1}	80	0.1	0.3019	0	1
Blockbuster _{t-1}	80	0.3	0.4611	0	1
Income	80	7.1069	0.3163	6.3969	7.4559
HHI	80	0.2767	0.0532	0.1142	0.3378
Death	80	3.6642	3.3666	0	11.6074

Source: Author's calculations using STATA 14.0 software.

The highest insurance density (demand) of 30.446 was recorded by life insurance business in 2013 and the lowest by bonds class of business in 2007. The 3rd June, 2015 fire and flood event recorded the highest number of death within the study period. Also, aside Demand and Death variables, the rest of the variables have their data values lying close to the mean of the dataset.

4.2.2 Multicollinearity Test

Multicollinearity occurs when the correlation between two or more explanatory variables is high. This means one explanatory variable can be used to predict the other. This problem can lead to unstable and unreliable regression estimates. To test for multicollinearity, a bilateral correlation matrix between the variables are presented in table 4.2. It can be observed that the highest correlation exist between Death and Unexpfreq_{t-1} variables. However, Benali and Feki (2017) posited that a correlation coefficient of more than 0.8 existing between two

independent variables indicate a problem of multicollinearity. From the table, there is no correlation coefficient which is more than 0.8 and hence there is no problem of multicollinearity.

Table 4.2: Correlation Matrix

	Demand	Unexpfreq _{t-1}	Blockbuster _{t-1}	Income	HHI	Death
Demand	1					
Unexpfreq _{t-1}	-0.0528	1				
Blockbuster _{t-1}	0.039	0.5092	1			
Income	0.3132	0.0254	-0.1474	1		
HHI	-0.609	0.0225	-0.0307	-0.3709	1	
Death	0.1497	0.7914	0.6642	0.3298	-0.2327	1

Source: Author’s calculations using STATA 14.0 software.

To decide whether there exist a panel effect in the model, a Breusch-Pagan Lagrange multiplier (LM) test was done. The null hypothesis in the LM test is that variances across entities is zero which means no significant difference across units (i.e. no panel effect) and hence a simple OLS is better. The alternate is that there exit a panel effect. The results for the panel effect test is shown below.

Table 4.3: Testing for Panel Effect

Chi-square value	P-value

22.30	0.0000
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Here, a p-value of 0.0000 which is less than 0.05 suggests that we reject the null hypothesis. It can therefore be concluded that OLS is not appropriate and that panel regression analysis should be considered since there exist a significant differences amongst the various classes of insurance business.

4.2.3 Test for Best Panel Model

To determine the appropriate panel model to be used, a Hausman test was carried out to decide between fixed and random effects with the null hypothesis that the preferred model is random effects versus the alternative to the fixed effects as shown in table 4.4

Table 4.4: Hausman Test

Chi-square value	P-value
114.75	0.0000

From the table above, the p-value of the test is less than 0.05. We reject the null hypothesis and conclude that fixed effects model is preferred to the random effects model.

4.2.4 Results of Panel Regression

Using a fixed effects panel regression model, the results of the model are presented in table 4.5.

Table 4.5: Regression Results of Demand for Insurance

Variables	Coefficient	Standard Error	T-Statistic	P-Value
(constant)	-69.439	23.079	-3.01	0.02**
Unexpfreq _{t-1}	-13.305	4.0161	-3.31	0.013**
Blockbuster _{t-1}	-1.0115	0.8011	-1.26	0.247
Income	6.3908	1.7481	3.66	0.008***
HHI	88.474	39.147	2.26	0.058*
Death	1.4224	0.4686	3.04	0.019**
R-squared	0.7185			
Adjusted R-squared	0.4604			

***, **, * Significance at 1%, 5% and 10%, respectively.

Source: Author's calculations using STATA 14.0 software.

From table 4.5, it can be seen that the unexpected frequency of extreme events in the previous year (Unexpfreq_{t-1}) negatively influenced the demand for insurance. This means that if the previous year experienced more than the median number of extreme events, it results in a negative demand for insurance. This could be due to the expectation of public and political responses as well as international assistance after losses from these events, as found by Lamond and Penning-Rowsell (2014), Ranger and Surminski (2011) and Ackah and Owusu (2012). An interview with Mr. Richard Amo-Yartey (the director in charge of geological disasters at NADMO) reveals that during the June 3rd flood and fire disaster which occurred in 2015 in Accra, the government gave each family of a victim GH¢10000 as compensation

amongst other items. Furthermore, China supported the country with US\$50000 during the heavy floods in 2010. This supports the fact that government intervention and international assistance during such events goes a long way to reduce the demand for insurance as a way of financing risk posed by extreme events. Again, according to Dlugolecki and Hoekstra (2006), extreme events does not positively affect demand for insurance because of the poor perception of risk exposure of these events due to lack of education and public awareness. In Ghana, most informal sector workers who form the majority of the population in the country, do not demand or use insurance as a precautionary measure but rather trust God to provide protective care as found by Ackah and Owusu (2012) and Archer (2013) in their studies. However, though the unexpected severe event of the previous year (Blockbuster_{t-1}) had a negative impact on insurance demand, it was not significant.

Income had a positive relationship with the demand for insurance. This confirms the findings of Zietz (2003), Bryan, Proctor, and Stoklosa (2015), Fofie (2016) and Peprah, Koomson, & Forson (2017) in their studies that individuals who earn higher income can afford to purchase insurance for their health and the education of their children as well as their properties and also, as income increases there is a desire to protect potentially higher levels of income in the event of premature death.

Herfindahl-Hirschman Index (HHI) which measures the level of market concentration and the extent of competition in the market was positively related to demand for insurance. This means that a growth in the level of competition reduces the market power which leads to a decrease in the price of insurance. Like general goods, a decrease in the price of insurance will cause an upsurge in demand. This confirms the findings of Fier and Carson (2015) in their studies.

The number of death in an extreme event (Death) had a positive relationship with the demand for insurance. This shows that if the number of death in an extreme event increases, it

positively affect the decision to patronise insurance. After a personal experience of a traumatic event, people may be led to purchase insurance in an effort to protect themselves from future harm. For instance, the funeral insurance policy is one of the most patronized policy in the life insurance business (National Insurance Commission, 2010; Ackah & Owusu, 2012). Fier and Carson (2015) found similar results in their studies.

4.2.5 Diagnostics Test

An assumption of the panel regression is that the errors must be serially uncorrelated as it causes the standard errors of the coefficients to be smaller than they actually are leading to inefficient estimates. Moreover, residuals across entities should not be correlated because it could lead to biasedness in test results. The Lagrangian-Multiplier/Wooldridge test for serial correlation and the Pasaran CD test for cross-sectional dependence in the panel model is presented in table 4.6. The null hypothesis states that there is no serial correlation and cross-sectional dependence.

Table 4. 6: Diagnostics Test for Serial Correlation and Cross-sectional Dependence

Diagnostics Test	Chi-square Value	P-value
Test for Serial Correlation	9.55	0.0891
Test for Cross-sectional Dependence	7.51	0.1853

Since the p-values in table 4.6 are greater than 0.05, we fail to reject the null hypothesis and conclude that there is no serial correlation or cross-sectional dependence in the model.

4.3 Extreme Events and Supply of Insurance

4.3.1 Descriptive Statistics

Table 4.7 displays the mean, standard deviation, minimum and maximum values for both the explained and the explanatory variables used for the study.

Table 4. 7: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Supply	80	14.4188	1.4797	10.1227	17.2388
Unexpfreq _{t-1}	80	0.1	0.3019	0	1
Blockbuster _{t-1}	80	0.3	0.4611	0	1
CR	80	0.3227	0.1061	0.16	0.56
Reins	80	18.4787	1.4131	13.2021	19.812

Source: Author’s calculations using STATA 14.0 software.

From table 4.7, life insurance business recorded the highest supply of insurance in 2016. Motor insurance also ceded the highest amount of insurance to reinsurance which is not surprising since it is the class of business that dominates the non-life market (NIC, 2016). Again, life class of business recorded the highest claim ratio (CR) in 2015.

4.3.2 Multicollinearity Test

Table 4. 8: Correlation Matrix

	Supply	Unexpfreq_{t-1}	Blockbuster_{t-1}	CR	Reins
Supply					
Unexpfreq_{t-1}					
Blockbuster_{t-1}					
CR					
Reins					

Supply	1				
Unexpfreq _{t-1}	-0.0888	1			
Blockbuster _{t-1}	-0.0405	0.5092	1		
CR	0.5532	0.1692	0.0166	1	
Reins	-0.2373	-0.0327	0.0242	0.0302	1

Source: Author’s calculations using STATA 14.0 software.

Table 4.8 shows a bilateral correlation matrix between the variables and it can be seen that the highest correlation exist between CR and supply. Since there is no correlation coefficient between the independent variables which is more than 0.8, the absence of multicollinearity is confirmed.

Also, to decide whether there exist a panel effect in the model, a Breusch-Pagan Lagrange multiplier (LM) test was performed. The results for the panel effect test is presented in Table 4.9.

Table 4. 9: Testing for Panel Effect

Chi-square value	P-value
191.88	0.0000

Here, a p-value of 0.0000 which is less than 0.05 suggests that we reject the null hypothesis and conclude that OLS is not appropriate. A panel regression analysis should be considered since there exist a significant differences amongst the various classes of insurance business.

4.3.3 Test for Best Panel Model

Now deciding between a fixed effects panel model and a random effects panel model will require a Hausman test which is presented in table below.

Table 4. 10: Hausman Test

Chi-square value	P-value
7.31	0.1206

Since the p-value of the test is greater than 0.05 we fail to reject the null hypothesis. Therefore, we conclude that random effects model is preferred to the fixed effects model.

4.3.4 Results of Panel Regression

Using a random effects panel regression model, table 4.11 presents the regression results.

Table 4. 11: Regression Results of Supply of Insurance

Variable	Coefficient	Standard Error	T-Statistic	P-Value
(constant)	8.3406	1.288	6.48	0.000***
Unexpfreq _{t-1}	-0.7971	0.4123	-1.93	0.053*
Blockbuster _{t-1}	0.0977	0.079	1.24	0.216
CR	5.4203	1.4853	3.65	0.000***
Reins	0.237	0.0668	3.55	0.000***
R-squared	0.8849			

Adjusted R-squared 0.8663

***, **, * Significance at 1%, 5% and 10%, respectively.

Source: Author's calculations using STATA 14.0 software.

From table 4.11, it can be observed that the unexpected frequency of extreme events in the previous year ($Unexpfreq_{t-1}$) negatively affects the supply of insurance. This means that if the previous year experienced more than the median number of extreme events, there will be a fall in the supply of insurance (Harrington & Niehaus, 2004). Extreme events may result in higher losses and insurers may be faced with two options; either to increase premiums to recoup their losses and restrict coverage or to completely remove cover from the market in order to maintain solvency and shareholder returns. In both ways, the availability and affordability (supply) of insurance will be reduced in the market. Also, as the unexpected frequency of these events increases, losses paid could also increase leading to a depletion of insurers' capital reserves and increase competition among insurers which could pressure some to exit the market (Turner & Deng, 2015). This finding is supported by researchers such as Chen, Doerpinghaus, Lin and Yu (2008), Maynard (2008) and Yi (2013) in their studies.

On the other hand, the unexpected severe event of the previous year ($Blockbuster_{t-1}$) positively impacted the supply of insurance but it was not significant.

Claims Ratio (CR) positively affected the supply of insurance. Since the fundamental duty of an insurer is to pay claims, the ability to pay claims and on time wins and maintains the confidence of existing policyholders and attract new ones. Thus, the greater the market share, the greater the supply of insurance in the market (NIC, 2016).

Reinsurance (Reins) had a positive relationship with the supply of insurance. The reinsurance companies support insurance firms by increasing their capacity to underwrite large risks, and accept liability for losses beyond an insurer's retention limit thereby reducing the amount of

capital needed to achieve a given level of solvency. Other researchers such as Prelipcean and Boscoianu (2010), and Benali and Feki (2017) support this findings in their studies.

4.3.5 Relationship between Supply and the Interaction of Claims Ratio and Reinsurance

From the supply model above, it was seen that both Claims Ratio (CR) and Reinsurance (Reins) had a positive influence on the supply of insurance. However, the ability to effectively pay claims may also depend on the amount of reinsurance to support payments when they fall due. This may increase the capacity of the insurer to underwrite more policies. The regression results of the combine effect of claims ratio and reinsurance (CR_ Reins) on Supply is shown in table 4.12. This is based on the AIC / BIC model selection by Brooks (2008). See appendix for details.

Table 4.12: Regression Results of Supply of Insurance (With CR_Reins)

Supply	Coefficient	Standard Error	T-Statistic	P-Value
Constant	12.4939	0.455	27.46	0.000***
Unexpfreq _{t-1}	-0.8832	0.2387	-3.7	0.000***
Blockbuster _{t-1}	0.1294	0.1543	0.84	0.402
CR_Reins	0.3308	0.0308	10.76	0.000***
R-squared	0.8771			
Adjusted R-squared	0.8593			

***,**, * Significance at 1%, 5% and 10%, respectively.

Source: Author's calculations using STATA 14.0 software.

The results in table 4.12 shows that the interaction between claims ratio and reinsurance (CR_Reins) positively and significantly affects the supply of insurance. This indicates that, a high reinsurance for a policy will increase the capability of the insurer to pay claims which will reduce the impact of losses on the insurer’s capital and reserves and enable the insurer underwrite more risks. This findings is supported by other researchers such as Berhe and Kaur (2017) in their studies.

4.3.6 Diagnostics Test

Table 4.13 shows the Lagrangian-Multiplier/Wooldridge test for serial correlation as well as the Pasaran CD test for cross-sectional dependence in the panel model.

Table 4. 13: Diagnostics Test for Serial Correlation and Cross-sectional Dependence

Diagnostics Test	Chi-square Value	P-value
Test for Serial Correlation	2.115	0.1892
Test for Cross-sectional Dependence	0.329	0.7423

The p-values of 0.1892 and 0.7423 are greater than 0.05. This means that there is no serial correlation in the model and also the error terms are not correlated across the class of insurance business.

4.4 Extreme Events and Profitability of Life Insurance Companies

4.4.1 Descriptive Statistics

Table 4.14 shows the descriptive statistics of the variables used to examine the profitability of the life insurance companies in Ghana.

Table 4. 14: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
ROA	127	0.0170	0.3233	-3.12	0.6
Unexpfreq	130	0.1	0.3012	0	1
Blockbuster	130	0.3	0.4600	0	1
PremSurp	124	3.1837	6.0909	-1.4977	38.6350
Size	125	17.0326	1.4846	12.5967	20.6554
ExpRatio	127	0.4989	0.2515	0.12	1.37
PremGrw	130	0.3264	0.3505	-0.5627	2.4827

Source: Author's calculations using STATA 14.0 software.

From table 4.14 the lowest ROA was recorded by Unique Life Insurance in 2011 which is over 300% reduction in its returns whilst Ghana Life Insurance Company recorded the highest returns in 2007. On the average life insurers' profitability within the study period was about 2%. The range of the premium to surplus ratio (PremSurp) variable is wider than the rest of the variables and also its spread around the mean is the greatest.

4.4.2 Multicollinearity Test

To verify whether the explanatory variables are not highly correlated or not, a bilateral correlation matrix between the variables is presented in table 4.15.

Table 4. 15: Correlation Matrix

	ROA	Unexpfreq	Blockbuster	PremSurp	Size	ExpRatio	PremGrw
ROA	1						
Unexpfreq	0.072	1					
Blockbuster	0.028	0.509	1				
PremSurp	-0.077	-0.069	0.011	1			
Size	0.068	-0.084	-0.084	-0.052	1		
ExpRatio	-0.121	0.060	0.043	-0.004	-0.277	1	
PremGrw	0.129	0.199	0.094	-0.231	-0.186	-0.033	1

Source: Author’s calculations using STATA 14.0 software.

From the correlation matrix above, the highest correlation of 0.51 exist between Unexpfreq and Blockbuster and that there is no correlation coefficient between two explanatory variables which is more than 0.8. Thus, the absence of multicollinearity is confirmed.

A Breusch-Pagan Lagrange multiplier (LM) test was carried out to decide whether there exist a panel effect in the model. The null hypothesis in the LM test is that variances across life insurance firms is zero meaning no panel effect and hence a simple OLS is better. Table 4.16 shows the results for the test for the panel effect.

Table 4. 16: Testing for Panel Effect

Chi-square value	P-value
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9.53	0.0011
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Here, a p-value of 0.0011 which is less than 0.05 suggests that we reject the null hypothesis and conclude that OLS is not appropriate. Panel regression analysis should be considered since there exist a significant differences amongst the various life insurance companies.

4.4.3 Test for Best Panel Model

A Hausman test for the best panel model was conducted in table 4.17 to decide between fixed and random effects with the null hypothesis that the preferred model is random effects.

Table 4. 17: Hausman Test

Chi-square value	P-value
7.64	0.2656

Since the p-value of the test is greater than 0.05 we fail to reject the null hypothesis. Therefore, we conclude that random effects model is preferred to the fixed effects model.

4.4.4 Results of Panel Regression

Using a random effects panel regression model, the results of the model are presented in table 4.18.

Table 4. 18: Regression Results of Profitability of Life Insurance Companies

Variables	Coefficient	Standard Error	T-Statistic	P-Value
(constant)	0.2341	0.2209	1.06	0.289

Unexpfreq	0.0726	0.0704	1.03	0.303
Blockbuster	-0.0496	0.0184	-2.69	0.007**
PremSurp	0.0015	0.0025	0.58	0.563
Size	-0.0093	0.0115	-0.81	0.417
ExpRatio	-0.1126	0.0593	-1.9	0.057*
PremGrw	0.0784	0.0363	2.16	0.031**
R-squared	0.3332			
Adjusted R-squared	0.2142			

***,**, * Significance at 1%, 5% and 10%, respectively

Source: Author's calculations using STATA 14.0 software.

However, in selecting the appropriate model, the AIC and BIC criterion was used. The regression model which minimized the value of the information criteria was considered (Brooks, 2008). The best regression model was the one without the variable Size (see tables 6 to 10 in the appendix for details).

Table 4. 19: Regression Results of Profitability of Life Companies (Without Size)

Variables	Coefficient	Standard Error	T-Statistic	P-Value
(constant)	0.0702	0.035	2.01	0.045**
Unexpfreq	0.0722	0.0704	1.03	0.305
Blockbuster	-0.0473	0.0177	-2.68	0.007**

PremSurp	0.0014	0.0023	0.63	0.527
ExpRatio	-0.1098	0.0611	-1.8	0.072*
PremGrw	0.0881	0.0316	2.78	0.005**
R-squared	0.3261			
Adjusted R-squared	0.2138			

***, **, * Significance at 1%, 5% and 10%, respectively.

Source: Own calculations using STATA 14.0 software.

From table 4.19, unexpected severe event in the year (Blockbuster) negatively influenced the profitability of life insurance companies. This implies that if there is an extreme event in the year with a loss among the highest 30% of all losses, it will lead to a fall in life insurers' profitability. This is because an unexpected severe event can increase losses and disrupt the activities of insurers by putting stress on their resources leading to a great negative impact on profitability. Insurers may invest at least part of their capital in equities and properties, and these may be adversely affected by extreme events. Also, financial assets may be held to support the capital and reserves of the insurer and these assets may be adversely affected leading to a fall in their value. Risks due to extreme events may also drive up insurers' capital requirements. Over the years, the minimum capital requirement for insurance companies in Ghana has increased from GH¢200 in 1989, GH¢5million in 2006, GH¢10million in 2013 to GH¢15million in 2015. As the value of assets are falling concurrently with a rise in the liabilities and capital requirements, the overall profitability of the insurer may be negatively affected. Researchers such as Coomber (2006) and Maynard (2008) supports this findings in their studies.

Both the unexpected frequency of extreme events ($Unexpfreq_{t-1}$) and the premium-to-surplus ratio (PremSurp) positively influenced the profitability of life insurers' but they were not significant.

Expenses ratio (ExpRatio) was seen to negatively influence life insurers' profitability. This ratio shows how efficient an insurance company's operations are at bringing in premiums. It implies that as the cost of underwriting new policies increases, it reduces the premiums available to invest and generate other income. This in turn reduces the profits available and the overall profitability of the insurance company. It confirmed the findings of Ullah, Faisal, and Zuhra (2016) in their studies.

Premium growth (PremGrw) evaluates the level of market penetration and it positively affected the profitability of life insurance companies. The growth in premiums may signify better performance of an insurer. Premiums are the major source of revenue for insurers and they can be invested to generate more income which will increase their capacity to pay claims, build confidence in policyholders and maintain solvency. This will also better the chances of insurance companies being profitable. The results from this study is consistent with Ahmed, Ahmed and Ahmad (2011) in Pakistan and Ullah, Faisal and Zuhra (2016) in Bangladesh

4.4.5 Diagnostics Test

The Lagrangian-Multiplier/Wooldridge test for serial correlation and the Pasaran CD test for cross-sectional dependence in the panel model is conducted in table 4.20.

Table 4. 20: Diagnostics Test for Serial Correlation and Cross-sectional Dependence

Diagnostics Test	Chi-square Value	P-value
Test for Serial Correlation	3.225	0.0977

Test for Cross-sectional Dependence	0.378	0.7319
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The p-values in table above shows that there is no serial correlation in the model and the error terms are not correlated across the insurance companies.

4.5 Extreme Events and Profitability of Non-life/General Insurance Companies

4.5.1 Descriptive Analysis

The descriptive statistics of the data for the non-life insurance companies is shown in table 4.21.

Table 4. 21: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
ROA	130	0.0368	0.2187	-2.15	0.73
Unexpfreq	130	0.1	0.3012	0	1
Blockbuster	130	0.3	0.46	0	1
PremSurp	128	2.1289	1.4523	0.2175	10.8682
Size	128	16.9519	1.136	13.9959	19.4796
ExpRatio	128	0.702	0.5331	0	4.95
PremGrw	129	0.3234	0.4148	-0.5471	2.7619

Source: Author’s calculations using STATA 14.0 software.

From table 4.21 the minimum ROA was recorded by Prime insurance company in 2014 which is over 200% reduction in its returns whilst Enterprise insurance company recorded the highest returns of over 70% increase in its returns in 2011. On the average the profitability of the general insurance companies within the study period was about 4% which is quite higher than that of the life companies.

4.5.2 Multicollinearity Test

To verify whether the explanatory variables are not highly correlated or not, a bilateral correlation matrix between the variables are presented in table 4.22.

Table 4. 22: Correlation Matrix

	ROA	Unexpfreq	Blockbuster	PremSurp	Size	ExpRatio	PremGrw
ROA	1						
Unexpfreq	0.058	1					
Blockbuster	0.111	0.512	1				
PremSurp	-0.020	0.034	-0.042	1			
Size	0.204	-0.058	-0.005	-0.116	1		
ExpRatio	-0.766	-0.016	-0.157	-0.090	-0.025	1	
PremGrw	-0.259	0.016	0.111	0.039	-0.253	0.389	1

Source: Author's calculations using STATA 14.0 software.

The table above shows that the highest correlation of 0.512 exist between Unexpfreq and Blockbuster variables. However, there is no correlation coefficient between two independent variables above 0.8 which confirms the absence of multicollinearity.

A Breusch-Pagan Lagrange multiplier (LM) test was done to decide whether there exist a panel effect in the model. The null hypothesis in the LM test is that variances across life insurance firms is zero meaning no panel effect and hence a simple OLS is better. Table 4.23 displays the results for the panel effect test.

Table 4. 23: Testing for Panel Effect

Chi-square value	P-value
9.03	0.0410

A p-value of 0.0410 which is less than 0.05 suggests that we reject the null hypothesis and conclude that OLS is not appropriate. Panel regression analysis should be considered since there exist a significant differences amongst the various non-life insurance companies.

4.5.3 Test for Best Panel Model

A Hausman test for the best panel model was conducted in table 4.24 to decide between fixed and random effects with the null hypothesis that the preferred model is random effects.

Table 4. 24: Hausman Test

Chi-square value	P-value
13.65	0.0338

Since the p-value of the test which is 0.0338 is less than 0.05 we reject the null hypothesis and conclude that fixed effect model is preferred to the random effect model.

4.5.4 Results of Panel Regression

Using a fixed effect panel regression model, the results of the model are presented in table 4.25.

Table 4. 25: Regression Results of Profitability of Non-life Insurance Companies

Variables	Coefficient	Standard Error	T- Statistic	P-Value
(Constant)	-1.0881	0.3659	-2.97	0.012**
Unexpfreq	0.0923	0.067	1.38	0.194
Blockbuster	-0.0541	0.0337	-1.6	0.135
PremSurp	-0.0164	0.0064	-2.55	0.025**
ExpRatio	-0.3697	0.0572	-6.47	0.000***
PremGrw	0.1118	0.0975	1.15	0.274
Size	0.082	0.0227	3.62	0.004**
R-squared	0.7848			
Adjusted R-squared	0.6001			

***, **, * Significance at 1%, 5% and 10%, respectively.

Source: Author's calculations using STATA 14.0 software.

From the table above, both the unexpected frequency of extreme events (Unexpfreq) and unexpected severe event (Blockbuster) in a year did not have any significant impact on the

profitability of non-life insurance companies. The reason being that, the losses from extreme events may cause insurers to raise premiums in order to recoup some of their losses. In Ghana some of the products offered by the general insurance companies, such as the third-party motor insurance policy, insurance against the hazards of collapse, fire, earthquake, storm and flood in respect of all commercial buildings, both complete and those still under construction are compulsory and workers' compensation insurance policy, are compulsory. This means that though premiums are increased, policyholders do not have a choice than to still purchase these products and as such, the companies can gradually recoup their losses. According to National Insurance Commission (2016), the premium income of the motor class grew by 46% in 2016 despite a major extreme event in the previous year. However, this differs from the findings of Benali and Feki (2017).

The premium-to-surplus ratio (PremSurp) which measures the insurer's financial strength was found to have an adverse effect on the profitability of non-life insurance companies. A decrease in this ratio indicates a greater capacity of the insurance company to underwrite new policies and absorb above average losses. A lower ratio also signifies a higher financial strength and the ability of insurers to engage in mitigation measures to reduce vulnerabilities to extreme events like offering discounts to owners and businesses that invest in preventive measures which eventually leads to an increase in profitability (Benali & Feki, 2017).

The natural log of total assets (Size) was found to positively and significantly influence the profitability of non-life insurance companies. Companies that have large amount of assets usually have greater capacity for dealing with unfavorable market fluctuations than smaller ones. Again, insurers with large size can exercise their market power in utilizing their products and take advantages of economies of scale in terms of labour cost, introducing different techniques such as creating new technologies so as to earn maximum profits which is consistent with the findings of Berhe and Kaur (2017) and Ullah, Faisal and Zuhra (2016).

Furthermore, larger insurance companies can get access to investment opportunities that are not available to smaller ones. Also, regulators are less likely to liquidate large insurers which makes small insurers more vulnerable to insolvency than large companies.

Expenses ratio (ExpRatio) negatively influenced non-life insurers' profitability. This indicates that if an insurance company's operations are inefficient at bringing in premiums, it may negatively affect the profitability of the company. When expenses ratio is high, the ability to pay claims promptly is affected. This means that as the cost of underwriting new policies increases, it reduces the premiums available to invest and generate other income. This leads to a reduction in the profits available and the overall profitability of the insurance company. It confirmed the findings of Ullah, Faisal, and Zuhra (2016) in their studies.

Premium Growth (PremGrw) had a positive impact on profitability but it was not significant.

From the regression results in table 4.25, Size had a positive relationship with insurer's profitability. However, the question is, as a company grows larger and larger, will the size continue to positively influence the insurer's profitability? Also, at what point will a growth in firm size no longer positively affect profitability? To answer this question, the squared of Size (Size²) is added to the regressors to fit a quadratic model to profitability and the results is presented in table 4.26.

Table 4. 26: Regression Results of Profitability of Non-life Companies (Including Size Squared)

Variables	Coefficient	Standard Error	T-Statistic	P-Value
Constant	-5.6816	2.5334	-2.24	0.045**
Unexpfreq	0.0782	0.0645	1.21	0.249

Blockbuster	-0.047	0.029	-1.62	0.131
PremSurp	-0.0163	0.0059	-2.76	0.017**
Size	0.6283	0.2974	2.11	0.056*
ExpRatio	-0.3691	0.0568	-6.49	0.000***
PremGrw	0.1097	0.0937	1.17	0.265
Size²	-0.0162	0.0087	-1.87	0.087*
R-squared	0.8366			
Adjusted R-squared	0.6032			

***,**, * Significance at 1%, 5% and 10%, respectively.

Source: Author's calculations using STATA 14.0 software.

From the results above, it can be observed that though the total assets (Size) positively influence insurer's profitability, beyond 19.392 (see appendix) any additional increase in size causes profit to decline. According to Adams and Buckle (2003), as insurance companies grow larger and larger, owners or shareholders find it challenging to competently and effectively control and keep an eye on deviant behaviour by managers. Also, the growth in the size of the company may lead to inefficiencies which may reduce insurers' profitability (Almajali, Alamro, & Al-Soub, 2012).

4.5.5 Diagnostics Test

To test for the presence of autocorrelation and cross-sectional dependence, the Lagrange Multiplier/Wooldridge test for serial correlation and the Pasaran CD Test for cross-sectional dependence was conducted and the result is shown in table 4.27.

Table 4. 27: Diagnostics Test for Serial Correlation and Cross-sectional Dependence

Diagnostics Test	Chi-square Value	P-value
Test for Serial Correlation	0.01	0.9820
Test for Cross-sectional Dependence	0.288	0.9878

Since the p-values are greater than 0.05, it shows that there is no serial correlation in the model and the error terms are not correlated across the insurance companies.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the findings as well as the conclusion drawn from the study. The chapter also provides recommendations based on the findings and suggests areas for future research. The limitations of the study are also presented in this chapter.

5.2 Summary of Findings

The study examined the impact of extreme events on the insurance market in Ghana looking specifically at their impact on the demand, supply and the profitability of insurers. The concept, nature and risk associated with extreme events and how they affected the insurance markets in various economies was explored. Nevertheless, the focus of this study was on the effect of extreme events on the Ghanaian insurance market.

To examine how extreme events affect the insurance market in Ghana, eight classes of business as well as thirteen life and non-life companies were sampled and used over the period 2007 – 2016. Secondary data was used and the method of analysis was panel data regression. The estimation results indicated that the unexpected frequency of extreme events had a negative significant relationship with the demand for insurance whilst the unexpected severity had a negative but insignificant impact which was consistent with the findings of Ackah and Owusu (2012). Moreover, income, HHI and death variables positively influenced the patronage of insurance in Ghana which was in line with studies conducted by Bryan, Proctor and Stoklosa (2015), Peprah, Koomson and Forson (2017) and Fier and Carson (2015).

In the case of the supply of insurance, there was a negative relationship between supply and unexpected frequency of extreme events. However, unexpected severity showed a positive relationship which was insignificant. Claims ratio and reinsurance also had a positive relationship with supply. The interactive variable of claims ratio and reinsurance (CR_Reins) positively influenced the supply of insurance. These findings are generally compactible with Born and Viscusi (2006) and Lamond and Penning-Rowsell (2014).

With regards to insurers' profitability, whilst unexpected severity of extreme events reduced the profitability of life insurers, it did not have any significant effect on non-life insurers. The unexpected frequency of extreme events however, did not have any effect on both life and non-life insurers' profitability. Additionally, premium growth and size positively affected insurers profitability while expense ratio and premium-to-surplus ratio negatively impacted the profitability of insurance firms. These findings were broadly in line with those of researchers such as Benali and Feki (2017), Berhe and Kaur (2017) and Ullah, Faisal and Zuhra (2016).

5.3 Conclusion

Ghanaians do not view insurance as a tool for managing the risks associated with extreme events. When a severe event with high loss unexpectedly occurs, most people affected do not have insurance and so there is no need to reduce supply since the loss to be paid by the insurance companies is minimal.

However, the reduction in supply may be mainly driven by voluntary insurance policies such as comprehensive motor insurance. This is because the coverage of compulsory insurance cannot be completely withdrawn from the market.

Extreme events risks are generally managed well by non-life insurance companies in Ghana. These companies are able to effectively respond to catastrophic losses.

5.4. Recommendations for Management and Policymakers

First of all, the public should be made aware and educated on the risks associated with extreme events, the risk exposure of Ghanaians as well as the necessity to patronize insurance as a way of dealing with the after effects of such events since we cannot rely on international assistance forever. Also, the general public should be educated on how to minimize extreme event losses through the use of standard pre-loss mitigation practices.

Additionally, the government should come up with ways of mitigating the risks associated with extreme events by decreasing the physical or environmental vulnerabilities of the country such as poor settlement layouts and drainage system, migration and population density in major cities like Accra.

Moreover, to ensure the growth and sustainability of the Ghanaian insurance market especially life insurance, the compulsory health insurance policy should be strictly enforced so as to reduce the losses paid by insurance companies and also make funds available for investment in sectors of the economy which will go a long way to boost the economic growth of Ghana.

Furthermore, insurance companies should assess the exposures of their investments, capital and reserves to extreme events. Additionally, NIC should constantly regulate the capital requirement of both insurers and reinsurers as they provide protection against extreme events so that they will be capable of paying claims to policyholders and maintain solvency.

Also, life insurance companies must increase their ability to pay claims and change their premium pricing according to environmental changes in the risks. This will strengthen their capacity to respond to extreme events.

Finally, insurers are encouraged to collect and analyze more comprehensive data on extreme events losses by using computer-assisted calculations to estimate the losses to be sustained during an extreme event so that risk-based pricing can be effective.

5.5 Limitation of Study and Direction for Future Research

The analysis has concentrated on insurance companies, even though the study could have covered the insurance industry in Ghana for a holistic view of extreme events impact on the insurance market. One avenue for further study would be to consider a more comprehensive data with more years to provide further insights into the impacts of extreme events on the insurance market in Ghana.

Unfortunately, the lack of data of existing literature on extreme events in Ghana as well as financial reports of some insurance companies due to the sensitive nature of the information was also a limitation. Future research could consider other relevant variables which might explain the remaining variances of the demand, supply and profitability of insurance companies.

REFERENCES

- Ackah, C., & Owusu, A. (2012). Assessing the Knowledge of and Attitude towards Insurance in Ghana. *International Research Conference on Microinsurance*. Twente.
- Adams, M., & Buckle, M. (2003). The Determinants of Corporate Financial Performance in the Bermuda Insurance Market. *Applied Financial Economics*, *13*, 133–143.
- Addai, E. K., Tulashie, S. K., Annan, J.-S., & Yeboah, I. (2016). Trend of Fire Outbreaks in Ghana and Ways to Prevent These Incidents. *Occupational Safety and Health Research Institute* , 284-292.
- Adivar, B., & Selen, E. S. (2013). Review of Research Studies on Population Specific Epidemic Disasters. *Disaster Prevention and Management: An International Journal*, *22*(3), 243-264.
- Akbar, A., Imdadullah, M., Aman Ullah, M., & Aslam, M. (2011). Determinants of Economic Growth in Asian Countries: A Panel Data Perspective . *Pakistan Journal of Social Sciences*, *13*(1), 145-157 .
- Akotey, J. O., Sackey, F. G., Amoah, L., & Manso, R. F. (2013). The financial performance of life insurance companies in Ghana. *The Journal of Risk Finance*, *14*(3), 286-302.
- Al-Abbasi, J. N., & Fahmi, K. J. (1985). Estimating Maximum Magnitude Earthquakes in Iraq Using Extreme Value Statistics. *Geophysical Journal International*; *82*(3), 535-548.
- Allotey, N. K., Arku, G., & Amponsah, P. E. (2010). Earthquake-disaster preparedness: the case of Accra. *International Journal of Disaster Resilience in the Built Environment*, *1*(2), 140-156.
- Almajali, A. Y., Alamro, S. A., & Al-Soub, Y. Z. (2012). Factors Affecting the Financial Performance of Jordanian Insurance Companies listed at Amman Stock Exchange. *Journal of Management Research*, *4*(2) , 266–289.
- Archer, P. M. (2013). *Factors Affecting the Patronage of Life Insurance in Ghana*. (Unpublished Masters Thesis). Stamford International University.
- Asante, F. A., & Amuakwa-Mensah, F. (2015). Climate Change and Variability in Ghana: Stocktaking. *Climate*, *3*, 78-99.
- Bajrektarevic, A. H., & Baumer, C. (2012). Climate Change and Re-Insurance: The Human Security Issue. *Economics, Management and Financial Markets*, *7*(4), 42–86.

- Benali, N., & Feki, R. (2017). The Impact of Natural Disasters on Insurers' Profitability: Evidence from Property/Casualty Insurance Company in United States. *Research in International Business and Finance*.
- Berhe, T. A., & Kaur, J. (2017). Determinants of Insurance Companies' Profitability Analysis of Insurance Sector in Ethiopia. *International Journal of Research in Finance and Marketing*,7(4), 124-137.
- Boadu, F., Dwomo-Fokuo, D. E., Boakye, J. K., & Frimpong, A. O. (2014). Assessing the Life Insurance Industry in Ghana. *European Journal of Business and Management*,6(21), 14-22.
- Boah-Mensah, E. (2017, June 27). Retrieved from The Business and Financial Times website: <http://thebftonline.com/business/insurance.com>
- Born, P., & Viscusi, W. K. (2006). The Catastrophic Effects of Natural Disasters on Insurance Markets. *J. Risk Uncertainty*, 55-72.
- Brainard, L. (2008). What is the role of insurance in economic development? *Zurich Government and Industry Affairs thought leadership series*, 1-13.
- Brooks, C. (2008). *Introductory Econometrics for Finance*. Cambridge: Cambridge University Press.
- Bryan, J., Proctor, A., & Stoklosa, K. (2015). An Analysis of the Effect of Income on Life Insurance. *Econometric Analysis Undergraduate Research Paper*, 1-16.
- Bryman, A. (2012). *Social Research Methods*. Oxford University Press.
- Carvalho, J. V., & Afonso, L. E. (2017, November 17). *Explanatory Factors for the Insurance Demand: Some Evidence from the São Paulo State Insurance Market*. Retrieved from Researchgate website: <http://www.researchgate.net>
- Cavallo, E., & Noy, I. (2009). The Economics of Natural Disasters. *Inter-American Development Bank Working Paper Series*, 5-46.
- Chen, X., Doeringhaus, H., Lin, B.-X., & Yu, T. (2008). Catastrophic Losses and Insurer Profitability: Evidence from 9/11. *The Journal of Risk and Insurance*, 75(1),39-62.
- CISL. (2016). *Investing for Resilience*. Cambridge: Cambridge Institute for Sustainability Leadership.
- Ciumas, C., & Coca, R. A. (2015). An Analysis of the Factors Influencing the Demand for Catastrophe Insurance. *Journal of Public Administration, Finance and Law*, 69-78.
- Cole, S., Bastian, G. G., Vyas, S., Wendel, C., & Stein, D. (2012). *The Effectiveness of Index-Based Micro -Insurance In Helping Smallholders Manage Weather-Related Risks*.

- London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.
- Coles, S. (2001). *An Introduction to Statistical Modelling of Extreme Values*. London: Springer-Verlag.
- Coomber, J. R. (2006). Natural and Large Catastrophes – Changing Risk Characteristics and Challenges for the Insurance Industry. *The International Association for the Study of Insurance Economics*, 88-95.
- Country Profile: GFDRR*. (2017, September 28). Retrieved from Global Facility for Disaster Reduction and Recovery (GFDRR): <http://www.gfdr.org>
- Courbage, C., & Mahul, O. (2013). Promoting Better Understanding on Sustainable Disaster Risk Management Strategies. *The International Association for the Study of Insurance Economics*, 401-405.
- Courbage, C., & Stahel, W. R. (2012). *Extreme events and insurance: 2011 annus horribilis*. Geneva: The Geneva Association.
- Cummins, J. D., & Mahul, O. (2009). *Catastrophe Risk Financing in Developing Countries: Principles for Public Interventions*. Washington DC: The International Bank for Reconstruction and Development / The World Bank.
- Cunningham, W. G. (2003). Terrorism: Definitions and typologies. In W. G. Cunningham, *Terrorism: Concepts, Causes, and Conflict Resolution*. Fort Belvoir, VA: Defense Threat Reduction Agency and George Mason University's Institute for Conflict Analysis and Resolution. .
- Disaster and Risk Profile: Preventionweb*. (2017, September 12). Retrieved from Preventionweb: <http://www.preventionweb.net/countries/gha/data>
- Dlugolecki, A., & Hoekstra, E. (2006). The role of the private market in catastrophe Insurance. *Climate Policy*, 648-657.
- Dorofti, C., & Jakubik, P. (2015). Insurance Sector Profitability and the Macroeconomic Environment. *European Insurance and Occupational Pensions Authority (EIOPA)*, 56-71.
- Dumm, R. E., Eckles, D. L., Nyce, C., & Volkman-Wise, J. (2017, October 16). *Demand for Catastrophe Insurance and the Representative Heuristic*. Retrieved from http://www.stjohns.edu/sites/default/files/tcb/eckles_chubb2015
- Embrechts, P., Resnick, S. I., & Samarodnitsky, G. (1999). Extreme Value Theory as a Risk Management tool. *North American Actuarial Journal*;3(2), 30-41.

- Ernst, & Young (EY). (2016). *Insurance opportunities in Sub-Saharan Africa*. London: EYGM Limited.
- Fier, S. G., & Carson, J. M. (2015). Catastrophes and the Demand for Life Insurance. *Journal of Insurance Issues*, 38 (2), 125–156.
- Fisher, R. A., & Tippett, L. H. (1928). Limiting forms of the frequency distribution of the largest or smallest member of a sample. *Proceedings of the Cambridge Philosophical Society*, 180–290.
- Flowerdew, R., & Martin, D. (2013). *Methods in Human Geography: A Guide for students Doing a Research Project (2nd Edition)*. Old Tappan, NJ, USA: Taylor and Francis.
- Gallagher, J. (2012). Learning About An Infrequent Event: Evidence from Flood Insurance Take-up in the US. *University of California at Berkeley Working Paper*.
- Gencer, E. A. (2013). Natural Disasters, Urban Vulnerability, and Risk Management: A Theoretical Overview. In E. A. Gencer, *The Interplay Between Urban Development Vulnerability, and Risk Management*. Mediterranean Studies .
- GFDRR. (2010). *Report on the status of Disaster Risk Reduction in Sub-Saharan Africa*. Washington D.C.: The International Bank for Reconstruction and Development/The World Bank.
- GFDRR. (2017, September 28). *Country Profile: GFDRR*. Retrieved from Global Facility for Disaster Reduction and Recovery (GFDRR): <http://www.gfdr.org>
- Ghana National Climate Change Policy. (2012). *Ghana National Climate Change Policy*. Accra: The Ministry of Environment, Science and Technology.
- Gilli, M., & Kellezi, E. (2006). An Application of Extreme Value Theory for Measuring Financial Risk. *Computational Economics*, 27(1), 1-23.
- Golnaraghi, M., Surminski, S., & Schanz, K.-U. (2016). *An Integrated Approach to Managing Extreme Events and Climate Risks. Towards a Concerted Public-Private Approach*. Zurich: The Geneva Association.
- Goodess, C. M. (2013). How is the Frequency, Location and Severity of Extreme Events Likely to Change up to 2060? *Environmental Science and Policy*, s4-s14.
- Grace, M. F., Klein, R. W., Kleindorfer, P. R., & Murray, M. (2001). *Catastrophe Insurance: Supply, Demand and Regulation*. Insurance Services Office and Wharton Catastrophic Risk Management Project.
- Guerineau, S., & Sawadogo, R. (2015). On the determinants of life insurance development in Sub-Saharan Africa: the role of institutions quality in the effect of economic development . *Etudes et Documents*, 2-34.

- Harrington, S. E., & Niehaus, G. (2004). *Risk Management and Insurance*. Boston: McGraw-Hill.
- Herweijer, C., Ranger, N., & Ward, R. E. (2009). Adaptation to Climate Change: Threats and Opportunities for the Insurance Industry. *The International Association for the Study of Insurance Economics*, 360-380.
- Hsiao, C. (2007). Panel Data Analysis — Advantages and Challenges. *Sociedad de Estadística e Investigación Operativa*, 1-63.
- International Federation of Red Cross. (2017, November 30). *International Federation of Red Cross and Red Crescent Societies*. Retrieved from IFRS Website: <http://www.ifrs.org>
- International Financial Corporation. (2016). *Innovative Insurance To Manage Climate Risks*. International Financial Corporation-World Bank Group.
- IPCC. (2013). *Fifth Assessment Report*. Intergovernmental Panel on Climate Change.
- IPCC. (2014). *Climate Change 2014 Synthesis Report Summary for Policymakers*. Bali: Intergovernmental Panel on Climate Change(IPCC).
- Jenkinson, J. (1955). The Frequency Distribution of the Annual Maximum (or Minimum) Values of Meteorological Events. *Quarterly Journal of the Royal Meteorological Society*: 81, 158-172.
- Jeon, J. (2015). The Strengths and Limitations of The Statistical Modeling of Complex Social Phenomenon: Focusing on SEM, Path Analysis, or Multiple Regression Models . *International Journal of Economics and Management Engineering*,9(5), 1634-1642.
- Jha, M. K. (2010). Natural and Anthropogenic Disasters:An Overview. In M. K. Jha, *Natural and Anthropogenic Disasters* (pp. 1-16). Springer,Dordrecht.
- Johnston, M. P. (2014). Secondary Data Analysis:A Method of which the Time Has Come. *Qualitative and Quantitative Methods in Libraries*, 619 –626.
- Karlan, D., Osei, R., Osei-Akoto, I., & Udry, C. (2014, September 12). Agricultural Decisions after Relaxing Credit and Risk Constraints. *The Quarterly Journal of Economics*,129(2), 597-652. Retrieved from <http://www.ilo.org/public/english/employment/mifacility/download/repaper23.pdf>
- Kealey, D., & Protheroe, D. (1996). The Effectiveness of Cross-cultural Training for Expatriates: An Assessment of the Literature on the Issue. *International Journal of Intercultural Relations*,20(2), 141-165.
- Kelly, U. (2006). Combining qualitative and quantitative methods in research practice: purposes and advantages. *Qualitative research in psychology*,3(4), , 293-311.
- Kerr, R. (2013). In the Hot Seat. *Science*, 688–689.

- Kim, Y. D., Anderson, D. R., Amburgey, T. L., & Hickman, J. C. (1995). The Use of Event History Analysis to Examine Insurer Insolvencies. *Journal of Risk and Insurance*, 62, 94-110.
- Korup, O., & Clague, J. J. (2009). Natural hazards, Extreme Events, and Mountain Topography. *Quaternary Science Reviews*, 977–990.
- Kreft, S., Eckstein, D., & Melchior, I. (2016). *Global Climate Risk Index 2017*. Berlin: Germanwatch.
- Kunreuther, H. C., & Michel-Kerjan, E. O. (2007). Climate Change, Insurability of Large-Scale Disasters and the Emerging Liability Challenge. *National Bureau of Economic Research*.
- Kunreuther, H., & Michel-Kerjan, E. (2009). Encouraging Adaptation to Climate Change: Long-Term Flood Insurance. *Resources for the Future*, 09-13.
- Lamond, J., & Penning-Rowsell, E. (2014). The Robustness of Flood Insurance Regimes Given Changing Risk Resulting From Climate Change. *Climate Risk Management*, 1-10.
- Lester, R. (2009). *Introduction to the Insurance Industry*. Washington DC: The International Bank for Reconstruction and Development/The World Bank.
- Linnerooth-Baye, J., & Mechler, R. (2009, July 3). *Insurance against Losses from Natural Disasters in Developing Countries*. Retrieved from United Nations Department of Economics And Social Affairs Web site: <http://www.un.org/esa/desa/papers>
- Malik, H. (2011). Determinants of Insurance Companies Profitability: . *Academic Research International*, 1(3), 315-321.
- Matveev, A. V. (2002). The Advantages of Employing Quantitative and Qualitative Methods in Intercultural Research: Practical Implications from the Study of the Perceptions of Intercultural Communication Competence by American and Russian Managers. *Russian Journal of Communication*, 59-67.
- Maynard, T. (2008). Climate Change: Impacts on Insurers and How They Can Help With Adaptation and Mitigation. *The International Association for the Study of Insurance Economics*, 33, 140–146.
- Michel-Kerjan, E. O., & Kousky, C. (2010). Come Rain or Shine: Evidence on Flood Insurance Purchases in Florida. *The Journal of Risk and Insurance*, 77(2), 369-397.
- Michel-Kerjan, E., Raschky, P., & Kunreuther, H. (2015). Corporate Demand for Insurance: New Evidence from the U.S. Terrorism and Property Markets. *The Journal of Risk and Insurance*, 82(3), 505–530.

- Mills, E. (2005). Insurance in a Climate of Change. *Sciencemag*,306, 1040-1044.
- Mills, E., Roth, R. J., & Lecomte, E. (2005). *Availability and Affordability of Insurance Under Climate Change: A Growing Challenge for the U.S.* Ceres.
- Mirza, M. M. (2003). Climate change and extreme weather events: can developing countries adapt? *Climate Policy*, 233-248.
- Mohammed, E. O., & Rahman, B. A. (1998). Hazards in Africa: trends, implications and regional distribution. *Disaster Prevention and Management: An International Journal*,7(2), 103-112.
- Molloy, S., & Mihaltcheva, S. (2013). Extreme Weather Events. In *Climate Vulnerability* (pp. 3-14). Elsevier Inc.
- Müller-Fürstenberger, G., & Schumacher, I. (2015). Insurance and Climate-driven Extreme Events . *Journal of Economic Dynamics & Control*, 59–73.
- Nadarajah, S. a. (2005). Analysis of extreme flood events for the Pachang River Taiwan . *Water Resources and Management*.
- Nenty, H. J. (2009). Writing a Quantitative Research Thesis. *Int J Edu Sci*, 1(1), 19-32.
- NIC. (2016). *National Insurance Commission Annual Report And Financial Statements*. Accra: National Insurance Commission.
- Nissim, D. (2010). Analysis and Valuation of Insurance Companies. *Center for Excellence in Accounting and Security Analysis*, 1-178.
- Ortyński, K. (2016). Determinants of Profitability of General Insurance Companies Performance in Poland. *Central European Review of Economics & Finance*,12(2), 53–66.
- Polit, D. F., & Hungler, B. P. (1995). *Nursing Research: Principles and Methods*. Lippincott.
- Prelicean, G., & Boscoianu, M. (2010). Financial Technologies Based on Innovation for Financing the Recovery After Extreme Events. *Buletin Stiintific*,2(30), 177-182.
- Ranger, N., & Surminski, S. (2011). A Preliminary Assessment of the Impact of Climate Change on Non-life Insurance Demand in the BRICS Economies. *Centre for Climate Change Economics and Policy*,72, 1-22.
- Richards, C. F., Burstein, J. L., Waeckerle, J. F., & Hutson, H. (1999). Emergency Physicians and Biological Terrorism. *Annals of Emergency Medicine*, 183-190.
- Sakshi, V. (2009). Catastrophic Risk and Insurance. *Management Prospective Ed.*, 225-240.
- Sanders, D. E. (2005). The Modelling of Extreme Events. *Institute of Actuaries and Faculty of Actuaries*, 1-39.

- Schäfer, L., Waters, E., Kreft, S., & Zissener, M. (2016). *Making Climate Risk Insurance Work for the Most Vulnerable: Seven Guiding Principles*. Bonn: UNU-EHS.
- Schuster, S. (2013). Natural Hazards and Insurance. In J. Palutikof, S. L. Boulter, A. J. Ash, S. M. Smith, M. Parry, M. Waschka, & D. Guitart, *Climate Adaptation Futures* (pp. 133-140). Cambridge: John Wiley & Sons.
- Sena, L., & Michael, K. (2006). *Disaster Prevention and Preparedness*. Ethiopia: Ethiopia Public Health Training Initiative.
- Siri, J. G., Newell, B., Proust, K., & Capon, A. (2016). Urbanization, Extreme Events, and Health: The Case for Systems Approaches in Mitigation, Management, and Response. *Global Environmental Change and Human Health*, 28(2S), 15S–27S.
- Stephenson, D. B. (2008). *Definitions, Diagnosis, And Origin Of Extreme Weather And Climate Events*. Cambridge University Press.
- Sturm, T., & Oh, E. (2010). Natural Disasters as the End of the Insurance Industry? Scalar Competitive Strategies, Alternative Risk Transfers, and the Economic Crisis. *Geoforum*, 154-163.
- Task Team on the Definition of Extreme Weather and Climate Events (TT-DEWCE). (2016). *Guidelines on the Definition and Monitoring of Extreme Weather And Climate Events*. Geneva: World Meteorological Organization.
- Timetric. (2014). *The Insurance Industry in Ghana, Key Trends and Opportunities to 2018*. London: Timetric.
- Turner, G. (2014). Microinsurance Demand After a Rare Flood Event: Evidence From A field Experiment in Pakistan. 1-30.
- Turner, G., & Deng, J. (2015). The Effect of Catastrophe Events on (Re)Insurance Pricing: Are Emerging Markets Different?
- Twum, E. A. (2014, June 6). Retrieved from myjoyonline Web Site:
<http://www.myjoyonline.com>
- Ullah, G. M., Faisal, M. N., & Zuhra, S. T. (2016). Factors Determining Profitability of the Insurance Industry of Bangladesh. *International Finance And Banking*, 3(2), 138-147.
- UNEP FI. (2002). *Financing a Sustainable Future-Strategies, Partnerships, and Opportunities*. Geneva: UNEP Finance Initiative.
- UNEP FI. (2014, October 10). *About us: UNEP FI/ Principles for Sustainable Insurance Initiative (PSI Initiative)*. Retrieved from UNEP Finance Initiative:
<http://www.unepfi.org/psi>

- United Nations Development Programme (UNDP). (2013). *Request Of Proposal For Consulting Services Development of Risk and Early Warning Systems In Ghana*. Ghana: United Nations Development Programme (UNDP).
- Ward, R., & Ranger, N. (2010). *Trends in Economic and Insured Losses From Weather-Related Events: A new analysis*. Centre for Climate Change Economics and Policy.
- Warner, K., Yuzva, K., Zissener, M., Gille, S., Voss, J., & Wanczeck, S. (2013). *Innovative Insurance Solutions for Climate Change: How to integrate climate risk insurance into a comprehensive climate risk management approach*. United Nations University Institute for Environment and Human Security (UNU-EHS).
- Watson, J. T., Gayer, M., & Connolly, M. A. (2007). Epidemics After Natural Disasters. *Emerging Infectious Diseases*,13(1), 1-5.
- WMO. (2014). *Atlas Of Mortality And Economic Losses From Weather, Climate And Water Extremes (1970–2012)*. Geneva: World Meteorological Organization.
- World Bank. (2013). *Initial Market Assessment - Country Scoping Note: Ghana*. Department For International Development.
- Yaffee, R. A. (2003). A Primer for Panel Data Analysis. *Social Sciences, Statistics & Mapping*, 1-11.

APPENDIX

REGRESSION RESULTS OF INTERACTIVE VARIABLE

Table 1: Regression results (Without Reins)

Supply	Coefficient	Standard Error	T-Statistic	P-Value
constant	12.6548	0.7819	16.19	0.000***
UnexpFreq _{t-1}	-0.8188	0.3968	-2.06	0.039**
Blockbuster _{t-1}	0.1005	0.0769	1.31	0.191
CR	-5.2852	2.9944	-1.77	0.078*
CR_Reins	0.59	0.1497	3.94	0.000***

***, **, * Significance at 1%, 5% and 10%, respectively

Table 2: Regression Results (Without CR)

Supply	Coefficient	Standard Error	T-Statistic	P-Value
constant	9.8133	1.3571	7.23	0.000***
UnexpFreq _{t-1}	-0.7811	0.4069	-1.92	0.055*
Blockbuster _{t-1}	0.0882	0.078	1.13	0.258
Reins	0.1592	0.0836	1.91	0.057*
CR_Reins	0.2873	0.0804	3.57	0.000***

***, **, * Significance at 1%, 5% and 10%, respectively

APPROPRIATE MODEL SELECTION USING AIC AND BIC

Supply Model

Table 3: AIC/BIC of Model (Without Reins)

DF	AIC	BIC
7	173.5418	190.216

Table 4: AIC/BIC of Model (Without CR)

DF	AIC	BIC
7	172.875	189.5312

Table 5: AIC/BIC of Model (Without Both CR and Reins)

DF	AIC	BIC
6	172.1608	186.453

Life Profitability Model

Table 6: AIC/BIC of Model including all Variables

DF	AIC	BIC
9	-95.0073	-69.9198

Table 7: AIC/BIC of Model (Without size)

DF	AIC	BIC
8	-96.3834	-74.0835

Table 8: AIC/BIC of Model (Without PremSurp)

DF	AIC	BIC
8	85.2146	107.5809

Table 9: AIC/BIC OF Model (Without both Size and PremSurp)

DF	AIC	BIC
7	81.8471	101.6453

**RELATIONSHIP BETWEEN SIZE SQUARED AND GENERAL INSURERS'
PROFITABILITY**

$$y = -5.6816 + 0.0782a - 0.047b - 0.0163c + 0.6283x - 0.3691d + 0.1097e \\ - 0.0162x^2$$

where; y represents ROA, a is the Unexpfreq, b stands for Blockbuster, c denotes PremSurp, d represents ExpRatio, e denotes PremGrw, x stands for Size and x^2 denotes Size²

At the maximum point, $\frac{\partial y}{\partial x} = 0$

$$0.6283 - 0.0324x = 0$$

$$0.0324x = 0.6283$$

$$x = \frac{0.6283}{0.0324} = 19.392$$

Therefore, the size of a non-life insurance company can grow up to 19.392 in order to positively influence profitability. Beyond this point, the size will no longer affect profitability positively.