UNIVERSITY OF GHANA

TECHNICAL EFFICIENCY, RISK AND CAPITAL REQUIREMENT OF INSURANCE FIRMS IN GHANA

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY IN RISK MANAGEMENT AND INSURANCE DEGREE

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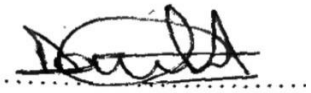
DECLARATION

I hereby declare that this work is a result of my own research and has not been presented by anyone for any academic award in this or any university. All references used in this work have fully been acknowledged.



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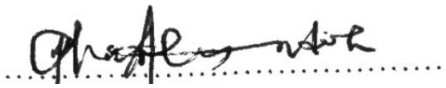
CERTIFICATION

I hereby certify that this long essay was supervised in accordance with procedures laid down by the University.



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DEDICATION

I dedicate this work to the Almighty God, who granted me Grace to successfully complete the study. I also dedicate this work to my late parents Mr Francis Ohemeng and Madam Mary Dankwah, and my family for the love and support they showed me throughout the study.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BCC: Banker, Charnes and Cooper

CCR: Charnes, Cooper and Rodes

DEA: Data Envelopment Analysis

MCR: Minimum Capital Requirement

NIC: National Insurance Commission

OLS: Ordinary Least Square

PTE: Pure Technical Efficiency

RBC: Risk-Based Capital

SBM: Slacks-Based Measure

SE: Scale Efficiency

TE: Technical Efficiency

VRS: Variable Returns to Scale

ABSTRACT

This study examines the effect of recapitalisation on technical efficiency and risk of life and non-life insurers in Ghana.

The study uses balanced panel data for 14 life and 17 non-life insurers from 2008 to 2017. Data is sourced from the annual reports submitted to the National Insurance Commission. The research work evaluates technical efficiency by employing a Data Envelopment Analysis that allows for the addition of multiple inputs and outputs in the production frontier. Both panels fixed effect and random effect models are used to determine the relationship between recapitalisation and technical efficiency. The study also uses a random effect model to determine the relationship between recapitalisation and insurer's risk.

The results show that recapitalisation has a significant positive relationship with technical efficiency, indicating the importance of recapitalisation in improving technical efficiency. Also, there was a significant positive relationship between recapitalisation and the risk of the insurer. This implies that, as the capital requirement of insurers increases, the risk of the insurer increases. The major determinants of technical efficiency of Ghanaian insurers include risk of the insurer, market share and expense ratio. Major determinants of insurance risk in Ghana are the type of insurer, size of the firm as well as the market share of the insurer.

Policywise, the findings of this study reinforce the suggestion by the Actuarial Society of Ghana that policymakers and regulators should adopt a risk-based capital system and must continue to initiate, design and model regulations that will help reduce risk and improve technical efficiency of both life and non-life insurers.

Keywords: insurer's risk, panel regression, recapitalisation, regulation, technical efficiency

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Every economy's financial sector contributes immensely to its economic growth (Qamruzzaman & Wei, 2018). In the United States, the entire financial and insurance sector contributed 7.4% of total Gross Domestic Product (GDP) in 2018, in the United Kingdom, it contributed 6.9% of total GDP, in China 6%, Nigeria 3.5% and in Ghana as well, it contributed 4.2% of total GDP (WDI, 2019). Ogieva and Omoregbe (2017) metaphorically describe the financial sector as the nucleus of productive activities of every economy. This is because it works as a channel that provides the necessary lubricant that keeps the wheels of the economy turning. Some functions performed by the financial sector include; efficient mobilization of funds, effective allocation of funds, risk management and sharing, financial advisory services and provision of credit information for informed decision making (Al-Afeef & Al-Ta'ani, 2017). To function well, financial institutions have to be financially stable. Following the recent 2007-2008 global financial crises, capital and risk regulation of financial institutions is now the core focus of regulators, especially in the wake of competition and inadequate supervision and regulation (Varotto, 2012; Acharya, Cooley, Richardson, & Walter, 2009; Crotty, 2009). Competitive financial environment pressures financial institutions to assume risky operations. This increases their risk-taking behaviour and risk appetite, which in turn leads to financial instability.

In the quest to ensure financial stability and to prevent another global financial crisis, researchers are of the view that proper financial sector regulations and reforms will reinforce the stability and efficiency of the firms (Kusi, Alhassan, Ofori-Sasu & Sai, 2019; Arner & Taylor, 2011). Ansah-Adu, Andoh and Abor (2011) are of the view that a company that operates in an environment where financial regulation is less rigorous has its efficiency reduced. Regulators in every country,

therefore, regulate their financial firms. According to Dhaene, Goovaerts and Kaas (2003), economic capital is a representation of all the economic resources of an entity. It serves as a requirement to protect itself from unforeseen circumstances up to a given level of risk tolerance. Over the past ten years, almost all principal economies have either revised or are still undergoing revision in their insurance regulation, Especially, with regards to insurance solvency with emphasis on Risk-Based Capital (RBC) systems. In the quest to properly regulate the insurance industry, the United States of America introduced their solvency modernisation initiative to evaluate its existing risk based capital system (Cummins & Phillips, 1999). The European Union also in 2016 replaced its Solvency I framework with Solvency II.

The increasing competition in the insurance industry in Ghana has sparked the need for proper regulation in the sector by the National Insurance Commission (NIC). Several regulatory reforms have been carried out. The major regulatory reforms include; the abolishing of composite insurance business since 2006, when the insurance Act 2006 was enacted. Another major regulatory reform is the abolishing of premium credit. The final reform which is looked at in this study is the periodic revision of the Minimum Capital Requirement (MCR). Ansah-Adu et al. (2011) posit that the insurance industry in Ghana is undersized and undercapitalized and can rarely underwrite huge risks. They believe undercapitalization reduces the efficiency of insurance firms. According to Jaiyeoba and Haron (2015), the two major objectives of recapitalisation are to reduce risk as well as to enhance technical efficiency. Recapitalisation ensures and enhances the efficiency of the insurance industry, and it is believed that companies with a broader capital base will achieve growth and efficiency (Orea & Kumbhakar, 2004).

In order to enhance stability and efficiency in the Ghanaian insurance industry, the Insurance Law 1989 (PNDC Law 227) required insurers in Ghana to meet a capital requirement of US$48 for life

insurance companies and US$96 for non-life. In 2006 when the Insurance Act was enacted, the MCR was revised to US$1million (an equivalence of GH¢1,078,600). With the quest to improve efficiency and reduce risk, the minimum capital base was raised to US$1.4million (an equivalence of GH¢5million) to be met by 2012 and increased further to US$ 4.2million (an equivalence of GH¢ 15million) to be met by 2015. This increase was an attempt to strengthen the capital base of Ghanaian insurers (NIC, 2014). In April 2019, the NIC announced another increase in regulatory minimum capital requirement from GH¢ 15million to GH¢ 50million. The question of the effectiveness of recapitalisation in improving efficiency and reducing risk is still not answered empirically. With the recent announcement of an increase in the minimum capital requirements earlier this year, a number of debates vehave been raised with respect to the constant increment in MCR. Nketia (2019) posits that the increment in the regulatory fixed capital requirement may look good considering the recent bank failures, but in reality, it may be leading to the failure of insurance companies. He added that a fixed capital requirement ightresult in insolvency since big risk-takers might take up a risk that exceeds the fixed standard capital requirement. They suggested that Risk-Based Capital (RBC) systems would solve the problem. This is because the RBC systems may dissuade companies from taking volatile risks which cost too much.

Kwarteng (2019) is of the view that the quest to recapitalise through the increment in the minimum capital requirements will issue a strong foundation for insurers to deliver and raise their contribution to GDP.

The big question still remains as to whether the periodic increase in MCR is serving its purpose of acting as a cushion for risk, ensuring stability and improving the efficiency of Ghanaian insurer, or there is a need to switch to the RBC system.

This study seeks to survey the effect of periodic recapitalisation on technical efficiency and also to determine whether risk is reduced after periodic recapitalisation. Considering the important role of insurance for cushioning risk and promoting that sense of peace in the business world (Malik, 2011; Oscar Akotey, Sackey, Amoah, & Frimpong Manso, 2013; Idris, 2016), this study becomes timely and of great relevance.

Researchers have studied recapitalisation and performance extensively in the banking sector (Fethi, Shaban & Weyman-Jones, 2012; Kanu, 2015; Oluitan, Ashamu & Ogunkenu, 2015; Manu, Gnanendra, & Gupta, 2018). To the best of the author's knowledge, very few studies have examined the effect of recapitalisation on the performance of insurance firms (Ibrahim & Abubakar, 2011). A cursory through the literature also shows that no study has investigated how risk and technical efficiency of the insurer are affected by a periodic recapitalisation.

1.2 Problem Statement

There are a number of studies on regulation and its effect on performance (Manu et al., 2018; Rachdi & Ben Bouheni, 2016; Yauri, Musa, & Kaoje, 2012; Fethi et al., 2012; Kukurah, Alhassan, & Sakara, 2014). However, there exist some gaps in recent literature.

First, despite the effort of regulators to ensure a proper cushioning of risk and enhanced efficiency by periodically increasing minimum capital requirement, most studies on regulation have focused on the mainstream banking industry, and very few have looked at the insurance industry (Lee, Cheng, Har, Nassir, & Razak, 2019; Swain & Swallow, 2015). A number of these studies seems to be concentrated on developed industries and do not consider whether or not recapitalisation reduces risk. There is a need to study the effect of periodic recapitalisation on the technical efficiency and risk of the insurer.

Secondly, most literature that studied insurance efficiency and recapitalisation in developing countries haswas done in isolation. Most studies on Insurance efficiency just sort to finding out the determinants of efficiency (Ansah-Adu et al., 2011; Owusu-Ansah, Dontwi, Seidu, Abudulai, & Sebil, 2010; Barros, Dumbo & Wanke, 2014; Eling & Luhnen, 2010). These studies found out that the major determinants of efficiency are; the drive for market share, firm size, the ratio of equity to total invested assets and change in market technology. However, considering the constant increment in MCR and the debates that surround its effectiveness in improving efficiency, these studies failed to consider how efficiency affects capital requirements. There is a need to consider the impact of recapitalisation on the efficiency and risk of the insurers. Most studies on recapitalisation in developing countries do not consider its influence on risk and efficiency (Ngugi & Afande, 2015; Jaiyeoba & Haron, 2015). The few studies that worked on the capital requirement and efficiency studied developed countries that spractised the RBC system (Cummins & Phillips, 2009; Schellhorn, 2000).

Finally, there are no clear studies that attempted to find out the impact of a regulatory increase in minimum capital of insurance on efficiency and risk-taking. Kusi, Alhassan, Ofori-Sasu and Sai, (2019) examined the effect of risk on performance in the presence of regulation. Their study, however, did not investigate the impact of an increasing minimum capital on risk and efficiency. There is, therefore, the need to investigate how recapitalisation affects risk and efficiency. This research work attempts to provide insights for the two opposing views as to whether recapitalisation accomplishes its goal of reducing risk and ensuring technical efficiency in insurance firms in Ghana. This is because the two main aims of recapitalisation are to reduce risk as well as to enhance efficiency (Jaiyeoba and Haron, 2015). The study further focuses on technical

efficiency because recapitalisation seeks to ensure that insurers maximise output with the minimal level of input in other to achieve a higher insurance penetration (Kwarteng, 2019).

1.3 Purpose of Study

The main purpose of the study is to examine the effect of recapitalisation on technical efficiency and risk of life and non-life insurers in Ghana.

1.4 Research Objectives

This research will seek to achieve the following set of objectives: To;

i. Examine the effect of the regulatory increase in fixed minimum capital requirement on the technical efficiency of life and non-life insurance firms.
ii. Examine the impact of the regulatory increase in fixed minimum capital requirement on insurer's risk of Ghanaian life and non-life insurance firms.

1.5 Research Questions

The research will seek to find answers to these research questions:

i. How has recapitalisation of the insurance industry affected the technical efficiency of life and non-life insurance firms in Ghana?
ii. How has recapitalisation of the insurance industry affected the risk of Ghanaian life and non-life insurance firms?

1.6 Research Hypotheses

$H_1 =$ Recapitalisation does not positively affect the technical efficiency of life and non-life insurance firms in Ghana.

$H_2 =$ Recapitalisation does not positively affect the risk of life and non-life insurance firms in Ghana.

1.7 Significance of the Study

According to Ahmed et al. (2010), without insurance, the world of business becomes unsustainable. This is because risky businesses will not have the tendency to retain all kinds of risks in the dynamic global economy. Swartz and Coetzer (2010) are of the view that insurance schemes make use of combination methods by pooling together the risk of a large group of individuals with the aim of minimizing overall risk.

Technical efficiency is, therefore, a relevant part of insurance that should not be downplayed. This study becomes of significant use to decision-makers and customers of various insurance firms. This is because they would be able to assess the technical efficiency of their insurers. It would be of relevance to insurance operators who have a goal of improving their output.

An awareness of the effect of minimum capital requirement on technical efficiency and risk will help policymakers design policies to improve the stability of the sector. The understanding of the level of inefficiency and factors that affect the efficiency of insurance firms in Ghana would enable regulators to design effective resource utilization strategies to improve efficiency in operations.

This study will immensely add to research in this area and could be used as a base for further empirical research on the subject. This research work will finally bring possible areas for improvement to the attention of managers of respective insurance companies.

1.8 Scope and Limitation of Study

This study focuses on both life and non-life insurance markets. Some of the limitations are that; not all life and non-life insurers can be used in this study due to difficulties in obtaining data. Also, the study period is limited to 2008 to 2017 due to data availability.

1.9 Organization of the Study

This study is organized into five chapters. Chapter one discusses the introduction of the research work. It comprises; the background of the study, statement of the problem, research objectives and research questions. Chapter two discusses existing literature on theories and the concept of capital requirement. The chapter also presents empirical findings of other studies, which serve as a basis for the development of assumptions.

Chapter three focuses on the research methodology used in conducting the research. The chapter contains various research approaches; the research design and strategies, sampling and sample size, data collection procedures as well as data analysis procedures. The fourth chapter presents the factual findings of the study. The actual evidence on the relationship between capital requirement and technical efficiency as well as capital requirement and risk are analyzed and presented. Summary of findings, conclusions and recommendations are presented in chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents concepts under regulation, theoretical and empirical review related to regulation, risk and efficiency mainly in the insurance industry and an overview of the Ghanaian insurance industry. The theoretical review shows the theoretical grounding for various concepts on regulation, capital and performance. The empirical review provides studies relating to efficiency, risk and recapitalisation. The overview of the Ghanaian insurance industry presents a description of the insurance market in Ghana.

2.2 Theoretical Framework on Regulation and Performance

According to Bouyon (2014), theories on regulation argue that regulations and reforms are to improve the performance of institutions in an industry. Other studies have, however, refuted this view and posited that regulations rather deprive institutions of the opportunities of diversifying, exploring risky opportunities, making the most of economies of scale and thereby reducing their performance. These opposing views are explained by two theories; public interest theory and economic interest theory. These are the main theories that underpin studies on regulation (Den-Hertog, 2010; Gaffikin, 2005). These theories would be further explained and linked to the insurance industry.

2.2.1 Public Interest Theory

Public interest theory, also known as the public theory of regulation, puts forward that the regulation seeks to protect and benefit the public at large. That is, in terms of the best possible allocation of scarce resources for the good of all individuals (Hantke-Domas, 2007). While there is no known origin of this theory, its notions can be traced back to the study by Pigou (1930) on

economic welfare. According to the theory, regulations are implemented with the aim of advancing the welfare of the society through efficiency, stabilization and fair distribution of income. Studies confirm this view with a significant positive relationship between regulation and performance in both banks and insurance companies (Rachdi & Ben Bouheni, 2016; Yauri et al., 2012; Ozkan, Balsari, & Varan, 2014; Fethi et al., 2012). Wilson (1984) is of the view that regulations are simply social welfare device. They used for the purpose of redistribution so as to correct misallocation of resources where there exist market failure or political crisis. The theory again reveals that government interventions are needed when there is a need for social welfare protection (Adams & Tower, 1994).

Linked to the Ghanaian insurance industry, regulation is aimed at protecting the insured from reckless risk takings by insurers and comes as a response to market imperfection (Feo & Hinriks, 2014). The NIC being the regulatory body in a quest to protect the welfare of the insured, have come up with a fixed minimum capital requirement. This is aimed at acting as a cushion for insurers risks and creating that sense of peace in the insurance industry (Oscar Akotey, Sackey, Amoah, & Frimpong Manso, 2013). Malik (2011) pointed out the relevance of insurance in our society and its ripple effect on the insured, government and the society as a whole and therefore called for effective regulation of the Ghanaian insurance industry.

The period increase of the MCR by the NIC to broaden the capital base and reduce risk supports the public interest theory.

2.2.2 Economic Interest Theory

The economic interest theory was introduced firstly by George Stigler in 1970. The theory is also referred to as the Private Theory of Regulation (Den Hertog, 2010). Stigler's Central postulation was that regulation, as a rule, is acquired by the industry and is designed and operated primarily

for its benefit. Unlike public interest theory that solely seeks to protect the welfare of the general public, the economic theory of interest emphasizes the interest of the dominant individuals or groups. This theory holds the view that regulations are implemented in response to demand from interest groups to maximize the interest of their members

Adams and Tower (1994) reported the essence of economic theory of regulation as described in Stigler (1974). They posit that it includes the incorporation of rational behaviour of both producers and consumers and also treats regulation as a product that is subject to the market forces. In view of this, both the insured and insurer being rational would continue in business if they benefit from the business. To the insured, the insurance business is beneficial if the insurer remains solvent and is able to meet the future obligation of paying claims when the insured event occurs. If the insurance business is beneficial, then the insured will be ready to pay a premium. On the other hand, the insurer is willing to continue abiding by regulations passed by the regulator if these regulations yield profitable outcomes.

With both consumers and insurance providers trying to make the most of the insurance business, both the consumer and insurance provider fights for their best interest (Gaffikin, 2005). Thus, they both try to find out information to reap the bigger benefit. In a situation where this aggression puts the market at risk, then it becomes imperative for the intervention of the regulatory body to protect the best interest of the market. The private interest theory holds that regulations are implemented in response to demands from interest groups to maximize the interest of their members (Kusi et al., 2019). This implies that regulations are set to tame, curtail and impede the risk-taking behaviour of firms to enhance efficiency in firms.

When applied to the Ghanaian insurance industry, the NIC aims at safeguarding the interest of insurance consumers and thus working to ensure solvency and technical efficiency (Cummins, Harrington, & Niehaus, 1993).

2.3 Empirical Review

This section reviews recent insurance studies on the efficiency of insurance firms and their determinants, recapitalisation and efficiency and finally, recapitalisation and risk. This review comprises a study period, methodology, sample size of study and findings of the study.

2.3.1 Efficiency of Insurance industries

The issue of efficiency is of great relevance to regulators for two major reasons. The first is that it ensures that firms are reformed to provide better services to people as well as becoming more competitive in the market (Yao, Han, & Feng, 2007). The second is to protect the consumers and also ensure prompt payment of insurance claims. This will help expand the insurance market as well as uplift wider participation. This will help in the maximization of the social benefits of insurance in the long run (Chakraborty, 2018). For this reason, several studies from all over the world have studied efficiency and its determinants. Some of these studies made use of Data Envelopment Analysis (DEA), while others made use of Stochastic Frontier Analysis (SFA). This study reviewed the efficiency of insurers using DEA, which was first proposed by Charnes, Cooper and Rhodes (1978).

Siddiqui and Das (2019) evaluated the efficiency of the top ten life insurance firms in India based on the gross premium for the periods of 2013-2017. The authors employed DEA in determining the technical efficiency of these insurance firms. The authors concluded that state life insurers had been structured throughout the study period. Private life insurers were found to exhibit variations in their performance due to the difference. Some private life insurers were, however, found to

operate efficiently during the period of study. This adds to the literature on insurer efficiency of the Indian insurance industry and brings to light the operating traits and efficiencies of the Indian life insurers. However, the research only focused on the top 10 life insurers based on the level of gross premium out of the 24 life insurers in India. Not only is gross premium a wrong basis for grading an insurer at the top, but the study also failed to identify what was driving the efficiency of these firms and did not consider the non-life insurers as well. This research extended the sample and examined 14 life and 17 non-life insurers in Ghana, and identified some determinants of technical efficiency.

Making use of 22 Jordanian insurance companies that operated for the period of 2000-2016, Jaloudi and Bakir (2019) studied the market structure, efficiency and performance of insurance firms in Jordan. The authors used the Herfindahl Hirschman Index (HHI), as well as the concentration ratio, to study the market structure of various insurers in the sector. They proxied Structure-Conduct-Performance as market share. The Data Envelopment Analysis technique was used to approximate the efficiency of insurers controlling for leverage, reinsurance and risk. They measured the performance as return on assets and estimated the model parameters employing a random effect regression model. The study being the first to test SCP and ES on the Jordan insurance sector, found the insurance market in Jordan to be highly concentrated. Also, only a few insurers controlled a large share of the premium. Their results supported the SCP hypothesis for the Jordan insurance market. Their findings revealed that both leverage and underwriting risk are negatively related to performance. The study, however, treated life and non-life insurers as a composite, and a true relationship cannot be drawn from the study. This research,, therefore, treated life and non-life insurers separately and not as composite insurers.

Studying the impact of deregulation on the efficiency of Mexican insurance firms, Reyna and Fuentes (2018) used DEA as an efficiency score measure of insurers in Mexico from 2001 to 2013. The authors conducted a productivity analysis which was based on the intertemporal analysis of cost variations. It was revealed that, despite an improvement in the insurers' cost efficiency, there still seems to be no improvement in the productivity of the Mexican insurers. An improvement in productivity was only seen in the top two market leaders and some specialized insurers in the industry. The study, however, ignored the fact that a rational economic agent prefers more output variables to less. Choosing claims as an output variable is therefore contradictory to the output features. This is because claims paid as an output variable has been refuted by some researchers due to the fact that an unexpected increase in claims will lead to inefficiency. Claims areare used as an input variable in this research.

Borges, Nektarios and Barros (2008) analyzed the technical efficiency of the Greek insurance industry. They studied 71 insurance firms between the period 1994 to 2003, where there was periodic volatility due to market deregulation. Analyzing their data based on a two-stage procedure as proposed by Simar and Wilson (2007), it was revealed that competition for market share is the major efficiency drive of efficiency among Greek insurers. Their findings again showed that the degree of consolidation has not been adequate enough to improve insurer efficiency. However, this study used losses as an output variable which has attached criticisms because an unexpected upward change in losses will result in inefficiency. This research excluded losses as one of its output variables.

Grmanová and Pukala (2018) compared the efficiency of commercial life insurers in Poland and the Czech Republic. The authors studied 17 commercial insurance firms in the Czech Republic and 26 commercial insurance firms in Poland for 2014. The methods employed were a

nonparametric quantitative model for efficiency assessment, DEA and Tobit regression model. The study found out that ten insurance firms were found to be efficient on the common Czech-Polish insurance market. Poland insurers were found as well found to be more efficient than insurers in the Czech Republic. The study used the estimated efficiency score as a dependent variable and market share as the independent variable. The Tobit regression showed a very low correlation between the variables. This work, however, had a number of limitations. First, only one year was studied (2014), which makes it very difficult to draw a definite conclusion. The work should have studied for a longer time period to check for consistency. It, however, failed to find out what was driving high efficiency in some insurance firms and ineffectiveness in other insurance firms. The study period of this research was, therefore, ten years.

Zimková (2015) studied both the super-efficiency and technical efficiency of 13 Slovakian insurers for the year 2013. The author analyzed technical efficiency and super efficiency with the help of DEA. The paper stands out from other works previously done by extending how the radial DEA models (CCR model and BCC model) are applied to a non-radial SBM model and a super-efficiency model. Super efficiency was used in ranking efficiency units to indicate outliers in the group of DMUs under study. The results indicated that in the year 2013, among 13 Slovak insurers, only one was super-efficient. The author revealed that management of inefficient insurance firms should adopt enhanced incentive policies, and also the Slovakian insurance regulatory body could make use of the Technical efficiency revealed to predict long-run competitiveness in the industry. The study by Zimková (2015), however, only studied thirteen insurance firms over a single time period (2013). A good conclusion can therefore not be drawn from just an analysis of one year, and there is,, therefore, a need to extend the period of study. This study period was therefore extended to a ten-year period and covered 31 life and non-life insurers in Ghana.

With a sample size of 12 non-life insurers from 2006 to 2010, Mandal and Dastidar (2014) studied the technical efficiency of non-life insurers in India and sought to find out the effect of the global recession on technical efficiency. The author employed DEA to measure technical efficiency scores. Their findings show that aside from one public non-life insurer, the other insurers were inefficient under the CRS assumption. Alternatively, using the VRS assumption, most insurers were efficient. The paper only dwelt on just non-life insurers and failed to address life insurers. Again, they failed to find out the determinants of efficiency in the non-life firms since it is essential for policy implementation. In this research, both life and non-life insurers were examined, and the determinants of efficiency were as well determined.

Barros et al. (2014) also sought to find out the efficiency of Angolan insurers. The paper first points out various approaches in analyzing the efficiency of the top seven insurers in Angola between the interval of 2003 to 2012. Bootstrapping estimates were used, and several DEA estimates were generated, allowing the use of confidence interval and a bias correlation in central estimates. The authors made use of a neutral network combined with DEA results in an attempt to produce a model for the performance of insurers with effective predictive ability. The findings showed that older insurer that originated from Portugal are more efficient. Also, there are scarce opportunities for accommodating future demand. This study, however, sampled only seven insurance firms out of the 27 insurers in Angola. This does not give a good picture of the entire industry since the sample is very small. Again, similar to Reyna and Fuentes (2018), the authors used claims payment as an output variable which contradicts output features. This research assessed 31 insurers in Ghana and as well used claims payment as an input variable.

Ansah-Adu et al. (2011) studied the cost efficiency of a sample of 30 Ghanaian insurers, 16 non-life insurers and 14 life insurers from 2006 to 2008. The DEA technique was used to estimate the

efficiency score of the sampled insurers. Their findings were in line with Alhassan, Addison and Asamoah (2014) that, life insurers were more efficient than non-life insurers. Also, their study revealed that, market share, insurer's size and equity ratio are positive drivers of insurance efficiency. However, their study period was very short (three years). This may not reflect the true situation. This study therefore analysed a ten-year period.

Owusu-Ansah et al. (2010) used DEA to evaluate the efficiency of 10 Ghanaian general insurance companies from 2002-2007. The study used debt capital, equity capital and management expenses as input variables. It also used net premium, claims and investment income as output variables. They observed that, Ghanaian insurers with higher market shares tend to have higher efficiencies. This implies that, the non-life insurer could increase their efficiency by trying to increase their market share. The study, however, investigated periods where there was composite insurance (2002 to 2006) and periods where there was no composite insurance (2007). The efficiency results may therefore have been affected. Again, claims paid was used as output variable though it does not qualify to be an output variable. This current research focused on periods after the abolishing of composite insurance and also used claims paid as an input variable.

2.3.2 Regulation and Efficiency

With the increasing competition in the financial sector, regulatory bodies put in efforts to implement policies to protect the public welfare and enhance efficiency (Cummins, Rubio-Misas, & Vencappa, 2017). Researchers across the globe have therefore focused on studying how regulations have affected efficiency in the financial sector. Majority of them have focused on developing countries and have studied the efficiency of banks (Triki, Kouki, Dhaou & Calice, 2017; Pessarossi & Weill, 2015; Osei-Assibey & Asenso, 2015; Maredza & Ikhide, 2013; Chortareas, Girardone, & Ventouri, 2012). Very few have, however, assessed the insurance

industry (Amanti & Siregar, 2019; Tennyson, 2007; Rees & Kessner, 1999). Most literature on insurance, investigated regulation and performance (Gaganis, Hasan, Papadimitri, & Tasiou, 2019; Lee, Arouri, & Lee, 2016).

Amanti and Siregar (2019) investigated the efficiency of non-life insurance companies in Indonesia from 2014 to 2015. This was as a result of an introduction of new capital regulation for insurers in 2015 by the Financial Services Authority Regulation. Studying seventy insurance firms, the study employed DEA, CCR and BCC models to study efficiency. The findings of their study revealed that the issuance of regulation on minimum capital of insurance companies had influenced the value of the non-life insurance companies. The authors indicated that an increase in capitalcould increase the industry's efficiency. However, the study based their conclusion on the same year the regulation on recapitalisation was enforced (2015), the single year used does not present a true reflection of the effect of recapitalisation. This research, therefore, made use of different years where there was recapitalisation to understand the true effect of recapitalisation.

With the aim of examining how capital size of Nigerian insurers affect their profitability, Ahmed (2016) made use of a correlation research design and a random effect panel regression model to study seventy-one listed insurance firms from 2006 to 2012. The author chose this time frame because prior to it, there had been recapitalisation of the Nigerian insurance industry. The research revealed that only capital base would not lead to a sound insurance industry. This research, however, focused on only the period after recapitalisation. This current study examined periods before recapitalisation and after recapitalisation to draw a solid conclusion on the comparison.

Hamisu and Salisu (2011) assessed the effect of 2006 recapitalisation and its impact on profitability in twenty-seven insurance companies in Nigeria. This was done by studying periods before and after the 2006 recapitalisation. Secondary data was sought from the regulatory body in

Nigeria. It was revealed in their study that, recapitalisation has no impact on profitability of Nigerian insurers both before and after the recapitalisation in 2006. The findings revealed that, there were some indications of an improvement in the absolute average profit figures after the recapitalisation in 2006.

The study by Gaganis, Liu and Pasiouras (2015) explored the impact of various regulatory policies on performance of insurance firms in Europe. The authors sampled one thousand, two hundred and seventy-sis insurers from eighteen different European countries from the period of 2005 to 2009. The study made use a multilevel mixed model with a random intercept at both country and firm-within-country level and controlled for other firm specific attributes. The U-shaped relationship between return on assets and insurance regulations was revealed. It was also revealed that, requirements that have to do with technical provision were negatively related to return on assets. Despite the fact that the research contributes immensely to stakeholders and policymakers in influencing their decision making, the study however, considered just five years which is not enough to give a true reflection of the industry. This study examined a 10-year period which gives a true reflection of the industry.

2.3.3 Regulation and Risk

Despite the fact that regulations are set to control risk, very few studies have studied the link between regulation and risk. Gehrig and Iannino (2018) analyzed the impact of systematic risk on the regulation of Europeans Insurers. The paper made use of multivariate regressions to identify the main drivers of systematic risk from the period of 1985 to 2016. The findings of the study revealed an increasing interconnectedness between banks and insurers that correlates with systematic risk exposure. It was revealed that, this interconnectedness between banks and insurers reached their peak during the crisis period. The study also found out that, while insurers were well capitalized at the commencement of the Basel process of capital regulation, after the

implementation of model-based approach, they started to become capital deficient. This paper contributed to providing regulatory tools to monitor risk exposures in the insurance sector. However, this paper had its focus on developed economies and not on developing ones like Ghana. This study will therefore address a developing country and find out how the regulation affects insurers risk.

Cummins and Sommer (1996) investigated how the capital of the property-liability insurance industry related to their risk. Their hypothesis stated a positive relationship between risk and capital in the property-liability insurance market. The study made use of a pooled panel sample of one hundred and forty-two property-liability insurance firms in the United States from the period of 1979 to 1990. The study found that, there exists a positive relationship between capital and risk of insurers. This study should have been extended to all non-life insurance firms as well as life insurance firms to conclude on the entire insurance industry. This current research assessed both life insurance firms and non-life insurance firms and concluded on the entire industry.

2.3.4 Regulation, Risk and Performance

Regulation and its effect on risk attitude and insurer performance has received less attention in literature. Most studies have focused on bank regulation, risk and efficiency (Said, Hasnan, & Alam, 2013; Maghyereh & Awartani, 2014; Kwan & Eisenbeis, 1997). The only study that investigated insurance regulation, risk and performance was conducted by Kusi et al., (2019). The authors explored the effect of risk on profitability of life and non-life insurers in the presence of regulation. Covering thirty insurance firms in Ghana between 2009 and 2015, this study made use of a robust least square and random effect technique to test the research hypothesis. Their study revealed that regulation on credit premium and capital requirement had an insignificant effect on the profitability of insurers. The study again proved that, both the regulation on credit premium

and capital requirement take away the effect of risk and hence improve profitability. Their study, however, did not find out the effect of only regulatory capital since it treated both credit premium regulation and capital regulation as a unit. This research investigated the effect of recapitalisation; a regulatory instrument, on technical efficiency and risk of Ghanaian insurers.

2.4 Research Gaps

The study identified these research gaps and addressed them in this current study.

Firstly, most studies on regulation have focused on mainstream banking industry and very few have examined the insurance industry (Lee, Cheng, Har, Nassir, & Razak, 2019; Swain & Swallow, 2015). Secondly, literature that have studied insurance efficiency and recapitalisation in developing countries were done in isolation. Most studies on Insurance efficiency only sought to find out the determinants of efficiency (Ansah-Adu et al., 2011; Owusu-Ansah, Dontwi, Seidu, Abudulai, & Sebil, 2010; Barros, Dumbo & Wanke, 2014; Eling & Luhnen, 2010).

Thirdly, most studies on recapitalisation in developing countries do not consider its influence on risk and technical efficiency (Ngugi & Afande, 2015; Jaiyeoba & Haron, 2015). The few studies that worked on capital requirement and efficiency studied developed countries that practiced the RBC system (Cummins & Phillips, 2009; Schellhorn, 2000).

Finally, there are no clear studies that have tried to find out the impact of recapitalisation on technical efficiency and risk taking on insurance firms in Ghana. Kusi, Alhassan, Ofori-Sasu and Sai, (2019) studied the effect of risk on performance in the presence of regulation. Their paper, however, did not investigate the impact of recapitalisation on risk and technical efficiency on insurance firms in Ghana. There is therefore the need to investigate how recapitalisation affects risk and technical efficiency of insurance firms in Ghana.

2.5 Conceptual Framework

This section presents a conceptual framework for the study.

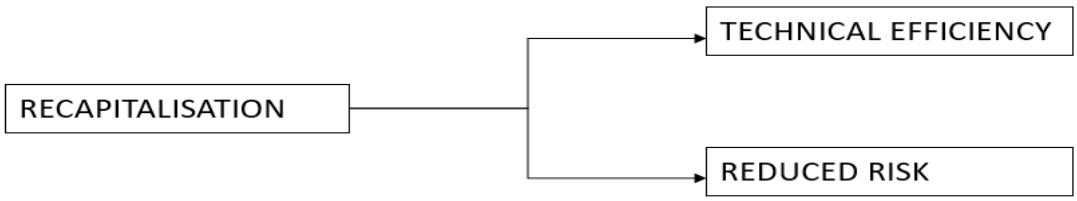

Figure 2.1: Conceptual Framework of the Study

Source: Author's compilation

From figure 2.1 above it is observed that recapitalisation of the insurance industry in Ghana affects all insurance firms in terms their technical efficiency and their risk.

2.6 Overview of Ghanaian Insurance Industry

The insurance in Ghana has gone through series of development since it began a while before independence. This section gives an overview of the insurance industry in Ghana which will be the focus of this study.

2.6.1 History of the Ghanaian Insurance Industry

The idea of resources pulling to cater for unforeseen contingencies (insurance) in Ghana, has been one practice that started years back even before the arrival of the British (Otoo, 2016). Some tribes in Ghana especially the Akan families were noted for making contributions to help finance the cost of burial in case a family member dies. They called this contribution "ɛtoɔ". This practice by Ghanaians was never regulated until the British merchants found their way to the Gold Coast

shores in the late 19th century (Appietu-Ankrah, 2008). Insurance has since then gone through a series of developments to make the industry better. This section will briefly assess the various stages insurance in Ghana has gone through from the existence of an appendage of the British insurance market through to the regulatory period and then to the efficiency period.

2.6.1.1 The Appendage Period

Insurance operations in Ghana are believed to have begun far back in the late 19th century when the British merchants arrived on the Gold Coast to trade (Appietu-Ankrah, 2008). These merchants imported machinery into Gold Coast and also exported cash crops and minerals from Gold Coast. In order to protect the traders from risk associated with trading activities, the practice of insurance was initiated (Otoo, 2016). However, due to the lack of regulators in the Gold Coast, the industry existed as an appendage of the British insurance market, thus, was controlled and regulated extensively by the British insurance companies through their agents in the Gold Coast without any local presence (Daykin & Cresswell, 2001). According to Otoo (2016) insurance operations during this period were centered on the British rather than the locals. It was in this period that the first insurance company; Royal Guardian Assurance Company (now Enterprise Insurance Company) was established in 1924 (GIA, 2019). Later, the first Ghanaian Insurance company; Gold Coast insurance was also established in 1955 to transact life businesses with the local folks (GIA, 2019). The period of appendage existed until 1963 when the Ghanaian insurance industry began its own regulation.

2.6.1.2 The Regulatory Period

After years of depending on the insurance regulation of the British, the Ghanaian insurance industry now depended on its own regulation. It began with the promulgation of the Workmen's Compensation Act of 1963 (Act 174), the Insurance Law of 1965 (Acts 288), the Insurance

Regulation of 1966 (LI 497) and the Insurance Amendment Decree of 1972 (GIA, 2019). These regulations provided the foundation to doing insurance business in the country. According to Aryeetey (2001), the Insurance Amendment decree of 1972 was the real turning point in the Ghanaian insurance history. This is because Ghanaians were given control over the industry. It was not long when the report by the Gepi-Attee committee in 1983 confirmed an increasing level of insolvency, fraud and malpractices of the industry which was attributed to absence of a developed supervisory body to oversee all activities of insurers (Aryeetey, 2001). This led to the enactment of the Insurance Law of 1989 (PNDC law 227) and the establishment of the National Insurance Commission in 1989. This body was responsible for effective supervision, administration and control of the Ghanaian insurance business. This brought back trust and growth of the sector (Agyapong, 2014).

2.6.1.3 The Efficiency Regulatory Period

This final period which has extended from 2006 till now is a period which marks the restructuring of the entire insurance to suit the standard regulation of international bodies (Otoo, 2016). This period of efficiency regulation began with the enactment of the Insurance Act 2006 (Act 724) which was in accordance with the core principles of International Association of Insurance Supervisors. This raised the Minimum Capital Requirement (MCR) and also abolished the composite business (NIC, 2019). The abolishing of composite insurance was to ensure that both life and non-life insurers work separately since they both covered different types of risks. Comparing the former Insurance Law of 1989 to that of 2006 you realize that the previous Act discouraged foreign participation but Insurance Act 2006 opened the industry for foreign competition, therefore, increasing the efficiency of the industry. The Act also made way for readjustment of the MCR to ensure efficiency among insurers and also enable them to underwrite

huge risk (Jaiyeoba & Haron, 2015). The Ghanaian insurance sector has therefore seen growth in terms of premium collected, profit margin and its size (Ansah-Adu et al., 2011).

2.6.2 Structure of the Ghanaian Insurance Industry

The Ghanaian insurance industry has undergone a series of regulatory changes from the 1930s, this has reflected in growth in the industry. From an initial foreign dominated industry comprising four principal agents, the industry now consists of 27 non-life insurance firms, 22 life insurance firms, 3 reinsurance firms, 1 reinsurance broker, 2 loss adjusters, 78 insurance brokerage firms and 7800 insurance agents (NIC, 2019). Table 2.1 below shows the number of life and non-life insurers that have existed from 2006 when the Insurance Act 2006 was enacted to 2019.

Table 2.1: Number of Life and Non-Life Insurers in each year

Year	Number of life Insurers	Number of Non-life insurers
2006	17	17
2007	17	17
2008	17	21
2009	17	23
2010	17	23
2011	18	24
2012	18	25
2013	18	25
2014	20	26
2015	24	27
2016	24	27
2017	24	27

2018	22	27
2019	22	27

Source NIC (2006-2019)

The Ghanaian Insurance industry has also seen a significant growth in gross premium as shown in Table 2.2.

Table 2.2 Gross Premium of Life and Non-Life Insurers in each year

Year	Non-life Insurance (GH¢)	Life Insurance (GH¢)
2006	114,597,969	49,609,297
2007	141,922,768	67,534,641
2008	187,250,912	89,243,821
2009	220,710,940	122,179,318
2010	270,773,967	187,244,627
2011	358,352,702	270,067,006
2012	494,891,864	355,765,109
2013	582,456,306	469,634,675
2014	659,262,969	580,590,473
2015	854,825,825	705,853,360
2016	1,070,057,051	858,781,522
2017	1,189,284,721	1,082,083,312

Source NIC (2006-2017)

The graph below shows the growth rate of gross premium of life and non-life insurance firms in Ghana. From the graph we see a higher growth rate of gross premium in life insurance firms from

2006 till 2014. Alhassan and Fiador (2014) attributed this growth to the increasing innovation and product development especially in the life insurance industry.

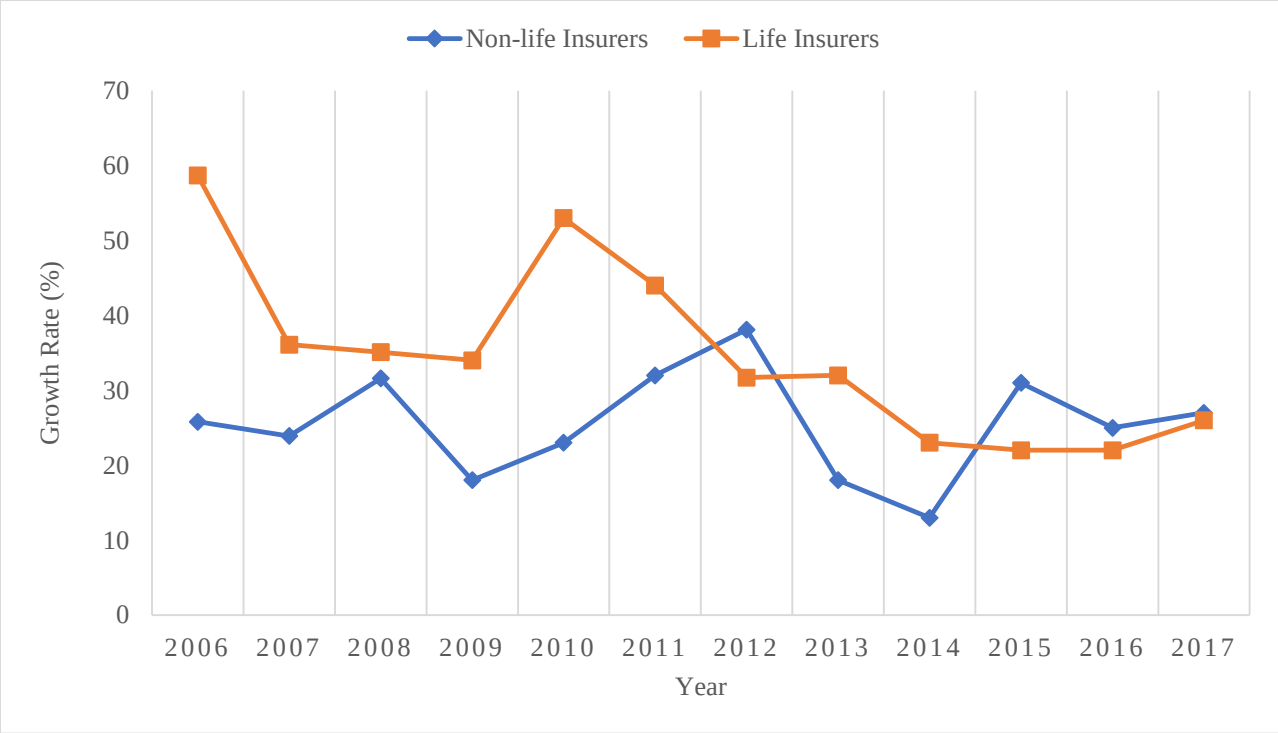

Figure 2.2: Trend of Growth Rate of Life and Non-Life Insurers

Source: Author's compilation from NIC (2006-2017)

2.6.3 The Life and Non-Life Insurance Market

The contribution of insurer's premium to the total industry premium of non-life insurance market is always higher compared to that of life businesses (NIC, 2016). From the NIC report 2017 the gross premium of the non-life market was about GH¢1.4 billion and that of the life industry was GH¢1.08 billion. The NIC attributed the higher gross premium of the non-life market to be driven by motor business premiums and fire insurance premiums (NIC, 2017).

According to NIC (2017) the total asset of the life insurance market has always been higher than non-life since 2013. The assets of both life and non-life insurers consist of Cash, Investment, Property, Plant and Equipment, Receivables, Intangibles and other Assets. The graph shows the total asset of life and non-life market from 2007 to 2017.

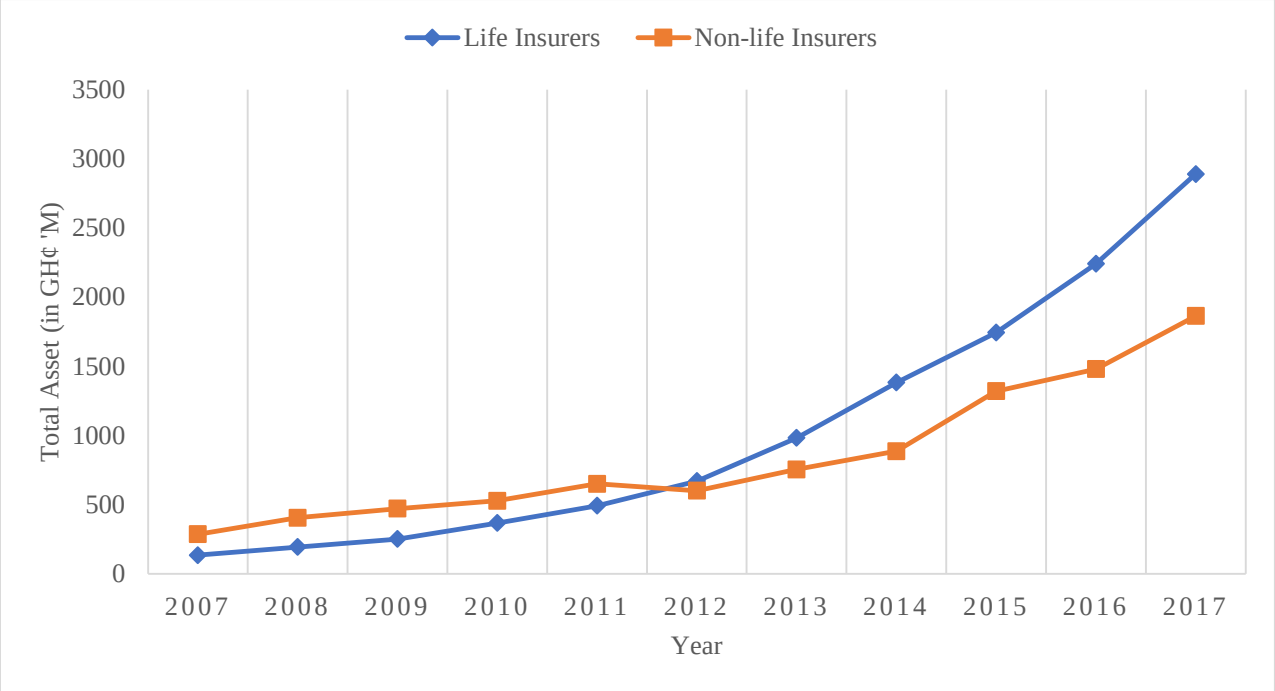

Figure 2.3: Trend of Total Asset of Life and Non-Life Insurers

Source: Author's compilation from NIC (2007-2017)

The investments in non-life business were relatively lesser than that of the life business. NIC (2016) in their publication showed that while the life insurance market invested about GH¢ 1.4 billion in 2015, the non-life insurance firms also had a total investment of GH¢ 627 million. Boadu, Dwomo-Fokuo, Boakye, and Frimpong (2014) are of the view that, life insurers run long-term insurance and therefore require a bigger investment to pay out claims. The graph below shows the total investment of both Life and non-life firms.

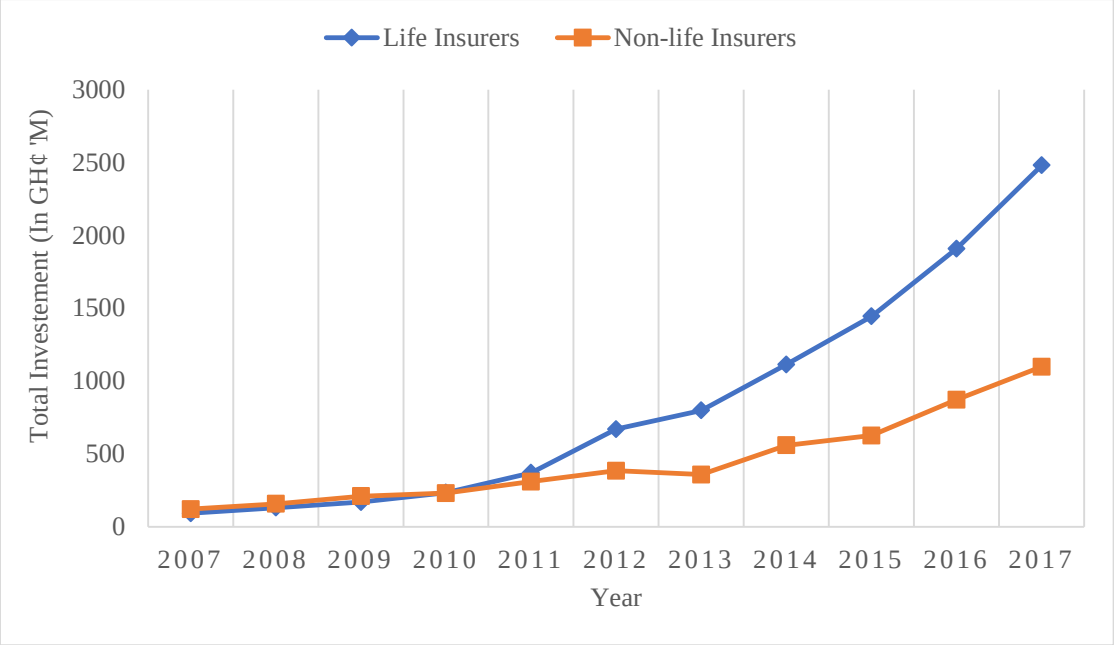

Figure 2.4: Trend of Total Investment of Life and Non-Life Insurers

Source: Author's compilation from NIC (2007-2017)

According to Jaiyeoba and Haron (2015) a well-capitalized market has a bigger muscle to take up huge risks. This implies that, higher capitalization reduces risk as well enhances efficiency. The total capitalization of Ghanaian life and non-life insurance industry is shown below. It indicates that the non-life insurance market has a greater total capitalization as compared to life the insurance market as shown in Figure 2.5. Figure 2.6 also shows the trend of profit after tax for both life and non-life insurers.

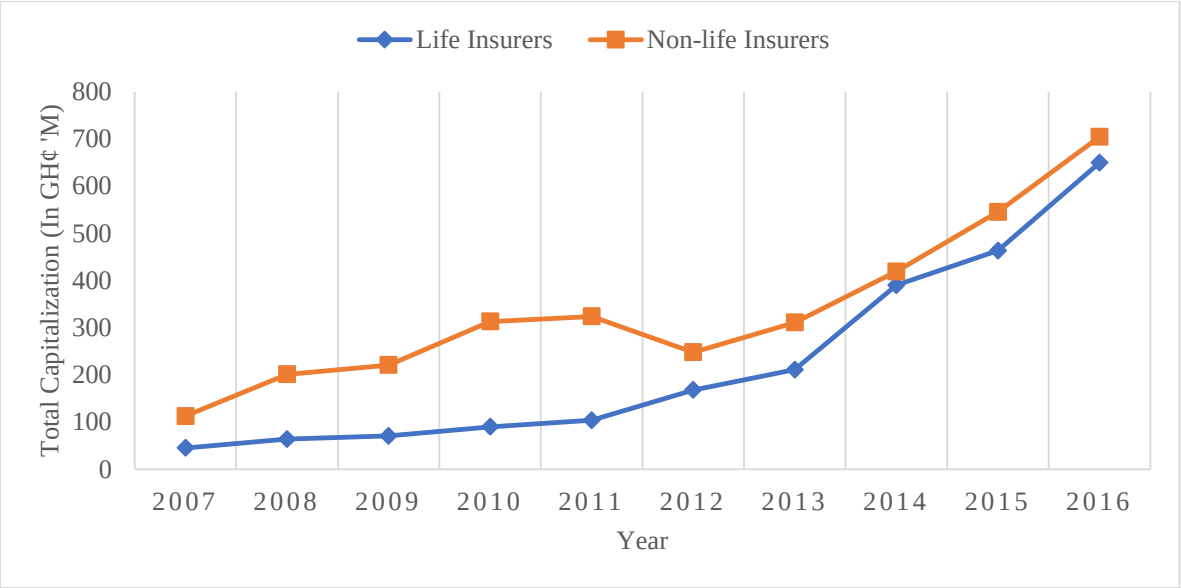

Figure 2.5: Trend of Total Capitalization of Life and Non-Life Insurers

Source: Author's compilation from NIC (2007-2017)

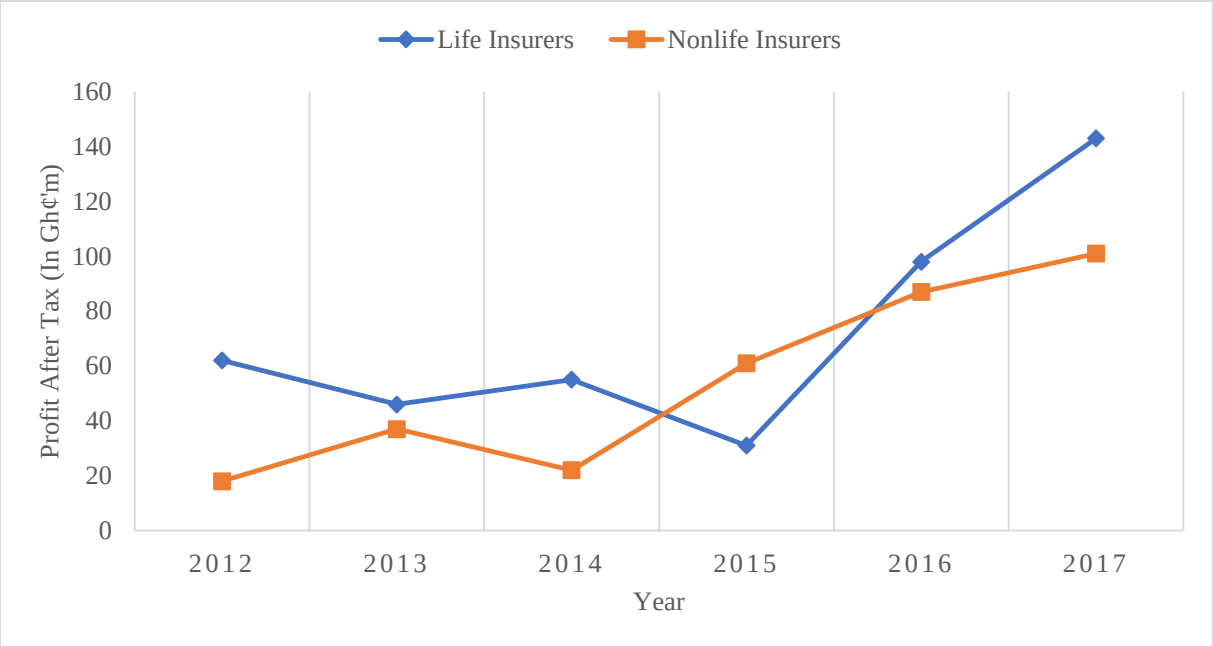

Figure 2.6: Trend of Profit after Tax of Life and Non-Life Insurers

Source: Author's compilation from NIC (2012-2017)

2.7 Summary

Under this chapter, the study first assessed the theoretical views that linked regulation to risk and efficiency by focusing on the Public Interest theory and Economic Interest theory. These theories were then applied to the insurance industry. The next was an empirical review and a conceptual framework on regulation, risk and efficiency of insurance firms. The last section discussed the overview of the Insurance industry in Ghana.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter, the study design, study area, the sample procedures and the analytical technique used to analyze the data are discussed. The chapter also explains how the relationship between recapitalisation and technical efficiency and risk will be determined.

3.2 Research Design

A very relevant component in the study of recapitalisation is the research design. It is relevant to come up with an appropriate way to collect data and analyse it accurately. According to Saunders, Lewis and Thornhill (2007), a research design may be explanatory, exploratory or descriptive. Researchers must first choose a research strategy in order to identify the appropriate way to collect data. Saunders et al. (2007) posits that, the overall plan of a research which comprises the research philosophy and approach used to solve an identified problem effectively is the research design. This philosophy refers to the beliefs and assumptions about how information about a phenomenon should be gathered and studied. According to Creswell and Creswell (2017), research approach is the plan which serves as a guide to achieve the research objectives stating three major approaches of research. These are quantitative approach, qualitative approach and mixed approach. This study adopted the quantitative approach since it enables an objective testing of hypothesis (Creswell & Creswell, 2017).

3.3 Data Source and Sampling Criteria

A panel data for 14 life and 17 non-life insurance firms in Ghana for a ten-year period from 2008 to 2017 was employed. The entire data (2008-2017) is used for the analysis using econometric techniques for panel regression models. The source of data is from the annual reports of insurance firms in Ghana submitted to the National Insurance Commission (NIC). The study relies on the

data from NIC because it is the insurance regulatory body and all insurers submit their annual report to the regulator (NIC). Again, most study on insurance in Ghana have sourced their data from NIC (Ansah-Adu et al., 2011; Alhassan et al., 2015; Owusu-Ansah et al., 2010; Oscar Akotey & Abor, 2013; Kusi et al., 2019).

3.4 Concept of Efficiency

Efficiency in itself originated from a work done by Farrell (1957). According to Farrell (1957), efficiency is a measure of the proportion of weighted outputs to inputs. Decision Making Units use similar inputs to produce similar output. Charnes, Cooper and Rhodes (1978) were the first to regard insurance firms as a Decision-Making Unit (DMU) in their study which differentiated profit oriented and nonprofit oriented business units. According to Thanassoulis (2001), the aim of the DMU is to transform inputs into outputs. A technically efficient firm is one that has the ability to produce greater output compared to other firms producing at similar level of input (Cherchye & Abeele, 2005). The objectives of Technical Efficiency can be attained by blending feasible sets of efficient inputs. Farrell (1957) reveals that, prices of inputs may affect prices independently because they are not static. The total technical efficiency measure obtained from constant return to scale is decomposed into pure technical efficiency and scale technical efficiency. A particular firm may be termed as scale inefficient if a difference exists between its Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) of technical efficiency of the organization. Scale efficiency is therefore calculated from the difference between the CRS and VRS of technical efficiency score (Byrnes, Färe, Grosskopf, & Kraft, 1987). According to Unakitan and Lorcu (2011), the purpose for splitting technical efficiency into pure technical efficiency and scale efficiency is to determine the source of inefficiency. Technical efficiency is therefore simple presented as:

$$TE = PTE + SE \quad (3.1)$$

where;

TE is the Technical Efficiency

PTE is the Pure Technical Efficiency

SE is the Scale Efficiency.

3.5 Basis of DEA

Data Envelopment Analysis (DEA) was adopted in order to estimate the technical efficiency of insurance companies in Ghana. Cullinane, Wang, Song and Ji (2006) defined DEA as a non-parametric linear programming frontier methodology for measuring the relative efficiency of Decision-Making Units (DMUs) that use similar and several inputs and outputs.

DEA was first introduced after Farrell (1957) motivated a need to develop a better method and models for evaluating productivity. In response to this, Charnes et al. (1978) first introduced DEA under the Constant Returns to Scale (CRS) assumption. Charnes et al. (1978) presented DEA as a mathematical programming model applied to observational data which provides a novel way of obtaining relational estimates which includes production function and efficiency production which is the foundation of modern economics.

The work of Charnes et al. (1978) was extended under the Variable Returns to Scale (VRS) assumption by work of Banker, Charnes and Cooper (1984). Previous studies have proven that, one benefit of DEA over all other measures of performance is that, it is good at revealing the relationship that may be hidden from all other methodologies. In a situation where one wants to measure efficiency, it is straight ahead tackled with DEA without requiring assumptions that are formulated explicitly and as well vary with the type of model.

DEA can be grouped mainly into two models. The first is the Charnes, Cooper and Rhodes (CCR) and Banker, Charnes and Coopers (BCC). For the CCR model, Constant Returns to Scale is assumed. This implies that, a relative change in input leads to an equal relative change in output. Luhnen (2009) argues that, this does not occur in reality since factors like regulations and unfavorable market conditions may cause DMUs not to always produce at their highest level.

In view of this situation, the BCC model was adopted to control for this situation. The BCC model, unlike the CCR model, assumes a variable return of scale. This implies that, a relative change in the input amount used in production does not lead to the same proportionate change in output as a result of imperfect market condition (Banker, Charnes & Cooper, 1984). According to Kader, Adams, Hardwick and Kwon (2014), under the variable returns of scale, technical efficiency can be decomposed into pure technical efficiency and scale efficiency. DEA as a measure of efficiency of DMUs can be measured in terms of minimizing input given a fixed level of output.

Researchers have argued on the numerous advantages of DEA which includes simplicity in measuring efficiency, permits to use several inputs and outputs and comparatively less demanding as compared to parametric approach (Cummins, Tennyson & Weiss, 1999; Alhassan & Biekpe, 2015). One major critique of DEA, however, is that, it is not a statistical technique and does not allow for standard errors (Hardwick, 1997). The technical efficiency under VRS for can be expressed as a linear programming problem as:

$$\min_{\lambda,x} \sum_{i=1}^{m} \lambda_i x_{i0} \tag{3.2}$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq x_{i0}; i = 1,2,3, \dots, m \tag{3.3}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}; r = 1,2,3, \dots, s \tag{3.4}$$

$$\sum_{j}^{n} \lambda_j = 1, \lambda_j \geq 1, j = 1,2,3, \dots, n \tag{3.5}$$

Equation 3.2 is a linear programming model used to minimise all inputs used by a particular DMU and is subject to some constraints. Equation 3.3 is the first constraints and it shows that, the sum of the weighted inputs of all DMUs is less or equal to the inputs used by DMU_0 (thus; $\sum_{j=1}^{n} \lambda_j x_{ij} \leq x_{i0}$). Equation 3.4 is the second constraint and it shows that, the sum of the weighted outputs of all the DMUs is greater than or equal to the outputs of DMU_0 (thus $\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}$). Equation 3.5 is the third constraint and it shows that, the sum of all the weights is equal to one (thus; $\sum_{j}^{n} \lambda_j = 1$) given the weights are non-negative integers (thus; $\lambda_j \geq 1$). The optimization model will be used to arrive at the technical efficiency values.

3.6 Output and Input variables selection

According to Cummins and Weiss (2013), the job of an insurer is similar to that of all others in the financial sector, their outputs are mainly in the form of services which are mainly intangible. Berger and Humphrey (1992) therefore points out that, there are three major output measures for financial providers. These output measures are user-cost approach, the asset approach, and the value-added approach.

Under the asset approaches, all firms are treated as typical financial intermediaries who are in the business of borrowing funds, transforming the borrowed funds into assets and paying out interest to cover for time value of the used amount (Berger & Humphrey, 1992). Insurance intermediation function is of major importance in the life insurance firms but to the property-liability insurers, intermediation function is more or less incident since they provide many services including financial intermediation.

Value-added approach considers those assets or liabilities that add higher value to the financial firm as output and those that do not add high value to the financial institution as input (Cummins & Weiss, 2013). Chen, Powers and Qiu (2009) posit that, the financial sector has proclaimed that, the most adopted approach is the value-added approach. The insurance industry adopts value-added approach because output indicators need to reflect the main services rendered by insurers. This includes risk pooling and bearing, financial intermediation and other financial services related to insured losses.

3.7 Input Variables

Inputs are those resources that are required in order to produce an output. Insurer's inputs come in the form of labor, capital and other insurance services. This study will use physical capital, managerial expense and claims incurred as input variables. This is mainly due to availability of data.

3.7.1 Physical Capital

A number of studies that worked on efficiency used physical capital as an input (Shujie, Zhongwei, & Genfu, 2007; Worthington & Hurley, 2002). This study will follow these works. According to Worthington and Hurley (2002), physical capital refers to the office space, computers, furniture,

plant and equipment and fittings. This study will, measure physical capital as the insurers' expenses on property, plants and equipment.

3.7.2 Managerial Expenses

This study uses managerial expense as an input variable and this is consistent with a number of studies on efficiency of insurance firms (Ansah-Adu et al., 2011; Al-Amri, Gattoufi & Al-Muharrami, 2012; Alhassan et al., 2015). Managerial expenses refers to all cost incurred in managing the firm's administrative expenses which included rent, utility, commission, office supply and general expense (Gardner & Grace, 1994).

3.7.3 Claims

One important part of insurance is claims payment. Claims payment have a tendency to increase trust of customers in the insurance firm. Many studies have used claims as an input variable because it forms part of the insurers expense. Also, no insurer seeks to maximize claims payment (Al-Amri et al., 2012; Brito, Pereira & Ramalho, 2013; Gaganis, Hasan & Pasiouras, 2013). Consistent with other literature, this study uses claims as an input variable because it forms part of the insurance firm's expenses and also insurers seek to minimize claims payment.

3.8 Output Variables

Outputs for this study are based on the value-added approach. Net premium and investment income are the output variables used.

3.8.1 Net Premium

Net premium earned is selected as the first output variable following the study on technical efficiency by Al-Amri et al. (2012). According to Rejda (2011), net insurance premium is the

amount of money that is paid to the insurer to cover the risk of the insured. Thus, the total premium received less the premium ceded to reinsurers. Following Huang and Eling (2013), Al-Amri (2015) and Alhassan et al. (2015) this study uses net premiums written as an output variable to proxy risk pooling and bearing. Also, net premiums written better represents the risk pooled (Al-Amri, 2015).

3.8.2 Investment Income

Following the study by Ansah-Adu et al. (2011) the second output variable that would be used in the study is investment income. Investment income is used because insurers borrow funds from policyholders and go ahead to invest these funds which therefore generates income. Also, since all firms seek to maximize output, investment income becomes an appropriate proxy for output (Al-Amri, 2015).

Table 3.1: Description of inputs and outputs

Variables	**Description**	**Weighting range of Technical efficiency**
Inputs		
Managerial Expense	Management Expense	0-1
Claims	Net claims incurred	0-1
Physical Capital	Physical capital expenses and depreciation	0-1
Outputs		
Net premium	Net premium written	0-1
Investment Income	Income generated from asset invested	0-1

From Table 3.1, an efficiency score of 1 indicates that, the insurance firm is at least the best performer on one particular dimension and a score of 0 indicates that, the insurance firm is at least the worst performer on one particular dimension respectively.

3.9 Econometric Model

Panel data technique was used to reveal the relationship between recapitalisation and technical efficiency and also recapitalisation and risk. Panel data is used because it determines whether the aim of recapitalisation (improve technical efficiency and cushion huge risk) is met. According to Wooldridge (2015), the nature of data compels the use of panel estimation technique and there are a number of advantages that comes with using panel technique.

According to Brooks (2008), panel estimation technique is preferred because of the advantages that come with the use of panel estimation. The first advantage of panel estimation is that, omission of variables and insurance specific effects are controlled. Also, it makes room for both the long-run and short-run effects and it is very advantageous since it overcomes the shortcomings of the times series and cross-sectional technique (Wooldridge, 2016). There are two techniques used to analyze panel data. These are random effect and fixed effect models.

3.9.1 Fixed Effect Model

This model comes into play when one is interested in analyzing the effect of variables which vary over time. Fixed effect models therefore explores the relationship between the dependent and independent variable within an entity (example; Insurance firm, bank, etc.) which has its own unique characteristics and may or may not influence the dependent variable. Using a fixed effect approach assumes that, something with the individual entity may bias the dependent variable or independent variable. It is therefore relevant to control for this effect. Fixed effect removes the effect of those time invariant characteristics and only assesses the net effect of the predictors on the outcome variables. According to Stock and Watson (2007), the key insight of fixed effect models is that, if the unobservable variables do not change over time, then any change in the dependent variable must be due to influence other than those fixed characteristics. The major

weakness of fixed effect models is that they will not work properly with data for which the within-cluster variation is minimal or for slow changing variables over time (Stock & Watson, 2007).

3.9.2 Random Effect Model

Random effect models are distinct from the fixed effect model. The major difference is that unlike fixed effect models, the variation across entities is assumed to be random and uncorrelated with the independent variable included in the model (Rasciute, Downward & Greene, 2017). One major strength of the random effect model is that, time invariant variables can be included. It also assumes that, the entity error term is not correlated with the predictor. In random effect models, individual characteristics that may or may not influence the predictor need to be specified. The major problem of this model is that, some variables may not be available and may lead to omitted variable bias in the model.

3.10 Relationship between Regulatory MCR and Technical Efficiency

Given the panel nature of the data, the study adopts the empirical model of Alhassan et al. (2015) and Ansah-Adu et al. (2011). However, the modification of the model is done by introducing regulatory minimum capital requirement as defined in equation (3.4).

$$TE_{it} = \beta_0 + \beta_1 RECAP_{it} + \beta_2 Mktshare_{it} + \beta_3 lnMGTEXP_{it} + \beta_4 lnNCL_{it} + \beta_5 Comp_{it} + \beta_6 Lev_{it} + \beta_7 IR_{it} + \beta_8 EXPRAT_{it} + \upsilon_{it} \quad (3.6)$$

where,

TE_{it} is the technical efficiency of firms i at period t

$RECAP_{it}$ is the proxy for recapitalisation of firm i at various time periods t.

$MktShare_{it}$ is the market share of insurer i at time t

$lnMGTEXP_{it}$ is the natural log of management expense of insurer i at time t

$lnNCL_{it}$ is the natural log of net claims incurred of insurer i at time t

$Comp_{it}$ is the competition measure of insurer i at time t

Lev_{it} is the leverage of insure i at time t

IR_{it} is the risk of insurer i at time t

$EXPRAT_{it}$ is the expense ratio of insurer i at time t.

v_{it} is the error term which is decomposed into $\mu_i + \omega_t + \varepsilon_{it}$, where, μ_i represents the firm fixed effect, ω_t represents the time fixed effect and ε_{it} represents the error term which varies over entity and time.

3.10.1 Variable definition

The variables used in the panel model 3.6 are discussed in this section.

3.10.1.1 Technical Efficiency

Technical Efficiency is used as the dependent variable in model 3.6. Technical efficiency is the dependent variable. One major aim of recapitalisation is to enhance the technical efficiency of the insurer. Technical efficiency is calculated using DEA.

3.10.1.2 Recapitalisation

Recapitalisation is an important component of reforms in the insurance industry. This variable impact efficiency of all insurers (Orea & Kumbhakar, 2004). Studies reveal that a lower capital

suggests that a firm is at a risky position (Berger, 1995). According to Genetay and Molyneux (1998), capitalization of firms comes with a number of benefits. The first is that, a well-capitalised firm will need to borrow less in order to support a given level of assets. Again, a well-capitalised firm will serve as a cushion for risk and finally it will raise expected earnings by reducing the expected cost of financial distress such as bankruptcy (Berger, 1995).

Regulation on minimum capital requirement has been proxied in various ways in literature. This study will use three of these proxies. Kusi et al. (2019) and Bougatef and Mgadmi (2016) in their study proxied regulation as a dummy. Therefore, our first proxy for Minimum Capital Requirement is the use of a dummy, where, 1 will represent years in which there was an increase in MCR and 0 otherwise. The second proxy for Minimum Capital Requirement is to use the log of the regulatory amount that existed in the various years. Kusi et al. (2019) used this to capture the effect of recapitalisation. This is referred to as the Minimum Capital Ratio.

The final proxy for minimum capital requirement is the ratio MCR to the Equity capital. This follows the IMF indicators for financial soundness (IMF, 2005). This will capture the varying effect of recapitalisation on individual insurance firms and will bring out the effect of recapitalisation on insurers. This study will make use of all three proxies.

Studies on the effect of capital regulation on performance has been inconclusive. Studies by Sani and Alani (2013) and Hamiu Ibrahim and Abubakar (2011) revealed that capital regulation has no significant effect on performance of insurers in Nigeria. Gaganis, Liu, & Pasiouras (2015), however, found an inverted U-Shaped relationship between performance and capital regulation. Ahmed (2016) posits that recapitalisation enhances efficiency and also provides the insurance firm with the requisite capacity to underwrite high-risk activities. Otoo (2016) in his study found a

negative relationship between efficiency and capitalization. Amanti and Siregar (2019) also, found a positive relationship between efficiency and regulation. Considering the contrasting views, this study, therefore, hypothesizes a significant relationship between recapitalisation and technical efficiency.

3.10.1.3 Equity Capital

Equity capital indicates the ability of an insurer to pay claims when it exceeds expectation (Danquah, Otoo, & Baah-Nuakoh, 2018). This depicts that, policyholders have more confidence in insurers with higher Equity capital. Ghanaian insurers define equity capital as stated capital, retained earnings, income surplus, capital surplus, contingent reserves as well as regulatory and statutory contingent reserves (NIC, 2019).

3.10.2 Control Variables and Hypothesis

The following variables will serve as controls for the relationship between recapitalisation and technical efficiency.

3.10.2.1 Market Share

Market share is measured as the ratio of a particular company's gross premium to the total gross premium. Market share is identified as a key determinant of efficiency among insurance companies (Simar & Wilson, 2007; Ansah-Adu et al., 2011). A study by Ansah-Adu et al. (2011) and Otoo (2016) revealed a positive relationship between market share and efficiency. Other studies found that inefficiencies may increase market share where competition exists (Danquah et al., 2018). Given the contrasting views, this study, therefore, hypothesizes a positive relationship between market share and technical efficiency.

3.10.2.2 Net Incurred Claims

Net incurred claims is the amount of money an insurance company pays out to the insured in the occurrence of a loss (NIC, 2017). The study measured net incurred claims as the natural log of the claims amount paid out by the insurer. Yusuf and Ajemunigbohun (2015) studied the effect of net incurred claims on efficiency and found that, claims payment had a negative effect on efficiency since high claims payment was an evidence of inefficiency among firms. Given that, a higher level of claims incurred tend to reduce the profit of the company, this study therefore, hypothesizes a negative significant relationship between net claims incurred and technical efficiency.

3.10.2.3 Competition

Competition in the study is measured by the Herfindahl-Hirschman Index (HHI). It is estimated as the summation of the squares of the market shares of firms in the industry.

$$HHI = \sum_{i=1}^{N} MS_i^{\,2} \qquad (3.7)$$

Different studies have concluded on varying findings on the effect of competition on efficiency. Chortareas, Garza-García, and Girardone, (2012) are of the view that the absence of competition leads to inefficiencies. This Implies that competition is good to ensure technical efficiency. Nurul and Worthington (2015) agreed with Chortareas et al. (2012) and posited that, with competition, firms become innovative and put in more effort to ensure efficiency in order to gain more market share. However, De Feo and Hindriks (2014) argued that a competitive environment encourages selection of risky policyholders which leads to high claims cost which results in inefficiencies. In Ghana the fierce competition has led to insurers adopting new technologies and innovations which may improve their efficiency. A positive relationship is therefore hypothesized between competition and technical efficiency.

3.10.2.4 Leverage

According to Alhassan et al. (2015), leverage in insurance comprises premiums collected in addition to the reserve funds used to cover for claims incurred and outstanding claims not reported. The study will follow Alhassan et al. (2015) and proxy leverage as the ratio of total liability to total asset. According to Jensen (1986), in order to reduce the risk of insolvency, leverage forces management to reduce inefficiencies to meet financial obligations and establish a positive relationship between leverage and efficiency. The study by Luhnen (2009) revealed a positive relationship between leverage and insurer's efficiency. Considering the fact that prompt payment of claims enhances confidence of the policyholder in the insurer and improves their efficiency his study hypothesizes a positive relationship between leverage and technical efficiency.

3.10.2.5 Risk

This research will follow Alhassan et al. (2015) and measure insurance risk as the ratio of net loss to total income. De Feo and Hindriks (2014) posited that, higher risk leads to inefficiencies. This assertion was supported by Nurul and Worthington (2015). Cummins et al. (2017) argued that efficiency enhances risk and shows a negative relationship. Following Cummins et al. (2017), the study therefore hypothesizes a negative relationship between risk and technical efficiency since the greater the ratio of loss to total income the more inefficient the insurer becomes.

3.10.2.6 Expense Ratio

Following the study by Altuntas and Rauch (2017), expense ratio is measured as the ratio of net operational expense to net premium. Mwangi and Iraya (2014) sought to establish a relationship between expense ratio and efficiency. Their findings revealed a significant relationship between expense ratio and efficiency. This view was supported by Angima (2017). This study hypothesizes

a significant relationship between expense ratio and technical efficiency since a higher expense ratio implies higher operational expense which affects the efficiency of insurers.

3.11 Relationship between Regulatory MCR and Risk

The model that shows the relationship between risk and regulatory MCR is shown below;

$$Risk_{it} = \beta_0 + \beta_1 RECAP_{it} + \beta_2 Comp_{it} + \beta_3 Size_{it} + \beta_4 EXPRATIO_{it} + \beta_5 Inves\ Ratio_{it} + \beta_6 Lev_{it} + \beta_7 NIR_{it} + \beta_8 MktShr_{it} + \beta_9 Type_i + \varepsilon_{it} \quad (3.8)$$

where,

$Risk_{it}$ is the risk of insurer i at period t

$RECAP_{it}$ is the proxy for Minimum Capital Requirement of firm i at various time periods t.

$Comp_{it}$ is the measure of competition of insurer i at time t

$Size_{it}$ is the size of insurer i at time t

$EXPRATIO_{it}$ is the expense ratio of insurer i at time t

$Inves\ Ratio_{it}$ is the investment ratio of insurer i at time t

Lev_{it} is the leverage of insurer i at time t

NIR_{it} is the Net Insurance Risk (NIR) ratio of insurer i at time t

$MktShr_{it}$ is the market share of insurer i at time t

$Type_i$ is the type of insurer i

ε_{it} is the error term which is decomposed into $k_i + m_t + \epsilon_{it}$, where, k_i represents the firm fixed effect, m_t represents the time fixed effect and ϵ_{it} represents the error term which varies over entity and time.

3.11.1 Risk

According to Rejda (2011), insurance risk represents any unreliability which could result in financial loss. The study will follow Alhassan et al. (2015) and proxy insurance risk as ratio of incurred losses to earned premiums (underwriting risk). The relationship between regulation and risk of previous studies has been inconclusive. Pasiouras and Gaganis (2013) studied the relationship between regulatory policies and insurance soundness. Their study revealed that, the power of regulation and supervisory body in enforcing sanctions have a positive and significant effect on insurer soundness. This implies that regulations tame risk-taking behavior of insurers. However, capital requirements have a positive effect on soundness. Lee and Lin (2016) in their study revealed that, regulation reduces risk-taking behavior of insurers.

3.11.2 Control Variables and Hypothesis

The following variables will serve as controls for the relationship between regulatory minimum capital requirement and risk of the insurer.

3.11.2.1 Competition

The proxy for competition is defined in section 3.10.2.3. Alhassan and Biekpe (2015) posit that, competition results in premium undercutting which in turn increases insurers risk. This indicates a positive relationship between competition and risk. Boyd and De Nicolo (2005) are of the view that, an aggressive market forces firms to be prudent in their risk selection so therefore reduces

their risk. This view was supported by Altuntas and Rauch (2017). Given the contrasting view, this study expects a significant relationship between competition and risk.

3.11.2.2 Investment Ratio

Investment ratio is defined as investment income divided by net premium earned. This ratio serves as a count of the effectiveness of an insurer's investment decisions. According to Altuntas and Rauch (2017), a higher investment income enhances insurer's risk taking. The study hypothsizes a negative effect of investment income on risk of the insurer. This is because proper investment decisions reduces the risk of loss to the insurer.

3.11.2.3 Size

The relationship between firm size and risk is inconclusive. Large insurance firms are more stable in terms of risk since large firms enjoy government subsidies (Cummins, Harrington & Klein, 1995). Again, they believe the lower chance of risk among large insurers is due to their ability to efficiently diversify their risk, adapt to market changes and enjoy economies of scale from their large production (Adams & Buckle, 2003). Alternatively, Altuntas and Rauch (2017) argued that, large insurers have a larger probability of risk than small insurers. This is because, larger insurers are motivated to undertake risky activities. This assertion was supported by Cetorelli, Hirtle, Morgan, Peristiani, and Santos (2007) who argued that a negative relationship exists between firm size and risk. Considering the contrasting views, the study expects a significant relationship between firm size and their risk.

3.11.2.4 Expense Ratio

This research will follow Altuntas and Rauch (2017) and measure expense ratio as the ratio of operating expense to net premium written indicating how efficient an insurer is in his operational activities. Sharpe and Stadnik (2007) in their study provide evidence that, expense ratio has a

negative impact on solvency on insurers. This study therefore hypothesizes a positive relationship between expense ratio and insurer's risk. This is because, insurers with high operational expense are more likely to be faced with a high level of risks.

3.11.2.5 Type of Insurer

Type of insurer will be measured as a dummy, 1 if the firm is a life insurer and 0 if the firm is a non-life insurer. Akotey and Abor (2011) provided evidence that almost all life insurers stated their risk appetite levels which helps them to identify which risk to absorb and which ones to transfer. On the other hand, non-life insurers have not laid down their risk appetite leading to a higher risk in non-life insurance firms.

3.11.2.6 Leverage

Leverage in insurance comprises premiums collected in addition to the reserve funds used to cover for claims incurred and outstanding claims not reported (Alhassan et al., 2015). Caporale, Cerrato, and Zhang (2017) revealed in their study that, leverage negatively affected risk. Adams and Buckle (2003) are of the view that, a higher leverage leads to insurers making good investment decisions which generates enough revenue to cover unexpected losses. This leads to a positive relationship between leverage and risk. Given the inconclusive results, this study hypothesizes a significant relationship between risk and leverage.

3.11.2.7 Net Insurance Risk (NIR) Ratio

Net insurance risk (NIR) ratio will be measured as the ratio of net premium written to total equity (Alhassan & Biekpe, 2018). According to Alhassan and Biekpe (2018), a low NIR ratio indicates a low risk. On the other hand, high NIR ratio implies a high equity which could influence investment decisions, implying that, the insurer may invest in riskier assets. This is because investing in risky assets may yield high returns. This increases the risk, leading to a negative

relationship between NIR ratio and risk. A negative relationship between NIR ratio and risk is hypothesized because a high ratio exposes the insurer to the risk of not being able to absorb unseen shocks.

3.11.2.8 Market Share

Proxies for market share is defined in section 3.10.2.1. The study by Akotey and Abor (2013) revealed a negative relationship between market share and insurers risk. This study followed Akotey and Abor (2013) and hypothesizes a negative relationship between risk and market share.

3.12 Summary

In this chapter, the methodology is discussed as well as the data sample and estimation procedure and provides justification for the methodology used.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.1 Introduction

This chapter provides the analyses of results as well as the steps involved in collecting data, analyzing it and arriving at the results. It highlights the descriptive statistics of the selected variables, the correlation matrix and finally, the regression analysis of the objectives set in this research.

4.2 Descriptive Statistics

Table 4.1 presents the descriptive statistics of the variables captured as output and input variables for technical efficiency score determination for life insurers. Table 4.2 also provides the descriptive statistics of the variables used as output and input variables for technical efficiency score determination for non-life insurers. The key descriptive measures are the mean, maximum and minimum, standard deviation and coefficient of variation of the pooled data from 2008-2017 for each variable.

Table 4.1: Descriptive statistics of input and output variables for life insurers.

Variable	Obs	Mean	Std. Dev.	Min	Max	CV
Inputs						
Physical Capital	140	3177689	4518237.4	12664	24,651,581	1.422
Managerial Expense	140	9196376	11157398	256149	50,873,429	1.213
Claims	140	13788223	24149539	42728	175,600,000	1.514
Outputs						
Net Premium	140	31238536	52413644	457873	282,600,000	1.678
Investment Inc.	140	9599429	17309631	37387	94,960,139	1.803

Source: Research data (2021)

From Table 4.1 above, with 140 observations, there is a wide difference between the minimum and maximum values for each input and output variable. This explains the difference in the size of life insurance firms. This difference in size is also revealed with the high standard deviation compared to the mean value of input and output variables. The coefficient of variation (CV) is, however, greater than one for all variables. This indicates the volatility of input and output variables in the life insurance industry. The minimum claims (GH¢ 42,728) paid by an insurer compared to the maximum claim (GH¢ 175,600,000) paid by another insurer shows difference in risk faced by various life insurers as well as difference in market size of insurers.

Table 4.2: Descriptive statistics of input and output variables for non-life insurers

Variable	Obs.	Mean	Std. Dev.	Min	Max	CV
Inputs						
Physical Capital	170	4218588	6392572	22,648	33,382,718	1.515
Managerial Expense	170	15766018	67253071	96,064	873,200,000	4.266
Claims	170	7456580	9614946	36212	57,069,000	1.289
Outputs						
Net Premium	170	19652751	21430583	36,1428	98,815,505	1.090
Investment Inc.	170	7135419	20118065	17,285	132,000,000	2.819

Source: Research data (2021)

From Table 4.2 above, with a total of 170 observations, a wide difference is seen between the minimum and maximum value of each input and output variable. This indicates the varying sizes of non-life insurance firms in Ghana. However, compared to life insurance firms, it is seen that, non-life insurers recorded the highest maximum physical capital, as well as managerial expense

and investment income while life insurance firms in Ghana records a higher maximum claims expense and net premium. However, the difference between minimum (GH¢ 36,212) claims and maximum claims (GH¢ 57069000) indicates the difference in risk faced by various non-life insurers in Ghana. The average investment income for life insurers (GH¢9599429) was found to be higher than non-life (GH¢ 7135419). This is as a result of the long term investment in which life insurers undertake. Comparing coefficient of variation, life insurers have a more volatile net premium as well as claims expense. On the other hand, non-life insurers have a more volatile physical capital, managerial expense and investment income.

In order to test the isotonicity property of DEA which states that, all inputs must be positively correlated with output variables (Cooper, Seiford & Zhu, 2011). Table 4.3 and Table 4.4 provides a correlation matrix of inputs and output variables used in estimating efficiency for both life and non-life insurers respectively.

Table 4.3: Correlation Matrix of Inputs and Output Variables for Life insurers

Variables	Physical capital	Managerial expense	Net incurred claims	Net premium	Investment Income
Physical capital	1.000				
Managerial expense	0.609 (0.000)	1.000			
Net incurred claims	0.540 (0.000)	0.830 (0.000)	1.000		
Net premium	0.592 (0.000)	0.823 (0.000)	0.910 (0.000)	1.000	
Investment Income	0.521 (0.000)	0.868 (0.000)	0.840 (0.000)	0.906 (0.000)	1.000

Source: Research data (2021)

Table 4.3 shows that all inputs are significant at 1% significant level and there is no violation of the isotonicity property. A rise in inputs leads to a significant rise in output produced by Ghanaian life insurers.

Table 4.4: Correlation Matrix of Inputs and Output Variables for Non-Life insurers

Variables	Physical Capital	Managerial Expense	Net Incurred Claims	Net Premium	Investment Income
Physical Capital	1.000				
Managerial Expense	0.081 (0.000)	1.000			
Net Incurred Claims	0.436 (0.000)	0.111 (0.000)	1.000		
Net Premium	0.567 (0.000)	0.166 (0.000)	0.929 (0.000)	1.000	
Investment Income	0.002 (0.000)	0.172 (0.000)	0.079 (0.000)	0.088 (0.000)	1.000

Source: Research data (2021)

From Table 4.4 above, all inputs are significant at 1% significance level. This implies that, there is no violation of the isotonicity property. A rise in inputs leads to a significant rise in output produced by Ghanaian non-life insurers.

Table 4.5: Summary Statistics of variables used in the empirical model

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
Technical Efficiency	310	.819	.214	.191	1
Insurer's Risk	310	.312	.22	.01	1.697
MCR (dummy)	310	.2	.401	0	1
Ln(MCR)	310	15.141	1.107	13.891	16.524
MCR/Equity	310	1.1	4.277	.003	66.005
Physical Capital	310	14.229	1.411	9.447	17.324
Managerial Expenses	310	15.55	1.163	11.473	20.588
Net Incurred Claims	310	15.165	1.515	10.497	18.984
Investment Income	310	14.514	1.715	9.758	18.698
Total Asset	310	17.093	1.272	12.597	20.241
Market Share	310	.061	.067	.001	.31
Investment Ratio	310	.559	2.414	.013	31.707
Competition (HHI)	310	.114	.045	.011	.176
Type of Insurer	310	.452	.498	0	1
Size	310	17.096	1.273	12.597	20.241
Leverage	310	.636	.382	.015	5.559
Exp. Ratio	310	.735	2.573	.04	44.928
NIR	310	1.915	3.266	.048	38.635

Source: Research data (2021)

From Table 4.5, technical efficiency for all insurers range from a minimum of 0.191 to a maximum of 1, with an average score of 0.819. This implies that, both life and non-life insurers in Ghana are on an average technically efficient. The standard deviation value of 0.214 implies that, technical efficiency is moderately distributed around its mean. The mean insurer's underwriting risk of 31.2% implies that, on an average, insurance firms in Ghana use about 31.2% of their premium written to pay claims.

For the period under study, the highest Minimum capital ratio (lnMCR) of insurers was 16.524 and the least was 13.891. The average minimum capital ratio recorded was 15.141. Another proxy for recapitalisation which was the proportion of equity capital that formed the MCR had a mean of 1.1 which implies that, on an average 110% of equity capital forms the MCR. The final proxy for recapitalisation is a use of a dummy where 1 represents a year in which there was an increase in MCR and 0 otherwise. For market share that indicates the level of an insurer's control in the market, the results show an average of 6.1%. The insurer with the largest market share had 31%, the least had 0.01%. This implies that, if the insurance market expands, very few insurers take advantage of the increase. The high standard deviation of investment ratio, expense ratio and NIR relative to their means explains the differences between life and non-life insurers. Also, the average HHI index of 11.4% implies that, the Ghanaian insurance industry is a very competitive one.

4.3 Efficiency Score

DEA was used to estimate efficiency score of Ghanaian insurers. Figure 4.1 and Figure 4.2 represents the DEA technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency score of life and non-life insurers respectively in Ghana from 2008 to 2017. The decomposition of TE into PTE and SE is to help identify the major source of technical inefficiencies and also because efficiency estimates were under the assumption of VRS.

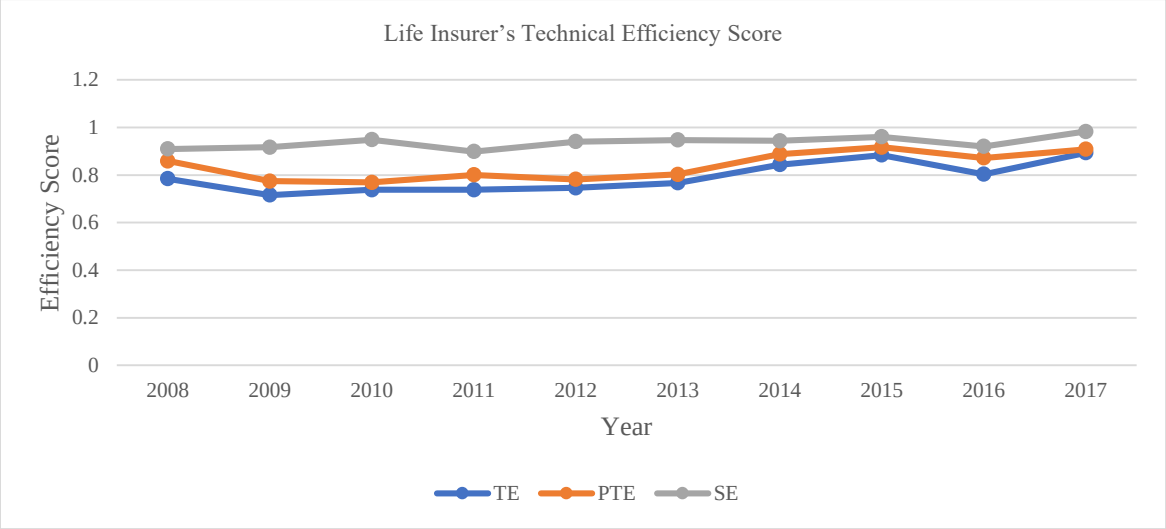

Figure 4.1: Life Insurer's Technical Efficiency Score

A decreasing trend in Pure TE is observed from the period of 2008 to 2013 which is consistent with the findings of Alhassan et al. (2015) for life insurers. TE scores of life insurers in Ghana averaged between 0.7159 and 0.893. This implies that life insurers in Ghana could improve between 0.2841 to 0.107. Life insurers could improve their TE by properly managing claims and underwriting by adopting advanced technology such as automated underwriting and claim handling to replace the manual system, this will go a long way to reduce claim cost, reduce underwriting cost as well as increase premiums and profit. Under the VRS hypothesis, TE was further broken down into PTE and SE. On the average PTE and SE accounted for 0.837 and 0.937 of TE respectively. The mean TE for the period is 79.1%. Appendix B shows the technical efficiency of 14 life insurers in Ghana.

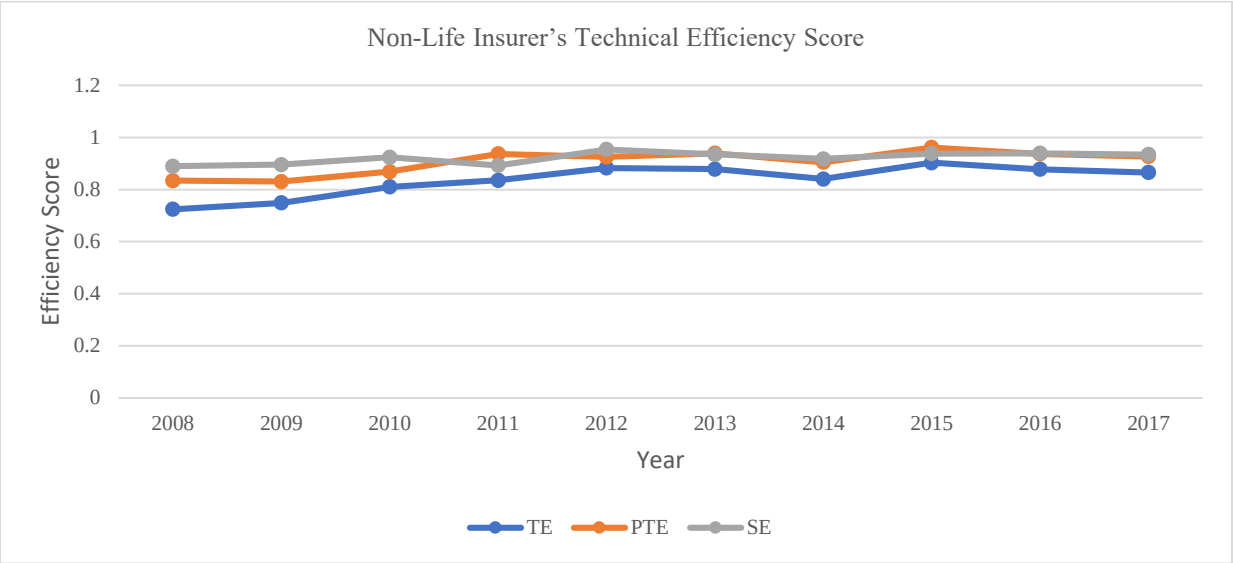

Figure 4.2: Non-Life Insurer's Technical Efficiency Score

Under the VRS hypothesis, averagely, PTE and SE accounted for 0.9067 and 0.9221 of technical efficiency respectively. The mean TE for the period is 0.8369.

Non-life insurers in Ghana had the TE averaged between 0.7242 and 0.9034. This implies that, non-life insurers in Ghana could improve their technical efficiency between 0.2758 to 0.0966. Non-life insurers could as well improve their TE by properly managing claims and underwriting and by adopting advanced technologies, this will go a long way to reduce claim cost.

On an average, non-life insurers are more technically efficient (0.837) compared to life insurers (0.7913). Appendix A shows the technical efficiency of 17 non-life insurers in Ghana.

4.4 Econometric Results and Analysis

To estimate the panel regression in section 3.10 and 3.11, some tests to ascertain the reliance of the model employed for the technique are performed.

4.4.1 Effect of Recapitalisation on Technical Efficiency

For the relationship between MCR and TE some tests are employed to tell how reliant the model employed for this research is. First the correlation between variables and VIF was computed to test for multicollinearity, then we ran a test of heterogeneity. After which the panel regression is estimated.

4.4.1.1 Multicollinearity

Before the relationship between recapitalisation and Technical efficiency is estimated a test of multicollinearity is performed using the correlation matrix in Table 4.6.

Table 4.6: Correlation Matrix of independent Variables

Variables	Tech. efficiency	MCR (dummy)	Ln(MCR)	MCR/Equity	Market Share	Ln (Net Incur. claims)	Competition (HHI)	Insurer's Risk	Leverage	Expense ratio
Tech. efficiency	1.000									
MCR (dummy)	0.096	1.000								
	(0.091)									
Ln(MCR)	0.220	0.377	1.000							
	(0.000)	(0.000)								
MCR/Equity	0.030	0.156	0.116	1.000						
	(0.598)	(0.006)	(0.041)							
Market Share	0.139	-0.004	-0.018	-0.151	1.000					
	(0.014)	(0.943)	(0.746)	(0.008)						
Ln (Net Incur. claims)	0.073	0.116	0.524	-0.074	0.608	1.000				
	(0.198)	(0.042)	(0.000)	(0.196)	(0.000)					
Competition (HHI)	-0.012	0.043	0.002	0.147	0.156	0.153	1.000			
	(0.839)	(0.450)	(0.978)	(0.010)	(0.006)	(0.007)				
Insurer's Risk	-0.257	0.043	0.221	0.153	-0.026	0.431	0.364	1.000		
	(0.000)	(0.446)	(0.000)	(0.007)	(0.643)	(0.000)	(0.000)			
Leverage	0.007	0.045	0.016	-0.014	-0.089	-0.054	0.104	0.177	1.000	
	(0.901)	(0.432)	(0.778)	(0.811)	(0.119)	(0.345)	(0.068)	(0.002)		
Expense ratio	0.029	-0.036	-0.080	-0.012	0.019	-0.014	0.009	-0.033	-0.016	1.000
	(0.614)	(0.527)	(0.159)	(0.832)	(0.737)	(0.800)	(0.880)	(0.566)	(0.780)	

Source: Research data (2021)

Correlation matrix tests for the presence of multicollinearity and shows the strength and direction of the relationship between variables. Kennedy (2008) posits that, there exist multicollinearity anytime a correlation coefficient is greater than 0.70. From the correlation matrix in Table 4.6, the highest correlation coefficient is 0.608 which is less than 0.70 indicating that there is no problem of multicollinearity. So we move forward to use the Variance Inflation Factor (VIF) to confirm the non-existence of the problem of multicollinearity. According to Phan, Daly and Akhter (2016), multicollinearity exists when the VIF of independent variables is greater than 10. From the VIF shown in appendix C, the problem of multicollinearity does not exist since the VIF of the independent variables are less than 10.

4.4.1.2 Heteroscedasticity

A Breusch-Pagan Lagrange multiplier test was done in order to find out whether there exists a panel effect in the model. The null hypothesis for the test states that, there is constant variance; that is, there exist no significant difference across units and hence there is no panel effect. This implies that OLS is the best. Alternatively, there exists a panel effect. From the results shown below, the P-value is 0.0000 which is less than 0.05. This means we reject the null hypothesis and conclude that OLS is not appropriate. A panel regression is therefore considered since a significant difference exists among the various classes of insurance business.

Table 4.7: Test of Heteroscedasticity

Chi-Square Value	44.29
P-Value	0.0000

Source: Research data (2021)

4.4.1.3 Test of Best Panel Model

A Hausman test is performed to determine the most appropriate panel model whether random effect or fixed effect. The null hypothesis states that, the preferred model is a random effect model. However, the alternate hypothesis states that, the preferred model is a fixed effect model. The tables shown in appendix D, E and F reveals which panel model is the best. For the model that proxy capital requirement as a dummy the had a p-value of 0.082. For the model that proxy capital requirement as the log of regulatory amount, the p-value is 0.043 and the final model that proxy capital requirement as the ratio of regulatory amount to equity showed a p-value of 0.089. The models that proxy capital requirement as a dummy and as the ratio of regulatory amount to equity have p-values greater than 0.05, we therefore fail to reject the null hypothesis and progress to use the random effect model for the two models. However, with the model that proxy capital requirement as the natural log of the regulatory amount, the p-value is less than 0.05. We therefore reject the null hypothesis and conclude that a fixed effect model is appropriate.

4.4.1.4 Results of Panel Regression

The panel regression examines the effect of recapitalisation on technical efficiency. Table 4.8 gives the results of the model that proxy recapitalisation as a dummy, Table 4.9 gives the results of the model that proxy recapitalisation as the natural log of the regulatory amount and Table 4.10 gives the results of the model that proxy recapitalisation as a ratio of the regulatory amount to equity capital. The results for all three proxies are discussed and compared below.

Table 4.8: Robust Analysis- Effect of Recapitalisation on Technical Efficiency

Technical Efficiency	Coefficient	Std. Err.	*t*-value	*p*-value	[95% Conf.	Interval]	Sig
MCR (dummy)	.042	.026	1.62	.104	-.009	.093	
Market Share	.039	.016	2.43	.015	.008	.07	**
Ln(net incurred claims)	-.292	.435	-.67	.502	-1.144	.56	
Competition (HHI)	-.042	.416	-0.10	.92	-.856	.773	
Insurers Risk	-.38	.11	-3.46	.001	-.595	-.164	***
Leverage	.043	.034	1.27	.204	-.023	.109	
Expense Ratio	.002	.001	1.62	.106	0	.005	
Constant	.332	.236	1.41	.158	-.129	.794	

Mean dependent var	0.819	SD dependent var	0.214
Overall r-squared	0.116	Number of obs	310.000
Chi-square	27.089	Prob > chi2	0.000
R-squared within	0.088	R-squared between	0.182

*** *p*<.01, ** *p*<.05, * *p*<.1

Table 4.9: Robust Analysis- Effect of Recapitalisation on Technical Efficiency

Technical Efficiency	Coefficient.	Std. Err.	*t*-value	*p*-value	[95% Conf.	Interval]	Sig
Ln (MCR)	.083	.022	3.82	.001	.039	.128	***
Market Share	-.382	.571	-0.67	.508	-1.549	.784	
Ln (net incurred claims)	-.041	.026	-1.56	.13	-.094	.013	
Competition (HHI)	-.497	.494	-1.01	.322	-1.505	.511	
Insurer's Risk	-.268	.101	-2.66	.012	-.474	-.062	**
Leverage	.048	.034	1.42	.165	-.021	.117	
Expense ratio	.003	.001	2.32	.027	0	.006	**
Constant	.304	.223	1.36	.183	-.151	.76	

Mean dependent var	0.819	SD dependent var	0.214
R-squared	0.184	Number of obs	310.000
F-test	8.286	Prob > F	0.000
Akaike crit. (AIC)	-235.431	Bayesian crit. (BIC)	-209.275

*** *p*<.01, ** *p*<.05, * *p*<.1

Table 4.10: Robust Analysis- Effect of Recapitalisation on Technical Efficiency

Technical Efficiency	Coefficient.	Std. .Err.	*t*-value	*p*-value	[95% Conf.	Interval]	Sig
MCR/Equity	.005	.002	2.81	.005	.002	.009	***
Market Share	.43	.016	2.61	.009	.011	.075	***
Ln (net incurred claims)	-.298	.441	-0.68	.5	-1.162	.566	
Competition (HHI)	-.101	.418	-0.24	.809	-.92	.717	
Insurer's Risk	-.402	.11	-3.67	0	-.616	-.187	***
Leverage	.049	.034	1.43	.152	-.018	.117	
Expense ratio	.002	.001	1.50	.134	-.001	.005	
Constant	.289	.242	1.19	.233	-.186	.763	

Mean dependent var	0.819	SD dependent var	0.214
Overall r-squared	0.119	Number of obs	310.000
Chi-square	31.610	Prob > chi2	0.000
R-squared within	0.094	R-squared between	0.177

**** p<.01, ** p<.05, * p<.1*

From the results displayed above in Table 4.8, Table 4.9 and Table 4.10 above, it is observed that, there exists a positive relationship between recapitalisation and technical efficiency revealed in their coefficients and p-values respectively. Table 4.9 and Table 4.10 also shows a significant relationship at 1%. However, Table 4.8 does not show a significant relationship between technical efficiency and recapitalization. This implies that, with respect to two of the proxies used, recapitalisation has an impact on technical efficiency. An increase in minimum capital requirement will as well increase technical efficiency.

For Table 4.8, Table 4.9 and Table 4.10 insurer's risk is seen to have a significant negative relationship with technical efficiency. This indicates that, a higher efficiency level is associated with insurers with lower risk.

In two of the models indicated in Table 4.8 and Table 4.10, market share is seen to have a significant positive relationship with technical efficiency. This implies that, higher market share is associated with higher efficiency. This confirms the findings by Ansah-Adu et al. (2011) and Otoo, (2016) revealing a positive relationship between market share and technical efficiency.

From Table 4.9, expense ratio has a significant positive relationship with technical efficiency. Thus, when recapitalisation is proxied as the natural log of the regulatory amount, an increase in the expense ratio increases technical efficiency. This is consistent with the findings of Mwangi and Iraya (2014) and Angima and Mwangi (2017) who sought to establish a relationship between expense ratio and efficiency. Their studies revealed a significant positive relationship between them. As a robustness check the pooled Ordinary Least Square (OLS) is run which is shown in Appendix K, L and M.

4.4.2 Effect of Recapitalisation on Insurers Risk

Another objective of recapitalisation to reduce insurers risk. In this section we will test for the most reliant model to use in this section. Testing for multicollinearity, heterogeneity and identify the best model to use.

4.4.2.1 Multicollinearity

The test of multicollinearity is performed using the correlation matrix in Table 4.11 and appendix G.

Table 4.11: Correlation Matrix of independent Variables

Variables	Insurer's Risk	MCR (Dummy)	Ln (MCR)	MCR/Equity	Investment Ratio	Competition (HHI)	Type of insurer	Leverage	Size	Expense Ratio	NIR	Market Share
Insurer's risk	1.000											
MCR (Dummy)	0.043	1.000										
	(0.446)											
Ln (MCR)	0.221	0.377	1.000									
	(0.000)	(0.000)										
MCR/Equity	0.153	0.156	0.116	1.000								
	(0.007)	(0.006)	(0.041)									
Investment Ratio	-0.011	-0.071	-0.132	-0.013	1.000							
	(0.842)	(0.212)	(0.020)	(0.823)								
Competition (HHI)	0.364	0.043	0.002	0.147	0.054	1.000						
	(0.000)	(0.450)	(0.978)	(0.010)	(0.345)							
Type of insurer	0.491	0.000	0.000	0.137	-0.074	0.541	1.000					
	(0.000)	(1.000)	(1.000)	(0.016)	(0.193)	(0.000)						
Leverage	0.177	0.045	0.016	-0.014	-0.031	0.104	-0.026	1.000				
	(0.002)	(0.432)	(0.778)	(0.811)	(0.588)	(0.068)	(0.650)					
Size	0.126	0.096	0.537	0.021	-0.063	-0.012	0.067	-0.120	1.000			
	(0.027)	(0.093)	(0.000)	(0.714)	(0.272)	(0.835)	(0.242)	(0.034)				
Expense Ratio	-0.033	-0.036	-0.080	-0.012	0.002	0.009	-0.025	-0.016	-0.019	1.000		
	(0.566)	(0.527)	(0.159)	(0.832)	(0.975)	(0.880)	(0.662)	(0.780)	(0.742)			
NIR	-0.078	0.045	-0.029	0.099	0.013	-0.010	-0.064	0.171	-0.051	-0.025	1.000	
	(0.173)	(0.434)	(0.605)	(0.080)	(0.817)	(0.861)	(0.264)	(0.003)	(0.370)	(0.666)		
Market Share	-0.026	-0.004	-0.018	-0.151	0.000	0.156	0.099	-0.089	-0.006	0.019	0.019	1.000
	(0.643)	(0.943)	(0.746)	(0.008)	(0.998)	(0.006)	(0.083)	(0.119)	(0.911)	(0.737)	(0.740)	

From the Table 4.11 above, the highest correlation coefficient is 0.541. According to Kennedy (2008), there exists multicollinearity if the correlation coefficient is greater than 0.70. Since the correlation matrix is less than 0.7, we conclude that, there is no problem of multicollinearity. With respect to the VIF in appendix G, none of the values is greater than 10. We therefore conclude that, there is no issue of multicollinearity among independent variables.

4.4.2.2 Heteroscedasticity

Again a Breusch-Pagan Lagrange multiplier test revealed the existence of a panel effect in the model. With the null hypothesis stating that, there exists no significant difference across units and that, there is no panel effect (OLS is appropriate), the alternative hypothesis states otherwise, that there is an existence of a panel effect.

Table 4.12: Test of Heteroscedasticity

Chi-Square Value	122.43
P-Value	0.0000

From the results displayed in Table 4.12 above, a P-value of 0.0000 implies that we reject the null hypothesis. This means that there exist a panel effect. We therefore conclude that there exists a panel effect and a panel regression should be used.

4.4.2.3 Test of Best Panel Model

To determine the most appropriate panel model, a Hausman test is performed. This is to ascertain whether random effect or fixed effect is appropriate. The null hypothesis states that, the preferred model is a random effect model. However, the alternate hypothesis states that the preferred model is a fixed effect model. The tables shown in appendix H, I and J tells the best panel model. For Appendix H that proxy recapitalisation as a dummy had a p-values of 0.0.153. For Appendix I that

proxy recapitalisation as the log of the regulatory amount, the p-value is 0.076 and Appendix J that proxy recapitalisation as the ratio of regulatory amount to equity showed a p-value of 0.443. These values are however greater than 0.05, we therefore fail to reject the null hypothesis that random effect model is appropriate.

4.4.2.4 Results of Panel Regression

The panel regression examines the effect of recapitalisation on insurer's risk. Table 4.13 gives the results of the model that proxy recapitalisation as a dummy, Table 4.14 gives the results of the model that proxy recapitalisation as the natural log of the regulatory amount and Table 4.15 gives the results of the model that proxy recapitalisation as a ratio of the regulatory amount to equity capital. The results for all three proxies are discussed and compared below.

Table 4.13: Robust Analysis- Effect of Recapitalisation on Insurer's risk

Insurer's Risk	Coefficient	Std. Err.	*t*-value	*p*-value	[95% Conf.	Interval]	Sig
MCR (Dummy)	.009	.015	0.64	.522	-.019	.038	
Investment Ratio	.003	.004	0.76	.445	-.005	.01	
Competition (HHI)	.436	.559	0.78	.436	-.66	1.531	
Type of insurer	.201	.054	3.69	0	.094	.308	***
Leverage	.113	.072	1.57	.116	-.028	.254	
Size	.031	.016	1.99	.046	.001	.062	**
Expense Ratio	0	.001	-0.16	.872	-.003	.002	
NIR	-.003	.003	-1.02	.309	-.009	.003	
Market Share	-.636	.399	-1.60	.11	-1.418	.145	
Constant	-.392	.329	-1.19	.234	-1.037	.254	

Mean dependent var	0.312	SD dependent var	0.220
Overall r-squared	0.292	Number of obs	310.000
Chi-square	45.943	Prob > chi2	0.000
R-squared within	0.128	R-squared between	0.494

**** p<.01, ** p<.05, * p<.1*

Table 4.14: Robust Analysis- Effect of Recapitalisation on Insurer's Risk

Insurer's Risk	Coefficient	Std. Err.	*t*-value	*p*-value	[95% Conf.	Interval]	Sig
Ln (MCR)	.052	.017	3.15	.002	.02	.084	***
Investment Ratio	.004	.004	0.99	.322	-.004	.011	
Competition (HHI)	.427	.55	0.78	.438	-.651	1.505	
Type of Insurer	.209	.056	3.77	0	.1	.318	***
Leverage	.098	.065	1.51	.132	-.03	.226	
Size	-.013	.018	-0.75	.453	-.049	.022	
Expense ratio	.001	.001	0.61	.545	-.002	.003	
NIR	-.003	.003	-1.02	.308	-.009	.003	
Market Share	-.664	.383	-1.73	.083	-1.415	.086	*
Constant	-.406	.313	-1.30	.194	-1.019	.207	

Mean dependent var	0.312	SD dependent var	0.220
Overall r-squared	0.323	Number of obs	310.000
Chi-square	72.041	Prob > chi2	0.000
R-squared within	0.183	R-squared between	0.495

**** p<.01, ** p<.05, * p<.1*

Table 4.15: Robust Analysis- Effect of Recapitalisation on Insurer's Risk

Insurer's Risk	Coefficient	Std. .Err.	*t*-value	*p*-value	[95% Conf.	Interval]	Sig
MCR/Equity	.004	.001	3.88	0	.002	.006	***
Investment Ratio	.003	.004	0.76	.448	-.005	.011	
Competition (HHI)	.384	.556	0.69	.49	-.706	1.473	
Type of Insurer	.198	.055	3.62	0	.091	.306	***
Leverage	.116	.07	1.64	.1	-.022	.254	
Size	.031	.016	1.98	.048	0	.062	**
Expense Ratio	0	.001	-0.19	.851	-.003	.002	
NIR	-.003	.003	-1.27	.205	-.009	.002	
Market Share	-.604	.401	-1.51	.132	-1.391	.182	
Constant	-.39	.332	-1.17	.24	-1.041	.261	

Mean dependent var	0.312	SD dependent var	0.220
Overall r-squared	0.297	Number of obs	310.000
Chi-square	58.853	Prob > chi2	0.000
R-squared within	0.135	R-squared between	0.495

**** p<.01, ** p<.05, * p<.1*

From the results in Table 4.14 and Table 4.15 above, it is observed that, there exists a significant positive relationship between recapitalisation and insurer's risk. The results revealed a p-values of 0.002 and 0.0000 respectively. This implies that, with respect to the proxies of recapitalisation, recapitalisation has a positive significant impact on insurer's risk, thus, an increase in recapitalisation increases the risk of the insurer.

On the control variables, type of insurer had a significant positive relationship with insurer's risk. This means that, on average holding all other factors constant, risk of the insurer is expected to be 0.201, 0.209 and 0.198 units (respectively) more if an insurer is life than non-life. This could be attributed to the larger claims incurred by life insurers during the period as compared to non-life insurer. A significant positive relationship at 5% is observed in Table 4.13 and Table 4.15 for the relationship between insurers risk and size. This means that, given recapitalisation, investment income, competition, leverage, expense ratio, NIR and market share, a unit increase in size of the insurer increases risk by 0.031.

Finally, in Table 4.14 market share has a significant negative relationship with risk of the insurer. That is, given recapitalisation, investment income, competition, leverage, expense ratio, NIR and risk, a unit increase in market share of the insurer reduces risk by 0.031. This means that a higher market share is associated with a lower insurer's risk. As a robustness check the pooled Ordinary Least Square (OLS) is run which is shown in Appendix N, O and P.

4.5 Summary

This chapter presented the findings and discussions related to the research objectives. Fourteen life insurers and seventeen non-life insurers were used in the analysis. Analysis and conclusions under this chapter were based on fixed effect models and random effect models. The first objective

discussed the effect of recapitalisation on technical efficiency which was achieved with the fixed and random effect panel models. The second objective discussed the effect on recapitalisation on risk. This was also achieved with the random effect panel models.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The chapter presents the summary of findings, conclusions drawn from the research work in relation to the research objectives and recommendations based on the results. The summary presents a snapshot of the work recounting the various highlights. Inference based on the empirical study is captured in the conclusion. Recommendations are proposed based on the conclusions drawn. Recommendations are relevant for future study, regulatory bodies as well as insurance practitioners.

5.2 Summary of key findings

The insurance industry plays a vital role in the economic development and economic growth of a country. With a major role of covering risks of individuals and groups of individuals, various economies regulate their insurance industry. The Ghanaian insurance regulator which is the NIC introduced a regulatory minimum capital to be met by all insurers. This decision was intended to improve insurer's technical efficiency and also reduce insurer's risk taking. It was therefore imperative to find the impact of recapitalisation on technical efficiency and insurer's risk.

DEA was used to compute the technical efficiency of the selected life and non-life insurers. The technical efficiency scores revealed that non-life insurers had an average technical efficiency score of 0.836895 and life insurers had an average technical efficiency score of 0.791398 indicating that, though the sector seems to be technically efficient on the average, non-life insurers were more technically efficient. This view is support by Alhassan and Fiador (2014) who attributed this to the increasing innovation and product development especially in the non-life insurance business.

Again, regression models were used to examine the relationship between recapitalisation and technical efficiency. It was revealed from the results that, in two of the models, recapitalisation (which was proxied as the natural log of the MCR and as a ratio of MCR to equity capital) had a significant positive effect on technical efficiency. This result is consistent with the study by Amanti and Siregar (2019) and Jaiyeoba and Haron (2015) who revealed in their work that, regulation has a positive significant relationship with efficiency in developing countries. This is because insurers will achieve efficiency and growth if there is an increment in the minimum capital requirement.

For the control variables, insurer's risk had a significant negative relationship with technical efficiency. This means that, the larger the risk of the insurer, the lower the tendency to be technically efficient. This result is in line with the study by Cummins et al. (2017) who posited that, the greater the risk, the more inefficient the insurer becomes. Market share revealed a positive relationship with technical efficiency. This however, contrast the findings of Danquah et al. (2018) who studied the non-life insurance industry and posited that, a higher market share resulted to inefficiency of the insurers. The findings however, confirm the findings by Ansah-Adu et al. (2011) and Otoo (2016) who studied the Ghanaian insurance industry and revealed a positive relationship between market share and efficiency.

Finally, to examine the impact of recapitalisation on insurer's risk of Ghanaian life and non-life insurance firms, the results from the random effect model revealed that, recapitalisation had a positive effect on risk of insurers. It also showed a significant relationship between recapitalisation and insurer's risk. This is in line with the findings of Pasiouras and Gaganis (2013) which revealed that, though the power of regulation and supervisory bodies in enforcing sanctions had a significant positive effect on insurance soundness, recapitalisation had a positive significant effect on insurer's risk.

For the control variables, type of insurer had a significant positive effect on risk. This implies that, risk is expected to be higher if the firm is a life insurer. This could be attributed to the larger claims incurred by life insurers during the period as compared to non-life insurer. Size of the insurer also had a significant positive relationship with insurer's risk. This supports the claim by Altuntas and Rauch (2017) who argued that, large insurers are more likely exposed to the risk of insolvency than small insurers. The final control variable which revealed a significant positive relationship with the risk of the insurer is market share. This implies that, insurers with larger market share have a larger risk than those with smaller market share. This is because, those with larger market share are motivated to undertake riskier activities (Altuntas & Rauch, 2017).

5.3 Conclusion

From the results averagely, non-life insurers in Ghana are found to be more technically efficient compared to the life insurers. It is also revealed that, recapitalisation which is one regulatory directive by the National Insurance Commission improves technical efficiency but does not reduce the risk of the insurers.

Again the major determinants of technical efficiency of Ghanaian insurers includes, risk of the insurer, market share and expense ratio. The major determinants of insurer's risk in Ghana are type of insurer, size of the firm and market share of the insurer.

5.4 Recommendations

Since it is evident that, insurance recapitalisation improves technical efficiency of Ghanaian insurers but however, does not reduce their risk, regulators can adopt the risk-based capital as suggested by the Actuarial Society of Ghana. This is because it has been proven to improve technical efficiency, reduce risk and improve insurer's profitability. This will go a long way to protect the insurer as well as the insured. Policy makers can as well initiate and design model

regulations which will not only help to tame insurer's risk but also, enhance insurers technical efficiency to improve the performance of both life and non-life insurers.

Finally, since the thesis is one of the first attempts to examine the effect of insurance recapitalisation, researchers can examine a wider time period and consider other periods where new fixed minimum capital was enforced. Researchers may as well conduct a cross country investigation of the impact of recapitalisation on risk and efficiency.

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APPENDICES

APPENDIX A
Technical Efficiency of non-life insurance firms in Ghana

NON-LIFE INSURERS	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Activa International	1	0.7558	0.88846	0.961097	0.701854	1	0.718956	0.797033	0.766051	0.758181
Donewell Insurance Company	0.613016	0.88071	0.753413	0.724738	0.620495	0.857154	1	1	1	0.950367
Enterprise Insurance Company Ltd	0.485624	1	0.778016	1	1	1	1	1	1	1
Equity Insurance Company	0.429105	1	1	1	1	0.921217	1	1	1	1
Ghana Union Assurance Company Limited	1	0.589648	1	0.608011	1	0.725383	1	1	0.739032	0.912893
Glico General Insurance Company Ltd	0.878938	0.63839	0.906966	1	0.742807	1	0.540862	0.9604	0.55775	0.564737
Metropolitan Insurance Company Ltd	1	0.970705	1	1	1	1	0.681401	0.8698	0.750601	0.806189
NSIA Ghana Company Ltd	0.663392	0.645001	0.83828	1	1	0.5648	0.614944	1	1	1
Phoenix Insurance Company	0.573196	1	1	1	0.827335	0.956972	0.977137	0.991718	0.906135	1
Prime Insurance	1	0.418784	0.354779	0.316285	1	1	0.190889	0.98245	1	0.72854
Provident Insurance Company	0.462431	0.338859	0.635038	0.583064	0.600702	0.628542	0.918655	0.656022	0.926006	0.761267
Quality Insurance Company Ghana Ltd	0.578604	0.333121	0.499511	0.95716	0.861104	0.814851	0.854617	0.725615	0.849566	0.901167
Regency Alliance Insurance Ghana Ltd	1	1	1	0.963174	0.867125	0.980336	1	0.87293	0.948638	0.954624
SIC Insurance Company Ltd	0.547696	0.390598	0.71106	0.739887	0.687182	0.729729	0.680039	0.711614	1	0.634707
Star Assurance Company	1	0.970745	1	1	1	1	1	1	1	1
Unique Insurance Company Ltd	1	0.737388	0.225158	0.641882	1	0.639057	0.953307	1	0.907799	0.928004
Vanguard Assurance Company	0.582986	1	1	0.864131	1	1	1	1	0.971262	0.90517

APPENDIX B

Technical Efficiency of Life insurance firms in Ghana

Life Insurance Firm	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CDH Life	0.372659	0.363632	0.426331	0.354513	1	1	0.930069	0.545703	0.464572	0.43577
Donewell Life	0.829839	0.363632	0.414985	0.541388	1	1	0.942848	1	0.568058	0.501437
Enterprise Life	1	1	1	1	1	1	1	1	1	1
Ghana Life	0.629722	1	0.381107	0.286495	0.446289	0.589482	1	0.543406	0.806753	0.894555
Ghana Union Life	1	1	1	1	0.991906	1	0.779578	1	0.809233	1
Glico Life	0.767675	0.472159	0.675043	0.75727	0.708725	0.734191	0.896868	1	0.78874	0.74788
Met Life	1	1	1	1	1	1	1	1	1	1
Phoenix Life	1	1	0.368386	0.366194	0.415802	0.44843	0.461	0.78335	1	1
Provident Life	0.790609	0.373184	0.956158	1	0.787564	0.50102	0.475524	0.74786	0.602471	1
Quality Life	0.549918	0.737316	0.898549	1	0.523245	0.576061	1	1	0.947267	1
SIC life	1	0.71637	0.9181	0.87297	0.872642	1	1	1	1	0.923279
Star life	0.329418	0.431212	0.598954	0.56758	0.677714	0.648662	0.609742	1	1	1
Unique Life	0.904187	1	0.691486	0.598642	0.306299	0.801883	1	1	0.676236	1
Vanguard Life	0.809453	0.565222	1	0.987372	0.719213	0.438261	0.712922	0.758833	0.586609	1

APPENDIX C

Variance Inflation Factor of Independent Variables

	VIF	1/VIF
Ln (net incurred claims)	4.785	.209
Market share	2.912	.343
Ln (MCR)	2.373	.421
Insurer's Risk	2.005	.499
Competition (HHI)	1.251	.8
MCR (Dummy)	1.214	.824
MCR/Equity	1.125	.889
Leverage	1.073	.932
Expense ratio	1.01	.99
Mean VIF	1.972	.

APPENDIX D: Hausman Test Results

	Coefficient.
Chi-square test value	12.629
P-value	.082

APPENDIX E: Hausman Test Results

	Coefficient.
Chi-square test value	14.471
P-value	.043

APPENDIX F: Hausman Test Results

	Coefficient.
Chi-square test value	12.385
P-value	.089

APPENDIX G

Variance Inflation Factor of Independent Variables

	VIF	1/VIF
Ln (MCR)	1.711	.585
Competition (HHI)	1.516	.66
Size	1.481	.675
Type of insurer	1.48	.676
MCR (Dummy)	1.209	.827
MCR/Equity	1.113	.899
Leverage	1.094	.914
Market Share	1.078	.928
NIR	1.056	.947
Investment Income	1.041	.961
Expense Ratio	1.01	.99
Mean VIF	1.253	.

APPENDIX H: Hausman Test Results

	Coefficient.
Chi-square test value	11.966
P-value	.153

APPENDIX I: Hausman Test Results

	Coefficient.
Chi-square test value	14.23
P-value	.076

APPENDIX J: Hausman Test Results

	Coefficient.
Chi-square test value	7.903
P-value	.443

APPENDIX K: Pooled OLS Results

Technical Efficiency	Coefficient	Std. Err.	*t*-value	*p*-value	[95% Conf	Interval]	Sig
MCR (dummy)	.042	.029	1.43	.155	-.016	.099	
Market Share	-.116	.245	-0.47	.637	-.598	.367	
Ln(Net Incurred Claims)	.036	.012	3.04	.003	.013	.06	***
Competition (HHI)	.454	.282	1.61	.108	-.101	1.009	
Insurer's Risk	-.408	.07	-5.81	0	-.546	-.27	***
Leverage	.044	.031	1.43	.153	-.017	.105	
Expense ratio	.002	.004	0.42	.674	-.007	.011	
Constant	.312	.169	1.84	.066	-.021	.646	*

Mean dependent var	0.819	SD dependent var	0.214
R-squared	0.130	Number of obs	310.000
F-test	6.427	Prob > F	0.000
Akaike crit. (AIC)	-104.526	Bayesian crit. (BIC)	-74.633

*** *p*<.01, ** *p*<.05, * *p*<.1

APPENDIX L: Pooled OLS Results

Technical Efficiency	Coefficient.	Std. Err.	*t*-value	*p*-value	[95% Conf	Interval]	Sig
Ln(MCR)	.065	.014	4.57	0	.037	.093	***
Market Share	.546	.282	1.94	.054	-.009	1.101	*
Ln (Net incurred claims)	-.01	.016	-0.64	.524	-.041	.021	
Competition (HHI)	.418	.274	1.53	.128	-.121	.956	
Insurer's Risk	-.329	.071	-4.66	0	-.468	-.19	***
Leverage	.036	.03	1.20	.231	-.023	.095	
Expense Ratio	.003	.004	0.78	.437	-.005	.012	
Constant	-.019	.175	-0.11	.913	-.364	.326	

Mean dependent var	0.819	SD dependent var	0.214
R-squared	0.181	Number of obs	310.000
F-test	9.508	Prob > F	0.000
Akaike crit. (AIC)	-123.217	Bayesian crit. (BIC)	-93.324

*** *p*<.01, ** *p*<.05, * *p*<.1

APPENDIX M: Pooled OLS Results

Technical Efficiency	Coefficient.	Std. Err.	*t*-value	*p*-value	[95% Conf	Interval]	Sig
MCR/Equity	.005	.003	1.85	.066	0	.011	*
Market Share	-.119	.244	-0.49	.625	-.599	.361	
Ln (Net Incurred Claims)	.04	.012	3.43	.001	.017	.064	***
Competition (HHI)	.414	.283	1.46	.145	-.143	.971	
Insurer's Risk	-.432	.07	-6.14	0	-.57	-.293	***
Leverage	.051	.031	1.64	.102	-.01	.111	
Expense Ratio	.002	.004	0.39	.695	-.007	.011	
Constant	.26	.168	1.55	.122	-.07	.59	

Mean dependent var	0.819	SD dependent var	0.214
R-squared	0.134	Number of obs	310.000
F-test	6.652	Prob > F	0.000
Akaike crit. (AIC)	-105.927	Bayesian crit. (BIC)	-76.034

*** *p<.01*, ** *p<.05*, * *p<.1*

APPENDIX N: Pooled OLS Results

Insurer's Risk	Coefficient.	Std. Err.	*t*-value	*p*-value	[95% Conf	Interval]	Sig
MCR (dummy)	-.009	.024	-0.39	.695	-.057	.038	
Investment Income	.003	.004	0.67	.503	-.005	.011	
Competition (HHI)	.537	.258	2.08	.038	.029	1.044	**
Type of Insurer	.195	.023	8.44	0	.15	.241	***
Leverage	.104	.026	4.05	0	.054	.155	***
Size	.088	.01	8.65	0	.068	.108	***
Expense ratio	0	.004	0.10	.919	-.007	.008	
NIR	-.002	.003	-0.60	.548	-.008	.004	
Market Share	-1.321	.192	-6.87	0	-1.699	-.942	***
Constant	-1.317	.168	-7.83	0	-1.649	-.986	***

Mean dependent var	0.312	SD dependent var	0.220
R-squared	0.438	Number of obs	310.000
F-test	26.029	Prob > F	0.000
Akaike crit. (AIC)	-217.731	Bayesian crit. (BIC)	-180.366

*** *p<.01*, ** *p<.05*, * *p<.1*

APPENDIX O: Pooled OLS Results

Insurer's Risk	Coefficient.	Std. Err.	*t*-value	*p*-value	[95% Conf	Interval]	Sig
Ln (MCR)	-.026	.013	-2.00	.046	-.051	0	**
Investment Ratio	.001	.004	0.36	.719	-.006	.009	
Competition (HHI)	.534	.256	2.09	.038	.031	1.038	**
Type of Insurer	.195	.023	8.49	0	.15	.24	***
Leverage	.105	.026	4.09	0	.054	.155	***
Size	.109	.015	7.38	0	.08	.138	***
Expense ratio	0	.004	0.02	.985	-.007	.007	
NIR	-.001	.003	-0.43	.668	-.007	.005	
Market Share	-1.59	.235	-6.76	0	-2.053	-1.127	***
Constant	-1.276	.167	-7.64	0	-1.605	-.948	***

Mean dependent var	0.312	SD dependent var	0.220
R-squared	0.446	Number of obs	310.000
F-test	26.789	Prob > F	0.000
Akaike crit. (AIC)	-221.677	Bayesian crit. (BIC)	-184.311

*** p<.01, ** p<.05, * p<.1*

APPENDIX P: Pooled OLS Results

Insurer's Risk	Coefficient.	Std. Err.	*t*-value	*p*-value	[95% Conf	Interval]	Sig
MCR/Equity	.004	.002	1.71	.088	-.001	.008	*
Investment Ratio	.003	.004	0.74	.463	-.005	.011	
Competition (HHI)	.479	.258	1.86	.064	-.028	.987	*
Type of Insurer	.192	.023	8.35	0	.147	.238	***
Leverage	.107	.026	4.17	0	.056	.158	***
Size	.087	.01	8.69	0	.067	.106	***
Expense Ratio	0	.004	0.12	.904	-.007	.008	
NIR	-.003	.003	-0.83	.405	-.008	.003	
Market share	-1.263	.193	-6.55	0	-1.642	-.883	***
Constant	-1.306	.166	-7.85	0	-1.634	-.979	***

Mean dependent var	0.312	SD dependent var	0.220
R-squared	0.444	Number of obs	310.000
F-test	26.579	Prob > F	0.000
Akaike crit. (AIC)	-220.590	Bayesian crit. (BIC)	-183.224

*** p<.01, ** p<.05, * p<.1*