SOURCES OF RISK IN INSURANCE MARKETS

By

Pholile Dladla

Supervisor:

Professor Liberty Mncube

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DECLARATION

I, Pholile Dladla, do hereby declare that the research work contained in this thesis is my own work, except where otherwise acknowledged or indicated. It is submitted for the degree of Doctor of Philosophy in Economics, University of the Witwatersrand, Johannesburg. This thesis has not, either partially or wholly, been submitted to this university or any other university for a degree.

Name of Student: Pholile Dladla

Date: 24 April 2020

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ABSTRACT

This thesis focuses on insurance risk management in select developed and emerging market economies, the impact of macroeconomic factors on insurance and bank risk, insurance share returns and the linkages between banks and insurances over the period 1988-2017. The thesis is divided into five chapters and three of them are empirical. Chapter 1 is the introduction. Chapters 2, 3 and 4 are empirical chapters examining the impact of macroeconomic factors on various risk indicators of insurance companies and banks. Chapter 5 concludes by highlighting the key issues and giving policy recommendations.

In chapter 1, we provide a layout of the background, research problem, objectives, and contributions of the study and the methodologies of each empirical chapter. Chapter 2 examines the macroeconomic determinants of insurance risk indicators for life and non-life insurance companies, in both the developed and emerging market economies. We use a linear consumption-based and a profit maximization model to theoretically derive the determinants of risk indicators. Our derivation is based on the utility and profit function. The results show that the most influential macroeconomic variables, on insurance risks, are exchange rates, interest rates and the variable on the consumption of other goods, across all countries in both the life and non-life subsectors.

Chapter 3 investigates the sensitivity of the share returns of life and non-life insurance companies to macroeconomic variables. We use a single linear equation to estimate the sensitivity of insurance company returns to these variables. We extend the Dladla and Malikane (2018) and Berendes et al. (2013) models by incorporating other macroeconomic variables through the Taylor rule. The main results highlight that most macroeconomic variables have a weak effect on the share returns of insurers, with the exception of interest rates, which plays a leading role.

Chapter 4 analyses the linkages between bank and insurance risk measures, the potential common drivers of these risks as well as the causal relationship between these risks. The results show that firstly, there are linkages between banks and insurance risk variables, with the most

notable link being between banks and non-life insurers. Secondly, GDP, long-term interest rates and exchange rates are the common drivers of risk in these two sectors. Lastly, that bank have the most notable spillover effects on insurance, in both life and non-life, as such banks risk variables contain useful information for predicting insurance risk variables.

Chapter 5 is the conclusion. We provide a summary of the key issues covered, the main findings and the policy recommendations. We also suggest areas of future research.

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CHAPTER 1: INTRODUCTION

1.1 Background

The insurance industry plays an important role in the world economy and, alongside banking, a vital part of the financial system. Insurance, through the transfer of risk, increases the value of firms by reducing the cost of financial distress, limiting externalities (Ashby and Diacon,1998) and insulating the agricultural industry from catastrophic events that result in reduced crop production and price volatility (Young et al., 2001). Insurance also facilitates international trade through private export credit insurance by covering the risk of payment default (van der Veer, 2017). Furthermore, Liedtke (2007) notes that the savings mobilized by insurance companies through insurance contracts makes the industry one of the largest institutional investors and thereby, allowing insurance to play a distinct role in economic growth. In fact, investments by insurance companies were 20% of GDP in the period 1993 to 2004 in Europe (Haiss & Sümegi, 2008).

The insurance industry is divided into life and non-life insurers. The differences between the two are mainly because of product, investment and duration differences. For example, non-life insurers have shorter investment horizons, product life cycles and are more susceptible to changes in the short-term interest rates, compared to life insurers (Caporale et al., 2017). Moreover, McShane et al. (2012) notes the differences in underwriting risk of property and casualty (non-life) and life and health insurers (life) which lead to different strategies.

The insurance industry faces a number of risks that may lead to bankruptcies. The magnitudes of these risks have also increased with an increase in globalization, resulting in heavy regulation of the industry. Baranoff et al. (2007) highlight the main risks that drive insolvencies in insurance companies as underwriting and investment risk while Nissim (2010) categorises these risks as underwriting, market and regulatory risk. Each of the risks has sources that can be linked to macroeconomic variables.

Underwriting risk arises because of pricing errors (Nissim, 2010). This risk influences the overall profitability of an insurance company. Thus, if underwriting risk increases, the operating costs would also increase resulting in lower profitability. The change in operating costs as a result of the underwriting risk is often driven by changes in inflation and a problem of insufficient premiums. Numerous studies examine the relationship between underwriting risk and profits. Doherty and Garven (1995) investigate the effects of interest rates on insurers underwriting profits and capital structure. Their results reveal that underwriting profits are unresponsive to interest rate changes, whilst Barth and Eckles (2009) argue that the rise in premium does not result in a rise in underwriting risk as represented by the loss ratio.

Market risks include changes in interest rates, stock prices, liquidity and credit risk (Nissim, 2010). Changes in interest rates have a direct impact on the loss ratio, the investment yield and the underwriting expense ratio, whilst stock prices impact the investment yield. Studies in the area of market risk show that market risk is highest for accident & health insurers, followed by life insurers and property & casualty insurers (Carson et al., 2008). Other studies investigate the degree of market risk emanating from the interconnection between banks, insurance companies, hedge funds and brokers (Billio et al., 2012). Billio et al. (2012) show that banks play a key role in transmitting shocks as compared to the other financial institutions. However, all four sectors have become highly correlated over time, which increases the level of systematic risk in the insurance and other finance sectors through an intricate web of relationships.

One of the important risks that determine an insurer's continued existence is the insolvency risk. Many studies on insolvency risk attempt to predict the rate or the determinants of this risk because it the main risk that leads to the failure of insurance companies. Caporale et al. (2017) measures the risk of insolvency for UK general insurers. They find that reinsurance levels, firm-specific and macroeconomic factors are amongst the determinants of this risk in the UK. Leadbetter and Dibra (2008) suggest that poor loss reserves and insufficient pricing are the foremost cause of insurer insolvency.

Different countries adopt different methods and techniques of managing different types of insurance risks. There are mainly three broad techniques used to manage and detect insurance risk (including insolvency). These methods include risk based capital regulation, capital assessment frameworks and solvency tests (Cummins and Phillips, 2009).

The risk based capital method is adopted by US, Canada and Australia. Cummins and Phillips (2009) find that the US RBC system is not a precise predictor of insolvencies for insurers in the US market. They further note that this system is static, rule-based and excludes risks such as catastrophic and operational risks. Cummins and Phillips (2009) also highlight the need to include qualitative solvency assessment techniques into the US RBC system) such as operational risk.

Capital assessment frameworks are used in Japan, Switzerland and UK. Altunnas et al. (2015) test whether or not country specific characteristics are relevant in determining insurers optimal capital structures. The authors employ variance decomposition and dynamic partial adjustment analysis to a range of listed insurance companies in both developed and developing markets, and find that country specific factors play an important role, in the disparity, in insurer's capital levels. They note that insurer capital structures are not homogeneous across countries and as such regulatory capital requirements should take into account these institutional differences to avoid market bias.

Cummins and Sommer (1996) apply simultaneous equations to examine the relationship between capital and portfolio risk of 142 property-liability insurers. Their results show that there is a positive relationship between capital and risk and that managerial incentives play a key role in determining capital and risk for property-liability insurers. This view on a direct relationship between capital and asset risk, which is similar to the results of studies carried out in the banking sector, is shared by Baranoff and Sager (2002). Baranoff and Sager (2002) make use of 1022 US life insurers annual statements from 1993-1997 in applying a simultaneous equation partial-adjustment model, they find a negative relationship between life insurer's optimal capital structure and product risk.

Switzerland, Japan and UK use a combination of solvency testing as well as capital assessment frameworks to manage insurance risk. Eling et al. (2007) and Doff (2008) analyse Solvency II proposals and processes. Eling et al. (2007) highlight the characteristics of effective solvency models; they note that the German, Switzerland and United Kingdom systems may be preferable systems. In addition, Eling et al. (2007) acknowledge the importance of research into market factors, suggesting that rating agencies have been more effective in identifying insurance companies in financial distress than regulators. Doff (2008) tests the solvency II framework against seven standards that are important for an efficient market and find that that Solvency II meets most of these standards. However, attention needs to be paid to internal factors such as corporate governance practices as part of the solvency assessment techniques.

It is difficult to understand the insurance industry without linking it to the banking industry because both industries play an active role in each other's markets due to diversification and spill overs in their products and activities (Baluch et al., 2011). For example, banks offer insurance-linked securities, whilst insurers are active in the equity and bond markets as investors. The interconnectedness of this two industries increase market risk (Billio et al., 2012). Allen and Jagtiani (2000) propose that the integration of banks and insurances is not justified on the basis that the diversification effects are insufficient.

However, there is growing literature that finds value in such mergers (see for example Lee, 2013, Lee and Zeng, 2016, Adams et al., 2009 and Boyd, Graham, and Hewitt (1993), Fields et al., 2007, Chen et al., 2009, Staikouras (2009), Chen and Tan (2011), Peng et al. ,2017). Castro (2013) investigates the macroeconomic factors that influence bank credit risk and finds that factors such as the exchange rate, the unemployment rate and GDP have a significant impact on bank credit risk.

The overarching purpose of the current research is to investigate the differential macro-economic factors that influence insurance risk in emerging and developed economies. Understanding these factors is important because it will assist regulators in appreciating the impact of their economic decision on various industries (specifically insurance and banking), that contribute immensely on the country's economic growth. This is even more important after the economic meltdown of 2008/09 where insurances and banks were found to be the main contributing agents to that crisis.

1.2 Research Problem

Most countries including South Africa are faced with a dire need to develop their countries and close the ever-increasing gap between the rich and the poor. However, this need is thwarted by a decline or stagnant economic growth, which makes development unrealisable for the most part. For example, emerging markets such as South Africa, Brazil and Russia are currently experiencing low economic growth, with growth estimates at 1.5% and 1.8% in 2018 and 2019 respectively (World Economic Outlook, 2018).

Economic growth is normally driven by specific industries, which include insurance and banking. For instance in the UK banks and the insurance industry contribute 5.4% to GDP, in 2008, whilst the contribution in France was between 4% and 6%, with the US sitting at above 8% (Burgess, 2011). In South Africa, banks and insurance contribute 9.5% to total real GDP, in 2015, (Botes and Kuhn, 2017). The importance of insurance and banking industries in the economy implies that policy-makers have to be very careful of how their policies impact on these industries. This is because any decisions that destabilises these industries would lead to an economic crises such as the one that the world experienced in the 2008 economic meltdown.

For example, the impact of the 2008/09 financial crisis on insurance and banks is estimated at one-third and two-third, respectively, of the overall value of US$4.1 trillion (Baluch et al., 2011). It is, therefore, paramount for governments, insurance as well as banking industries to understand economic factors that impact on insurance risk to avert any catastrophic insurance risk that may prevent the country's economic growth.

In many countries, banks distribute life and non-life insurance products, with South Europe showing the most advancement in this area (Lorent, 2010). The activities of Banks and Insurance companies have direct and indirect effects on each other; these effects are further enhanced by financial liberalization that has taken place. The literature on the effects of these spillovers is mixed. One strand of literature highlights the negative spill over effects of insurance activities on banking activities such as Allen and Jagtiani (2000).

Allen and Jagtiani (2000) find that the diversification effects of insurance on banking are not sufficient to validate banks expanding their activities into insurance underwriting. Whilst another strand notes the risk, reducing effects of life insurance when merged with a Bank Holding Company (BHC), (Boyd, Graham, and Hewitt, 1993). They do this by comparing the risk characteristics of unmerged BHCs with that of the simulated merges between BHCs and non-banking financial services firms. Furthermore Lee, Lin and Zeng (2016) note the role of insurance markets in reducing banking and currency crisis.

Webb, Grace, and Skipper (2002) estimate the impact of financial intermediaries (banks, life, and nonlife insurers) on economic growth their results show that insurance and banking increase capital stock productivity, which drives investment and output spurring economic growth. Another example of this important link and its impact on economic growth is cited by Pradhan et al. (2017) by investigating the inter-linkages between the banking and insurance industries on the economic growth of the G-20 countries. Pradhan et al. (2017) find that these two industries have a significant impact on economic growth of G20 countries, in the long run.

Therefore understanding the interconnectedness of these two industries is important in light of their contribution to economic growth and product development. The problem, we are faced with, is understanding the nature of these relationships and the correlation of their risks to macroeconomic variables.

1.3 Research Objectives

The current research has three main objectives and they are stated as follows:

- To build macroeconomic model that predicts insurance risk in emerging and developed economies.
- To examine the sensitivity of the returns of life and non-life insurance companies to interest rates and other macroeconomic variables.
- To investigate the linkages between bank and insurance risk measures, the potential common drivers of the risks as well as the causal relationship between the risks.

1.4 Contribution of Study

1.4.1 Theoretical and methodological contributions

Utility theory is used in insurance to determine the individual demand for insurance (Mayers and Smith, 1983). For example, Zou and Cadenillas (2014) investigate the optimal consumption, investment and insurance policies of a utility maximising investor. On the other hand, the theory of profit maximisation is used to explain insurance supply and pricing (See, Pantelous and Passalidou; 2015).

The current research contributes to existing utility and profit maximization theory by using these two theories as a base for the basic linear demand and supply model from the resource constraint and profit function models, in Chapter 2. The parameters of this model are transparent and have a clear economic interpretation. The theoretical contribution of this paper is to extend the utility function to that of an insurance driven consumption and to add to the existing profit function to reflect that of an insurer, taking into account insurance specific costs such as the cost of increasing the book of business.

There is an important body of literature, which argues that macroeconomic variables play a significant role in determining insurance risk. The studies by Barth and Eckles (2009), Carson et al. (2008), Nissim (2010) and Chang et al. (2012) finds that the interest rates, inflation rates and prices of insurance play a significant role in explaining variations in the risk of insurers. However, the models that are used in these studies are not derived from micro foundations and as such their parameters are not transparent.

In chapter four, there are two main methodological contributions to the literature:

1. First we derive a model that links insurance risk indicators (growth rate in reserves, the solvency ratio and the underwriting expense ratio) to banking risk indicators(loan loss provisions, the capital adequacy ratio and the cost-income ratio).
2. Second, we embed macroeconomic factors common to both insurance and banking, in the formulation of the model. These contributions are noteworthy as they sensitize policymakers to the relationship between the risks in these two sectors and the binary effect of certain macroeconomic variables on the financial system.

1.4.2 Empirical contribution

Extensive literature on factors that influence banking risk exists for example Baselga-Pascual et al. (2015) investigate the macroeconomic and bank-specific factors that influence bank risk in Europe. The author's panel spans from 2001 to 2012 and consists of 204 commercial banks. Baselga-Pascual et al. (2015) find that high inflation and low interest rates increase bank risk whilst profitability and liquidity decreases bank risk. Jiménez and Saurina (2004), Ahmad and Ariff (2007), Bonfim (2009), Ali and Daly (2010) Castro (2013), examine credit risk and drivers of this risk in banking. Their findings suggest that loans from savings banks, collateralized loan and bank-borrower relations contribute to a higher probability of default, thereby increasing credit risk in banks.

The linkages between banks and insurance companies are highlighted in studies undertaken by Carow (2001b) Chen and Tan (2011), and Liu and Zhang (2016). Chen and Tan (2011) investigate the wealth effects of mergers between banks and insurance companies in Europe; they find that there are positive wealth effects generated by such mergers. Lee and Zeng (2016) use panel cointergration and VAR to test the linkages between bank credit and insurance activities. Their results show that there is significant positive cointergration between the two sectors, but that this cointergration varies across countries and is influenced by income levels. Whilst Carow (2001b)'s findings show that share prices of insurance companies generally decreased after a merger announcement with banks whilst that of banks do not significantly change.

The research contributes empirically to the existing literature in various ways:

First, to the best of our knowledge, this is one of few cross-country analyses of common risk drivers of banks and insurance companies. As such, the results provide comprehensive evidence of the determinants of insurer risk indicators across different economies.

Secondly, we explicitly examine the links between interest rates, inflation, exchange rates and GDP with broad insurer risk ratios, by structurally decomposing the risk ratios.

Thirdly, we run a VAR on the error terms to ascertain whether or not the components that are independent of the common macroeconomic factors are correlated.

The empirical contribution of chapter 2 is that our model extends the two factor model by Berendes et al. (2013). The model used by Berendes et al. (2013) measures the sensitivity of insurance returns to interest rate risk. We extend this model by incorporating other macroeconomic variables such as exchange rates, inflation rates and gross domestic product, through the Taylor rule.

1.5 Benefits of the study

The benefits of understanding the sources of insurance risk indicators stems from the formulation of appropriate policies to mitigate the effects of adverse shocks to insurance companies by regulators. These shocks are ultimately transmitted to economies, in the form of insolvencies. For example, Guo et al. (2009) notes the importance of macroeconomic shocks on insurance premiums, furthermore, highlighting the seemingly financial instrument like nature that premiums have taken.

Moreover, understanding the determinants of risks will assist insurers to manage solvency ratios and other ratios that are important to their long-term survival, such that a change in any one of the macroeconomic factors, can encourage a reorganization of the important elements in the insurance environment, (See Doherty and Kang (1988), Guo et al., 2009, Chang et al., 2012, Guo and Huang (2013) and Berends et al., 2013). Although this work is undertaken in the banking industry, we cannot assume that the same factors that influence risk in the banking sector will influence risk in the insurance sector. This is because there are differences in core activities, accounting considerations and regulatory approaches between the sectors

The research will assist policymakers in understanding the common risk drivers between banks and insurance, the casual relationships and the spill over effects of risks between these two sectors. Moreover, the results of this study are anticipated to deepen the understanding of policymakers on the depth of financial market integration and hence the extent of risk transmission in each domestic economy. It will also serve as a guide to monetary policy authorities on the appropriate exchange rate and interest rate regime.

In the same spirit investigating these risk characteristics can provide useful information to investors and policymakers allowing them to understand the risk spill overs and the impact of these spill overs on the financial stability of these two sectors. It will also contribution in decisions regarding the collaborative developments in the sectors, innovation of financial products and setting and adjusting of certain macroeconomic variables.

1.6 Organisation of the final thesis

The thesis will be organised as follows: Chapter 1 will present the main introduction, Chapter 2 will investigate the Macroeconomic Determinants of Insurance Risk in Developed and Emerging Markets. Chapter 3 examines the sensitivity of insurer share prices to macroeconomic variables, Chapter 4 will look at linkages between insurance and bank risk indicators and Chapter 5 provides a conclusion

In this section, we presented the background to the research; addressed the research problem and discussed the objectives and contributions of the research.

Section Two: Literature Review

2.1 Introduction

This section reviews the literature related to the role of insurance, insurance and banking activities and risks and insurance share prices. The theoretical underpinnings of the research and the empirical literature and its findings are reviewed in this section.

2.2 Theoretical Underpinning

2.2.1 Utility Theory

Expected utility theory is defined as a guide of satisfaction that emanates from economic goods, whilst a utility function plots wealth levels that match the level of satisfaction, this theory is attributed to Von Neumann and Morgenstern (1944) (cited in Skipper & Skipper, 1998). Over time the growth of insurance has led to an increase in the demand for insurance and has become an important area in insurance literature, this literature has developed from the risk aversion theory proposed by Pratt (1964) and by Arrow (1971) (cited in Schlesinger, 1997). Furthermore, both these theories have been established within the expected utility theory framework (Schlesinger, 1997).

Analyses of the demand for insurance, that stems from utility theory, is undertaken by researchers such as Yaari (1965), Fischer (1973), Pissarides (1980), Campbell (1980), Karni and Zilcha (1985, 1986), Lewis (1989), and Bernheim (1991) (cited in Browne and Kim, 1993). Recent studies in the area include work done by Truett et al. (1990) Chen et al. (2001), Li et al. (2007) and Burren (2013).

Truett et al. (1990) conduct a comparative study on the life insurance demand in Mexico and the USA. Using a regression model they find that the income elasticity of demand is higher in Mexico compared to the USA. Furthermore, factors such as education, income level and age influence the demand for life in insurance in Mexico. Chen et al. (2001) also contribute to this literature by noting that period, age and cohort affects the purchase rate of insurance, their findings are similar to those produced by Li et al. (2007). In their study observing life insurance consumption determinants in OECD countries, Li et al. (2007) find that, a combination of socio-economic as well as product market factors explain the consumption of life insurance.

2.2.2 Profit Maximisation

The second theory that is used for the insurance supply model is the profit maximisation theory. This theory is used to explain insurance supply and pricing (See Pantelous and Passalidou; 2015). From as early as the 1970's, researchers were finding models that depict insurance behaviour and pricing (See Stiglitz (1977), McCabe and Witt (1980), Guelman et al., 2014 and Geng et al., 2017).

Stiglitz (1977) studies the behaviour of a monopolist insurer; the results indicate that price discrimination by the insurers leads to a limitation in the insurance contracts that are sold. McCabe and Witt (1980) develops a financial model for a non-life insurer that takes into account underwriting and investment income as well as the impact of regulation on the insurer's profits. The study shows that when regulatory and management decisions are made, insurers must consider economic trade-offs.

Recent studies, in this area, look at the pricing and supply problem from a policy holder welfare angle, for example Guelman (2014) measures price elasticities for auto insurance. The study shows that rate changes have an impact on the renewal decision made by the insured. Geng et al. (2017) develop a profit-maximising model in order to explain the effect of online return-freight insurance premiums and compensation on the profits of the insurer and insurance demand. The results illustrate that higher premiums and compensation rates increase the insurer's revenue.

2.3 Empirical literature review

2.3.1 The role of insurance industry

The insurance industry plays an important role in the world economy and, alongside banking, a vital part of the financial system. Insurance, through the transfer of risk, increases the value of firms by reducing the cost of financial distress, limiting externalities (Ashby and Diacon, 1998). In addition insurance insulates the agricultural industry from catastrophic events that result in reduced crop production and price volatility (Young et al., 2001) and facilitating international trade through private export credit insurance by covering the risk of payment default (van der

Veer, 2017). Liedtke (2007) notes that the savings mobilized by insurance companies through insurance contracts, makes the industry one of the largest institutional investors and thereby allowing insurance to play a distinct role in economic growth.

Cummins and Sommer (1996) apply simultaneous equations in examining the relationship between capital and portfolio risk of 142 property-liability insurers. Their results show that there is a positive relationship between capital and risk and that managerial incentives play a key role in determining capital and risk for property-liability insurers. Findings on the relationship between capital and asset risk, are similar to the findings of studies carried out in the banking sector.

To highlight this point further, Baranoff and Sager (2002) make use of 1022 US life insurers annual statements, from 1993-1997, in applying a simultaneous-equation partial-adjustment model. Their study shows that there is a negative relationship between life insurers optimal capital structure and product risk. These results are consistent with studies on the impact of guarantee funds.

Sommer (1996) explores the connection between property-liability prices and insolvency risk and discovers a negative relationship between the two variables. Interestingly Sommer (1996) points out that US property-liability insurers are penalized for default risk regardless of guarantee funds.

An interesting study and one of few to look at the relationship between macroeconomic factors and mortgage insurance premiums is by Chang et al. (2012). This study makes use of a linear regression in detecting co-movements between macroeconomic variables, such as inflation, land prices and stock price index, and mortgage insurance premiums. The authors find a strong statistical relationship between land prices and mortgage insurance premiums. Moreover, they suggest that future research should also look at default risk, given the sub-prime crisis.

Guo et al. (2009) carry out another study that looks at the impact of macroeconomic shocks on insurance premiums. Their structural vector error correction model shows that while aggregate supply and oil shocks help to explain insurance premiums, the most influential factor in explaining volatility in insurance prices are shocks to the financial market.

Applying the three stage least squares estimation technique, Doherty and Kang (1988) demonstrate temporal movements in insurance premiums. They find that insurance premiums are sensitive to interest rates; this causes the insurance price cycle to be consistent.

2.3.2 Risk Assessment Models

There is a vast amount of literature that investigates the accuracy of solvency assessment models in predicting insolvencies in both the non-life and life insurance market. Arguments against the predictive strength of the US Risk Based Capital (RBC) system have been made by Hooker et al. (1996), Cummins et al. (1999) and Cummins and Phillips (2009), with the RBC being compared to other solvency assessments models such as the Switzerland solvency test and the European Union's solvency system.

Comparing these three solvency detection systems, Cummins and Phillips (2009) find that the US RBC system is not a precise predictor of insolvencies for insurers in the US market. They note that this system is static, rule-based and excludes risks such as catastrophic and operational risks. Furthermore, the authors highlight the need to include qualitative solvency assessment techniques into the US RBC system. They also point out the need for the US RBC model to include qualitative measures such as operational risk, as part of the assessment methods.

2.4 Insurance Activities and Banking Credit

Liu, He, Yue and Wang (2014) inspect the long-run and short-run linkages between insurance activity and banking credit for G-7 countries, using Johansen cointegration test with GMM-IV estimator. Liu & Lee (2014), by means of an advanced bootstrap VAR model with a fixed rolling window, examine the underlying connection between insurance activities and banking credit in China.

Results from Liu, He, Yue and Wang (2014) show that only France and Japan have predictive power from life insurance activity to banking credit and that the short-run causal relationships between nonlife insurance activity and banking credit is country-specific. Whilst the study by Liu & Lee (2014) indicates that none of the traditional VAR models have stable parameters, and therefore the full sample results are unreliable. However from the rolling window results the authors note that the causal links between insurance activities and banking credit are time varying.

2.4.1 Insurance Activities and Economic Growth

There is a growing body of literature focusing on the relationship between insurance, economic growth and development. For example, Adams et al. (2009) uses time-series data spanning from 1830 to 1998, to observe the historical relation between insurance, commercial bank lending and economic growth in Sweden. The researchers are able to show that economic growth and bank lending is Granger caused by insurance with a four-year lag, whilst bank lending does not have the same effects on economic growth or insurance.

Using bootstrap Granger causality test Liu, Lee, Lee (2016) argue that there is a long and short run linkage and time-lagged causality, respectively, between insurance activity and economic growth in G-7 countries. The results show that this relationship varies across different countries and that the positive impact of non-life insurance on economic growth is bigger compared to that of life insurance. In addition, Haiss and Sumegi (2008) investigate both the influence of insurance investment and premiums on GDP growth in Europe. Using a panel data of 29 European countries, they find positive influence of life insurance on GDP growth in 15 of the 29 countries.

2.4.2 Insurance Share Returns and Inflation Rates

Adekunle et al. (2015) study the elements that influence share prices of insurers in Nigeria; they run a multiple panel regression model and find that, inflation rates and earnings per share have a significant effect on the share prices of Nigerian insurance. The authors also recommend that closer attention be paid to the influence of financial ratios on share prices of insurers. Additionally Alagidede (2009) examines this relationship, in African countries. Using OLS estimates, the results indicate a positive relationship between inflation and stock returns in Kenya and Nigeria.

2.4.3 Insurance Share Returns and Interest rates

Berendes et al. (2013) investigates the sensitivity of life insurers to interest rates; they do this by using a two-factor model to measure the changes in the stock prices of life insurers to interest rate fluctuations. They find a negative relationship between share prices and interest rates, especially during the 2008/09 financial crisis. These results are consistent with their observation that future profit opportunities of life insurers tend to decrease with a decrease in interest rates. Furthermore fluctuations in interest rates are expected to significantly affect the expected value of insurer's liabilities, and this is because insurers sell long-term products, whose present value relies on interest rates.

2.4.4 Insurance Share Returns and Exchanges Rates

When Japan experienced a recession and deflation for ten years, quantitative monetary easing was implemented with one of the aims being, to influence stock prices for economic recovery (Kurihara, 2006). Kurihara (2006) investigates the relationship between macroeconomic variables, such as exchange rates and interest rates, and share prices ,with a focus on exchange rates. The study shows that in the Japanese economy, interest rates have no impact on Japanese stock prices whereas exchange rates and U.S. stock prices have the most influence.

2.4.5 Insurance Share Returns and GDP

Abbas et al. (2018) analyse the relation between share prices and macroeconomic variables for G7 countries, using GARCH models they find that the volatility of industrial production growth and oil prices have the most significant influence on the direction of stock markets. Tiwari et al. (2018) test the relationship between share prices and economic growth, using data that spans over 215 years. They find that, in the long run, there is a robust casual effect from GDP to share prices and that negative shocks in GDP have a larger impact on share prices than positive shocks.

2.4.6 Insurance and Bank Spill-overs

The activities of Banks and Insurance companies have direct and indirect effects on each other; this effect is further enhanced by financial liberalization that has taken place. The literature on the effects of these spill overs is mixed, however Lee, Lin and Zeng (2016) note the role of insurance markets in reducing banking and currency crises.

One strand of literature highlights the negative spill over effects of insurance activities and banking activities such as Allen and Jagtiani (2000), who find that the diversification effects of insurance on banking are not sufficient to validate banks expanding their activities into insurance underwriting.

Whilst another strand notes the risk reducing effects of life insurance when merged with a Bank Holding Company (BHC), (Boyd, Graham, and Hewitt, 1993). They do this by comparing the risk characteristics of unmerged BHC's with that of the simulated merges between BHC's and non-banking financial services firms.

Section two presented the theoretical underpinning of the thesis as well as some of the key papers in the area for both chapter two, three and four. In the following chapter, a detailed description of the methodology and the data is presented.

Section Three: Methodology

3.1 Introduction

This section presents the methods and methodologies used to achieve the objectives presented in Section 1. The section starts by presenting the data used in this research as well as the data sources. Then the research design is presented next, for the various tests that will be performed.

3.2 Data

The research uses annual banking, life and non-life insurance company data and annual macroeconomic data from 1988 to 2017, for developed countries and for emerging markets. The insurance data include all available company data per country, while the macroeconomic data include all the variables that are theoretically derived from the models. The insurance company data is aggregated using averages, per year, in order to allow for a country specific and comparative analysis. The annual insurance company data is obtained from *Thompson Reuters DataStream database*, whilst the annual macroeconomic data is obtained from the *OECD* and *Federal Reserve Economic Data (FRED)* databases.

3.3 Research Design

3.3.1 Macroeconomic Determinants of Insurance Risk in Developed and Emerging Markets

3.3.1.1 Deriving the economic factors that influence insurance risk

In this part of chapter two, we derive a step-by-step model that depicts a theoretical relationship between insurance risk indicators and macroeconomic factors. The objective is to show that this model is composed of five macroeconomic variables whose parameters have an explicit economic interpretation. These variables are inflation rates, the short-term and long-term interest rates, exchange rates and income.

The starting point is the consumer’s optimal demand function. This model states that the value of insurance consumption is determined by the optimization of the utility function subject to a resource constraint as follows

$$U\left(I_{i,t}\right) = \frac{I_{i,t}^{1-\gamma}}{1-\gamma} + \frac{X_{i,t}^{1-\theta}}{1-\theta}, \tag{1}$$

Subject to:

$$M_{i,t} = P_{i,t} I_{i,t} + \left(q_{i,t} + \alpha r_{i,t}\right) X_{i,t} - c_{i,t} I_{i,t} \tag{2}$$

Where $P_{i,t}$ is the price i.e. the insurance premium, $I_{i;t}$ is the amount of insurance i.e. the quantity insured and $X_{i;t}$ is the consumers other consumption goods. Furthermore, from the resource constraint I note that $M_{i;t}$ is the consumer's income, $q_{i;t}$ is the inflation rate, $r_{i;t}$ is the interest rates, these rates can either be short -term for property and casualty insurers or long term for life and health insurers and $X_{i;t}$ is the consumption of other goods. $c_{i,t} = C_{i,t}\left(I_{i,t}\right)$ is the total coverage per unit, whilst $\alpha = \frac{D_{i,t}}{X_{i,t}}$ denotes the debt-consumption ratio. Following an optimization and linearization process, we obtain the first equation to be estimated, the linear optimal insurance demand equation, Eq. (3):

$$i_{i,t} = \beta\left(c_{i,o}.c_{i,t} - p_{i,0}.p_{i,t}\right) + \psi\left(q_{i,t}.q_{i,t} + \alpha r_{i,t}\right) + \eta x_{i,t} - c_{i,t} I_{i,t} \tag{3}$$

Where; t= 1, 2,., T time periods and i= 1, 2,.N individual countries $\beta = \frac{1}{\gamma}\left[\frac{p_{i,o} - c_{i,o}}{q_{i,o} + \alpha r_{i,o}}\right]^{-1}$

And $\psi = \frac{1}{\gamma}\left(q_{i,0} + \alpha r_{i,0}\right)^{-1}$ and $\eta = \frac{\theta}{\gamma}$. Note that these parameters have an economic interpretation; β is the ratio of household insurance consumption, this parameter allows us to extract the demand for insurance by households relative to other goods. ψ is the steady state cost of purchasing and financing other goods, η is the consumption of other goods and ε is the error term.

In this part of the derivation, we solve the insurance company's profit maximisation problem by optimising the following profit function:

$$\pi_{i,t} = P_{i,t}I_{i,t} - \delta c_{i,t}.I_{i,t} - (1-\delta)E_{i,t}c_{i,t}.I_{i,t} - \frac{I_{i,t}^{1+\beta}}{1+\beta} \qquad (4)$$

Where $E_{i,t}$ is the exchange rate, $E_{i,t}C_{i,t}\left(I_{i,t}\right).I_{i,t}$ denotes the proportion of the insurance claims underwritten by foreign markets, $\frac{I_{i,t}^{1+\beta}}{1+\beta}$ is the cost associated with increasing the book of business, i.e. underwriting expenses and noting that $c_{i,t} = C_{i,t}\left(I_{i,t}\right)$. Once more following an optimization and linearization process we obtain, Eq. (5):

$$\hat{p}_{i,t} = \sigma_c\hat{c}_{i,t} + \sigma_e\hat{e}_{i,t} + \sigma_q\hat{q}_{i,t} + \sigma_r\hat{r}_{i,t} + \sigma_x\hat{x}_{i,t} + \varepsilon_{i,t} \qquad (5)$$

3.3.1.2 Factors that influence insurance risk

We decompose, linearize and introduce macroeconomic variables to the insurance risk ratio and obtain Eq. (6), Eq. (7), Eq. (8), Eq. (9) and Eq. (10):

$$\widehat{LR}_{i,t} = (1-\sigma_c)\hat{c}_{i,t} - \sigma_e\hat{e}_{i,t} - \sigma_q\hat{q}_{i,t} - \sigma_r\hat{r}_{i,t} - \sigma_x\hat{x}_{i,t} + \varepsilon_{i,t} \qquad (6)$$

$$\begin{aligned}\widehat{UER}_{i,t} = {} & \left(\gamma_i\beta c_{i,0} - \gamma_p\lambda_c\right)\hat{c}_{i,t} - \gamma\beta p_{i,o}\hat{p}_{i,t} + \left(\gamma_i\rho q_{i,0} - \gamma_p\lambda_p\right)\hat{q}_{i,t} + \left(\gamma_i\rho\alpha - \gamma_p\lambda_r\right)\hat{r}_{i,t} \\ & + \left(\gamma_i\eta - \gamma_p\lambda_x\hat{x}_{i,t}\right) + \gamma_p\lambda_e\hat{e}_{i,t} + \varepsilon_{i,t} \qquad (7)\end{aligned}$$

$$\widehat{SR}_{i,t} = \pi_c\hat{c}_{i,t} + \pi_e\hat{e}_{i,t} + \pi_q\hat{q}_{i,t} + \pi_r\hat{r}_{i,t} + \pi_x\hat{x}_{i,t} - \hat{y}_{i,t} + r_{i,t-1} + \varepsilon_{i,t} \qquad (8)$$

$$IY_{i,t} = -r_{i,t} + \varepsilon_{i,t} \qquad (9)$$

And

$$\Delta K_{i,t} = \delta_k\Delta k_{i,t} \qquad (10)$$

Panel data estimation techniques are used to estimate the regression equations. To empirically test the model in section 3.3.1.1 and 3.3.1.2, we calculate insurance risk ratios (the dependent variables), such as loss, underwriting expense, investment yield and solvency ratios. We use annual aggregated observations of claims, net premiums written and earned, underwriting expenses, capital and surplus, net investment assets and total investment income.

The dependent variables are calculated as follows, the loss ratio is calculated by diving claims by premiums, the underwriting expense ratio is underwriting expenses divided by net premiums. The solvency ratio is net written premiums divided by capital and surplus, the investment yield is achieved by dividing the net investment income by the total investment assets and the last ratio is the reserve ratio which takes into account the growth rate in reserves.

In addition, each proxy for the determinants is selected as follows. The total coverage per unit is constructed using claims and the quantity insured (net written premiums). The data on the debt consumption ratio is constructed using household debt and consumption of other goods proxied by the gross domestic product.

We note that the debt-consumption ratio only starts in 1995 for most developed countries under consideration but is scarce for emerging markets as such we have excluded this variable for emerging markets.

Annual dividend data is available from the mid 1990's and in other instances from the early 2000's, we have used the available data to estimate where possible, affecting the sample period of certain regression equations that include dividends. The proportion of insurance claims underwritten by foreign markets is formulated using exchange rates, claims and quantity insured.

Other determinants including the price of insurance, proxied by net premiums, inflation, this is measured by the rate of change of the consumer price index (CPI). Short and long term interest rates are proxied by the 3 month Treasury bill rate and the 10 year government bond yield respectively.

Short term and long-term interest rates are used in both non-life insurance estimations. The stream of income from the assets is proxied by the investment income, as well as the exchange rates proxied by the real effective exchange rates.

To avoid the problem of scale, most variables are converted to natural logarithms, similar to Chang et al. (2012). We use panel data estimation techniques to estimate the regression equations. The regression techniques are used to determine which factors, derived using the model is section 3, significantly influence the insurance risk.

3.3.2 The Share Returns of Insurance Companies and Macroeconomic Fundamentals

In this part of the paper, we formulate a linear share return equation. The objective is to measure the response of life and non-life insurance share returns to macroeconomic variables, in particular interest rates. These variables include the long and short-term interest rates, output gap, exchange rates and inflation rates. The existence of the short-term interest rate in this model permits us to introduce macroeconomic variables through the Taylor rule (See Dladla and Malikane; 2018, Jiang and Molodtsova; 2015 and Jiang; 2014). Our starting point is the linear asset-pricing model by Dladla and Malikane (2018). This model measures the effects of macroeconomic variables on stock returns. We state this model in general terms as follows:

$$R_{j,t} = \alpha + \theta_d div_{t+1} - \theta_r \Delta r_t - \theta_R \Delta R_t + \varepsilon_t \qquad (1)$$

Where α captures the firm specific risk, div_{t+1} is the one period ahead dividend growth, Δr_t is the effect of the short rate on the discount factor and $\varepsilon_{i,t}$ is the error term.

Assume:

$$div_{t+1} = \varphi \Delta y_{t-1} \qquad (2)$$

The Taylor rule is an equation that defines how central banks set the short-term interest rate in response to inflation and excess demand pressure (Dladla and Malikane; 2018). Most developed countries use the Taylor rule as a scale when setting policies, in addition, the rule contains valuable evidence about future asset prices (Gerlach and Schnabel; 2000). Changes in the short-term interest rate can affect market risk and create financial market instability; central banks also tend to respond to inflation and the output gap by considering the previous level of the short-term interest rate, through interest rate smoothing (Dladla and Malikane; 2018).

These changes have a direct impact on the assets, liabilities, losses and underwriting expenses of insurers. Building on this literature, we assume:

$$r_t = r^* + \emptyset_\pi(\pi_{t-1} - \pi^*) + \emptyset_y(\Delta y_{t-1} - g^*) + \emptyset_e \Delta e_{t-1} + \emptyset_r r_{t-1}$$

$$r_t = r_0 + \emptyset_\pi \Delta\pi_{t-1} + \emptyset_y \Delta y_{t-1} + \emptyset_e \Delta e_{t-1} + \emptyset_r r_{t-1}$$

$$r_t - r_{t-1} \equiv \Delta r_t = r_0 + \emptyset_\pi \Delta\pi_{t-1} + \emptyset_y \Delta y_{t-1} + \emptyset_e \Delta e_{t-1} + (1 - \emptyset_r)\emptyset_r r_{t-1} \qquad (3)$$

Where π_t is the inflation rate, y_t is the output gap and Δe_t is the percentage change in the real effective exchange rate .Substituting eq. (3) into eq. (1) we obtain the following:

$$\Rightarrow R_{j,t} = \alpha + \theta_d.\varphi\Delta y_{t-1} - \theta_r\left[r_0 + \emptyset_\pi \Delta\pi_{t-1} + \emptyset_y \Delta y_{t-1} + \emptyset_e \Delta e_{t-1} + (1 - \emptyset_r)\emptyset_r r_{t-1}\right] - \theta_R \Delta R_t + \varepsilon_t \qquad (4)$$

Simplifying eq. (4)

$$R_{j,t} = \alpha + \left(\theta_d.\varphi - \theta_r\emptyset_y\right)\Delta y_{t-1} - \theta_r\emptyset_\pi \Delta\pi_{t-1} - \theta_r\emptyset_e \Delta e_{t-1} + \theta_r(1 - \emptyset_r)\emptyset_r r_{t-1} - \theta_r r_0 - \theta_R \Delta R_t + \varepsilon_t$$

$$R_{j,t} = \alpha + \beta_y \Delta y_{t-1} - \beta_\pi \Delta\pi_{t-1} - \beta_e \Delta e_{t-1} + \beta_r r_{t-1} - \theta_r r_0 - \theta_R \Delta R_t + \varepsilon_t \qquad (5)$$

3.3.3 The Linkages between Insurance and Bank Risk Indicators

To explore the linkages between insurance and bank risk measures we use panel vector auto regression (VAR) model also used by Liu et al. (2014) and Liu and Zhang (2016), who test the short-and long run relationship between bank credit and insurance activity. Liu and Lee (2014) and Liu et al. (2014) critique traditional VAR models as they exhibit unstable parameters and advocate for advanced rolling VAR models that have much more reliable results and account for the time-varying causal relationship between insurance and banking risk measures. We link insurance risk indicators used in Chapter 2 to bank risk such as loss provisions, cost-income ratio and capital adequacy ratio.

We begin by running Seemingly Unrelated Regressions (SUR); the error terms obtained from these regressions are then tested for correlation. However, we note the criticism levied by Adams et al., (2014) on these correlation methods and hence we run a VAR on the error terms to ascertain whether the components that are independent of the common macroeconomic factors are correlated.

The next model, panel VAR, assists us in determining the short-run and long-run causal relationship between these risks. The last model we use to measure spill over effects between banking and insurance risks is the impulse response functions following Adams et al. (2014).

We specify the model as follows:

$$\begin{bmatrix} y_t^b \\ y_t^i \end{bmatrix} = \begin{bmatrix} \alpha_0 \\ \beta_0 \end{bmatrix} + \begin{bmatrix} 0 & y_t^i \\ y_t^b & 0 \end{bmatrix} \begin{bmatrix} \alpha_i \\ \beta_b \end{bmatrix} + \begin{bmatrix} X_t^b \\ X_t^i \end{bmatrix} \begin{bmatrix} \alpha_b \\ \beta_i \end{bmatrix} + \begin{bmatrix} \varepsilon_t^b \\ \varepsilon_t^i \end{bmatrix} \qquad (1)$$

Where y_t^b and y_t^i denotes banking and insurance risk indicators, X_t denotes a vector of common macroeconomic factors such as GDP, interest rate and exchange rates associated with banking and insurance and ε_t denotes the error term.

Next we specify the following VAR process:

$$\begin{bmatrix} \Delta y_t^b \\ \Delta y_t^i \end{bmatrix} = \begin{bmatrix} -\lambda y^b & 0 \\ 0 & -\lambda y^i \end{bmatrix} \begin{bmatrix} \epsilon_{yt-1}^b \\ \epsilon_{yt-1}^i \end{bmatrix} + \begin{bmatrix} \theta_b(L) & \varphi_i(L) \\ \varphi_b(L) & \gamma_i(L) \end{bmatrix} \begin{bmatrix} \Delta y_{t-1}^b \\ \Delta y_{t-1}^i \end{bmatrix} + \begin{bmatrix} \eta_t^b \\ \eta_t^i \end{bmatrix} \qquad (2)$$

Where

Simplifying the above process into an equation, we obtain:

$$q_t = \Omega \epsilon_{yt-1} + \Phi q_{t-1} \qquad (3)$$

The measures of risks that we use for the insurance sector are growth rate in reserves, which can be linked to loan loss provisions in banking, the solvency ratio that can be linked to the capital adequacy ratio in banking and the underwriting expense ratio, which can be linked to the cost-income ratio in banking. These dependent risk indicators allow us to analyse different aspects of the financial sector such as asset quality, efficiency and solvency. The measures of the independent variables are the same as in chapter two.

CHAPTER 2: MACROECONOMIC DETERMINANTS OF INSURANCE RISK IN DEVELOPED AND EMERGING MARKETS

2.1 Introduction

The insurance industry plays an important role in the world economy and, alongside banking, a vital part of the financial system. Insurance, through the transfer of risk, for example, insulates the agricultural industry from catastrophic events that result in reduced crop production and price volatility (Young et al., 2001).

Insurance also facilitates international trade through private export credit insurance by covering the risk of payment default (van der Veer, 2017). Furthermore Liedtke (2007) notes that the savings mobilized by insurance companies through insurance contracts, makes the industry one of the largest institutional investors and thereby allowing insurance to play a distinct role in economic grow.

The significance and contribution of the insurance market towards the world economy is further highlighted in the 2015 Sigma Report. The Sigma Report notes the percentage growth of life and non-life premiums in advanced markets, in 2014, as 3.8% and 1.8% respectively. The growth in life insurance premiums increased insurance penetration and outperformed GDP, whilst non-life insurance premiums grew at the same pace as the advanced market economies. Furthermore, investments by insurance companies were 20% of GDP in the period 1993 to 2004 in Europe (Haiss & Sümegi, 2008).

The insurance industry is faced with a number of risks that lead to bankruptcies, the effect of these risks have also increased with an increase in globalization, resulting in heavy regulation of the industry. Countries such as Australia, Canada and the USA have introduced risk based capital regulation from as early as 1992. On the other hand, Japan, Switzerland and the United Kingdom have implemented solvency tests and "capital assessments frameworks" respectively, with a major focus on solvency regulation (Cummins and Phillips, 2009). Concerns over solvency have been validated by the recent 2008/2009 financial crisis, which resulted in increased longevity and mortality risks (Altuntas et al., 2015).

Baranoff et al. (2002) highlight the main risks that drive insolvencies in insurance companies as underwriting and investment risk, while Nissim (2010) categorises these risks as underwriting, market and regulatory risk. Each risk has sources that can be linked to macroeconomic variables. For example underwriting risk arises as a result of pricing errors (Nissim, 2010), this risk governs the overall profitability of an insurance company, as such leaving companies exposed to high costs which can be driven by inflation and insufficient premiums. Market risks are associated with interest rates, stock prices, liquidity and credit risk (Nissim, 2010) again the components of this risk have a strong relation to macroeconomic factors.

Market risk can be directly tied to insurance risk, for example, interest rates have a direct impact on the loss ratio, the investment yield and the underwriting expense ratio, whilst stock prices impact the investment yield. Should insurers pay attention to macroeconomic variables in their risk management frameworks and which variables should be on the radar of insurance regulators? It is important to separate the analysis of life and non-life insurers, as there are product, investment and duration differences. For example, non-life insurers have shorter investment horizons, product life cycles and are more susceptible to changes in the short-term interest rates, compared to life insurers (Caporale et al., 2017).

There are numerous studies in the banking literature that investigate the synergies between banks and insurance companies, as well as the macroeconomic determinants of bank risk. Billio et al. (2012) note the complexity of this interconnectedness and attributes it to deregulation and financial modernisation. Castro (2013) investigates the macroeconomic factors that influence bank credit risk; the study finds that factors such as the exchange rate, the unemployment rate and GDP have a significant impact on bank credit risk.

With the overlapping products sold by banks and insurance companies, this type of research is important. Baluch et al. (2011) highlight that both banks and insurers play an active role in each other's markets due to the diversification and spill over of their products and activities. For example banks offer insurance-linked securities, whilst insurers are active in the equity and bond markets as investors. Furthermore liability and credit risk insurers are more sensitive to banking crisis and economic downturns. This sensitivity highlights the need for a comprehensive analysis on the links between macroeconomic factors and insurance risks, as done in banking literature, see Bohachova (2008), Bonfim (2009), Ali and Daly (2010) and Castro (2013), who find a link between broad banking risks, credit risk in particular, and macroeconomic factors.

Understanding the factors that influence insurance risk is essential as insurance firms play a significant role in the economy. Failure of these firms may disrupt the whole economy, increase systematic risk and negatively affect the real economy. Indeed a case of the role of insurance in the economy is made by several researchers (see Ashby and Diacon, 1998; Young et al., 2001, Liedtke, 2007 and van der Veer, 2017)

Furthermore, we do not know whether the factors that influence banking risk are the same as the ones that affect insurance risk given the potential interconnectedness of the two sectors. Billio et al. (2012) note that insurance firms, banks, brokers and hedge funds are highly interrelated, through a complex network of relationships, increasing the systematic risk among these four sectors.

The aim of this study is to examine the macroeconomic determinants of insurance risk indicators for life and non-life insurance companies, in both developed and emerging market economies by using a model that is derived from micro foundations. This study can be useful to central banks that regulate insurance companies by providing an early warning system of potential problems as well as providing insight on the impact of monetary and fiscal policy decisions on insurance.

We use a linear consumption-based and a profit maximization model to theoretically derive the determinants of risk indicators. Our derivation is based on the utility and profit function. One advantage of this model is that the parameters have an economic interpretation, thereby permitting an examination of the macroeconomic sources of variation in insurance risk measures and allowing a comparative analysis for both the developed and developing economies. We estimate the model for six developed and four emerging market economies.

The impact and casual effect of the insurance-growth nexus varies across both developed and developing countries as seen in Arena (2008). Using GMM, Arena (2008) discovers that life insurance influences economic growth in high-income countries, whilst non-life insurance influences growth in both developing and high-income countries. Han et al. (2010), looking at 77 economies, finds that life and non-life insurance play a significant role in economic growth in developing countries compared to developed countries. These studies highlight the significance, especially in emerging markets, of investigating the drivers of risk faced by insurers given the substantial role played by insurance in various economies.

The extant literature investigates various topics relating to insurance risk. For example Berends et.al. (2013) focuses largely on the sensitivity of life insurance firms to interest rate changes. Certain studies look at the relationship between asset risk, product risk and capital risk (Baranoff and Sager, 2002) and the determinants of insurance premiums (Doherty and Kang, 1988, Guo et al., 2009, Chang et al., 2012 and Guo and Huang, 2013) but not the factors that drive these risks in insurance.

Whilst other studies focus on determinants of optimal insurer capital (Cummins and Sommer, 1996, Baranoff and Sager, 2002 and Altuntas et al., 2015), the predictive power of solvency assessment models (Hooker et al., 1996, Cummins et al., 1999 and Cummins and Phillips, 2009) and an in-depth analysis of Solvency II processes and proposals (Eling et al., 2007 and Doff, 2008). However, all of these studies are not directly testing for the macroeconomic factors that impact on insurance risk.

Furthermore, an extensive body of literature covers Basel I and II regulation, bank risks and the determinants of bank risks (Festic´et al., 2011, Castro, 2013 and Alexander et al., 2014). Some of the determinants highlighted by these researchers include, gross capital formation, exports, GDP and credit growth, unemployment, interest and real exchange rates respectively.

The contribution of this paper is to present a theoretical derivation of macroeconomic determinants of insurance risk indicators that can assist policy-makers in understanding, identifying and mitigating insurer insolvency. Our research extends the existing literature in various ways. First, to the best of our knowledge, this is one of few cross-country analysis of both life and non-life insurer risk. As such, our results provide comprehensive evidence of the determinants of insurer risk indicators across different economies. Secondly, we explicitly examine the links between interest rates, inflation, exchange rates and GDP with broad insurer risk ratios, by structurally decomposing the risk ratios. Thirdly, our results support the view that the macroeconomic environment plays a crucial role in insurance companies' risk management frameworks.

The benefits of understanding the sources of insurance risk indicators stems from the formulation of appropriate policies to mitigate the effects of adverse shocks to insurance companies by regulators. These shocks are ultimately transmitted to economies, in the form of insolvencies. For example, Guo et al. (2009) note the importance of macroeconomic shocks on insurance premiums, furthermore highlighting the seemingly financial instrument like nature that premiums have taken.

Other studies such as Sommer (1996), Cummins and Danzon (1997), Guo and Huang (2013) investigate the effects of risks on insurance premiums. However, few studies examine the effects of macroeconomic factors on risk indicators, in particular, the comparative analysis of macroeconomic determinants of risk in emerging and developing markets. Therefore understanding the relative importance of these macroeconomic shocks is crucial for sound solvency management and decreasing the potential transmission effects on economies.

Furthermore understanding the determinants of risks will assist insurers to manage solvency ratios and other ratios that are important to their long-term survival. As such changes in any one of the macroeconomic factors, can encourage a reorganization of the important elements in the insurance environment (See Doherty and Kang (1988), Guo et al., 2009, Chang et al., 2012, Guo and Huang (2013) and Berends et al., 2013). Although this work has been undertaken in the banking industry, we cannot assume that the same factors that influence risk in the banking sector will influence risk in the insurance sector. This is because there are differences in core activities, accounting considerations and regulatory approaches between the sectors.

Furthermore, insurance, similar to banks, plays an important role in the economic growth of a country as seen by Haiss and Sumegi (2008), who find a significant impact of insurance premiums and investment on GDP growth in 15 European countries. Ward and Zurbruegg (2000) use co-integration analysis to test the insurance-growth nexus in OECD countries and find that insurance does contribute to economic growth and vice versa, however the contribution is country specific.

The paper is structured as follows: Section 2 reviews existing literature, in Section 3 we formulate a macroeconomic determinant model and section 4 provides the describe of the data and methodology, Section 5 estimates the model's parameters and Section 6 concludes with some policy recommendations.

2.2 Literature Review

2.2.1 The Role of Insurance

The insurance industry plays an important role in the world economy and, alongside banking, a vital part of the financial system. Insurance, through the transfer of risk, increases the value of firms by reducing the cost of financial distress, limiting externalities (Ashby and Diacon, 1998). In addition insurance insulates the agricultural industry from catastrophic events that result in reduced crop production and price volatility (Young et al., 2001) and facilitating international trade through private export credit insurance by covering the risk of payment default (van der Veer, 2017). Liedtke (2007) notes that the savings mobilized by insurance companies through insurance contracts, makes the industry one of the largest institutional investors and thereby allowing insurance to play a distinct role in economic growth.

Cummins and Sommer (1996) apply simultaneous equations in examining the relationship between capital and portfolio risk of 142 property-liability insurers. Their results show that there is a positive relationship between capital and risk and that managerial incentives play a key role in determining capital and risk for property-liability insurers. Findings on the relationship between capital and asset risk, are similar to the findings of studies carried out in the banking sector.

To highlight this point further, Baranoff and Sager (2002) make use of 1022 US life insurers annual statements, from 1993-1997, in applying a simultaneous-equation partial-adjustment model. Their study shows that there is a negative relationship between life insurers optimal capital structure and product risk. These results are consistent with studies on the impact of guarantee funds.

Sommer (1996) explores the connection between property-liability prices and insolvency risk and discovers a negative relationship between the two variables.

Interestingly Sommer (1996) points out that US property-liability insurers are penalized for default risk regardless of guarantee funds.

An interesting study and one of few to look at the relationship between macroeconomic factors and mortgage insurance premiums is by Chang et al. (2012). This study makes use of a linear regression in detecting co-movements between macroeconomic variables, such as inflation, land prices and stock price index, and mortgage insurance premiums. The authors find a strong statistical relationship between land prices and mortgage insurance premiums. Moreover, they suggest that future research should also look at default risk, given the sub-prime crisis.

Another study that looks at the impact of macroeconomic shocks on insurance premiums is carried out by Guo et al. (2009). Their structural vector error correction model shows that while aggregate supply and oil shocks help to explain insurance premiums, the most influential factor in explaining volatility in insurance prices are shocks to the financial market.

Applying the three stage least squares estimation technique, Doherty and Kang (1988) demonstrate temporal movements in insurance premiums. They find that insurance premiums are sensitive to interest rates; this causes the insurance price cycle to be consistent.

2.2.2 Risks in the Insurance Industry

Cummins and Sommer (1996) apply simultaneous equations in examining the relationship between capital and portfolio risk of 142 property-liability insurers. Their results show that there is a positive relationship between capital and risk and that managerial incentives play a key role in determining capital and risk for property-liability insurers. Findings on the relationship between capital and asset risk, are similar to the findings of studies carried out in the banking sector.

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Sommer (1996) points out that U.S property-liability insurers get penalized for default risk regardless of guarantee funds.

Guo and Huang (2013) use a structural VAR to identify the risks that affect property-liability insurers in China. They find evidence that market and supply shocks account for permanent growth in premiums, whilst speculative shocks in the Chinese market, are responsible for the volatility in the price. Cummins and Danzon (1997) test the link between insurance prices and default risk. Using insurance companies underwriting general liability business, they find evidence of a negative relationship between insurance prices and default risk.

2.2.3 Accuracy of Solvency Assessment Models

There is a vast amount of literature that investigates the accuracy of solvency assessment models in predicting insolvencies in both the non-life and life insurance market. Arguments against the predictive strength of the U.S. Risk Based Capital (RBC) system have been made by Hooker et al. (1995), Cummins et al. (1999) and Cummins and Phillips (2009), with the RBC being compared to other solvency assessments models such as the Switzerland solvency test and the European Union's solvency system.

Comparing these three solvency detection systems, Cummins and Phillips (2009) find that the U.S. RBC system is not a precise predictor of insolvencies for insurers in the U.S. market. They note that this system is static, rule-based and excludes risks such as catastrophic and operational risks. Furthermore, the authors highlight the need to include qualitative solvency assessment techniques into the U.S. RBC system. They also point out the need for the U.S. RBC model to include qualitative measures such as operational risk, as part of the assessment methods.

Cummins et al. (1999) investigate the precision of U.S key solvency models in predicting insolvencies in the U.S property-liability insurance market. These models are tested and compared to cash flow simulation models by applying logistic regressions to data from 1990 to 1992. The models show that, among the key U.S solvency models, the Financial Analysis and Surveillance Tracking (FAST) audit ratio system outperforms the RBC system in its predictive ability. Additionally, the authors provide evidence that the cash flow simulation models have higher predictive power compared to the main solvency models, because the cash flow simulation variables are significant.

Using a sample of insolvent and solvent insurers from 1989 to 1993, Cummins et al. (1995) examine the efficiency of the RBC formula for non-life insurers. The authors apply a logit analysis and find that risk-based capital alone is not a good predictor of insolvencies, however the regression results improve when other variables, such as organizational form and the size of the firm, are included. Moreover, they find that RBC models are better at predicting insolvencies for smaller non-life insurers than for larger ones. Cummins et al. (1995) recommend an improvement of the RBC model, in order to minimize insolvency costs. However, Dickinson (1997) make an argument in favour of RBC models, noting that RBC models are universal and can be used for broader financial management of insurance companies.

Other studies, such as Eling et al. (2007) and Doff (2008), analyse solvency II proposals and processes. Eling et al. (2007) highlight the characteristics of effective solvency models; they note that the German, Switzerland and United Kingdom systems may be preferable systems. In addition, Eling et al. (2007) acknowledge the importance of research into market factors, suggesting that rating agencies have been more effective in determining insurance companies in financial distress than regulators. Doff (2008) tests the solvency II framework against seven standards that are important for an efficient market. The author reports that Solvency II meets most of these standards and draws attention to the need of internal factors such as corporate governance practices, as part of the solvency assessment techniques, in the same spirit as Cummins and Phillips (2009).

2.2.4 Determinants of Insurance Risk

An interesting study and one of few to look at the relationship between macroeconomic factors and mortgage insurance premiums is by Chang et al. (2012). This study makes use of a linear regression in detecting co-movements between macroeconomic variables, such as inflation, land prices and stock price index, and mortgage insurance premiums.

The authors find a strong statistical relationship between land prices and mortgage insurance premiums. Moreover, they suggest that future research should also look at default risk, give the sub-prime crisis.

Another study that looks at the impact of macroeconomic shocks on insurance premiums is carried out by Guo et al. (2009). Their structural vector error correction model shows that while aggregate supply and oil shocks help to explain insurance premiums, the most influential factor in explaining volatility in insurance prices are shocks to the financial market.

Applying the three stage least squares estimation technique, Doherty and Kang (1988) demonstrate temporal movements in insurance premiums. They find that insurance premiums are sensitive to interest rates; this causes the insurance price cycle to be consistent.

Doherty and Garven (1995) have a different outlook on the relationship between premiums and interest rates. The authors investigate the effects of interest rates on insurer's underwriting profits and capital structure. Their results reveal that underwriting profits are unresponsive to interest rate changes.

Another body of insurance literature analyses the determinants of insurance prices. Fung et al. (1998) find that interest rates and the uncertainty variable, which is a combination of interest rates and the variances of losses, are the two most significant factors that influence premiums in the property-liability market. Whilst the uncertainty variable is responsible for forecast errors of premiums. These results are obtained by employing a vector autoregressive model on both by-line and industry data. The authors note that different factors have a significant impact on the premiums of various by-lines.

On the other hand, there are studies that focus on the determinants of optimal regulatory capital for the insurance industry. Altunnas et al. (2015) test whether or not country specific characteristics are relevant in determining insurers optimal capital structures.

The authors employ variance decomposition and dynamic partial adjustment analysis to a range of listed insurance companies in both developed and developing markets. They find that country specific factors play an important role in the disparity in insurers capital levels. They also note that insurer capital structures are not homogeneous across countries; therefore, regulatory capital requirements should take into account these institutional differences to avoid market bias.

The effects of macroeconomic factors such as interest rates, inflation and exchange rates on insurers product risk, changes in assets and liabilities, premiums, growth, capital structure and underwriting profits have been observed by Doherty and Kang (1988),Doherty and Garven (1995) Outreville (1996), Guo et al. (2009) and Berends et al. (2012). These authors provide a foundation for the study of macroeconomic variables in relation to insurance risk.

2.3 Theoretical Modelling

Derivation of the Basic Linear Insurance Demand Equation

In this part of the paper, we derive a systematic model that depicts a theoretical relationship between insurance risk indicators and macroeconomic factors. The objective is to show that this model is composed of five macroeconomic variables whose parameters have an explicit economic interpretation. These variables are inflation rates, the short-term and long-term interest rates, exchange rates and income.

The presence of a resource constraint in this model allows us to introduce macroeconomic factors through the optimization process similar to Burren (2013) and Sun and Dong (2015). Our starting point is the consumer's optimal demand function. This model states that the value of insurance consumption is determined by the optimization of the utility function subject to a resource constraint as follows.

$$U\left(I_{i,t}\right) = \frac{I_{i,t}^{1-\gamma}}{1-\gamma} + \frac{X_{i,t}^{1-\theta}}{1-\theta}, \qquad (1)$$

Subject to:

$$M_{i,t} = P_{i,t}I_{i,t} + \left(q_{i,t} + \alpha r_{i,t}\right)X_{i,t} - c_{i,t}I_{i,t} \qquad (2)$$

Where $I_{i;t}$ is the amount of insurance i.e. the quantity insured and $X_{i;t}$ is the consumers other consumption goods. Furthermore, from the resource constraint we note that $M_{i;t}$ is the consumer's income, $q_{i;t}$ is the inflation rate, $r_{i;t}$ is the interest rates, these rates can either be short term for property and casualty insurers or long term for life and health insurers and $X_{i;t}$ is the consumption of other goods. $c_{i,t} = C_{i,t}(I_{i,t})$ is the total coverage per unit, whilst $\alpha = \frac{D_{i,t}}{X_{i,t}}$ denotes the debt-consumption ratio. Optimising eq. (1) and eq. (2) we obtain the following first order conditions:

$$\frac{\partial L}{\partial I_{i,t}} = I_{i,t}^{-\gamma} - \lambda(P_{i,t} - c_{i,t}) = 0 \tag{3}$$

$$\frac{\partial L}{\partial X_{i,t}} = X_{i,t}^{-\theta} - \lambda(q_{i,t} - \alpha r_{i,t}) = 0 \tag{4}$$

Combining eq. (3) and eq. (4) we obtain the following equation:

$$I_{i,t} = \left(\frac{P_{i,t} - c_{i,t}}{q_{i,t} - \alpha r_{i,t}}\right)^{-\frac{1}{\gamma}} . X_{i,t}^{\frac{\theta}{\gamma}} \tag{5}$$

Linearizing and setting eq. (5) in a panel structure, allows us to get the following linear optimal insurance demand equation:

$$i_{i,t} = \beta(c_{i,o}.c_{i,t} - p_{i,0}.p_{i,t}) + \psi(q_{i,t}.q_{i,t} + \alpha r_{i,t}) + \eta x_{i,t} - \varepsilon_{i,t} \tag{6}$$

Where; t= 1, 2,., T time periods and i= 1, 2,.N individual countries $\beta = \frac{1}{\gamma}\left[\frac{p_{i,o} - c_{i,o}}{q_{i,o} + \alpha r_{i,o}}\right]^{-1}$

And $\psi = \frac{1}{\gamma}(q_{i,0} + \alpha r_{i,0})^{-1}$ and $\eta = \frac{\theta}{\gamma}$. Note that these parameters have an economic interpretation; β is the ratio of household insurance consumption, this parameter allows us to extract the demand for insurance by households relative to other goods. ψ is the steady state cost of purchasing and financing other goods, η is the consumption of other goods and ε is the error term.

Derivation of the Basic Linear Insurance Supply Equation

In this part of the derivation, we solve the insurance company's profit maximisation problem by optimising the following profit function:

$$\pi_{i,t} = P_{i,t}I_{i,t} - \delta c_{i,t}.I_{i,t} - (1-\delta)E_{i,t}c_{i,t}.I_{i,t} - \frac{I_{i,t}^{1+\beta}}{1+\beta} \qquad (7)$$

Where $E_{i,t}$ is the exchange rate, $E_{i,t}C_{i,t}(I_{i,t}).I_{i,t}$ denotes the proportion of the insurance claims underwritten by foreign markets, $\frac{I_{i,t}^{1+\beta}}{1+\beta}$ is the cost associated with increasing the book of business, i.e. underwriting expenses and noting that $c_{i,t} = C_{i,t}(I_{i,t})$. Eq. (7) is optimised to obtain the following first order condition:

$$\frac{\partial \pi_{i,t}}{\partial I_{i,t}} = P_{i,t} - \delta c_{i,t} - (1-\delta)E_{i,t}c_{i,t} - I_{i,.t}^{\beta} = 0 \qquad (8)$$

Linearizing eq. (8) with respect to $c_{i,t}$, $E_{i,t}$ and $I_{i,t}$ we obtain eq.(9):

$$\hat{p}_{i,t} = \frac{c_{i,0}}{p_{i,0}}\hat{c}_{i,t} + \frac{\mu}{(1+\phi\beta p_{i,0})}\hat{e}_{i,t} + \frac{\rho q_{i,0}}{(1+\beta p_{i,0})}\hat{q}_{i,t} + \frac{\rho\alpha}{(1+\beta p_{i,0})}\hat{r}_{i,t} + \frac{\eta}{(1+\beta p_{i,0})}\hat{x}_{i,t} \qquad (9)$$

Let $\sigma\hat{c}_{i,t} = \frac{c_{i,0}}{p_{i,0}}$, $\sigma\hat{e}_{i,t} = \frac{\mu}{(1+\phi\beta p_{i,0})}$, $\sigma\hat{q}_{i,t} = \frac{\rho q_0}{(1+\beta p_{i,0})}$, $\sigma\hat{r}_{i,t} = \frac{\rho\alpha}{(1+\beta p_{i,0})}$ and $\sigma\hat{x}_{i,t} = \frac{\eta}{(1+\beta p_{i,0})}$, therefore:

$$\hat{p}_{i,t} = \sigma_c\hat{c}_{i,t} + \sigma_e\hat{e}_{i,t} + \sigma_q\hat{q}_{i,t} + \sigma_r\hat{r}_{i,t} + \sigma_x\hat{x}_{i,t} + \varepsilon_{i,t} \qquad (10)$$

Measuring the Dependent Variables

Let $\widehat{LR}_{i,t}$ denote the loss ratio, we decompose and linearize the loss ratio to obtain eq.(11):

$$\widehat{LR}_{i,t} = \frac{C_{i,t}(I_{i,t})}{p_{i,t}}$$

$$\widehat{LR}_{i,t} = \hat{c}_{i,t} - \hat{p}_{i,t} \tag{11}$$

Where $C_{i,t}$ is the insurance claims, $I_{i,t}$ is the insurance quantity i.e. the quantity insured and $p_{i,t}$ is the insurance premiums. We can then substitute eq. (10) into eq. (11) to get the following equation:

$$\widehat{LR}_{i,t} = (1-\sigma_c)\hat{c}_{i,t} - \sigma_e \hat{e}_{i,t} - \sigma_q \hat{q}_{i,t} - \sigma_r \hat{r}_{i,t} - \sigma_x \hat{x}_{i,t} + \varepsilon_{i,t} \tag{12}$$

Eq. (12) is the first risk measure, which is reformulated to explicitly take into account macroeconomic fundamentals. The parameters of eq. (12) still have a structural interpretation as convolutions of insurance company specific factors and macroeconomic factors. Eq. (12) provides a neat structural summary of a number of observations found in empirical literature. The anticipated positive relationship between the loss ratio and the claims, provided ($1-\sigma_1$) >0, can be found in Barth and Eckles (2009).

Furthermore note that eq.(12), again provided $\frac{\rho q_{i,0}}{(1+\beta p_{i,0})} > 0$, inflation rate negatively affects loss ratios via the profit function.

Next we draw similar links for the underwriting expense ratio, which measures the operating performance in underwriting (Nissim: 2010), which can be written as follows:

$$Underwriting\ Expense\ Ratio = \frac{Underwriting\ Expenses}{Net\ Premium} = \frac{\frac{I_{i,t}^{1+\beta}}{1+\beta}}{P_{i,t}}$$

Let $\widehat{UER}_{i,t}$ denote the underwriting expense ratio:

$$\widehat{UER}_{i,t} = \frac{\frac{I_{i,t}^{1+\beta}}{1+\beta}}{P_{i,t}} \tag{13}$$

Noting that $\frac{I_{i,t}^{1+\beta}}{1+\beta}$ is the underwriting expenses and $P_{i,t}$ is the net premiums. Differentiating Eq. (13), we obtain the following first order condition:

$$\widehat{UER}'_{i,t} = I_{i,0}^{\beta} + P_{i,t}^{-2} \tag{14}$$

Linearizing Eq. (14):

$$\widehat{UER}'_{i,t} = \gamma_i \hat{\imath}_{i,t} - \gamma_p \hat{p}_{i,t} \tag{15}$$

Substitute Eq. (6) and Eq. (10) into Eq. (15):

$$\begin{aligned}\widehat{UER}_{i,t} = {} & (\gamma_i \beta c_{i,0} - \gamma_p \lambda_c)\hat{c}_{i,t} - \gamma \beta p_{i,o} \hat{p}_{i,t} + (\gamma_i \rho q_{i,0} - \gamma_p \lambda_p)\hat{q}_{i,t} + (\gamma_i \rho \alpha - \gamma_p \lambda_r)\hat{r}_{i,t} \\ & + (\gamma_i \eta - \gamma_p \lambda_x)\hat{x}_{i,t} + \gamma_p \lambda_e \hat{e}_{i,t} + \varepsilon_{i,t}\end{aligned} \tag{16}$$

Eq. (16) illustrates the theoretical link between the underwriting expense ratio and the macroeconomic variables.

Solvency is one of the key indicators of whether or not an insurer will meet its liabilities; this indicator can be expressed as:

$$Solvency\ Ratio = \frac{Net\ Written\ Premiums}{Capital\ and\ Surplus} = \frac{P_{i,t}}{A_{i,t} - L_{i,t}}$$

Where A and L denotes the assets and liabilities of an insurance company respectively. Furthermore let $SR_{i,t}$ be the solvency ratio and ΦA be a fraction of the assets i.e. the liabilities:

$$SR_{i,t} = \frac{P_{i,t}}{(1-\Phi)A_{i,t}} \qquad (17)$$

Noting that assets can be represented as:

$$A_{i,t} = \frac{\delta y_{i,t}}{1+r_{i,t-1}} \qquad (18)$$

Where $\delta y_{i,t}$ is the stream of income paid by the assets such as dividends, in this a proportion of GDP and $r_{i,t}$ is the discount factor. Linearizing Eq. (18) and Eq. (17):

$$\hat{a}_{i,t} = \hat{y}_{i,t} - r_{i,t-1} \qquad (19)$$

and

$$\widehat{sr}_{i,t} = \hat{p}_{i,t} - \hat{a}_{i,t} \qquad (20)$$

We substitute Eq. (19) into Eq. (20):

$$\widehat{sr}_{i,t} = \hat{p}_{i,t} - \hat{y}_{i,t} + r_{i,t-1} \qquad (21)$$

However, from Eq. (10) $\hat{p}_{i,t} = \sigma_c \hat{c}_{i,t} + \sigma_e \hat{e}_{i,t} + \sigma_q \hat{q}_{i,t} + \sigma_r \hat{r}_{i,t} + \sigma_x \hat{x}_{i,t} + \varepsilon_{i,t}$, therefore:

$$\widehat{SR}_{i,t} = \pi_c \hat{c}_{i,t} + \pi_e \hat{e}_{i,t} + \pi_q \hat{q}_{i,t} + \pi_r \hat{r}_{i,t} + \pi_x \hat{x}_{i,t} - \hat{y}_{i,t} + r_{i,t-1} + \varepsilon_{i,t} \qquad (22)$$

The next ratio that we look is the investment yield, which will be represented as:

$$Investment\ Yield = \frac{Net\ Investment\ Income}{Total\ Investment\ Assets} = \frac{\delta y_t}{A}$$

Note that Eq. (18) and Eq. (19), let $IY_{i,t}$ denote investment income and linearize the equation above to obtain the following:

$$IY_{i,t} = \hat{y}_{i,t} - \hat{a}_{i,t} \tag{23}$$

and

$$IY_{i,t} = \hat{y}_{i,t} - \hat{y}_{i,t} - r_{i,t-1} \tag{24}$$

Therefore:

$$IY_{i,t} = -r_{i,t-1} \tag{25}$$

The last ratio is the loss reserve, we intend to look at the growth rate in the loss reserve ratio; however, we note that this ratio is determined by institutional and regulatory factors and as such, there is little need to theoretically derive it. Nissim (2010) explains this ratio as a liability to insurance companies, which consists of estimates of expected claim payments and claim expenses.

$$\Delta K_{i,t} = \frac{k_{i,t} - k_{i,t-1}}{k_{i,t-1}} \tag{26}$$

Where $\Delta K_{i,t}$ is the growth rate in the reserves of insurance firms. Simplifying Eq. (26) we obtain:

$$\Delta K_{i,t} = \delta_k \Delta k_{i,t} \tag{27}$$

We estimate the following equations, using panel data regression estimations, across eight developed and nine developing countries.

$$i_{i,t} = \beta\left(c_{i,o}.c_{i,t} - p_{i,0}.p_{i,t}\right) + \psi\left(q_{i,t}.q_{i,t} + \alpha r_{i,t}\right) + \eta x_{i,t} - \varepsilon_{i,t} \tag{6}$$

$$\hat{p}_{i,t} = \sigma_c \hat{c}_{i,t} + \sigma_e \hat{e}_{i,t} + \sigma_q \hat{q}_{i,t} + \sigma_r \hat{r}_{i,t} + \sigma_x \hat{x}_{i,t} + \varepsilon_{i,t} \tag{10}$$

$$\widehat{LR}_{i,t} = (1-\sigma_c)\hat{c}_{i,t} - \sigma_e\hat{e}_{i,t} - \sigma_q\hat{q}_{i,t} - \sigma_r\hat{r}_{i,t} - \sigma_x\hat{x}_{i,t} + \varepsilon_{i,t} \tag{12}$$

$$\widehat{UER}_{i,t} = (\gamma_i\beta c_{i,0} - \gamma_p\lambda_c)\hat{c}_{i,t} - \gamma\beta p_{i,o}\hat{p}_{i,t} + (\gamma_i\rho q_{i,0} - \gamma_p\lambda_p)\hat{q}_{i,t} + (\gamma_i\rho\alpha - \gamma_p\lambda_r)\hat{r}_{i,t} + (\gamma_i\eta - \gamma_p\lambda_x)\hat{x}_{i,t} + \gamma_p\lambda_e\hat{e}_{i,t} + \varepsilon_{i,t} \tag{16}$$

$$\widehat{SR}_{i,t} = \pi_c\hat{c}_{i,t} + \pi_e\hat{e}_{i,t} + \pi_q\hat{q}_{i,t} + \pi_r\hat{r}_{i,t} + \pi_x\hat{x}_{i,t} - \hat{y}_{i,t} + r_{i,t-1} + \varepsilon_{i,t} \tag{22}$$

$$IY_{i,t} = -r_{i,t-1} \tag{25}$$

And

$$\Delta K_{i,t} = \delta_k\Delta k_{i,t} \tag{27}$$

2.4 Data and Methodology

We use annual life and non-life insurance company data as well as annual macroeconomic data from 1989 to 2016 for developed countries and 1997 to 2016 for emerging markets. The insurance company data is aggregated using averages, per year. The annual insurance company data is obtained from Thompson Reuters DataStream database, whilst the annual macroeconomic data is obtained from the OECD and Federal Reserve's Economic Data (FRED) databases.

To empirically test our model, we calculate insurance risk ratios, such as loss, underwriting expense, investment yield and solvency ratios. Using annual aggregated observations of claims, net premiums written and earned, underwriting expenses, capital and surplus, net investment assets and total investment income, we compute these risk ratios.

In addition, each proxy for the determinants is selected as follows. The total coverage per unit is constructed using claims and the quantity insured (net written premiums). The data on the debt consumption ratio is constructed using household debt and consumption of other goods proxied by the gross domestic product. We note that the debt-consumption ratio only starts in 1995 for most developed countries under consideration but is scarce for emerging markets as such we have excluded this variable for emerging markets.

Annual dividend data is available from the mid 1990's and in other instances from the early 2000's, we have used the available data to estimate where possible, affecting the sample period of certain regression equations that include dividends. The proportion of insurance claims underwritten by foreign markets is formulated using exchange rates, claims and quantity insured.

Other determinants include the price of insurance proxied by net premiums, inflation, which is measured by the rate of change of the consumer price index (CPI). Short and long-term interest rates are proxied by the 3-month Treasury bill rate and the 10-year government bond yield respectively. Short-term and long-term interest rates are used in both the life and non-life insurance estimations. The stream of income from the assets is proxied by the investment income, as well as the exchange rates proxied by the real effective exchange rates.

To avoid the problem of scale, most variables are converted to natural logarithms, similar to Chang et al. (2012); we use panel data estimation techniques to estimate our regression equations. The regression techniques are used to determine which factors, derived using the model is section 3, significantly influence the insurance risk. Table 2.1 below shows the list of countries that form part of the study

Table 2.1 List of Countries

Canada	Malaysia	United Kingdom
France	South Africa	United States of America
Indonesia	South Korea	
Japan	Switzerland	

The countries that form part of the sample are chosen because they represent a wide regulator regime for example Japan, Switzerland and the United Kingdom implement solvency test and “capital assessment frameworks”, whilst the USA and Canada use risk based capital regulation (Cummins and Phillips, 2009). There are more developed countries compared to emerging market countries due to the availability of data. The choice of variables is guided by the existing literature (see Nissim, 2010) as well as the availability of data.

In many developed countries, managing insurance risk ratios have been shown to play a key role in stabilizing the insurance market, through solvency monitoring, and providing protection to policyholders and investors (Cummins and Phillips, 2009).

Table 2.2 summaries the variables and data, whilst table 2.3 represents the descriptive statistics for both life and non-life insurance.

Table 2.2 Description of Variables and data sources

Variables	Definition	Data Source
	Dependent Variables	
$\widehat{LR}_{i,t}$	Loss Ratio = claims/earned premiums	Thompson Reuters DataStream
$\widehat{UER}_{i,t}$	Underwriting Expense Ratio = underwriting expenses/net premiums	Thompson Reuters DataStream
$\widehat{SR}_{i,t}$	Solvency Ratio = Net written premiums/capital and surplus	Thompson Reuters DataStream
$IY_{i,t}$	Investment Yield = net investment assets/total investment income	Thompson Reuters DataStream
$\Delta K_{i,t}$	Loss Reserves= Δ in loss reserves/loss reserves	Thompson Reuters DataStream
	Independent Variables	
$p_{i,t}$	Insurance premiums	Thompson Reuters DataStream
$c_{i,t}$	Total coverage per unit	Thompson Reuters DataStream
$q_{i;t}$	Inflation rate	OECD and FRED
$\alpha r_{i;t}$	Debt-consumption ratio	OECD and FRED
$x_{i,t}$	Consumers other consumption goods	OECD and FRED
$e_{i,t}$	Exchange rate	OECD and FRED
$r_{i;t}$	Interest rates	OECD and FRED
$y_{i,t}$	Dividends	OECD and FRED

Table 2.3 Descriptive Statistics for Life Insurance

Var.	Obs.	Mean	Std. Dev.	Min.	Max.
Panel 1: Developed Countries					
$LR_{i,t}$	106	0.85	0.26	0.33	1.84
$UER_{i,t}$	106	0.12	0.06	0.00	0.25
$SR_{i,t}$	106	78.36	41.46	0.00	129.01
$IY_{i,t}$	106	0.06	0.02	0.00	0.14
$\Delta K_{i,t}$	106	18.09	0.79	15.75	19.68
$p_{i,t}$	106	16.08	0.74	13.81	17.27
$c_{i,t}$	106	255.80	22.48	189.75	303.20
$q_{i;t}$	106	0.02	0.01	-0.01	0.04
$\alpha r_{i;t}$	106	201.13	24.44	155.73	264.66
$x_{i,t}$	106	3.27	1.05	1.65	5.08
$e_{i,t}$	106	4.60	0.12	4.27	4.83
$r_{i;t}$	106	0.04	0.02	-0.00	0.08
$y_{i,t}$	106	2.24	1.26	0.00	5.40
Panel 2: Emerging Markets					
$LR_{i,t}$	63	0.59	0.34	0.00	1.12
$UER_{i,t}$	63	0.15	0.10	0.03	0.46
$SR_{i,t}$	63	73.84	244.29	-6.46	1634.35
$IY_{i,t}$	63	0.06	0.04	0.00	0.20
$\Delta K_{i,t}$	63	19.42	3.64	10.98	24.92
$p_{i,t}$	63	18.21	3.56	12.37	22.86
$c_{i,t}$	63	328.91	131.90	122.16	524.88
$q_{i;t}$	63	0.04	0.03	-0.01	0.12
$x_{i,t}$	63	11.91	10.15	1.11	22.86
$e_{i,t}$	63	4.57	0.16	4.20	4.99
$r_{i;t}$	63	0.08	0.04	0.01	0.19
$y_{i,t}$	63	2.62	0.93	1.18	6.40

Table 2.4 Descriptive Statistics for Non-Life Insurance

Var.	Obs.	Mean	Std. Dev.	Min.	Max.
		Panel 1: Developed Countries			
$LR_{i,t}$	135	0.74	0.18	0.34	1.15
$UER_{i,t}$	135	0.19	0.09	0.09	0.54
$SR_{i,t}$	135	31.37	79.48	2.12	702.90
$IY_{i,t}$	135	0.05	0.02	0.01	0.11
$\Delta K_{i,t}$	135	18.38	2.27	14.50	23.27
$p_{i,t}$	135	17.07	2.25	13.79	22.06
$c_{i,t}$	135	290.40	77.42	183.99	475.21
$q_{i;t}$	135	0.01	0.01	-0.01	0.07
$\alpha r_{i;t}$	135	159.51	89.44	0.00	291.94
$x_{i,t}$	135	11.38	10.64	1.59	24.85
$e_{i,t}$	135	4.62	0.10	4.25	4.89
$r_{i;t}$	135	0.03	0.03	-0.01	0.14
$y_{i,t}$	135	1.81	1.52	00.00	5.40
		Panel 2: Emerging Markets			
$LR_{i,t}$	57	0.77	0.42	0.06	1.91
$UER_{i,t}$	57	0.21	0.09	0.06	0.42
$SR_{i,t}$	57	161.81	474.09	7.74	2328.84
$IY_{i,t}$	57	0.11	0.10	-0.03	0.39
$\Delta K_{i,t}$	57	16.96	3.80	12.21	22.93
$p_{i,t}$	57	16.77	110.40	116.23	476.41
$c_{i,t}$	57	271.50	0.02	-0.01	0.10
$q_{i;t}$	57	0.03	9.28	1.11	21.84
$x_{i,t}$	57	8.35	0.15	4.24	4.99
$e_{i,t}$	57	4.59	0.03	0.01	0.17
$r_{i;t}$	57	0.05	1.14	0.00	6.40
$y_{i,t}$	57	2.47	3.89	12.74	23.66

Table 2.3 and 2.4 present the summary statistics for the variables used in the analysis for both life and non-life insurance. Our sample size for life insurance is higher for developed countries, 106, than for emerging markets, 63, this can be explained by the fact that there are more listed life insurers in developed countries compared to emerging market countries. This is also the case for non-life insurance in developed countries; in general, there are more non-life/short term insurers, in developed countries. We note that on average the Solvency Risk ratio makes up the highest percentage of risk in both the life and non-life markets as well as in developed and developing countries and has a mean range of 31% to 162%. This high percentage is expected and as solvency risk is one of the important risk variables in an insurance company.

Premiums fluctuate between 16% and 18%, showing relative stability of premium collection in both sub-sectors and economies. The minimum and maximum values range between -6% to 190% and the standard deviation is around 167%, on average, indicating a larger spread in the variables between sub-sectors and countries. Of the independent variables, one that stands out in terms of its standard deviation, is the debt consumption ratio, with a spread of 24% and 160. This spread can be explained by various factors such as the difference in the income levels of households, which in turn can influence the consumption level of households in the different counties and access to credit.

2.5 Empirical Results

We first conduct panel unit root tests in order to determine whether or not the variables are stationary. Using both the Levin, Lin, And Chu (2002) and the Im, Pesaran, And Shin (2003) we find that once the variables have been differenced they are all stationary (see Table 2A-2B in the appendix for stationarity test results).

Demand for Insurance

As a first test of our model, we estimate eq. (6), which constitutes our basic linear insurance demand equation, with the quantity insured as the dependent variables and the ratio of household insurance consumption, the demand for insurance by households relative to other goods, the cost of purchasing and financing other goods and the consumption of other goods, as the independent variables. Following Haiss and Sumegi (2008) and Castro (2013), we use panel data analysis.

Table 2.5 Estimation of the Basic Linear Demand and Supply Model

	Panel 1A: Life estimates of the demand model				Panel 1A: Non-Life Insurance estimates of the demand model			
	Developed Countries		Emerging Countries		Developed Countries		Emerging Countries	
Var.	**Pooled OLS**	**2SLS**	**Pooled OLS**	**2SLS**	**Pooled OLS**	**2SLS**	**Pooled OLS**	**2SLS**
β_i	0.03*	0.04*	0.03*	0.03*	0.03*	0.03*	0.01*	0.01*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ψ_i	0.00*	0.09*	5.28**	10.07**	0.01*	0.02*	0.58	0.58
	(0.00)	(0.00)	(0.09)	(0.06)	(0.04)	(0.00)	(0.36)	(0.36)
η_i	-0.05*	-0.16*	0.01	0.01	0.01	0.01	0.12	0.12
	(0.05)	(0.00)	(0.30)	(0.29)	(0.38)	(0.46)	(0.53)	(0.53)
R^2	0.93	0.87	0.96	0.96	0.99	0.99	0.99	0.99
	Panel 1B: Life Insurance estimates of the supply model				**Panel 1B: Non-Life Insurance estimates of the supply model**			
σ_c	0.03*	0.04*	0.02*	0.01*		0.03*	0.03*	0.01*
	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
σ_e	0.47*	0.62*	0.19	0.07		0.47*	0.08	0.99*
	(0.01)	(0.02)	(0.83)	(0.90)		(0.03)	(0.55)	(0.00)
σ_q	2.22	18.51*	0.26	0.26		0.05	0.86	1.20
	(0.34)	(0.04)	(0.90)	(0.90)		(0.98)	(0.36)	(0.53)
σ_r	4.33*	2.14	5.55	5.55		0.83	1.84	1.29
	(0.00)	(0.50)	(0.27)	(0.27)		(0.54)	(0.19)	(0.30)
σ_x	-0.07*	-0.09*	-0.03	-0.03		0.00	0.00	0.03
	(0.00)	(0.04)	(0.93)	(0.93)		(0.50)	(0.43)	(0.54)
R^2	0.93	0.89	0.99	0.99		0.99	0.99	0.99

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%. In each regression, the dependent variable is the loss ratio and the estimated coefficients are β (ratio of household insurance consumption), ψ (cost of purchasing and financing other goods) and η (consumption of other goods).

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and

N (Non-Life-Emerging countries) = 57.

The results are presented in Table 2.5, Panel 1A. Firstly, we note that the magnitudes of the parameters that are associated with the consumption of insurance (β) are small and less than 1. The size of this parameter is expected, since the demand for insurance by households is relative to other goods. The demand coefficients, β tends to be statistically significant across all economies. The sign of β is positive for the majority of the countries, which suggests that the demand for insurance by households relative to other goods is positive and significant. There is little variation of β across countries which could be attributed to the fixed nature of insurance consumption, suggesting that most household expenditure on insurance is stable.

The parameter for the cost of purchasing and financing other goods (ψ) can carry a positive or negative sign according to eq. (6). Across all developed economies, where it is significant, ψ carries a positive sign. Embedded in this parameter is the inflation rate and the debt consumption ratio. The inflation rate will ultimately increase the cost of purchasing other goods, whilst an increase in both the long and short interest rates, will drive up the cost of financing these goods through the debt-consumption ratio. From the results in table 2.5, Panel 1A, we anticipate that the debt-consumption ratio is lower than the inflation rate, i.e. the increase in interest rates is less than the increase in the inflation rate, which explains the positive relationship between the demand for insurance and the cost of purchasing and financing other goods.

Theoretically, we expect the signs on all the variables to be positive, in the supply model, the results in table 2.5, Panel 1B, indicate that the theory holds, as most variables carry a positive sign, in general. The results in Table 2.5, Panel 1B, show that the sign of the parameter for the consumption of other goods σ_x has variation across countries and different types of insurance, i.e. life and non-life. However this variable is mainly positive for non-life insurance in both developed and emerging market countries.

The significance of the consumption of other goods parameter (σ_x) in developed countries, under life insurance, may be due to the relationship between insurance products and demand, as seen in table 2.5, Panel 1A, where we noted that life insurance is a substitute good in developed countries. Therefore, the demand and supply of insurance goods will vary with the consumption of other goods.

On average the remaining parameters take on the expected signs, for example there is a positive and significant relationship between life and non-life total insurance coverage (σc) and the supply of insurance. Whilst an increase in the inflation rate (σq), leading to an increase in the price of insurance (premium growth) will correctly increase the supply of insurance, evidence of this relationship is also found in Guo and Huang (2013). Contrary to Doherty and Kang (1988), we note that interest rates have a positive, but insignificant, effect on insurance premiums.

An interesting parameter that varies in terms of significance, but retains its expected sign, is that of the cost of increasing the book of business i.e. underwriting expenses, σe , included in this parameter is the exchange rate. We note that an increase in the exchange rate will increase the underwriting expenses, which in turn increases the supply of insurance, particularly that of non-life insurance. This may be due to the short-term nature of non-life insurance as well as the number of foreign entities undertaking non-life business.

Determinants of Insurance Risk

We now turn our attention to the results of the risk-ratio indicators, as presented in tables 2.6-2.7.

Table 2.6 Estimation of the Loss Ratio and the Underwriting Expense Ratio Models

Panel 1A: Life Insurance estimates of the Loss Ratio Model					Panel 1A: Non-Life Insurance estimates of the Loss Ratio Model			
	Developed Countries		Emerging Countries		Developed Countries		Emerging Countries	
Var.	Pooled OLS	2SLS	Pooled OLS	2SLS	Pooled OLS	2SLS		
$(1-\sigma_c)$	0.02*	0.02*	0.01*	0.01*	-0.00*	-0.00*	-0.00**	-0.00
	(0.00)	(0.00)	(0.03)	(0.03)	(0.01)	(0.01)	(0.06)	(0.99)
σ_e	0.26	0.26	-0.95	-0.95	-0.52*	-0.51*	0.19	0.15
	(0.46)	(0.46)	(0.47)	(0.47)	(0.02)	(0.02)	(0.73)	(0.82)
σ_q	2.76	2.76	-4.77	-4.77	-3.22*	-3.09*	-1.53	-9.43**
	(0.11)	(0.11)	(0.39)	(0.39)	(0.02)	(0.03)	(0.63)	(0.09)
σ_r	1.36	1.36	10.57	10.57	0.00	-0.02	4.30	22.37*
	(0.67)	(0.67)	(0.35)	(0.35)	(0.99)	(0.82)	(0.29)	(0.04)
σ_x	0.10	0.10	-0.04	-0.04	-0.01	-0.01	-0.04*	0.00
	(0.62)	(0.62)	(0.21)	(0.21)	(0.10)	(0.11)	(0.02)	(0.91)
R^2	0.73	0.73	0.52	0.52	0.70	0.70	0.71	0.57
Panel 1B Life Insurance estimates of the Underwriting Expense Ratio Model					**Panel 1B: Non-Life Insurance estimates of the Underwriting Expense Ratio Model**			
	Developed Countries		**Emerging Countries**		**Developed Countries**		**Emerging Countries**	
$(\gamma_i \beta c_{i,0} - \gamma_p \lambda_c)$	0.02	0.02	0.01*	0.01*	0.01*	0.01*	-0.01	-0.01
	(0.25)	(0.25)	(0.00)	(0.00)	(0.01)	(0.01)	(0.33)	(0.36)
$\gamma \beta p_{i,o}$	-0.80**	-0.80**	-0.83*	-0.83*	-0.60*	-0.60*	0.06	0.05
	(0.09)	(0.09)	(0.00)	(0.00)	(0.00)	(0.00)	(0.73)	(0.81)
$(\gamma_i \rho q_{i,0} - \gamma_p \lambda_p)$	2.61	2.61	-0.07	-0.07	0.75	1.60	-2.21	-2.31
	(0.65)	(0.65)	(0.97)	(0.97)	(0.61)	(0.36)	(0.43)	(0.32)
$(\gamma_i \rho \alpha - \gamma_p \lambda_r)$	-4.80	-4.80	-2.08	-2.08	-0.00	-0.14	-0.48	-1.40
	(0.50)	(0.50)	(0.62)	(0.62)	(0.94)	(0.39)	(0.89)	(0.78)
$(\gamma_i \eta - \gamma_p \lambda_x)$	0.24**	0.24**	-0.17	-0.17	0.01	0.01	-0.02	-0.03
	(0.06)	(0.06)	(0.38)	(0.38)	(0.18)	(0.19)	(0.19)	(0.23)
$\gamma_p \lambda_e$	-0.27	-0.27	-0.41	-0.41	-0.40**	-0.35	-0.52	-0.51
	(0.74)	(0.74)	(0.36)	(0.36)	(0.09)	(0.16)	(0.31)	(0.34)
R^2	0.50	0.50	0.82	0.82	0.80	0.79	0.70	0.70

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and

N (Non-Life-Emerging countries) = 57

We note that, on average, there is a negative and significant relation between coverage and the loss ratio for the non-life sector. We propose that this relationship is likely to be explained by the concept of the "law of large numbers". The law of large numbers can be seen by the decrease in the underwriting risk (loss ratio) as the total coverage increases therefore allowing insurers to accurately predict their losses as the exposure units’ increase.

By definition the law of large numbers is taken "as the number of exposure units increases, the more closely the actual loss experience will approach the probable loss experience" (Rejda; 2011, 21). This relationship is further cemented in the non-life business as the exposure units tend to be higher given the short-term nature of the business but if the exposure growth is managed with caution, non-life insurers can generate profits in the long run (D'Arcy and Gorvett; 2004).

Furthermore a rise in coverage is also suggestive of premium growth as the book of business increases, again this underlying negative relationship between premium growth and non-life insurance loss ratio, is displayed in table 2.6, Panel 1A and supported by Barth and Eckles (2009). Barth and Eckles (2009) argue that the rise in premium does not result in a rise in underwriting risk measured by the loss ratio. On the other-hand, the positive and significant relation between coverage and the loss ratio for the life insurance is also indicative of the long-term nature of the business, in that as coverage (exposure units) increases loss ratios, in the long run, also increase.

It is worth noting that exchange rates and inflation have a negative effect in emerging markets for non-life and life insurers respectively. For the interest rate parameter (σ_r), there is ambiguity in terms of the signs; theoretically, we expect the sign to be negative. However, where the parameter is contrary to theory, it is mostly insignificant. The non-significance of the interest rate parameter in non-life insurance may be due to the liquid, short-term assets that non-life insurers invest in, as such reducing the sensitivity to interest rates and having a minimal impact on the underwriting profit and hence the underwriting risk (Nissim, 2010).

Generally in our underwriting expense ratio model, most parameters can either take a negative or positive sign, with the expectation of the net premium parameter ($\gamma\beta p_{i,0}$) and the exchange rate parameter ($\gamma_p\lambda_e$) which theoretically take on negative and positive signs respectively. The results in table 2.6, Panel 1B, confirm our theoretical derivation, as there is, mainly, a negative and significant relationship between the underwriting expense ratio and the net premiums, this can be explained by underwriting cycles.

When the underwriting cycle is at its peak the premiums are high, which in turn leads to a reduction in the underwriting expenses and an overall increase in the underwriting expense ratio.

However, the underwriting peak does not last long as the high premiums and underwriting capacity attracts competition (Nissim, 2010).

Theoretically, we anticipate that an increase in the exchange rate is likely to result in an increase in the underwriting profits, especially for the domestic insurance market. However, from the results above we note that the exchange rate parameter ($\gamma_p\lambda_e$) has a negative, but insignificant effect on the underwriting expense ratio. On average, the derived variables explain 50% to 80% of the variation in the operational efficiency, as displayed by the R^2 of the underwriting expense ratio model.

Table 2.7 Estimation of the Solvency Ratio

	Panel 1A: Life Insurance estimates for solvency ratio				**Panel 1A: Non-Life Insurance estimates for solvency ratio**			
	Developed Countries		**Emerging Countries**		**Developed Countries**		**Emerging Countries**	
Var.	**Pooled OLS**	**2SLS**	**Pooled OLS**	**2SLS**	**Pooled OLS**	**2SLS**	**Pooled OLS**	**2SLS**
π_c	0.02*	0.01	0.01*	0.01*	0.00	0.01	-0.01	-0.01
	(0.00)	(0.48)	(0.00)	(0.00)	(0.46)	(0.24)	(0.14)	(0.15)
π_e	1.05	-0.02	2.41	2.41	0.43	0.58	-0.64	-0.66
	(0.17)	(0.99)	(0.02)	(0.02)	(0.64)	(0.55)	(0.30)	(0.29)
π_q	2.78	16.94	-6.47	-6.47	0.20	-2.10	-6.95	-7.22
	(0.70)	(0.78)	(0.25)	(0.25)	(0.97)	(0.74)	(0.15)	(0.14)
π_r	9.91	14.96	29.84*	29.84*	-6.09	-4.86	14.11*	15.26**
	(0.22)	(0.79)	(0.01)	(0.01)	(0.51)	(0.62)	(0.04)	(0.06)
π_x	-1.10*	-0.91*	0.04	0.04	0.02	0.01	-0.32*	-0.30*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.57)	(0.85)	(0.04)	(0.04)
$y_{i,t}$	0.55*	0.91*	0.14	0.14	0.03	0.05	0.18**	0.18**
	(0.00)	(0.01)	(0.37)	(0.37)	(0.73)	(0.52)	(0.06)	(0.06)
$r_{i,t-1}$	26.25*	6.72	12.11	12.11	0.13	-0.92	-2.36	-2.53
	(0.00)	(0.79)	(0.28)	(0.28)	(0.66)	(0.20)	(0.54)	(0.52)
R^2	0.93	0.85	0.72	0.72	0.77	0.75	0.88	0.88

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and

N (Non-Life-Emerging countries) = 57

The results presented in table 2.7, Panel 1A for the dividend parameter ($\gamma_p\lambda_e$) are positive with half the sample showing significant coefficients. Liang and Huang (2011) can explain this relationship via the minimum reserve requirement. They note that as the minimum reserve requirement increases, the dividend pay-out increases as well, furthermore the solvency state improves with an improvement in dividends, but the insurer's profits decrease.

The discount factor parameter ($r_{i,t-1}$) is non-significant in 7 of the 8 results, with majority of the coefficients showing the expected sign, a careful analysis of the results reveals that most of the negative signs are in non-life insurance. Brockett et al. (2004) substantiate the positive relationship through the link between interest rates and capital. The author's note that an increase in interest rates results in an inflow of capital to the insurance industry, this in turn can increase the solvency ratios as well the solvency regulator capital.

It is in particularly high interest rate periods that many insolvencies in the insurance industry are recorded, as seen in the interest rate hikes of the 1980's (Brockett et al., 2004).

Table 2.8 Estimation of the Investment Yield and Growth in Reserves

Panel 1A: Life Insurance estimates for investment yield					Panel 1A:Non-Life Insurance estimates for investment yield			
Var.	**Developed Countries**		**Emerging Countries**		**Developed Countries**		**Emerging Countries**	
	Pooled OLS	**2LS**	**Pooled OLS**	**2LS**	**Pooled OLS**	**2LS**	**Pooled OLS**	**2LS**
$r_{i,t-1}$	13.62*	16.21*	0.10	-0.61	0.07	0.07	-3.77*	-3.77*
	(0.00)	(0.00)	(0.98)	(0.87)	(0.45)	(0.45)	(0.04)	(0.04)
R^2	0.26	0.26	0.18	0.18	0.57	0.57	0.73	0.73
Panel 1B: Life Insurance estimates for growth in reserves					**Panel 1B:Non-Life Insurance estimates for growth in reserves**			
δ_k	8.22*	8.22*	9.30*	9.30*	8.43*	8.43*	5.77*	5.77*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R^2	0.98	0.98	0.99	0.99	0.95	0.99	0.99	0.99

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and

N (Non-Life-Emerging countries) = 57

The last set of results from table 2.8, Panels 1A and 1B, show that the interest rate parameter ($r_{i,t-1}$) is, mainly, positive but non-significant. However, of keen interest, is that the interest rate parameter takes on the correct sigh and is largely significant in emerging markets. The parameter that displays the expected sign and has high levels of significance is the growth in reserves parameter (δ_k). Reserves are a highly monitored and regulated aspect of insurer solvency (Leadbetter and Dibra, 2008). Furthermore, Nissim (2010) highlights that life insurer reserves make up about 73% of their total adjusted liabilities and equity, whilst non-life insurers have the same composition at 60%.

2.6 Robustness Checks

In this section of the paper, we test the robustness of our model, using pooled OLS. In particular, we look at the potential effects of the 2008/09 financial crisis, in affecting, if at all, the characteristics of the relationships post 2008, as well the nature of the relationships prior to the crisis. We check the robustness of our model by estimating the results in tables 2.5 to 2.7 at different sample periods i.e. pre and post the 2008/09 financial crisis.

Furthermore, we note that differences could also be brought about by the different regulatory regimes, as well as the application of the regulation in different countries such as Canada and USA, which use the risk based capital regulation compared to Japan, Switzerland and the UK, which use the solvency tests and capital assessments frameworks (Cummins and Phillips, 2008).

Table 2.9 Pre and Post 2008 Estimates of the Demand Model

	Panel 1A: Life				Panel 1A: Non-Life			
	Developed		Emerging		Developed		Emerging	
Var.	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**
β_i	0.04*	0.03*	0.03*	0.03*	0.03*	0.03*	0.00	0.01*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.32)	(0.00)
ψ_i	0.02	0.02*	3.74	9.78*	-0.00	0.00	0.90	0.93
	(0.21)	(0.21)	(0.33)	(0.00)	(0.50)	(0.89)	(0.42)	(0.41)
η_i	0.02	-0.08**	0.02	-0.01*	0.00	-0.01	0.01	-0.30*
	(0.59)	(0.09)	(0.23)	(0.01)	(0.20)	(0.63)	(0.97)	(0.02)
R^2	0.95	0.88	0.95	0.99	0.99	0.99	0.99	0.99

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and N (Non-Life-Emerging countries) = 57

From the demand results, in table 2.9 above, we note that the consumption of other goods has a positive effect on the demand of insurance before the 2008/09 financial crisis. However, after the financial crisis, the effect of this variable changes to negative, indicating that an increase in the consumption of other goods decreases the demand for insurance. From these results, we see a substitution effect take place, where the decrease in demand in insurance can be attributed to consumers switching to other goods.

Table 2.10 Pre and Post 2008 Estimates of the Supply Model

	Panel 1A: Life				Panel 1A: Non-Life			
	Developed		Emerging		Developed		Emerging	
Var.	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**
σ_c	0.04*	0.03*	0.02*	0.02*	0.03*	0.03*	0.04*	0.03*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
σ_e	0.41*	0.34	1.30	-1.38**	0.32	-0.19	-0.66	-0.88
	(0.02)	(0.59)	(0.31)	(0.06)	(0.14)	(0.12)	(0.31)	(0.22)
σ_q	0.84	7.08	6.72	-0.88	4.17	-0.94	0.63	9.42
	(0.81)	(0.25)	(0.25)	(0.88)	(0.15)	(0.22)	(0.82)	(0.27)
σ_r	4.78*	1.03	-8.37	-18.17**	-2.27	-0.29	-17.41*	-11.99*
	(0.04)	(0.90)	(0.11)	(0.06)	(0.22)	(0.87)	(0.00)	(0.05)
R^2	0.94	0.87	0.95	0.99	0.99	0.99	0.99	0.99

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and

N (Non-Life-Emerging countries) = 57

Looking at the supply model we note that the nature of the relationships change in the sample post 2008. Prior to the financial crisis the impact of most macroeconomic variables on the supply of insurance is positive as theoretically expected.

However, in the period post the crisis, exchange rates and interest rates start reducing the supply of insurance. Melvin and Taylor (2009) notes that prior to August 2007, exchange rates were steady but this steady period is followed by volatility in the foreign exchange market during and post August 2007. As such, the negative effect of exchange rates is plausible and can be explained by the volatility in the foreign exchange markets. In the same spirit the high interest rates during and after the crisis (Melvin and Taylor; 2009) would have made it difficult for consumers to meet their debt obligations on insured items let alone maintain insurance policies. In turn, this state of affairs would have informed the supply of insurance.

Table 2.11 Pre and Post 2008 Estimates of the Loss Ratio Model

	Panel 1A: Life Pre and Post 2008				Panel 1A: Non-Life Pre and Post 2008			
	Developed		Emerging		Developed		Emerging	
Var.	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**
$(1-\sigma_c)$	0.01*	0.04*	-0.00	0.01*	-0.00	0.00	-0.01*	0.03*
	(0.01)	(0.00)	(0.85)	(0.04)	(0.13)	(0.67)	(0.00)	(0.00)
σ_e	0.14	0.86	1.16	-0.66	-0.30	0.28	0.42	-0.37
	(0.73)	(0.22)	(0.45)	(0.66)	(0.19)	(0.29)	(0.54)	(0.28)
σ_q	1.98	4.00	3.67	-9.72	-1.06	2.17	-0.05	-11.67*
	(0.56)	(0.23)	(0.38)	(0.43)	(0.52)	(0.15)	(0.99)	(0.01)
σ_r	1.07	3.22	9.23	31.57**	-0.04	-0.01	3.58	11.21*
	(0.75)	(0.63)	(0.27)	(0.08)	(0.60)	(0.90)	(0.45)	(0.00)
σ_x	0.07	0.14	-0.12*	-0.02	-0.01	-0.00	-0.06*	0.078
	(0.65)	(0.76)	(0.02)	(0.22)	(0.18)	(0.97)	(0.00)	(0.52)
R^2	0.81	0.64	0.70	0.27	0.85	0.73	0.85	0.85

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and

N (Non-Life-Emerging countries) = 57

We note that the R^2 post the financial crisis is lower compared to the pre 2008-sample results, indicting the weakening effect that the crisis had in the explanatory power of the macroeconomic variables on claims. In the emerging market, in life insurance, the power of the explanatory variables in explaining the variation of loss ratios, dropped to 27%. However, most variables do not have a significant effect in explaining movements in insurance losses.

Table 2.12 Pre and Post 2008 Estimates of the Underwriting Expense Ratio Model

	Panel 1A: Life				Panel 1A: Non-Life			
	Developed		Emerging		Developed		Emerging	
Var.	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**
$(\gamma_i \beta c_{i,0} - \gamma_p \lambda_c)$	0.07* (0.03)	-0.00 (0.74)	0.01 (0.18)	-0.01 (0.14)	-0.00 (0.99)	0.05* (0.00)	-0.02 (0.19)	-0.02* (0.05)
$\gamma \beta p_{i,o}$	-1.89* (0.05)	-0.45 (0.14)	-0.56 (0.13)	0.20 (0.30)	-0.09 (0.76)	-1.80* (0.00)	0.28 (0.38)	0.71** (0.06)
$(\gamma_i \rho q_{i,0} - \gamma_p \lambda_p)$	19.80 (0.12)	-1.22 (0.64)	1.30 (0.76)	-12.22** (0.06)	3.29 (0.16)	2.85 (0.59)	0.48 (0.91)	1.89 (0.85)
$(\gamma_i \rho \alpha - \gamma_p \lambda_r)$	-14.62 (0.20)	-3.71 (0.48)	-3.13 (0.57)	13.37 (0.18)	-3.12 (0.20)	-13.01* (0.01)	-6.65 (0.38)	27.01** (0.09)
$(\gamma_i \eta - \gamma_p \lambda_x)$	-6.55 (0.18)	-4.54* (0.04)	-0.02 (0.25)	-0.03* (0.00)	-0.00 (0.93)	0.02* (0.00)	-0.07* (0.03)	0.06 (0.22)
$\gamma_p \lambda_e$	0.36 (0.81)	0.11 (0.84)	1.23 (0.32)	0.48 (0.52)	-0.14 (0.65)	0.90** (0.09)	0.24 (0.82)	1.03 (0.31)
R^2	0.66	0.85	0.64	0.87	0.81	0.75	0.50	0.81

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and N (Non-Life-Emerging countries) = 57

The effect of macroeconomic variables on underwriting expense ratios is the least affected by the financial crisis. The two distinct variables, premiums and exchange rates, continue to have the same negative and positive impact, respectively, on the underwriting expense ratio pre and post 2008. These variables maintain their theoretical assumptions in spite of the global crisis.

Table 2.13 Pre and Post 2008 Estimates of the Solvency Ratio Model

	Panel 1A: Life				Panel 1A: Non-Life			
	Developed		Emerging		Developed		Emerging	
Var.	Pre 2008	Post 2008	Pre 2008	Post 2008	Pre 2008	Post 2008	Pre 2008	Post 2008
π_c	0.02*	0.00**	0.01*	-0.00	0.01*	-0.01	-0.01*	0.01
	(0.00)	(0.08)	(0.01)	(0.67)	(0.00)	(0.35)	(0.00)	(0.51)
π_e	1.43*	0.66*	5.30*	1.94	0.08	1.33	1.86*	-0.30
	(0.13)	(0.02)	(0.00)	(0.15)	(0.93)	(0.62)	(0.04)	(0.90)
π_q	-36.59*	-0.94	6.24	1.75	8.20	-7.60	6.45**	-3.59
	(0.02)	(0.46)	(0.11)	(0.86)	(0.29)	(0.71)	(0.07)	(0.90)
π_r	16.35	-5.75*	36.32*	12.89	7.77	-35.78	3.10	61.20
	(0.33)	(0.02)	(0.00)	(0.36)	(0.29)	(0.29)	(0.67)	(0.14)
π_x	-1.25*	-1.59*	0.02**	0.08*	-0.02	0.11*	-0.18*	-0.09
	(0.00)	(0.00)	(0.06)	(0.00)	(0.60)	(0.05)	(0.00)	(0.50)
$y_{i,t}$	0.80*	0.03	0.33*	-0.45	0.13	0.36	0.03	0.91
	(0.00)	(0.28)	(0.01)	(0.21)	(0.14)	(0.16)	(0.72)	(0.23)
$r_{i,t-1}$	26.60*	0.91	-0.88	-10.62	-10.42	-39.10	-14.71*	-11.72
	(0.05)	(0.72)	(0.89)	(0.36)	(0.18)	(0.25)	(0.03)	(0.74)
R^2	0.96	0.99	0.97	0.86	0.88	0.59	0.96	0.85

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and

N (Non-Life-Emerging countries) = 57

Both the pre and post 2008 results indicate that dividends, on the main, maintained its positive effect on solvency ratios, with the exception of the post 2008 sample for life insurers in emerging markets, this could be an indication of a potential corrective effect on dividends post the crisis, as theoretically projected. In addition, the impact of dividends has reduced with only, two pre crisis values, showing a significant impact.

The negative effect of interest rates on solvency ratios have increased for both the pre and post 2008 samples, particularly in non-life insurance. Previously the positive effect noted in the full sample was explained by an increase in capital inflow and subsequently an increase in solvency margins (Brockett et al., 2004). Conversely, the decrease in solvency ratios as a result of increases in interest rates i.e. the opposite effect, seen in periods of financial crisis, can be explained by the potential decreases in capital inflow, in periods of credit crunch characterising financial crisis, and further exacerbating insurance insolvencies in these periods.

In table 2.14 below, the growth rate in insurance reserves is not affected by the financial crisis, as the change in the coefficient and the impact of the coefficient as not changed in any substantial manner compared to the full sample.

Table 2.14 Pre and Post 2008 Estimates of Investment Yields and Growth in Reserves

	Panel 1A: Life Pre and Post				Panel 1A: Non-Life Pre and Post			
	Developed		Emerging		Developed		Emerging	
Var.	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**	**Pre 2008**	**Post 2008**
$r_{i,t-1}$	4.59	17.27*	1.13	3.52	0.14	-0.01	-5.14*	1.17*
	(0.32)	(0.02)	(0.63)	(0.62)	(0.20)	(0.93)	(0.03)	(0.02)
R^2	0.69	0.25	0.12	0.45	0.71	0.45	0.68	0.60
δ_k	8.42*	9.21*	12.17*	9.07*	8.19*	8.69*	4.53*	7.92*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R^2	0.97	0.99	0.99	0.99	0.99	0.99	0.99	0.99

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%

N (Life-Developed countries) = 106, N (Life-Emerging countries) = 63, N (Non-Life-Developed countries) = 135 and N (Non-Life-Emerging countries) = 57

2.7 Conclusion

There is a significant body of literature which argues that macroeconomic variables play a significant role in determining insurance risk. Studies by Barth and Eckles (2009), Carson et al. (2008), Nissim (2010) and Chang et al. (2012) find that interest rates, inflation rates and prices of insurance play a significant role in explaining variations in the risk of insurers. However, the models that are used in these studies are not theoretically derived and so their parameters are not transparent. In this paper we bridge this important gap in the literature by deriving a basic linear demand and supply model from the resource constraint, profit function and risk models from these modules by decomposing insurance risk ratios and embedding the micro foundation models. The parameters of this model are transparent and have a clear economic interpretation.

Upon estimating this model for a set of selected advanced and emerging market economies for both the life and non-life industries, we find that our model produces estimates of total coverage, exchange rates and inflation rates (premium growth) that are superior to the ones reported in existing literature. In summary, the most influential macroeconomic variables, on insurance risk, are exchange rates, interest rates and the variable on the consumption of other goods, across all countries in both the life and non-life subsectors. For regressions of actual risk indicators, we find that the R^2 produced by the demand and supply models ranges between 87% and 90%. For insurer risk indicators the R^2 ranges between 27% and 90%. These statistics are in line with those found in existing literature.

In terms of the demand and supply regressions, we find that firstly, overall our model performs better when estimated using the pooled and two-stage least squares techniques than the fixed effects technique. Secondly, our risk models perform better than the models proposed in existing literature, as they i) include a wide range of macroeconomic variables and ii) is theoretically derived and they structurally decomposes the risk ratios. When we check the resilience of our model to the 2008/09 financial crisis, we find that on average models such as the underwriting expense ratio, the solvency ratio and the growth in reserves remained robust pre and post the crisis period. In the period post the financial crisis, exchange rates and interest rates had the most notable effect on some of the models in this paper.

On average, our analysis has several important implications for policy-makers in insurance. For instance, it is important to encourage both insurers and policy-makers to monitor the response of insurance risk to macroeconomic variables.

The sensitivity of risks in the insurance market to these variables should be noted and communicated to other regulating authorities, such as monetary policy authorities. Of equal importance is the detailed understanding of the transmission effects of these shocks that ultimately lead to insolvencies and hence the formulation of regulation policies in the insurance markets and the management of risks in this market.

There are at least two directions in which future research can be undertaken on the basis of the model we have derived in this paper. One line of research would be to examine the other forms of risk based capital models against both the macroeconomic variables and country or firm specific factors, given the relative performance of the models in this paper. Another line of research to which our model can contribute relates to the detailed examination of the effects of the exchange rates on both the life and non-life lines of business.

CHAPTER 3: THE REALTIONSHIP BETWEEN SHARE RETURNS OF INSURANCE COMPANIES AND MACROECONOMIC FUNDAMENTALS: A PANEL STUDY.

3.1 Introduction

3.1.1 Background

Life and non-life insurers have different operating strategies due to the nature of their business, whilst life insurers have predictable claims and as such have a long-term focus; non-life insurers have uncertainty about the volume and timing of claims (Grundle, Dong and Gal; 2016). This means that the investment focus and income needs of these segments of the industry are different and we, therefore, anticipate that the optimal investment portfolios for each will also be different. This point is made by Grundle et al. (2016) who notes that life insurers, due to the nature of their business, require long-term assets, less liquidity compared to non-life insurers and as such can engage in "buy and hold" strategies. To this extent, we expect their share returns to respond differently to differing macroeconomic fundamentals, as well.

Share prices of insurance companies are an important signalling tool, to investors, of the financial health of insurers. Financial statements of insurers do not always reflect reliable financial information of matters such as underwriting profits and loss reserves (Akhigbe et al., 1993). It is for this reason that investors are often left to interpret certain information from share prices; this raises the problem of information asymmetries in relation to the true economic conditions of insurance companies. Additionally share prices are, traditionally, used in models that determine premiums across life and health insurance, these models generally measure the long-term profitability of an insurance contract from initiation (Feldblum, 1996).

Shares can also play an important role as insulators of insolvencies in insurance, for example Antal and Sumandea-Simionescu (2015), investigate the solutions to avoid insolvencies in Romanian insurance companies. The authors use variables such as affiliation, business risk, company size, liquidity, shareholder structure as some of the variables that determine insurer insolvencies. Their results show that shares owned by insurance companies, in affiliated companies, acts as a protective barrier against the risk of insolvencies. The importance of asset prices on insurer solvency is further shown by Dull et al. (2017), the authors concentrate on sovereign risk transmission to insurance companies, in the bond market. Dull et al. (2017) find that risks in sovereign bond portfolios, especially default risks, are an important driver of insurer risk.

The relationship between share prices and losses of insurers is show by Kim et al. (2014), by looking at the pricing model for Catastrophic Equity Put (CatEPut) options. Their results show that there is correlation between the share prices of insurance companies and catastrophe losses. Similarly, previous literature directly tested the effects of large losses on the share prices of insurers. Cummins and Danzon (1997) note that, in the mid-1980s' when short-term insurers experienced a sharp increase in losses, the market value of insurer's equity decreased. This decrease highlights the negative relationship between share prices and loss ratios of insurance companies.

Jaimungal and Wang (2006) further highlight the relationship between asset prices and losses by examining the pricing and hedging of catastrophe put options under random interest rates with losses. Using a jump-diffusion model, they find that interest rates and catastrophic losses play a significant role in the prices of the CatEPut option. It would appears that the relationship between share prices and losses is bidirectional.

Information asymmetries are an important area in the insurance industry. Akhigbe et al. (1993) notes that due to these asymmetries and the lack of complete information from insurers financial statements, investors, tend to rely heavily on other financial market signals to measure the changes in financial condition of insurers, such as changes in stock market prices and dividend policy.

Furthermore the absence of complete information may contribute to ambiguity and therefore increases in stock price volatility (Akhigbe et al., 1993).Therefore understanding the sensitivity of the share prices of insurers is important in light of information asymmetries and the role share prices play in disseminating information about the financial condition of insurance companies, to investors. The problem, we are faced with, is understanding the variables that affect share returns as well as the changes in share returns, if any, in light of the role shares play in the insurance sector.

The aim of the study is to examine the sensitivity of the share prices of life and non-life insurance companies to macroeconomic variables. We use a single linear equation to estimate the sensitivity of insurance company returns to these variables. Our model is an extension of the two factor model by Berendes et al. (2013). The model used by Berendes et al. (2013) measures the sensitivity of insurance returns to interest rate risk. We extend this model by incorporating other macroeconomic variables such as exchange rates, inflation rates and gross domestic product, through the Taylor rule. We estimate the model for six advanced and four emerging market economies, in order to understand the heterogeneity amongst countries.

The study of the sensitivity of insurer returns is significant to insurers, policyholders and investors because of the impact that the value of share prices have on the assets and liabilities of both life and non-life insurance and the performance of this sector which ultimately affects financial markets. Furthermore share returns contribute to market risk, which is a risk insurers are concerned about, as changes in share prices affect the investment yield through changes in investment income and assets.

Financial markets are affected by insurer insolvencies via externalities; the failure of one institution can trigger a systematic collapse of other related institutions, whilst policyholder liabilities can grow exponentially. Prudent management of share prices allows continuous operation of insurers by managing loss, solvency, underwriting and reserve ratios this is because market returns mirror information quicker than non-market-based measures such as accounting variables (Billio et al., 2012).

The study will contribute to the body of knowledge in relation to the common risk factors that influence the share price of insurance companies. Moreover, knowledge of the optimal share price return of insurance companies, in heterogeneous macroeconomic environments, is beneficial because changes in share prices can lead to:

- Changes in the investment income of insurance companies,
- In ensuring policyholder liabilities are met,
- In stabilising solvency capital and thereby
- Reducing the rate of insurer insolvencies and

- Contributing to an increase in investor confidence.

To the best of our knowledge, this is one of few studies that examine the direct relationship between insurance stock returns and broader macroeconomic variables, using Taylor rule fundamentals.

The rest of the paper is structured as follows: Section 2 reviews existing literature, in Section 3 we describe the data and specify our model. Section 4 estimates the model's parameters and Section 5 concludes with some policy recommendations.

3.2 Literature Review

There are a vast number of studies that look at the relationship between stock markets and macroeconomic variables, these studies in general examine the impact of variables such as exchange rates, inflation rates and GDP on the share prices of both emerging and developed markets. Ernest et al. (2016) undertake such a study; they use panel data of 41 emerging markets ranging from 1996 to 2011. Their results show that macroeconomic variables such as, exchange rate, money supply, inflation and GDP have a significant impact on stock market performance in emerging stock economies. These results are further supported by Tripathi et al. (2014) who run a Granger causality and Johansen Co-integration test to test the casualty relationship between share prices and macroeconomic variables in India. The results of this study demonstrate a negative co-integrative relationship between share prices and inflation rates and exchange rates.

Similarly Liu et al. (2008) note the effects of industrial production, interest rates, inflation rates, exchange rates and money supply on the Chinses stock market. Their study reveals a co-integrative and positive long run relationship between stock market performance and macro-variables. In the same breath, Abugri (2008) looks at the equity returns of four Latin American economies, using a VAR model. The author tests whether or not the dynamics in certain macro-variables such as exchange rates, interest rates, industrial production and money supply explain the stock returns of these economies. Abugri (2008) finds that these macro-variables a have a consistent and significant role in explaining equity returns in all four markets.

Contrary to these findings Baele et al. (2010), examines the economic causes of stock and bond co-movements, the authors find that macroeconomic fundamentals play an insignificant role in explaining stock and bond return correlations. Similarly Campbell et al. (1993) conduct a study that decomposes excess stock and 10-year bond returns into changes in expectations of, inflation, short-term real interest rates, and future stock. The study shows that real interest rates have little impact on returns.

3.2.1 Share Returns and Inflation Rates

Adekunel et al. (2015) study the elements that influence share prices of insurers in Nigeria; they run a multiple panel regression model and find that, inflation rates and earnings per share have a significant effect on the share prices of Nigerian insurance. The authors also recommend that closer attention be paid to the influence of financial ratios on share prices of insurers. Additionally Alagidede (2009) examines this relationship, in African countries. Using OLS estimates, the results indicate a positive relationship between inflation and stock returns in Kenya and Nigeria.

Commonly studies on share prices and inflation rates, in developed countries, find a negative and significant relation between share prices and inflation rates. This is seen in Apergis et al. (2002) for tests conducted on the relationship between stock prices, inflation, and interest rates, in Greece, from 1988–1999. The outcomes show a strong relationship in support of share prices and inflation rates. In the USA and the UK, Boudoukh and Richardson (1993) find that long horizon nominal stock returns are positively linked to both ex-ante and ex-post long-term inflation.

We also see the stock price-inflation relationship in studies undertaken in other markets such as Indonesia and Malaysia, which measure the effect of inflation rates on share returns of these economies. Majid et al. (2001) test this relationship, in light of the Fisher hypothesis. The results display that the stock returns, in Malaysia, are independent of the inflationary trends as such can be used as a hedge against inflation, however Majid et al. (2001) find that, for Indonesia there is a negative relationship between the two.

This view is further strengthen by Al-Khazali et al. (2004) who probe the statistical relationship between share prices and inflation rates in nine Pacific Basin countries. On average, their analysis shows that, in the short-run, there is a negative relationship between these two variables, this relationship is displayed in all nine markets.

Opposing studies, on the other hand show that this relationship exists but is insignificant. For example, Floros (2004) notes some form of relationship between the Athens Stock Exchange Price Index and inflation rates, using and OLS model, however this relationship is not statistically significant.

Hondroyiannis et al. (2006), using a Markov Switching vector autoregressive model, also find that there is no relations between these two variables, despite the method used to separate inflation into two components.

3.2.2 Share Returns and Interest rates

Berendes et al. (2013) investigates the sensitivity of life insurers to interest rates; they do this by using a two-factor model to measure the changes in the stock prices of life insurers to interest rate fluctuations. They find a negative relationship between share prices and interest rates, especially during the 2008/09 financial crisis. These results are consistent with their observation that future profit opportunities of life insurers tend to decrease with a decrease in interest rates. Furthermore fluctuations in interest rates are expected to significantly affect the expected value of insurer's liabilities, and this is because insurers sell long-term products, whose present value relies on interest rates.

Papadamou et al. (2017) assess the dynamic effects of interest rates on share prices, under diverse levels of central bank transparency, from 1998 to 2008, in emerging markets. The authors provide evidence for a negative association between stock returns and interest rate differences, which decreases under a transparent central bank. Noting the importance of share prices and interest rates to economic growth, Alam et al. (2009) search for an empirical relationship between these two variables, in 15 developed and developing countries. Alam et al. (2009) find that for all 15 countries, interest rates have a negative and significant relationship with share prices. The authors also note that for six countries, changes in interest rates significantly affect changes in share prices.

Observing that insurer assets and liabilities are sensitive to interest rates and that insurer solvency is significantly linked to interest rate volatility, Brewer III et al. (2007) study the interest rate sensitivity of monthly stock returns of life insurers using a GARCH-M model. Their analysis confirms that life insurer equity values are sensitive to long term interest rates; this study also complements the insolvency research that associates insurer financial performance to changes in interest rates.

Furthermore Carson et al. (2008) lead a study on market risk, interest rate risk, interdependencies in stock returns and stock return volatilities for accident and health insurers, life insurers and property and casualty insurers. They note that stock returns of life insurers are the most sensitive to interest rates, portraying a negative relation.

In European economies, Nasseh et al. (2000)'s study supports the presence of a significant, long-term relationship between share prices and macroeconomic variables. The Johansen Cointegration test of this study reveal a significant relationship between share price levels and short and long term interest rates as well as industrial production. The authors state that macroeconomic variables have strong explanatory power in the variance of share prices and that share prices are determined by macroeconomic activity.

3.2.3 Share Returns and Exchanges Rates

When Japan experienced a recession and deflation for ten years, quantitative monetary easing was implemented with one of the aims being, to influence stock prices for economic recovery (Kurihara, 2006). Kurihara (2006) investigates the relationship between macroeconomic variables, such as exchange rates and interest rates, and share prices, with a focus on exchange rates. The study shows that in the Japanese economy, interest rates have no impact on Japanese stock prices whereas exchange rates and U.S. stock prices have the most influence.

Contrary to Kurihara (2006), in India both interest rates and exchange rates have an influence on share prices (Ajaz et al., 2017). In a study conducted by Ajaz et al. (2017) looking at the dynamic interactions between monetary and financial variables in the Indian framework, under an asymmetric structure. The authors find an asymmetric reaction of stock prices to changes in exchange rate and interest rate. These results are useful to policy makers as they help in understanding the policy transmission mechanism through the asset price channel (Ajaz et al., 2017).

Bahmani-Oskooee et al. (2016) use a nonlinear ARDL approach and an error correction model to test the effects of exchange rates in Brazil, Canada, Chile, Indonesia, Japan, Korea, Malaysia, Mexico, and the U.K. The effects of exchange rates vary, depending on whether the country is export or import oriented. The authors find that, in the short-run, exchange rate changes have asymmetric effects on share prices (Bahmani-Oskooee et al. (2016)). These results are similar to the results of Ajaz et al. (2017)

In the same vein, Koutmos et al. (2003) investigates whether or not exchange rate exposure is asymmetric over appreciation–depreciation cycles. They conduct tests on nine sector indexes in four major countries and find that exposure is asymmetrical and the asymmetries are prominent in the financial sector.

3.2.4 Share Returns and GDP

Abbas et al. (2018) analyse the relation between share prices and macroeconomic variables for G7 countries, using GARCH models they find that the volatility of industrial production growth and oil prices have the most significant influence on the direction of stock markets. Tiwari et al. (2018) test the relationship between share prices and economic growth, using data that spans over 215 years. They find that, in the long run, there is a robust casual effect from GDP to share prices and that negative shocks in GDP have a larger impact on share prices than positive shocks.

Cooper et al. (2008) tests predictive power of the output gap on U.S. stock returns. Their results confirm that the output gap is a strong predictor of U.S. stock returns, both in-sample and out-of-sample and it is robust to checks. In addition, Fama and French (1989) note that the output gap has a negative impact on stock returns and produces lower expected returns when economic conditions are strong, this result is similar to the result found by Tiwari et al. (2018) on the negative shocks in GDP.

Vivian and Wohar (2013) provide a balanced view on the ability of the output gap in determining stock returns. They find that, generally the output gap is a leading indicator of cross-sectional portfolio returns in the U.S., via the market return. However, simulating Fama-French portfolio's they find that, although output gap is a key business cycle indicator, there is mixed evidence on its ability to forecast stock returns in these portfolio types.

3.3 Theoretical Framework

3.3.1 Data

We use annual life and non-life insurance share price company data as well as annual macroeconomic data from 1988 to 2017 for developed countries and 1994 to 2016 for emerging markets. The annual insurance share price company data is obtained from Thompson Reuters DataStream database, whilst the annual macroeconomic data is obtained from the OECD and Federal Reserve's Economic Data (FRED) databases.

The share price data is transformed by taking its natural logs and then differencing the logs to compute share returns. Our choice of countries is informed by availability of data and the relative size, global importance and regulatory advancement of the insurance industry of each economy. Other determinants include inflation rates, which are measured by the rate of change of the consumer price index (CPI). Short and long-term interest rates are proxied by the 3-month Treasury bill rate and the 10-year government bond yield respectively.

We use the Taylor rule to introduce the interest rate variables in our model. We note that although not all countries in our study follow inflation targeting, however the Taylor rule can be used to approximate their interest rates (see Clarida, Gali, and Gertler; 1998).The exchange rates are proxied by the real effective exchange rates and we use gross domestic products, which is transformed into the output gap. Table 3.1 below, summaries the variables used in our model as well as the data sources. Also, see tables' 3A-B, in the appendix, for a list of all the companies whose share returns were used in the estimations.

Table 3.1 Summary of Variables and Data Sources

Variables	Definition	Data Source
Independent Variables		
$R_{j,t}$	Stock returns of insurance companies	OECD and FRED
y_t	Output gap/GDP	OECD and FRED
π_t	Inflation rate	CPI obtained from OECD and FRED
e_t	Real effective exchange rates	OECD and FRED
r_t	Short term interest rates	OECD and FRED
R_t	Long term interest rates	OECD and FRED

Table 3.2 Descriptive Statistics for Life Insurance

	Can.			Fra.			Jap.			Swi.			UK			USA		
Var.	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
$R_{j,t}$	129	0.09	0.35	22	0.02	0.03	81	0.07	0.29	28	0.04	0.54	156	0.01	0.44	520	0.02	0.87
y_t	168	0.00	0.02	28	0.00	0.02	176	0.01	0.02	28	0.00	0.02	280	-0.01	0.03	868	-0.00	0.02
π_t	168	0.02	0.01	28	0.02	0.01	224	0.01	0.01	28	0.01	0.02	280	0.03	0.02	868	0.03	0.01
e_t	168	-0.01	0.05	28	-0.00	0.03	224	-0.01	0.09	28	0.01	0.04	280	0.00	0.06	868	0.00	0.04
r_t	174	0.04	0.03	29	0.04	0.03	1136	0.00	0.00	1199	0.00	0.01	1190	0.01	0.03	899	0.03	0.03
R_t	174	0.06	0.03	29	0.05	0.03	232	0.02	0.02	29	0.03	0.02	290	0.06	0.02	899	0.05	0.02

	Ind.			Mal.			S.Afr			S.Kor		
Var.	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
$R_{j,t}$	17	0.06	0.17	21	0.05	0.16	102	-0.02	0.78	41	0.05	0.14
y_t	18	0.05	0.10	22	0.04	0.13	132	-0.03	0.03	85	0.02	0.02
π_t	18	0.08	0.04	22	0.02	0.01	132	0.06	0.02	85	0.03	0.01
e_t	18	0.04	0.11	22	-0.01	0.06	132	-0.02	0.10	85	0.02	0.10
r_t	190	0.01	0.04	191	0.00	0.01	186	0.07	0.05	186	0.02	0.02
R_t	189	0.01	0.04	189	0.01	0.02	186	0.08	0.05	186	0.02	0.03

Table 3.3 Descriptive Statistics for Nonlife Insurance

	Can.			Fra.			Jap.			Swi.			UK			USA		
Var.	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
$R_{j,t}$	139	0.05	0.73	100	0.06	0.35	61	0.04	0.48	118	-0.12	0.60	178	0.02	0.57	1582	0.05	0.63
y_t	224	0.00	0.02	140	0.00	0.01	110	0.01	0.02	140	0.00	0.02	392	-0.01	0.03	2296	-0.00	0.02
π_t	224	0.02	0.01	140	0.02	0.01	140	0.01	0.01	140	0.01	0.02	392	0.03	0.02	2296	0.03	0.01
e_t	224	-0.01	0.05	140	-0.00	0.03	140	-0.01	0.09	140	0.01	0.04	392	0.00	0.06	2296	0.00	0.04
r_t	232	0.04	0.03	145	0.04	0.03	110	0.00	0.00	145	0.02	0.03	406	0.05	0.04	2378	0.03	0.03
R_t	444	0.02	0.03	449	0.00	0.01	442	0.01	0.02	449	0.00	0.01	440	0.04	0.03	889	5.45	1.84

	Ind.			Mal.			S.Afr			S.Kor		
Var.	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
$R_{j,t}$	191	0.09	0.23	139	0.07	0.22	46	0.19	1.34	140	0.08	0.24
y_t	300	-0.01	0.27	200	0.05	0.12	60	0.09	0.03	175	0.01	0.04
π_t	300	0.09	0.08	200	0.03	0.01	60	4.48	0.12	200	0.03	0.02
e_t	300	-0.00	0.18	200	-0.01	0.06	57	0.05	0.02	168	-0.00	0.13
r_t	240	0.14	0.10	208	0.04	0.02	60	1.38	0.13	208	0.07	0.05
R_t	260	0.05	0.01	273	0.05	0.01	60	-1.60	0.41	273	0.06	0.03

Table 3.2 and 3.3 present the summary statistics for the variables used in the analysis for both life and non-life insurance. From the tables above, we note that from the macroeconomic variables, the exchange rate variable, has a stable average value, with a mean of approximately zero, over both life and non-life insurance for developed and emerging countries. This stability of the average value can also be seen for the inflation rate, and the interest rates, with means ranging from 0.01 to 0.09 for both categories of insurance and countries, with the exception of South African and American non-life insurers.

We note, with interest, that the average value of the short-term interest rates, for Japan is 0.00. This generally reflects the low levels of short-term interest rates that prevail in Japan for the period under study. The average values of the GDP variable fluctuate around -0.03 to 0.05 for most countries for both life and nonlife insurance.

The dispersion of the data, as shown by the standard deviation, reflects minimum scattering amongst the macroeconomic variables, with values ranging from 0.01 to 1.84 for both life and nonlife and developed and developing countries. On average, our sample size for life insurance is smaller than that of nonlife insurance. This is to be expected, as there are less stringent regulatory requirements, in most countries, in setting up a non-life insurance company compared to a life insurance company. The average observation for life insurance in developed countries is 160, with USA being an outlier, and 45 for emerging markets. On the other hand, non-life insurance observations, on average, are between 354 for developed countries and 129 for emerging markets, again with the USA being an outlier. We note that nonlife insurance business seems to have a higher presence in both developed and developing countries, primary due to regulatory ease.

3.3.2 Model Specification

In this part of the paper, we formulate a linear share return equation. The objective is to measure the response of life and non-life insurance share returns to macroeconomic variables, in particular interest rates. These variables include the long and short-term interest rates, output gap, exchange rates and inflation rates. The existence of the short-term interest rate in this model permits us to introduce macroeconomic variables through the Taylor rule (See Dladla and Malikane; 2018, Jiang and Molodtsova; 2015 and Jiang; 2014). Our starting point is the linear asset-pricing model by Dladla and Malikane (2018). This model measures the effects of macroeconomic variables on stock returns. We state this model in general terms as follows:

$$R_{j,t} = \alpha + \theta_d div_{t+1} - \theta_r \Delta r_t - \theta_R \Delta R_t + \varepsilon_t \qquad (1)$$

Where α captures the firm specific risk, div_{t+1} is the one period ahead dividend growth, Δr_t is the effect of the short rate on the discount factor and $\varepsilon_{i,t}$ is the error term.

Assume:

$$div_{t+1} = \varphi \Delta y_{t-1} \qquad (2)$$

The Taylor rule is an equation that defines how central banks set the short-term interest rate in response to inflation and excess demand pressure (Dladla and Malikane; 2018). Most developed countries use the Taylor rule as a scale when setting policies, in addition, the rule contains valuable evidence about future asset prices (Gerlach and Schnabel; 2000). Changes in the short-term interest rate can affect market risk and create financial market instability; central banks also tend to respond to inflation and the output gap by considering the previous level of the short-term interest rate, through interest rate smoothing (Dladla and Malikane; 2018).

These changes have a direct impact on the assets, liabilities, losses and underwriting expenses of insurers. Building on this literature, we assume:

$$r_t = r^* + \emptyset_\pi(\pi_{t-1} - \pi^*) + \emptyset_y(\Delta y_{t-1} - g^*) + \emptyset_e \Delta e_{t-1} + \emptyset_r r_{t-1}$$

$$r_t = r_0 + \emptyset_\pi \Delta\pi_{t-1} + \emptyset_y \Delta y_{t-1} + \emptyset_e \Delta e_{t-1} + \emptyset_r r_{t-1}$$

$$r_t - r_{t-1} \equiv \Delta r_t = r_0 + \emptyset_\pi \Delta\pi_{t-1} + \emptyset_y \Delta y_{t-1} + \emptyset_e \Delta e_{t-1} + (1-\emptyset_r)\emptyset_r r_{t-1} \quad (3)$$

Where π_t is the inflation rate, y_t is the output gap and Δe_t is the percentage change in the real effective exchange rate .Substituting eq. (3) into eq. (1) we obtain the following:

$$\Rightarrow R_{j,t} = \alpha + \theta_d.\varphi\Delta y_{t-1} - \theta_r[r_0 + \emptyset_\pi \Delta\pi_{t-1} + \emptyset_y \Delta y_{t-1} + \emptyset_e \Delta e_{t-1} + (1-\emptyset_r)\emptyset_r r_{t-1}] - \theta_R \Delta R_t + \varepsilon_t \quad (4)$$

Simplifying eq. (4)

$$R_{j,t} = \alpha + (\theta_d.\varphi - \theta_r\emptyset_y)\Delta y_{t-1} - \theta_r\emptyset_\pi \Delta\pi_{t-1} - \theta_r\emptyset_e \Delta e_{t-1} + \theta_r(1-\emptyset_r)\emptyset_r r_{t-1} - \theta_r r_0 - \theta_R \Delta R_t + \varepsilon_t$$

$$R_{j,t} = \alpha + \beta_y \Delta y_{t-1} - \beta_\pi \Delta\pi_{t-1} - \beta_e \Delta e_{t-1} + \beta_r r_{t-1} - \theta_r r_0 - \theta_R \Delta R_t + \varepsilon_t \quad (5)$$

3.4 Empirical Results

We carry out panel unit root tests in order to determine if the variables are stationary or not. Since panel data methodology, uses both time and cross sectional analyses it is important that the variables should be stationary in order to avoid possible spurious relationships among the variables (Banerjee, 1999). The unit root test results are presented in the appendix, in tables' 2A-B.

Table 3.4 Estimation of the Share Returns

	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S. Kor.
Sample	88-17	88-17	88-17	88-17	88-17	88-17	94-17	94-17	94-17	94-17
					LIFE INSURANCE					
β_y	0.43	0.27	-0.69	-8.44	-3.87	1.45	0.42	0.39	-0.92	-0.61
	(0.83)	(0.60)	(0.73)	(0.23)	(0.21)	(0.63)	(0.59)	(0.47)	(0.89)	(0.72)
β_π	3.66	2.07*	-1.80	-16.56	-7.54	7.92	2.55	2.49	-1.45	-6.55
	(0.48)	(0.05)	(0.68)	(0.38)	(0.18)	(0.21)	(0.48)	(0.57)	(0.89)	(0.01)
β_e	0.89	-0.55*	0.27	-1.50	2.09*	0.22	-0.62	-0.14	1.03	0.04
	(0.18)	(0.05)	(0.65)	(0.58)	(0.01)	(0.84)	(0.57)	(0.91)	(0.26)	(0.88)
β_r	-6.14*	-0.91	51.03	-10.10	-2.57	-1.13	-0.42	-6.32	5.95	-4.54
	(0.03)	(0.29)	(0.21)	(0.49)	(0.26)	(0.77)	(0.89)	(0.30)	(0.26)	(0.22)
β_R	6.29*	0.72	-11.06	24.87	8.02*	-2.75	-1.12	7.25	-3.77	13.47*
	(0.05)	(0.45)	(0.46)	(0.12)	(0.04)	(0.57)	(0.87)	(0.23)	(0.54)	(0.00)
R^2	0.06	0.39	0.03	0.22	0.07	0.00	0.15	0.17	0.03	0.49

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%

Table 3.5 Estimation of the Share Returns

	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S. Kor.
Sample	88-17	88-17	88-17	88-17	88-17	88-17	94-16	94-16	94-16	94-16
					NON-LIFE INSURANCE					
β_y	-0.05	1.06	-8.93*	-6.25	1.66	-2.17	0.08	-0.01	-11.90	-0.61
	(0.99)	(0.71)	(0.04)	(0.11)	(0.65)	(0.43)	(0.74)	(0.97)	(0.46)	(0.61)
β_π	3.75	5.21	-18.11*	-5.30	-3.56	3.16	0.53	-0.29	-7.93	-3.28
	(0.71)	(0.41)	(0.05)	(0.60)	(0.55)	(0.56)	(0.25)	(0.89)	(0.75)	(0.27)
β_e	-2.08	1.52	-0.45	1.09	-0.95	0.83	-0.03	0.04	-0.79	0.11
	(0.12)	(0.33)	(0.66)	(0.44)	(0.33)	(0.43)	(0.91)	(0.95)	(0.79)	(0.69)
β_r	-2.37	-0.16	-4.20	-0.73	2.67	3.52	0.28	0.25	-6.60	-3.26
	(0.57)	(0.93)	(0.95)	(0.90)	(0.10)	(0.33)	(0.59)	(0.93)	(0.73)	(0.44)
β_R	6.33**	-1.21	12.13	4.32	-0.71	-0.04	-2.43	0.51	-7.99	5.56
	(0.06)	(0.56)	(0.49)	(0.37)	(0.74)	(0.36)	(0.62)	(0.86)	(0.63)	(0.27)
R^2	0.06	0.03	0.16	0.05	0.03	0.01	0.02	0.00	0.03	0.04

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

3.4.1 Inflation

We regress the stock returns of life and non-life insurance companies, in each of the six developed and four emerging market countries, on five macroeconomic variables (Table 3.4-3.5). In Life insurance and of the ten countries, in our sample, on average five countries consistently display the correct negative sign but the relationship is mostly insignificant. Bahmani-Oskooee et al. (2016) explains that the negative impact of inflation on share returns is because of a decrease in profits due to an increase in input costs, which ultimately hurts share prices.

However, for French life insurers, there is a positive and significant relationship, which is also found by Anari and Kolari (2001). For Canada, USA, Indonesia and Malaysia the relationship is positive but insignificant. This positive relationship can also be seen in the results found by Boudoukh and Richardson (1993), Anari and Kolari (2001) who find that this relationship can be positive in the long run, Alagidede (2009) and Floros (2004).

For non-life companies, the negative relationship between inflation and share returns exists on average in six of the ten countries studied. This relationship is mostly insignificant and can be explained by Anari and Kolari (2001) and Bahmani-Oskooee et al., (2016), who note that in the short run shares go through a negative transitory period and hence the negative relation.

3.4.2 Interest Rates

There is evidence that the long rate plays a negative role in driving the equity returns of life insurance, in four of the ten countries in our sample, however this impact is insignificant. In general, these results are consistent with theory; this is because the stock returns of life insurers are mostly sensitive to long-term interest rates, portraying a negative relation (Carson et al. (2008) and (Brewer III et al. (2007)), given the long term nature of investment assets found in the portfolios of life insurers (see table 3.6). We note, however, that for Canada, UK and South Korea mostly, the long rate is positive and significant (See in Erdem et al. (2005), Fama (1981)).

In non-life insurance, there are approximately four countries that show a positive relationship between the short rates and equity prices (Nasseh et al., 2000 and Erdem et al., 2005). Although most of the relationships are insignificant, the sign of the cofficient is to be expected given the short-term nature of assets and liabilities of non-life insurers (Nissim, 2010), see table 3.6.

Table 3.6 Investment Portfolio Allocation of Domestic Direct Insurers

		LIFE		NON-LIFE				LIFE		NON-LIFE	
		2014	2015	2014	2015			2014	2015	2014	2015
Can.	Bonds	0.0	0.0	77.6	77.7	Fra.	Bonds	83.0	82.2	60.7	61.0
	Shares	0.0	30.4	17.1	16.1		Shares	11.9	12.0	24.6	23.7
	Other	100.0	69.6	5.3	6.3		Other	5.0	5.8	14.6	15.3
Jap.	Bonds	67.8	69.6	32.5	31.2	Swi.	Bonds	61.1	60.4	36.6	34.7
	Shares	8.2	7.5	29.4	24.1		Shares	2.4	3.1	3.9	4.5
	Other	24.0	22.9	38.1	44.6		Other	36.4	36.5	59.5	60.8
UK	Bonds	63.8	62.8	40.2	38.6	US	Bonds	73.4	73.4	67.9	67.9
	Shares	13.0	11.8	6.1	6.1		Shares	3.7	3.6	14.3	14.3
	Other	23.2	25.4	53.7	55.3		Other	22.9	23.0	17.8	17.8
Ind.	Bonds	28.6	23.1	15.6	17.7	Mal.	Bonds	56.4	56.6	48.3	46.1
	Shares	30.1	30.8	17.6	18.6		Shares	16.5	16.8	5.2	4.1
	Other	41.3	46.1	66.8	63.7		Other	27.2	26.6	46.5	49.8
S.Afr.	Bonds	19.8	12.0	14.7	18.0	S.	Bonds	54.4	53.6	37.3	35.6
	Shares	63.9	78.4	26.3	25.9	Kor.	Shares	4.5	3.9	3.8	3.1
	Other	16.3	9.6	59.0	56.1		Other	41.1	42.5	58.8	61.3

Source: OECD Global Insurance Market Trends

We note, as anticipated, that life and non-life insurers invest heavily, between 20%-80% of total investment assets, in bonds, explaining their sensitivity to interest rates validating the results found in tables 3.4 to 3.5.

3.4.3 Exchange Rates

The results, of the relationship between share returns and exchange rates, are generally mixed as can be seen in Ajaz et al. (2017), Bahmani-Oskooee et al. (2016), Koutmos et al. (2003) and Wangbangpo and Sharma (2002). In the life insurance sector, we find that these mixed results hold, with some countries taking on a positive sign while others carry a negative relation. However, our results for this sector are predominantly insignificant, with the exception of France and UK life insurance.

Ajaz et al. (2017), suggests that the effects of exchange rates can be analysed by thinking of the "goods market", in our case a market where insurance is sold and brought, where exchange rates have an impact on the competitiveness of a business through earnings and cost of funds. As noted in chapter 2, in the insurance sector, exchange rates have an impact on the claims costs and underwriting expenses, through the proportion of business underwritten by foreign markets; this will ultimately influence the earnings of an insurer.

In the non-life sector, half of the countries display a negative and insignificant relation between exchange rates and share returns. This effect can partially be explained by a currency appreciation, which can increase underwriting expenses, claims costs and subsequently reduce underwriting profits. This reduction in underwriting profits will in turn affect non-life insurer's share prices; this may be due to the short-term nature of non-life insurance as well as the number of foreign entities undertakings in the non-life business (See table 3 C, in the appendix).

3.4.4 GDP

In the life sector, the output gap generally has a positive but insignificant impact on share returns. This positive relation is to be expected, as an increase in economic activity leads to growth in company earnings, in our case insurer earnings (Bahmani-Oskooee et al., 2016). This relation can also be explained by the long term trade of life insurance companies and the nature of life liabilities. Other findings that support this positive relationship are conducted in the USA (Chen, Roll, and Ross; 1986) and in France and Canada (Abbas et al., 2018) on industrial production and share prices returns. There is also a negative correlation between share returns and GDP, the evidence to support this result can be found in Spyrou (2001). Our full sample of annual regressions yield an adjusted R^2 of between 1% and 50%, this is consistent with other studies in this field (See Dladla and Malikane; 2018, Jiang and Molodtsova; 2015 and Spyrou; 2001).

3.5 Robustness Tests

In this section of the paper, we structurally break our data into two sample periods, the first period is prior to the 2007/2008 financial crisis and the second period is post the crisis. This is done to test the resilience of the model and to ascertain whether or not insurers remain sensitive to interest rates, as seen in the results above, in the two sample periods.

Table 3.7 Estimation of Life Insurance Companies Share Returns

	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S. Kor.
					LIFE INSURANCE PRE 2008					
β_y	1.70	-0.05	-18.16	-8.92	-12.58	4.51	-1.85	0.93	-1.45	-4.00
	(0.74)	(0.97)	(0.42)	(0.42)	(0.19)	(0.55)	(0.87)	(0.48)	(0.59)	(0.71)
β_π	5.40	1.43	29.94	-16.82	-27.88	8.78	15.07	10.92	-0.18	-10.92
	(0.65)	(0.65)	(0.56)	(0.61)	(0.17)	(0.60)	(0.63)	(0.35)	(0.95)	(0.73)
β_e	1.78	-0.70**	1.84	-2.72	0.64*	0.14	0.30	-0.64	0.54*	0.08
	(0.26)	(0.10)	(0.65)	(0.51)	(0.52)	(0.93)	(0.98)	(0.76)	(0.02)	(0.98)
β_r	-9.22*	0.65	114.01	-19.26	2.82	-1.68	11.51	-5.80	0.65	-21.84
	(0.04)	(0.71)	(0.40)	(0.48)	(0.52)	(0.80)	(0.71)	(0.62)	(0.71)	(0.71)
β_R	10.55	-1.06	-183.02	43.84	3.88	-0.37	-33.03	1.55	-0.49	39.16
	(0.16)	(0.58)	(0.04)	(0.23)	(0.33)	(0.96)	(0.69)	(0.90)	(0.77)	(0.47)
R^2	0.09	0.42	0.54	0.27	0.03	0.00	0.56	0.27	0.18	0.88
					LIFE INSURANCE POST 2008					
β_y	-1.43*	0.18	-1.30	-5.97	-12.61*	-4.13*	0.04	-0.14	-22.99	-1.13
	(0.29)	(0.87)	(0.32)	(0.30)	(0.01)	(0.04)	(0.91)	(0.50)	(0.36)	(0.39)
β_π	-4.10**	2.53	-1.39	-6.63	-19.48*	5.38	0.59	1.01	-62.93	-0.93
	(0.06)	(0.23)	(0.65)	(0.66)	(0.00)	(0.14)	(0.74)	(0.53)	(0.31)	(0.65)
β_e	0.57	-0.15	0.12	-1.34	7.23*	1.99**	0.99	0.96	0.17	-0.03
	(0.12)	(0.85)	(0.79)	(0.53)	(0.00)	(0.06)	(0.28)	(0.20)	(0.95)	(0.92)
β_r	3.84*	-1.64	85.88**	6.71	-14.04*	4.74	-1.44	-2.63	29.22	-2.43
	(0.02)	(0.31)	(0.09)	(0.73)	(0.02)	(0.13)	(0.57)	(0.59)	(0.18)	(0.35)
β_R	-4.39	0.96	-17.80	-30.78	54.03*	-7.50	-1.54	-6.16	-53.74	3.30
	(0.15)	(0.69)	(0.38)	(0.11)	(0.00)	(0.20)	(0.70)	(0.45)	(0.31)	(0.36)
R^2	0.14	0.55	0.11	0.84	0.38	0.08	0.55	0.70	0.05	0.12

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

From table 3.8 above, we note that the results, in general, improve post the 2007/08 financial crisis. The variable with the most improvement is the output gap, which has moved from not having an impact on share returns of life insurers, pre 2008, to having a negative and significant impact, post 2008. This negative impact can be explained by decreases in GDP post the crisis; this decrease would in turn have negatively affected earnings across most sectors and ultimately share returns, as macroeconomic factors such as GDP and employment failed to improve after the crisis (Hall; 2010).

Table 3.8 Estimation of Non-Life Insurance Companies Share Returns

	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S. Kor.
					NON-LIFE INSURANCE PRE 2008					
β_y	-3.16	-3.40	-4.36	-7.20	4.02	-10.76	-0.27	-0.32	-52.91	-2.39
	(0.47)	(0.59)	(0.40)	(0.14)	(0.66)	(0.15)	(0.69)	(0.48)	(0.20)	(0.36)
β_π	-3.18	2.61	-1.46	-17.63	10.73	-30.14**	-0.10	-3.84	-36.64	-7.90
	(0.78)	(0.86)	(0.90)	(0.20)	(0.56)	(0.09)	(0.93)	(0.33)	(0.40)	(0.33)
β_e	-0.22	-0.01	-0.85	-0.812	-0.69	-1.17	0.17	0.28	1.45	0.37
	(0.85)	(0.99)	(0.25)	(0.68)	(0.51)	(0.48)	(0.81)	(0.70)	(0.65)	(0.52)
β_r	-3.92	-2.68	-21.32	7.68	-2.28	8.91	0.48	4.03	-43.18	-7.89
	(0.21)	(0.39)	(0.55)	(0.26)	(0.59)	(0.17)	(0.58)	(0.33)	(0.13)	(0.50)
β_R	3.59	-2.60	2.77	3.83	1.64	-0.06	-6.30	-3.31	-148.21**	12.34
	(0.12)	(0.41)	(0.80)	(0.43)	(0.38)	(0.42)	(0.47)	(0.47)	(0.08)	(0.36)
R^2	0.07	0.03	0.21	0.06	0.03	0.01	0.02	0.04	0.32	0.07
					NON-LIFE INSURANCE POST 2008					
β_y	4.77	-0.51	-7.99	-8.79	4.43	10.34*	0.25	0.48	-47.70	-3.95**
	(0.64)	(0.78)	(0.19)	(0.22)	(0.51)	(0.02)	(0.28)	(0.47)	(0.24)	(0.06)
β_π	7.36	3.90	-14.27	34.11	-3.19	8.36	-0.76	1.92	-118.92*	-1.19
	(0.69)	(0.23)	(0.32)	(0.11)	(0.68)	(0.38)	(0.57)	(0.64)	(0.21)	(0.69)
β_e	-7.07*	2.20	-0.97	-1.56	-1.85	2.44	0.23	-0.07	-21.23	0.56
	(0.01)	(0.10)	(0.60)	(0.59)	(0.35)	(0.48)	(0.69)	(0.97)	(0.35)	(0.17)
β_r	8.50	-1.51	-103.40	-48.47*	2.60	-11.19	-0.39	-14.70	-56.56	0.83
	(0.54)	(0.48)	(0.64)	(0.02)	(0.60)	(0.13)	(0.76)	(0.07)	(0.54)	(0.82)
β_R	16.20*	0.09	61.35	13.95	-2.93	0.30**	2.95*	0.95	-77.64	2.29
	(0.07)	(0.96)	(0.50)	(0.35)	(0.49)	(0.07)	(0.77)	(0.96)	(0.38)	(0.67)
R^2	0.14	0.15	0.17	0.20	0.03	0.03	0.05	0.09	0.10	0.07

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

From table 3.9, the only variable that shows an improvement in terms on the expected sign is the output gap, with the US output being positive and highly significant. These results indicate that on average, our model shows a weak relationship between macroeconomic factors and share returns in both periods under evaluation, similar result are noted by Abbas et al. (2018). However it is important to note the financial crisis had a higher corrective impact on both life and non-life insurance companies, this is seen by an improvement in the significance of some of the macroeconomic variables on share returns for most life and non-life insurers, such as GDP.

3.6 Conclusion

Upon estimating our linear share return model for developed and emerging market economies for both the life and non-life industries, we find that the theoretical relationships hold for most variable and countries. The R^2 produced by all the regressions range between 1% and 50%. These statistics are in line with those found in existing literature.

In terms of the macroeconomic relations, using panel GMM, we find that the share returns of insurers behave in a different manner compared to other financial market share returns in relation to changes in the economy and the business environment.

This is because most macroeconomic variables have a weak effect on share returns of most insurers, with the exception of interest rates. Brewer III et al. (2007), Berendes et al. (2013) and Abbas et al. (2018) support these. Furthermore, from the robustness test, we see an improvement in the relationship between share returns and GDP post the financial crisis, particularly for US.

On average, our analysis has several important implications for policy-makers. For instance, it is important to encourage both insurers and policy-makers to monitor the response of financial markets, especially share prices of insurers, to interest rate changes. Of equal importance is the detailed understanding of the transmission effects of insurance risks into the financial markets that can ultimately lead to insolvencies and to potential market bubbles, as can be seen with the contribution of AIG to the 2008/09 financial crisis (Adams, Füss, and Gropp, 2014).

CHAPTER 4: LINKAGES BETWEEN INSURANCE AND BANK RISK INDICATORS

4.1 Introduction

The integration of banking and insurance activities remains an active area of research in risk management. While Allen and Jagtiani (2000) proposes that such integration is not justified on the basis that the diversification effects are insufficient, there is growing literature that finds value in such mergers (see for example Lee, 2013, Lee and Zeng, 2016, Adams et al., 2009 and Boyd, Graham, and Hewitt, 1993).Numerous studies within this area look at the links between insurance activities and bank credit, insurance activities and economic growth as well as the spill-over effects of insurance on banking and vice versa, the industries interconnectedness and its contribution to systematic risk.

Our focus on banks and insurance risks is motivated by the growing interdependency, deregulation and financial product innovations of these two sectors. Researchers such as Adams et al. (2014) note the delicate products that interconnect banks and insurance firms, such as credit default swaps, which can be underwritten by both banks and, as evident from the 2008/9 financial crisis, insurance firms. From as early as 1989, in the European markets (Fields et al., 2007) bancassurance mergers and products have been gaining momentum in the financial services industry. Studies such as (Fields et al., 2007, Chen et al., 2009, Staikouras, 2009, Chen and Tan, 2011, Peng et al., 2017) highlight the rewards from these types of mergers as being an increase in shareholder value, a reduction in the overall company risk and diversification.

Lorent (2010) further notes the interdependency of these two sectors by highlighting the high development of Bancassurance (banking services offered by insurers) in Europe and the significance of life insurers offering financial services and investment funds in financial markets. In short, there is growing evidence of insurance firms moving into non-core activities such as derivatives trading, insuring financial products and investment management, Billio et al. (2012), that lends itself to interest in this area.

Despite the vast amount of literature in this area, little is known about the linkages between bank and insurance risk and the common drivers of this risk.

Existing research links banking risks and macroeconomic environment, however this research concentrates on periods of banking crises (Bohachova, 2008) whilst other research links insurance activity to bank activity (Liu, Yue, and Wang, 2014, Liu, and Zhang, 2016).

Importantly Adams, Füss, and Gropp, (2014) note that the extent of involvement of insurance companies in banking products and vice versa was accurately revealed in the bailout of AIG during the 2008/9 financial crisis. It is mostly at this point that markets realized the exposure of many banks to insurance risk. Using bank risk, insurance risk and macroeconomic data, this paper directly test the linkages between bank and insurance risk measures, the potential common drivers of this risk as well as the causal relationship between these risks.

Much of the debate over solvency management and Basel II is centred on, tighter solvency standards. The recommendation is that these solvency standards can be through regulating and stipulating the adequate level of capital required. Regulated capital levels are important in order to maintain solvency, risk management, economic capital modelling, and supervision as well as market discipline (see Elder et al., 2009 and Bartram et al., 2007).

Empirically there is a relationship between banking and insurance. This research will facilitate policymakers understanding of the common risk drivers between banks and insurance, the casual relationships and the spillover effects of risks between these two sectors. Moreover, the results of this study are anticipated to extend policymakers understanding of the complexity of financial market integration and hence the extent of risk transmission in each domestic economy.

This study will also serve as a potential guide to monetary policy authorities on the exchange rate and interest rate regime that will affect the two largest players in the financial services sector. In addition, the research will broaden government knowledge on the effectiveness, or lack thereof, of solvency assessment and management and Basel policies, in accurately managing the risks in these two sectors.

In the same spirit, investigating these risk characteristics can provide useful information to investors and policymakers about the risk spillovers and the impact of these spillovers on the financial stability of these two sectors, which have a significant contribution to the financial system. This will aid the decision making process regarding the collaborative developments in the sectors, innovation of financial products and the setting and adjusting of certain macroeconomic variables.

Furthermore some of the countries in this study are relevant as they have high insurance penetration, for both life and non-life insurance, based on the ratio of direct gross premiums to GDP (OECD, 2014). For example, countries like the USA, UK, Japan, Germany and France have penetration percentages of 8.3%, 11.6%, 7.0%, 6.8% and 8.8% respectively (OECD, 2014).

We add to the exiting literature, Liu et al. (2014), Liu and Lee (2014), Adams et al. (2014) and Liu and Zhang (2016), by undertaking a microscopic analysis of the linkages between insurance and banking risk measures. The question we ask is whether these risks are linked due to natural synergies in the activities of these two financial institutions or are they linked because there are common macroeconomic factors such as GDP, interest rates and exchange rates that drive the linkages.

We make three main contributions to the literature. First we derive a model that links insurance risk indicators (growth rate in reserves, the solvency ratio and the underwriting expense ratio) to banking risk indicators (loan loss provisions, the capital adequacy ratio and the cost-income ratio). Second, we embed macroeconomic factors common to both insurance and banking, in the formulation of the model.

These contributions are noteworthy as they sensitize policymakers to the relationship between the risks in these two sectors and the binary effect of certain macroeconomic variables on the financial system. Third, we run a VAR on the error terms to ascertain whether the components that are independent of the common macroeconomic factors are correlated.

This chapter connects with chapters two and three, in that it allows us to ultimately investigate the risk environment and performance of insurance companies in cultivating a holistic risk conscious approach and reducing insolvencies and externalities. Once we have an idea of what drives risk (chapter 2) in insurance companies and the effect of macroeconomic variables on the share prices of insurance companies (chapter 3), we extend the study on risk to the banking sector (chapter 4), combining these two large players in the financial services sector.

The remainder of this paper is structured as follows: Section 2 reviews existing literature, in Section 3 we formulate a model that links insurance and banking risks and describe the data, Section 4 estimates the model's parameters and Section 5 concludes with some policy recommendations.

4.2 Literature Review

Global financial integration mandates regulatory authorities to focus on the rapid rise in banking risks and the proceeding systematic risk. Numerous studies have paid particular attention to credit risk and drivers of this risk in banking, Jiménez and Saurina (2004), Ahmad and Ariff (2007), Bonfim (2009), Ali and Daly (2010) and Castro (2013) provide an empirical analysis of the causes of the probability of default (PD) of bank loans in the Spanish banking sector. Their findings suggest that loans from savings banks, collateralized loan and bank-borrower relations contribute to a higher probability of default.

On the other hand, Ahmad and Ariff (2007) find that management quality and regulatory capital change credit risk. Other contributory factors include profitability, liquidity and solvency (Bonfim, 2009), using dynamic panel data Castro (2013) finds GDP and credit growth and interest and unemployment rates.

Systematic risk in banking and the spillover effect on the economy is another area of interest amongst financial researchers. Acharya (2009), model systematic risk by looking at the correlation across assets of different banks, parts of the study focus on the likelihood of default by banks on deposits and financial externalities from failure amongst banks. The results show that bank closure policy and capital adequacy requirements heighten systematic risk.

Contrary to studies that find systematic risk between banks, Bartram et al., (2007) assess the strength of the transmission mechanism between banks, using a sample of 334 banks in 28 countries; their research shows slight confirmation of systemic transmission of financial shocks in developed economies even before Basel II capital rules. Despite its importance, little is known about the ties between banking and insurance risk indicators. Existing research mostly focuses on:

4.2.1 Insurance Activities and Banking Credit

Liu, He, Yue and Wang (2014) inspect the long-run and short-run linkages between insurance activity and banking credit for G-7 countries, using Johansen cointegration test with GMM-IV estimator. Liu & Lee (2014), by means of an advanced bootstrap VAR model with a fixed rolling window, examine the underlying connection between insurance activities and banking credit in China.

Results from Liu, He, Yue and Wang (2014) show that only France and Japan have predictive power from life insurance activity to banking credit and that the short-run causal relationships between non-life insurance activity and banking credit is country-specific. Whilst the study by Liu & Lee (2014) indicates that none of the traditional VAR models have stable parameters, and therefore the full sample results are unreliable. However from the rolling window results the authors note that the causal links between insurance activities and banking credit are time varying.

Liu and Zhang (2016) extend studies in this area by showing the long- and short-run dynamic linkages between insurance activities and banking credit for 45 countries within three income levels from 1980 to 2011. Using panel cointegration and VAR model analysis, the authors find that there is a positive and significant cointegration relationship between insurance and banking in most of the countries examined, however this relationship varies across different income levels and sample periods.

Furthermore, Liu and Zhang, (2016) discover that there is a unidirectional causality relationship between life insurance and banking credit and non-life insurance and banking credit in countries with low and high income respectively. On the other hand, they find bidirectional causality between life insurance and banking credit in high-income countries. Chen et al. (2013), finds a stronger and longer bidirectional relationship, having corrected for conditional heteroscedasticity, of banks on insurers compared to insurers on banks.

4.2.2 Insurance Activities and Economic Growth

We also note that there is a growing body of literature that specifically focuses on the relationship between insurance and economic growth and development.

For example, Adams et al. (2009) use time-series data spanning from 1830 to 1998, to observe the historical relation between insurance, commercial bank lending and economic growth in Sweden. The researchers are able to show that economic growth and bank lending is Granger caused by insurance with a four-year lag, whilst bank lending does not have the same effects on economic growth or insurance.

Using bootstrap Granger causality test Liu, Lee, Lee (2016) argue that there is a long and short run linkage and time-lagged causality, respectively, between insurance activity and economic growth in G-7 countries. The results show that this relationship varies across different countries and that the positive impact of non-life insurance on economic growth is bigger compared to that of life insurance. In addition, Haiss and Sumegi (2008) investigate both the influence of insurance investment and premiums on GDP growth in Europe. Using a panel data of 29 European countries, they find positive influence of life insurance on GDP growth in 15 of the 29 countries

Lee, Lee and Chiu (2013) implement the panel seemingly unrelated regressions augmented Dickey-Fuller (SURADF) in testing the relationship between real life insurance premiums per capita and real gross domestic product (GDP) per capita for 41 countries with different income levels. Their results indicate that a 1% increase in the real life premium raises real GDP by 0.06%, in the long run. These results also indicate that there exists bidirectional casualties between life insurance markets and economic growth in both the long and short run.

Other studies, with similar results, in this area include Ward and Zurbruegg (2000), Arena (2008) and Lee (2013). However, Lee, Lee and Chiou (2017), find that on the contrary, high levels of insurance activity have a negative effect on economic growth.

4.2.3 Insurance and Bank Spillovers

The activities of Banks and Insurance companies have direct and indirect effects on each other; this effect is further enhanced by financial liberalization that has taken place. The literature on the effects of these spillovers is mixed, however Lee, Lin and Zeng (2016) note the role of insurance markets in reducing banking and currency crises.

One strand of literature highlights the negative spillover effects of insurance activities on banking activities such as Allen and Jagtiani (2000), who find that the diversification effects of insurance on banking are not sufficient to validate banks expanding their activities into insurance underwriting.

Whilst another strand notes the risk reducing effects of life insurance when merged with a Bank Holding Company (BHC), (Boyd, Graham, and Hewitt, 1993). They do this by comparing the risk characteristics of unmerged BHCs with that of the simulated merges between BHC's and non-banking financial services firms.

The other focus of literature in this area is on the interconnectedness of banks and insurance activities and hence its effect on systematic risks. For instance Adam et al. (2014; 577) reminds us that "the exposure of many banks to American International Group (AIG) via credit default swap (CDS) contracts was basically unknown to investors and was only revealed after AIGs bailout in Sept. 2008, when a list of banks that benefited most from the rescue package was published".

Adam et al. (2014) investigate the risk spillovers amongst financial institutions, (insurance companies, commercial and investment bank and hedge funds) by deriving a state-dependent sensitivity value-at-risk (SDSVaR) model and estimates it using quantile regressions. This model allows them to measure the duration, direction and size of the risk spillover; they find that the size and duration of risk spillovers are subject to the state of the market.

In relation to banks and insurance activities, Adam et al. (2014) find that a 1% rise in the VaR of hedge funds leads to a 0.28% rise in the VaR of commercial banks and a 0.34% rise in the VaR of insurance companies, in periods of market distress. Furthermore, this study notes that in periods of market calmness and volatility, banks progressively affect insurance companies.

Another important study in the areas is that by Billio, Getmansky, Lo and Pelizzon (2012), the aim of this study is to measure the connectedness of insurance companies, banks, hedge funds and broker/dealers.

Specifically they Billio et al. (2012) principal-components analysis and Granger-causality and discover that banks play a key role in transmitting shocks as compared to the other financial institutions. However all four sectors have become highly correlated over time which is increasing the level of systematic risk in the insurance and finance industries through a intricate web of relationships.

In addition, Bernal, Gnabo, and Guilmin (2014) add to the existing discussion on systematic risk by evaluating the overall risk arising from the financial system by paying attention to the following sectors; banks, insurance and other financial services in the USA and Europe. Bernal et al. (2014) use a CoVaR systemic risk measure and find that in the Eurozone, banks are the most systematically riskier compared to the other financial services. Whilst in the USA, the insurance sector contributes the most to systematic risk. On average, the three sectors studied have the largest contribution to this risk.

The existing literature investigates broadly the transmission mechanisms of risks from one institution to another, the contribution of these institutions to systematic risk, as well as the relationship between banking and insurance. However with the same breath this section points out the gap in literature concerning an analysis on the linkages between bank and insurance risk measures, the potential common drivers of this risk as well as the short-run and long-run causal relationship between these risks.

4.3. Theoretical Modelling

4.3.1 Data

We use annual data obtained from Thompson-Reuters DataStream and the Organization for Economic Cooperation and Development Statistics Database (OECD Stats) for the period 1988 to 2017. To empirically test our model we run an advance rolling panel vector autoregression for the 10 countries in our study.

We link insurance risk indicators used in Chapter 1 to bank risk such as loss provisions, cost-income ratio and capital adequacy ratio. We then embed macroeconomic factors, such as long and short interest rates proxied by 10-year government bonds and the 3-month Treasury bill rate respectively, exchange rates proxied by the real effective exchange rates and the gross domestic product (GDP). These macroeconomic variables are common to both insurance and banking and are used in the formulation of the model.

The insurance risk indicators we use are the growth rate in reserves, the solvency ratio, which is computed by diving written premiums by capital and surplus, and the underwriting expenses, computed by dividing the underwriting expenses by earned premiums. The matching bank risk indictors are the loan loss provisions, the capital adequacy ratio calculated by dividing tier 1 capital by net revenue and the cost income ratio calculated by taking a ratio of operating expenses and risk weighted assets, respectively. Finally, we run a VAR on the error terms to establish whether the components that are independent of the common macroeconomic factors are correlated.

As part of the data transformation, most variables are log transformed (see Chang et al., 2012), with the exception of interest rates, and we conduct stationarity tests. Furthermore we difference most macroeconomic variables, prior to estimating, in line with existing literature, as most macroeconomic variables are non-stationary (See Hosseini et al., 2011).

Table 4.1 Description of Variables and their data sources

Variables	Definition	Data Source
	Dependent Variables	
ΔK_t^i	Loss Reserves= Δ in loss reserves/loss reserves	Thompson Reuters DataStream
SR_t^i	Solvency Ratio = Net written premiums/capital and surplus	Thompson Reuters DataStream
UER_t^i	Underwriting Expense Ratio = underwriting expenses/net premiums	Thompson Reuters DataStream
LLP_i^b	Provision for loan losses	Thompson Reuters DataStream
CAR_t^b	Capital Adequacy Ratio=Tier1 capital/Risk Weighted Assets	Thompson Reuters DataStream
$CIR_{i,t}$	Cost Income Ratio=Operating Costs/Operating Income	Thompson Reuters DataStream
	Independent Variables	
$e_{i,t}$	Exchange rate	OECD and FRED
$r_{i;t}$	Interest rates	OECD and FRED
$y_{i,t}$	Gross Domestic Product	OECD and FRED

Table 4.1 above summaries the notation, measurement and data source for the variables in the study.

4.3.2 Descriptive statistics

Tables 4.2 and 4.3 below, display the summary statistics for the life, non-life and banking sectors for the variables under consideration in our model. We note that, on average, the growth in reserves data is positively skewed with the frequency of the data displayed being positive. The data confirms that reserves, in most countries that have experienced tighter regulation, have indeed been growing, whilst the dispersion is stable remaining below 1 standard deviation away from the mean. The loan loss provisions in the banking sector are also skewed positively; however, these reserves are higher compared to the ones in insurance and exhibit a wider spread, again the motivation for higher reserves can be found in Basel III regulation.

We anticipate that the solvency ratio will be positive, indicating that more insurers have remained solvent and going concerns. This is confirmed in the data as all means are positive, an indication again that the tighter regulations post the financial crisis have been effective. There are however, a few high mean and standard deviation values this could be as a result of the increased capital and surplus requirement due to stricter regulation. Similarly, the Capital Adequacy Ratio in banking is positive but is much lower and steady, fluctuating around 0.

The underwriting expense ratios are positively skewed, demonstrating a potential rise in the underwriting expense of most insurers. Comparing this ratio to the cost-income ratio in banking, we note that on average costs for both sectors have been increasing with cost-income ratio also displaying a positive mean; however, the costs have been increasing at a higher rate for banking compared to insurance.

Table 4.2 Descriptive Statistics for Life Insurance and Banking

	Can.			Fra.			Jap.			Swi.			UK			USA		
Var.	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
ΔK_t^i	435	0.02	0.02	377	0.02	0.02	1192	0.00	0.01	754	0.02	0.02	522	0.03	0.40	899	0.03	0.02
SR_t^i	435	57.34	86.50	977	41.88	58.39	1192	0.65	2.97	754	67.04	89.97	522	8.47	8.92	899	8.47	8.91
UER_t^i	435	0.15	0.04	377	0.06	0.04	1192	0.00	0.00	754	0.06	0.02	522	0.18	0.05	899	0.18	0.05
LLP_i^b	260	11.92	2.00	263	11.53	2.35	762	9.99	1.96	392	9.44	1.95	235	12.52	2.52	687	7.13	1.69
CAR_t^b	138	0.11	0.02	76	0.19	0.26	444	0.35	1.08	222	0.19	0.22	125	0.12	0.04	430	0.13	0.07
CIR_t^b	108	270.44	3593.52	238	0.69	0.17	778	0.88	0.18	518	0.94	0.36	229	1.76	7.46	703	0.86	0.28
y_t	435	2.76	0.06	377	3.28	0.03	184	4.00	0.06	754	1.71	0.08	522	3.23	0.06	899	5.03	0.04
r_t	1194	0.01	0.02	1199	0.00	0.01	1136	0.00	0.00	1199	0.00	0.01	1190	0.01	0.03	899	0.03	0.03
R_t	435	0.06	0.03	377	0.05	0.01	1192	0.00	0.01	754	0.03	0.02	522	0.06	0.02	899	0.05	0.02
e_t	435	4.48	0.12	377	4.61	0.04	232	4.61	0.16	754	4.57	0.07	522	4.69	0.09	899	4.67	0.07

	Ind.			Mal.			S.Afr			S.Kor		
Var.	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
ΔK_t^i	663	0.00	0.00	210	0.06	0.36	153	0.12	0.12	160	0.43	0.85
SR_t^i	702	5.96	9.25	220	332.24	747.24	153	7.04	3.50	173	95.31	257.67
UER_t^i	546	0.09	0.05	220	0.22	0.14	153	0.16	0.06	170	0.14	0.04
LLP_i^b	447	9.07	2.63	212	11.16	1.26	131	12.30	1.38	140	12.23	1.77
CAR_t^b	335	0.16	0.08	134	0.11	0.03	64	0.18	0.16	25	0.11	0.02
CIR_t^b	434	0.92	0.61	233	2.56	0.89	124	5.77	24.53	170	966.86	230.47
y_t	780	22.43	0.35	230	21.27	0.39	207	1.42	0.16	180	2.36	0.06
r_t	183	0.01	0.04	184	0.00	0.01	184	0.07	0.05	183	0.02	0.02
R_t	780	0.16	0.05	210	0.05	0.01	207	0.10	0.03	180	0.04	0.02

e_t	780	4.44	0.17	230	4.61	0.09	207	4.51	0.14	180	4.75	0.14

Table 4.3 Descriptive Statistics for Non-Life Insurance and Banking

	Can.			Fra.			Jap.			Swi.			UK			USA		
Var.	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
ΔK_t^i	354	0.03	0.02	377	0.07	0.25	1120	0.00	0.00	754	0.04	0.17	522	-0.08	0.43	899	0.03	0.02
SR_t^i	345	71.41	92.05	377	5.17	1.52	1120	21.91	10.98	728	10.56	11.56	522	163.72	469.05	320	3.33	2.21
UER_t^i	345	0.15	0.03	377	0.12	0.02	1120	0.15	0.05	754	0.20	0.05	522	0.28	0.13	1120	0.20	0.02
LLP_i^b	260	11.92	2.00	263	11.53	2.35	762	9.99	1.96	392	9.44	1.95	235	12.52	2.52	687	7.13	1.69
CAR_t^b	138	0.11	0.02	76	0.19	0.26	444	0.35	1.08	222	0.19	0.22	125	0.12	0.04	430	0.13	0.07
CIR_t^b	26	0.55	1.07	238	0.69	0.17	778	0.88	0.18	518	0.94	0.36	229	1.76	7.46	703	0.86	0.28
y_t	435	2.76	0.06	377	3.28	0.03	184	4.00	0.06	754	1.71	0.08	522	3.23	0.06	899	5.03	0.04
r_t	435	0.04	0.03	377	0.04	0.03	1136	0.00	0.00	754	0.02	0.03	522	0.05	0.04	899	0.03	0.03
R_t	435	0.06	0.03	377	0.05	0.02	1192	0.00	0.01	754	0.03	0.02	522	0.06	0.02	899	0.05	0.02
e_t	435	4.48	0.12	377	4.61	0.04	232	4.61	0.16	754	4.57	0.07	290	4.69	0.09	899	4.67	0.07
	Ind.			Mal.			S.Afr			S.Kor								
Var.	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev						
ΔK_t^i	897	0.13	0.21	230	0.10	0.12	180	0.02	0.43	230	0.15	0.09						
SR_t^i	897	17.27	10.45	230	12.62	3.78	180	424.90	724.85	230	23.43	11.83						
UER_t^i	897	0.18	0.07	180	0.22	0.07	180	0.26	0.07	230	0.13	0.06						
LLP_i^b	435	9.06	2.66	190	11.34	1.13	123	12.35	1.41	139	12.25	1.76						
CAR_t^b	334	0.16	0.08	134	0.11	0.03	64	0.18	0.16	25	0.11	0.02						
CIR_t^b	425	0.92	0.62	211	2.66	0.87	116	5.99	25.36	163	979.20	225.72						

y_t	780	22.43	0.35	230	21.27	0.39	207	1.42	0.16	180	2.36	0.06
r_t	702	0.12	0.08	230	0.03	0.01	207	0.09	0.04	187	0.04	0.02
R_t	780	0.16	0.05	210	0.05	0.01	207	0.10	0.03	180	0.04	0.02
e_t	780	4.44	0.17	230	4.61	0.09	207	4.51	0.14	180	4.75	0.14

4.4 Model Specification

To explore the linkages between insurance and bank risk measures we use panel VAR granger causality tests also used by Liu et al. (2014) and Liu and Zhang (2016), who test the short-and long run relationship between bank credit and insurance activity. Liu and Lee (2014) and Liu and Zhang (2016) critique traditional VAR models as they exhibit unstable parameters and advocate for advanced rolling VAR models that have much more reliable results and account for the time-varying causal relationship between insurance and banking risk measures.

We begin by running Seemingly Unrelated Regressions (SUR), the error terms obtained from these regressions are then tested for correlation. We however note the criticism levied by Adams et al. (2014) on these correlation methods and hence we run a VAR on the error terms to ascertain whether or not the components that are independent of the common macroeconomic factors are correlated. The next estimation technique, panel VAR granger causality tests, assists us in determining the causal relationship between these risks. The last estimation techniques we use to measure these spills between banking and insurance risk are impulse response functions following Adams et al. (2014). We estimate the panel VAR, and then we run impulse response functions to identify the spillovers.

Practically we start by first estimating Seemingly Unrelated Regressions of the risk pairs for both insurance and banking, then we extract the error terms from the SUR risk pairs. In the next step we run panel VAR estimations on the error terms, then from these models we track the impulse response functions of the error terms for each risk pair to measure the spill overs.

The measures of risks that we use for the insurance sector are growth rate in reserves, which can be linked to loan loss provisions in banking, the solvency ratio that can be linked to the capital adequacy ratio in banking and the underwriting expense ratio, which can be linked to the cost-income ratio in banking. These risk indicators allows us to analyse different aspects of the financial sector such as asset quality, efficiency and solvency.

We specify our model as follows:

$$\begin{bmatrix} y_t^b \\ y_t^i \end{bmatrix} = \begin{bmatrix} \alpha_0 \\ \beta_0 \end{bmatrix} + \begin{bmatrix} 0 & y_t^i \\ y_t^b & 0 \end{bmatrix} \begin{bmatrix} \alpha_i \\ \beta_b \end{bmatrix} + \begin{bmatrix} X_t^b \\ X_t^i \end{bmatrix} \begin{bmatrix} \alpha_b \\ \beta_i \end{bmatrix} + \begin{bmatrix} \varepsilon_t^b \\ \varepsilon_t^i \end{bmatrix} \qquad (1)$$

Where y_t^b and y_t^i denotes banking and insurance risk indicators, X_t denotes a vector of common macroeconomic factors such as GDP, interest rate, exchange rates and inflation rates associated with banking and insurance and ε_t denotes the error term.

Next, we specify the following VAR process:

$$\begin{bmatrix} \Delta y_t^b \\ \Delta y_t^i \end{bmatrix} = \begin{bmatrix} -\lambda y^b & 0 \\ 0 & -\lambda y^i \end{bmatrix} \begin{bmatrix} \epsilon_{yt-1}^b \\ \epsilon_{yt-1}^i \end{bmatrix} + \begin{bmatrix} \theta_b(L) & \varphi_i(L) \\ \varphi_b(L) & \gamma_i(L) \end{bmatrix} \begin{bmatrix} \Delta y_{t-1}^b \\ \Delta y_{t-1}^i \end{bmatrix} + \begin{bmatrix} \eta_t^b \\ \eta_t^i \end{bmatrix} \qquad (2)$$

Simplifying the above VAR process into an equation, we obtain:

$$q_t = \Omega \epsilon_{yt-1} + \Phi q_{t-1} + \varepsilon_y \qquad (3)$$

4.5 Empirical Results

As a first step, we estimate seemingly unrelated regressions (see results in tables 4 A-D of the appendix), using the error terms from the SUR regressions we test for correlation, to see the independence of other factors from macroeconomic factors. Table 4.4, below, displays these correlation results.

4.5.1 Correlation of Independent Factor

In a system of models there is potential bias in the equations, this is because the error term can be correlated to the explanatory variables, in the equations. In this part of the work, we test whether or not the insurance risk and banking risk variables are correlated, by running a VAR on the errors terms obtained from the SUR regressions and reporting on the correlations of these error terms.

Table 4.4 Correlation of Residuals for Life Insurance and Banking System

Life Insurance and Banking

	Can.			Fra.			Jap.			Swi.			UK		
Var.	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}
$\alpha^i_{\Delta k}$	-0.03	-0.16	-0.74	0.35	0.28	0.26	-0.55	-	-	-0.13	-0.13	0.14	-0.24	-0.04	-0.65
α^i_{SR}	-0.25	-0.76	-0.61	-0.28	-0.37	-0.15	-	-0.47	-	0.23	0.09	0.27	-0.01	-0.29	0.02
α^i_{UER}	0.05	-0.25	-0.59	0.11	0.28	-0.36	-	-	-	0.05	-0.12	0.01	0.44	-0.04	0.46

	USA			Ind.			Mal.			S.Afr			S.Kor		
Var.	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}
$\alpha^i_{\Delta k}$	-0.12	0.09	-0.11	-0.21	-0.20	-	0.27	-0.06	-0.20	-0.22	0.21	0.53	0.23	-	-0.19
α^i_{SR}	-0.19	0.09	-0.13	-0.16	-0.25	-	0.12	0.69	-0.15	-0.10	0.24	0.46	-	-	-
α^i_{UER}	0.04	0.04	0.05	-	-	-	0.04	-0.05	-0.12	0.32	-0.18	-0.63	-0.27	-	0.54

Banking and Life Insurance

	Can.			Fra.			Jap.			Swi.			UK		
Var.	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}
β^b_{LLP}	-0.03	-0.25	0.05	0.35	-0.28	0.11	-0.55	-	-	-0.13	0.23	0.05	-0.24	-0.01	0.44
β^b_{CAR}	-0.16	-0.76	-0.25	0.28	-0.37	0.28	-	-0.47	-	-0.13	0.09	-0.12	-0.04	-0.29	-0.04
β^b_{CIR}	-0.74	-0.61	-0.59	0.26	-0.15	-0.36	-	-	-	0.14	0.27	0.01	-0.65	0.02	0.46

	USA			Ind.			Mal.			S.Afr			S.Kor		
Var.	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}
β^b_{LLP}	-0.12	-0.19	0.04	-0.21	-0.16	-	0.27	0.12	0.04	-0.22	-0.10	0.32	0.23	-	0.19
β^b_{CAR}	0.09	0.09	0.04	-0.20	-0.25	-	-0.06	0.69	-0.05	0.21	0.24	-0.18	-	-	-
β^b_{CIR}	-0.11	-0.13	0.05	-	-	-	0.20	-0.15	-0.12	0.53	0.46	-0.63	-0.19	-	0.54

Table 4.5 Correlation of Residuals for Non-Life Insurance and Banking System

Non-Life Insurance and Banking

	Can.			Fra.			Jap.			Swi.			UK		
Var.	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}
$\alpha^i_{\Delta k}$	-0.04	-0.32	-	0.45	-0.20	-	0.07	0.35	0.25	-0.10	-0.31	0.41	-0.37	-	0.21
α^i_{SR}	-0.14	-0.66	-	-	-	-	-0.16	-0.65	-0.21	-0.06	0.21	0.01	-	-0.02	0.01
α^i_{UER}	-	-	-	0.32	-	-0.35	0.07	-0.03	0.30	0.06	-0.11	-0.24	0.03	-0.01	0.01

	USA			Ind.			Mal.			S.Afr			S.Kor		
Var.	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}
$\alpha^i_{\Delta k}$	0.07	-0.05	0.08	-0.20	0.06	0.05	0.61	0.12	0.43	0.85	0.34	0.19	0.06	-	-0.20
α^i_{SR}	0.01	-0.03	0.13	0.06	0.09	0.09	0.13	0.10	0.27	-0.01	0.23	0.16	-	-	-
α^i_{UER}	0.03	0.07	-0.11	-0.25	-0.13	0.48	0.76	0.11	-0.01	-0.16	-0.64	-0.10	0.25	-	0.04

Banking and Non-Life Insurance

	Can.			Fra.			Jap.			Swi.			UK		
Var.	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}
β^b_{LLP}	-0.04	-0.14	-	0.45	-	-0.32	0.07	-0.16	0.07	-0.10	-0.06	0.06	-0.37	-	0.03
β^b_{CAR}	-0.32	-0.66	-	-	-	-	0.35	-0.65	-0.03	-0.31	0.21	-0.11	-	-0.02	-0.01
β^b_{CIR}	-	-	-	-0.20	-	-0.35	0.25	-0.21	0.30	0.41	0.01	-0.24	0.21	0.01	0.01

	USA			Ind.			Mal.			S.Afr			S.Kor		
Var.	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}
β^b_{LLP}	0.07	0.01	0.03	-0.20	0.06	-0.25	0.61	0.13	0.76	0.85	-0.01	-0.16	0.06	-	0.25
β^b_{CAR}	-0.05	-0.03	0.07	0.06	0.09	-0.13	0.12	0.10	0.11	0.34	0.23	-0.64	-	-	-
β^b_{CIR}	0.08	0.13	-0.11	0.05	0.09	0.48	0.43	0.27	-0.01	0.19	0.16	-0.10	-0.20	-	0.04

From table 4.4 we note that the components that are independent of the macroeconomic variable have a low negative correlation to each other. In other words, most of the life insurance and banking risk variables move in opposite directions to each other. This is indicative of a diversified financial system in both developed and emerging markets, with the developed countries leading. These results are supported by studies that look at mergers and acquisitions between banks and insurance companies, which find that total risks remain constant, there are no changes to systematic risk and that there are positive wealth effects from these merges (see Boyd et al., 1993, Fields, 2004, Chen and Tan, 2011 and Lee et al., 2016).

The results displayed in table 4.5 for non-life and banking, are contrary to the results in table 4.4. Non-life and banking risk variables are positively correlated; however, the correlation is low for most components that are independent of macroeconomic variables. Conversely, the underwriting expense ratio and loan loss provisions in Malaysia and insurance reserves and loan loss provisions in South Africa show a high level of correlation. These results are indicating possible systematic risk and lack of diversification of the financial markets, as represented by insurance and banking, with emerging markets leading (See Billio et al., 2012 and Bernal et al. 2014).

4.5.2 Causal Relationships

In this section of the estimations, we look at whether or not there is granger causality of the variables in our insurance and banking system. Put differently do the insurance risk variables contain useful information for predicting banking risk variables, over and above the past histories of the other variables (macroeconomic variables) in the system, and vice versa. This is because we anticipate that an increase in the error term of the banking equation (ε_t^b) will cause y_t^b to increase in equation 1, then if y_t^b increases y_t^i will also increase because of the relationship is the second part of equation 1, if y_t^i increases it also increases the first part of equation 1 where it is an explanatory variable.

We beginning by running unit root estimations before conducting VAR granger causality tests, these results are presented in the appendix for chapter 4, in tables' 4E-F. The results in tables' 4E-F show that, on average, most of the variables in the system are stationary, however macroeconomic variables are generally non-stationary and as such most of them have been differenced.

We test for the following causality relationships:

a) Bank risk and macroeconomic variables granger cause insurance risk variables
b) Insurance risk and macroeconomic variables granger cause bank risk variables
c) There is bidirectional feedback i.e. causality among the variables and
d) The variable are independent

Table 4.6 VAR Granger Causality Results for Life Insurance

	Can.			Fra.			Jap.		Swi.			UK		
Var.	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}
β^b_{LLP}	16.57*	9.12*	1.21	0.64	6.50*	0.99	26.61*	1.06	4.29	0.65	14.78*	0.78	4.41	2.54
	(0.00)	(0.01)	(0.55)	(0.73)	(0.04)	(0.61)	(0.00)	(0.59)	(0.12)	(0.72)	(0.00)	(0.67)	(0.11)	(0.28)
β^b_{CAR}	2.20	44.39*	42.02*	2.48	5.28**	0.35	0.33	3.88	3.32	2.09	3.55	5.719**	2.72	1.69
	(0.33)	(0.00)	(0.00)	(0.29)	(0.07)	(0.84)	(0.85)	(0.14)	(0.19)	(0.35)	(0.17)	(0.06)	(0.26)	(0.43)
β^b_{CIR}	49.06*	15.89*	4.63**	22.57*	6.91*	42.99*	1.20	0.95	24.96*	14.91*	10.14*	9.70*	2.78	8.38*
	(0.00)	(0.00)	(0.09)	(0.00)	(0.03)	(0.00)	(0.55)	(0.62)	(0.00)	(0.00)	(0.01)	(0.01)	(0.25)	(0.02)
y_t	6.05*	2651.59*	0.19	49.73*	14.07*	21.82*	0.00*	0.00*	34.33*	167.68*	16.49*	9.99*	13.37*	4.71**
	(0.05)	(0.00)	(0.91)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.09)
r_t	0.98	0.60	19.05*	2.51	0.81	0.53	0.00*	0.00*	7.25*	1.59	0.73	21.14*	22.24*	1.39
	(0.61)	(0.74)	(0.00)	(0.29)	(0.67)	(0.77)	(0.00)	(0.00)	(0.03)	(0.45)	(0.69)	(0.00)	(0.00)	(0.52)
R_t	145.68*	164.99*	7.57*	247.82*	233.69*	35.49*	0.00*	0.00*	222.33*	9.28*	12.24*	20.10*	55.81*	6.59*
	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.04)
e_t	9.75*	1014.18*	3.34	15.21	377.10*	15.78*	89.51*	0.00*	21.75*	5.30**	11.43*	14.57*	4.65**	3.36
	(0.01)	(0.00)	(0.19)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)	(0.00)	(0.00)	(0.09)	(0.19)

	USA			Ind.			Mal.			S.Afr.			S.Kor	
Var.	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{UER}
β^b_{LLP}	1.32	13.29*	0.07	0.76	0.29	0.55	2.78	2.86	0.71	6.80*	5.70**	0.25	3.58	2.68
	(0.52)	(0.00)	(0.97)	(0.68)	(0.87)	(0.76)	(0.25)	(0.24)	(0.70)	(0.03)	(0.06)	(0.88)	(0.16)	(0.26)
β^b_{CAR}	2.68	2.48	2.79	2.12	0.06	1.10	2.02	2.15	14.36*	3.58	1.23	0.22	-	-
	(0.26)	(0.29)	(0.25)	(0.35)	(0.97)	(0.58)	(0.37)	(0.34)	(0.00)	(0.17)	(0.53)	(0.89)	(-)	(-)
β^b_{CIR}	105.36*	57.47*	2.91	6.31*	2.97	16.01*	4.87**	3.25	7.16*	22.96*	33.87*	3.57	7.03*	8.10*
	(0.00)	(0.00)	(0.23)	(0.04)	(0.23)	(0.03)	(0.09)	(0.20)	(0.03)	(0.00)	(0.00)	(0.17)	(0.03)	(0.02)
y_t	96.58*	832.28*	210.94*	6.37	27.10*	56.10*	73.36*	20.53*	52.03*	11.68*	2.91	27.65*	39.76*	19.8*
	(0.00)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.23)	(0.00)	(0.00)	(0.00)

r_t	28.68*	287.98*	163.7*	0.17	0.48	1.57	2.58	1.95	1.79	13.74*	2.79	0.78	0.14	6.34*
	(0.00)	(0.00)	(0.00)	(0.92)	(0.79)	(0.46)	(0.28)	(0.38)	(0.41)	(0.00)	(0.25)	(0.68)	(0.93)	(0.04)
R_t	16.12*	759.82*	191.02*	10.91*	18.38*	38.83*	495.21*	2.15	24.86*	1.13	11.49*	11.46*	89.32*	13.74*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.34)	(0.00)	(0.57)	(0.00)	(0.00)	(0.00)	(0.00)
e_t	247.01*	451.14*	41.67*	7.78*	124.87*	45.97*	241.86*	9.61*	27.60*	67.74*	0.39	60.99*	146.89*	16.78*
	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.82)	(0.00)	(0.00)	(0.00)

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

Table 4.7 VAR Granger Causality Results for Banking and Life Insurance

	Can.			Fra.			Jap.		Swi.			UK		
Var.	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}
$\alpha^i_{\Delta k}$	4.29	0.24	0.45	3.93	0.99	1.27	6.51*	0.59	8.17*	2.83	22.37*	5.94*	3.75	4.52
	(0.12)	(0.89)	(0.81)	(0.14)	(0.61)	(0.53)	(0.04)	(0.74)	(0.01)	(0.24)	(0.00)	(0.05)	(0.15)	(0.10)
α^i_{SR}	0.64	6.15*	0.30	0.33	6.95*	10.50*	1.24	7.64*	0.34	1.63	12.91*	3.98	2.08	0.73
	(0.73)	(0.05)	(0.86)	(0.85)	(0.03)	(0.01)	(0.54)	(0.02)	(0.84)	(0.44)	(0.00)	(0.14)	(0.35)	(0.69)
α^i_{UER}	0.67	7.97*	1.94	1.55	2.71	1.61	-	-	0.95	15.60*	0.91	6.03*	3.10	0.69
	(0.71)	(0.02)	(0.38)	(0.46)	(0.26)	(0.45)	(-)	(-)	(0.62)	(0.00)	(0.63)	(0.05)	(0.21)	(0.71)
y_t	14.83*	35.16*	0.43	1.03	7.09*	2.44	7.81*	3.91	4.43	2.24	1.09	3.52	5.13**	5.25**
	(0.00)	(0.00)	(0.81)	(0.60)	(0.03)	(0.30)	(0.02)	(0.14)	(0.11)	(0.33)	(0.58)	(0.17)	(0.08)	(0.07)
r_t	0.53	0.95	8.98*	1.03	1.51	0.14	5.91*	1.67	0.34	0.27	0.31	3.72	0.15	1.31
	(0.77)	(0.62)	(0.01)	(0.60)	(0.47)	(0.93)	(0.05)	(0.43)	(0.84)	(0.88)	(0.85)	(0.16)	(0.93)	(0.52)
R_t	1.71	3.44	1.60	8.95*	17.90*	0.99	10.88*	3.26	7.70*	10.73*	63.32*	3.46	1.74	0.94
	(0.42)	(0.18)	(0.44)	(0.01)	(0.00)	(0.61)	(0.00)	(0.20)	(0.02)	(0.00)	(0.00)	(0.18)	(0.42)	(0.62)
e_t	21.64*	17.88*	0.20	0.69	3.52	7.22*	4.35	7.47*	2.38	7.40*	11.98*	3.34	0.71	2.48
	(0.00)	(0.00)	(0.90)	(0.71)	(0.17)	(0.03)	(0.11)	(0.02)	(0.30)	(0.02)	(0.00)	(0.19)	(0.70)	(0.29)
	USA			Ind.			Mal.			S.Afr.			S.Kor	
Var.	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CIR}

$\alpha^i_{\Delta k}$	0.21	4.75**	25.95*	0.22	3.50	8.93*	1.88	2.30	3.63	30.06*	1.49	0.89	10.48*	10.95*
	(0.90)	(0.09)	(0.00)	(0.90)	(0.17)	(0.01)	(0.39)	(0.32)	(0.16)	(0.00)	(0.47)	(0.64)	(0.01)	(0.00)
α^i_{SR}	1.89	5.47	1.31	4.27	1.22	3.82	2.74	2.62	17.11*	0.32	1.29	0.5	1.69	14.63*
	(0.39)	(0.06)	(0.52)	(0.12)	(0.54)	(0.14)	(0.25)	(0.27)	(0.00)	(0.85)	(0.53)	(0.77)	(0.43)	(0.00)
α^i_{UER}	34.66*	5.47**	2.95	3.29	0.90	9.20*	3.87	1.03	18.79*	1.92	3.21	1.01	6.47*	11.01*
	(0.00)	(0.06)	(0.23)	(0.19)	(0.64)	(0.01)	(0.14)	(0.60)	(0.00)	(0.38)	(0.20)	(0.60)	(0.04)	(0.00)
y_t	0.29	1.71	2.33	0.77	1.09	9.33*	0.19	1.47	6.55*	18.37*	4.09	1.05	8.60*	0.60
	(0.87)	(0.43)	(0.31)	(0.68)	(0.58)	(0.01)	(0.91)	(0.48)	(0.04)	(0.00)	(0.13)	(0.59)	(0.01)	(0.74)
r_t	2.60	3.17	12.44*	0.07	5.30**	-	0.13	7.21*	3.67	3.37	0.68	0.34	2.23	8.39*
	(0.27)	(0.20)	(0.00)	(0.96)	(0.07)	(-)	(0.94)	(0.03)	(0.16)	(0.19)	(0.71)	(0.84)	(0.33)	(0.02)
R_t	1.93	8.11*	0.97	4.14	5.17**	9.06*	2.49	2.88	3.96	10.04*	1.79	0.35	22.95*	1.37
	(0.38)	(0.02)	(0.61)	(0.13)	(0.08)	(0.01)	(0.29)	(0.24)	(0.14)	(0.01)	(0.41)	(0.84)	(0.00)	(0.50)
e_t	1.05	3.92	5.92*	1.82	0.35	15.00*	2.17	0.98	5.82*	5.66**	1.02	0.13	8.99*	8.04*
	(0.59)	(0.14)	(0.05)	(0.40)	(0.84)	(0.00)	(0.34)	(0.61)	(0.05)	(0.06)	(0.60)	(0.94)	(0.01)	(0.02)

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

Table 4.8 VAR Granger Causality Results for Non-Life Insurance

	Can.			Fra.			Jap.			Swi.			UK		
Var.	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}
β^b_{LLP}	3.04	16.59*	4.19	19.83*	4.53	1.38	0.06	4.26	19.79*	0.34	2.92	2.37	-	0.71	1.61
	(0.22)	(0.00)	(0.12)	(0.00)	(0.10)	(0.50)	(0.97)	(0.11)	(0.00)	(0.85)	(0.23)	(0.31)	(-)	(0.70)	(0.45)
β^b_{CAR}	1.28	16.23*	25.48*	1.39	4.90**	0.78	1.41	0.06	1.74	0.99	0.00	1.42	-	1.39	1.61
	(0.53)	(0.00)	(0.00)	(0.50)	(0.09)	(0.68)	(0.50)	(0.97)	(0.42)	(0.61)	(0.99)	(0.49)	(-)	(0.59)	(0.45)
β^b_{CIR}	0.10	5.13**	0.34	0.17	9.27*	20.47*	13.88*	1.80	4.54	33.44*	40.11*	15.39*	-	1.81	2.05
	(0.95)	(0.08)	(0.84)	(0.92)	(0.01)	(0.00)	(0.00)	(0.41)	(0.10)	(0.00)	(0.00)	(0.00)	(-)	(0.41)	(0.36)
y_t	60.12*	29454.35*	42.43*	0.00*	34.97*	35.59*	4.86**	143.08*	71.62*	4.03	217.20*	93.17*	1.01	56.60*	3.09
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.09)	(0.00)	(0.00)	(0.13)	(0.00)	(0.00)	(0.60)	(0.00)	(0.21)
r_t	100.02*	978.42*	67.24*	0.00*	0.44	17.44*	33.04*	42.23*	92.89*	182.35*	123.90*	62.35*	8.75*	12.82*	12.50*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.80)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
R_t	98.69*	1999.66*	13.56*	0.00*	277.95*	37.78*	14.45*	160.60*	48.44*	96.38*	49.68*	113.73*	0.75	15.16*	5.06**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.69)	(0.00)	(0.08)
e_t	86.12*	1177.63*	17.86*	29.29*	7.30*	36.93*	21.95*	82.50*	18.06*	124.61*	24.16*	74.79*	1.44	50.25*	17.18*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.49)	(0.00)	(0.00)

	USA			Ind.			Mal.			S.Afr.			S.Kor		
Var.	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}	$\alpha^i_{\Delta k}$	α^i_{SR}	α^i_{UER}
β^b_{LLP}	1.32	1.79	8.25*	0.95	0.38	0.34	0.45	6.51*	0.90	9.79*	1.36	0.39	1.38	0.22	2.94
	(0.52)	(0.41)	(0.02)	(0.62)	(0.83)	(0.84)	(0.80)	(0.04)	(0.64)	(0.01)	(0.51)	(0.82)	(0.50)	(0.89)	(0.23)
β^b_{CAR}	2.68	1.34	0.12	1.02	1.72	69.68*	0.26	1.09	8.86	1.47	0.88	1.21	0.43	0.28	0.01
	(0.26)	(0.51)	(0.94)	(0.60)	(0.42)	(0.00)	(0.88)	(0.58)	(0.01)	(0.48)	(0.65)	(0.55)	(0.81)	(0.87)	(0.99)
β^b_{CIR}	105.36*	7.75*	16.68*	29.63*	41.01*	0.56	12.70*	17.45*	10.25*	5.35**	2.90	0.53	2.11	13.80*	0.65
	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.76)	(0.00)	(0.00)	(0.01)	(0.07)	(0.23)	(0.77)	(0.35)	(0.00)	(0.72)
y_t	96.58*	19.19*	46.28*	0.00*	1513.32*	602.40*	240.40*	68.60*	20.96*	-	5.26	39.37*	3.97	125.86*	68.09*

	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(-)	(0.07)	(0.00)	(0.14)	(0.00)	(0.00)
r_t	28.68*	596.34*	19.93*	0.00*	141.30*	98.10*	32.18*	8.01*	1.85	-	7.63*	8.35*	3.93	18.88*	42.93*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.40)	(-)	(0.02)	(0.02)	(0.14)	(0.00)	(0.00)
R_t	16.12*	2072.15*	47.82*	0.00*	131.27*	288.78*	254.88*	2.52	2.70	-	9.17*	56.80*	7.85*	14.29*	273.18*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.28)	(0.26)	(-)	(0.01)	(0.00)	(0.02)	(0.00)	(0.00)
e_t	247.01*	2002.81*	73.45*	0.00*	412.09*	654.47*	345.60*	8.41*	33.34*	-	1.39	26.94*	6.85*	10.85*	137.43*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(-)	(0.50)	(0.00)	(0.03)	(0.00)	(0.00)

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

Table 4.9 VAR Granger Causality Results for Banking and Non-Life Insurance

	Can.			Fra.			Jap.			Swi.			UK		
Var.	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}
$\alpha^i_{\Delta k}$	1.72	5.11*	12.04*	9.05*	8.41	0.82	0.20	0.07	1.36	2.90	2.40	4.22	-	-	-
	(0.42)	(0.00)	(0.00)	(0.01)	(0.01)	(0.66)	(0.91)	(0.97)	(0.51)	(0.23)	(0.30)	(0.12)	(-)	(-)	(-)
α^i_{SR}	6.63*	4.24	0.15	4.02	1.25	11.40*	2.12	2.59	4.79**	4.36	9.00*	8.61*	0.48	0.25	1.32
	(0.04)	(0.12)	(0.93)	(0.13)	(0.54)	(0.00)	(0.35)	(0.27)	(0.09)	(0.11)	(0.01)	(0.01)	(0.78)	(0.88)	(0.52)
α^i_{UER}	2.78	1.64	2.00	5.66*	0.94	8.20*	65.95*	1.76	1.93	7.51*	14.68*	16.81*	4.13	0.21	4.75**
	(0.25)	(0.44)	(0.37)	(0.06)	(0.62)	(0.02)	(0.00)	(0.41)	(0.38)	(0.02)	(0.00)	(0.00)	(0.13)	(0.90)	(0.09)
y_t	4.21	8.57*	0.11	7.46*	3.97	3.32	0.1	0.06	2.21	2.44	0.03	7.17*	1.01	3.93	8.08*
	(0.12)	(0.01)	(0.95)	(0.02)	(0.14)	(0.19)	(0.94)	(0.97)	(0.33)	(0.29)	(0.98)	(0.03)	(0.60)	(0.14)	(0.02)
r_t	5.90*	4.34	1.70	9.91*	2.41	3.60	0.53	6.26*	1.75	1.19	0.10	1.18	8.75*	0.39	0.81
	(0.05)	(0.11)	(0.43)	(0.01)	(0.30)	(0.17)	(0.77)	(0.04)	(0.42)	(0.55)	(0.95)	(0.56)	(0.01)	(0.82)	(0.67)
R_t	9.77*	4.54	3.53	11.23*	4.77**	0.00	2.72	2.47	0.29	0.75	7.53*	27.99*	0.75	1.52	2.14
	(0.01)	(0.10)	(0.17)	(0.00)	(0.09)	(0.99)	(0.26)	(0.29)	(0.86)	(0.69)	(0.02)	(0.00)	(0.69)	(0.47)	(0.34)
e_t	23.17*	3.74	1.03	0.17*	0.76	13.38*	1.23	0.50	0.68	1.52	2.00	13.30*	1.44	1.40	2.77
	(0.00)	(0.15)	(0.60)	(0.92)	(0.68)	(0.00)	(0.54)	(0.78)	(0.71)	(0.47)	(0.37)	(0.00)	(0.49)	(0.50)	(0.25)
	USA			Ind.			Mal.			S.Afr.			S.Kor		

Var.	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}	β^b_{LLP}	β^b_{CAR}	β^b_{CIR}
$\alpha^i_{\Delta k}$	0.21	4.75**	25.95*	1.39	3.24	31.24*	0.40	1.03	3.83	35.99*	0.80	4.38	6.65*	1430*	5.00**
	(0.90)	(0.09)	(0.00)	(0.50)	(0.20)	(0.00)	(0.82)	(0.60)	(0.15)	(0.00)	(0.67)	(0.11)	(0.04)	(0.00)	(0.08)
α^i_{SR}	1.89	7.18*	3.57	14.16*	4.33	29.08*	2.88	0.64	27.82*	24.63*	0.29	0.35	3.10	4.77**	4.34
	(0.39)	(0.03)	(0.17)	(0.00)	(0.11)	(0.00)	(0.24)	(0.73)	(0.00)	(0.00)	(0.86)	(0.84)	(0.21)	(0.09)	(0.11)
α^i_{UER}	34.66*	2.98	3.32	2.28	9.76*	1.50	3.17	0.99	35.09*	18.21*	4.75**	1.58	5.17**	11.40*	1.20
	(0.00)	(0.23)	(0.19)	(0.32)	(0.01)	(0.47)	(0.21)	(0.61)	(0.00)	(0.00)	(0.09)	(0.45)	(0.08)	(0.00)	(0.55)
y_t	0.29	4.04	4.95**	0.97	12.85*	3.10	3.24	6.03*	0.41	31.68*	2.69	0.23	1.22	-	3.83
	(0.87)	(0.13)	(0.08)	(0.62)	(0.00)	(0.21)	(0.20)	(0.05)	(0.81)	(0.00)	(0.26)	(0.89)	(0.54)	(-)	(0.15)
r_t	2.60	2.81	23.61*	0.33	6.94*	9.94*	3.89	3.47	0.98	16.69*	2.42	1.59	0.02	-	0.31
	(0.27)	(0.25)	(0.00)	(0.85)	(0.03)	(0.01)	(0.14)	(0.18)	(0.61)	(0.00)	(0.30)	(0.45)	(0.99)	(-)	(0.86)
R_t	1.93	0.38	0.82	1.36	8.34*	0.66	2.22	5.05**	12.34*	0.77	1.33	0.46	8.86*	-	7.33*
	(0.38)	(0.82)	(0.66)	(0.51)	(0.02)	(0.72)	(0.33)	(0.08)	(0.00)	(0.68)	(0.51)	(0.80)	(0.01)	(-)	(0.03)
e_t	1.05	0.79	6.51*	13.05*	3.95	15.57*	2.84	2.26	5.49**	5.66**	4.67**	2.46	8.99*	-	12.33*
	(0.59)	(0.68)	(0.04)	(0.00)	(0.14)	(0.00)	(0.24)	(0.32)	(0.06)	(0.06)	(0.09)	(0.29)	(0.01)	(-)	(0.00)

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

4.5.3 Life Insurance and Banking

From the results of table 4.6 and 4.7, we note that bank risk and macroeconomic variables granger cause insurance risk variables. As such there is a unidirectional causality effect across all counties for life insurance with the exception of South Korea, where the relationship is bidirectional between South Korean life insurers and banks. This unidirectional causality is led by bank risk variables on insurance risk variables, these finding are in-line with the findings from Billio et al. (2012), Adams et al. (2014), Chen et al. (2014) and Liu and Zhang (2016), where it is noted that banks play a significant role in transmitting shocks in financial markets.

We also note that GDP and long-term interest rates show up quite often as having a significant causality effect on life insurance risk variables, with exchange rates having a presence in Switzerland, USA, Indonesia, Malaysia and South Africa. Long-term interest rates have a highly significant effect on all the banking risk variables in Switzerland, highlighting the sensitivity of Swiss banks to interest rates (Festic et al., 2011, Castro, 2013 and Boungou, 2019). Of particular interest, where macroeconomic variables are concerned, is Japan and South Korea, where all four tested macroeconomic variables have a highly significant impact and causality effect on both life insurers and banks.

Furthermore, we note the strong causality effect between solvency ratios of life insurers and the capital adequacy ratios of banks for Canada and France, other studies in the area of systematic risk have found that capital adequacy requirements heighten systematic risk (See Acharya, 2009). USA presents positive and significant causality of life insurance reserves and underwriting expense ratios on banking. Whilst a unidirectional causality is seen in Canada for banking loan loss provisions on life insurance reserves and with the banking, cost-income ratio being the most predisposed in Indonesia.

4.5.4 Non-Life Insurance and Banking

The results presented in tables 4.8-4.9 show a mix in the causality effects, with half of the countries showing having bidirectional causality effects and the other half-showing unidirectional effect. Whereas the UK presents with no causality effects in either direction, indicating that, the variables in banking and non-life insurance are independent of each other.

In the sample, Canada, France, Japan, USA and Indonesia, display bidirectional feedback, where bank risk and macroeconomic variables granger cause insurance risk variables and vice versa.

Of particular interest in the countries that show bidirectional feedback are the non-life insurance solvency ratios, which are highly significant across all bank risk variables for Canada. The loan loss provisions and non-life reserves have a dual effect across both sectors for France and the effects of banking cost income ratio's across all non-life risk variables for USA, with the macroeconomic variables being highly influential for non-life insurance risk variables. In addition, the countries that show unidirectional causality are Malaysia, from banks to non-life insurance (see Billio et al., 2012, Chen et al., 2014 and Liu and Zhang, 2016), Switzerland, South Africa and South Korea from non-life insurance to banks.

In Malaysia bank risk and macroeconomic variables granger cause insurance risk variables. Whilst in the second set we fail to reject the null noting that insurance risk and macroeconomic variables do not granger cause bank risk variables. For the other three countries, Indonesia, South Africa and South Korea, we note that bank risk and macroeconomic variables do not granger cause insurance risk variables. However, we note that non-life insurance risk and macroeconomic variables granger cause bank risk variables, for Indonesia, South Africa and South Korea.

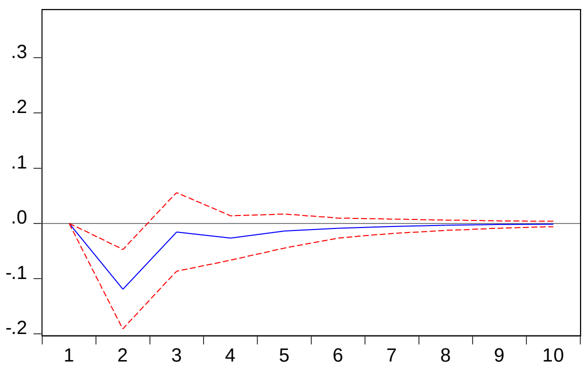
4.5.5 Spill-over Effects

We perform impulse response function tests on risk pairs to measure the spill over effect of each risk pair on one another, in both insurance and banking. The spill over results of these risk pairs are presented below, we only look at risk pairs that show persistence spill overs in both sectors, the choice of the presented pairs is influenced by the granger causality test results in section 7.2 above. For the full set of results, see chapter 4's appendix.

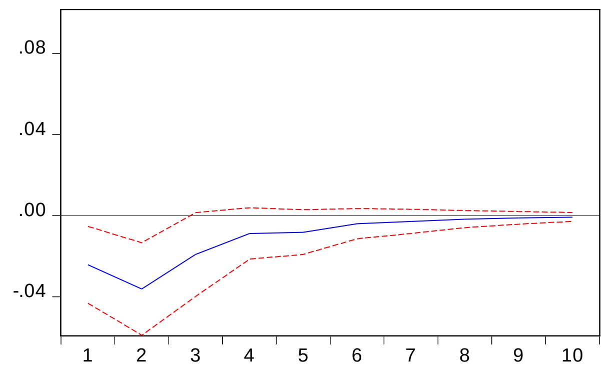
Life Insurance and Banking-Developed Countries

Canada

Response of Solvency Ratio to Capital Adequacy Ratio

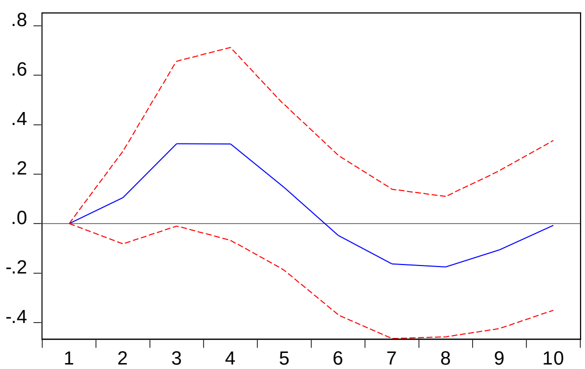


Response of Capital Adequacy Ratio to Solvency Ratio

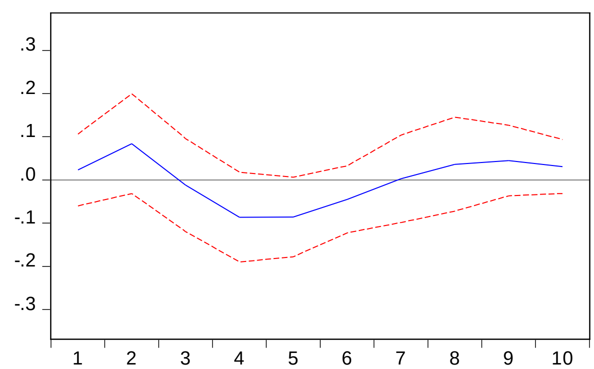


France

Response of Solvency Ratio to Capital Adequacy Ratio

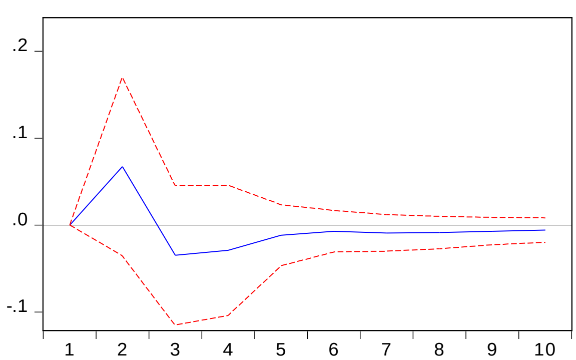


Response of Capital Adequacy Ratio to Solvency Ratio

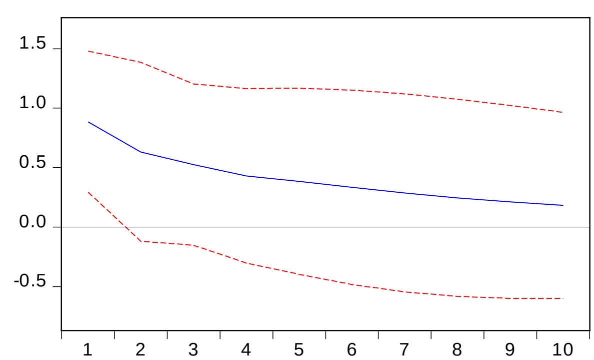


Japan

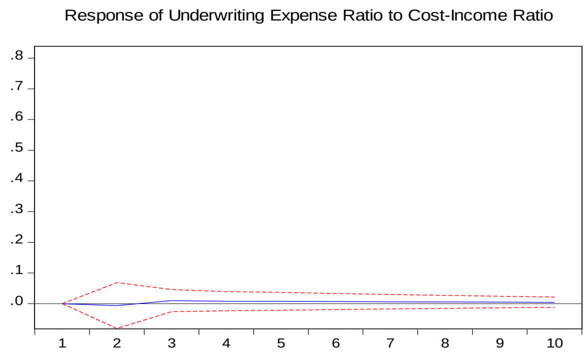
Response of Reserves to Loan Loss Provisions



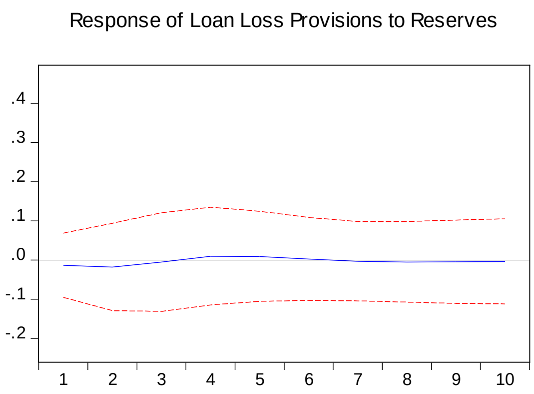
Response of Loan Loss Provisions to Reserves

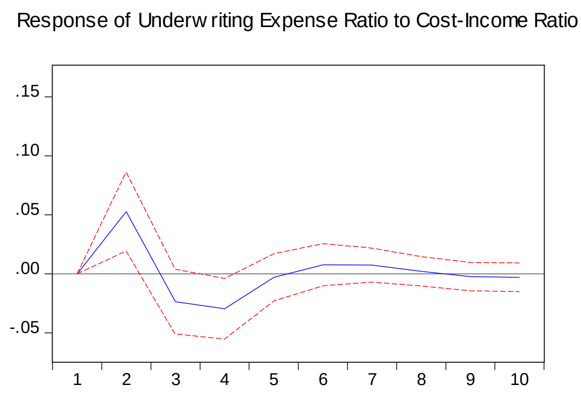


Switzerland



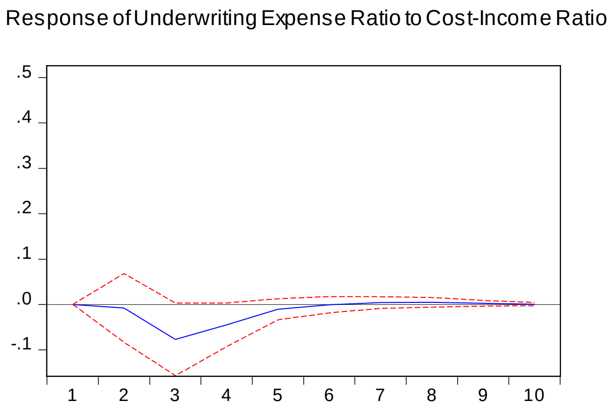
United Kingdom

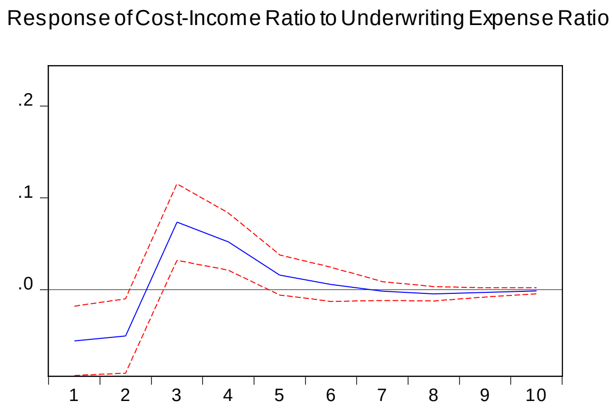




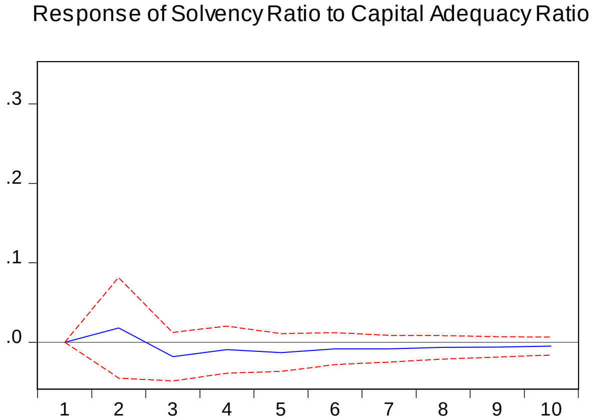
Life Insurance and Banking-Emerging Market Countries

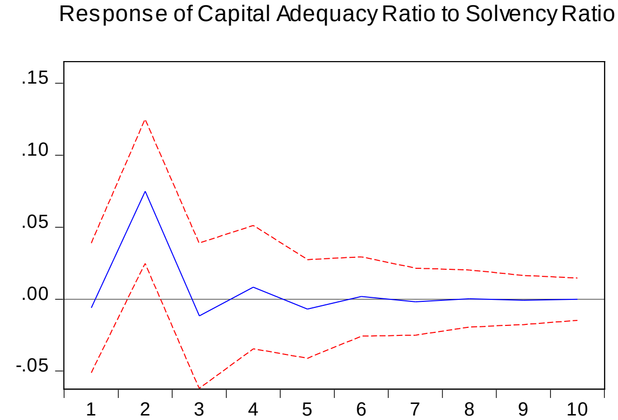
Malaysia



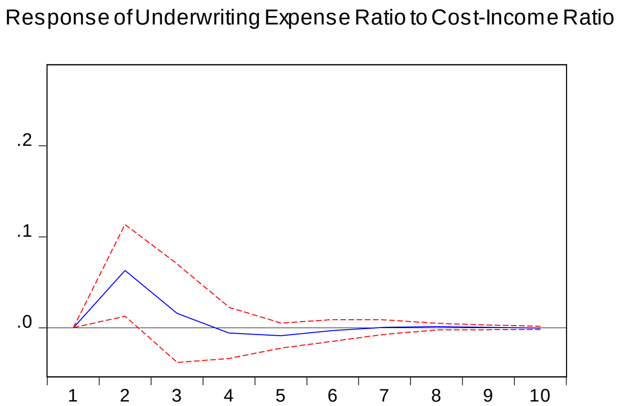


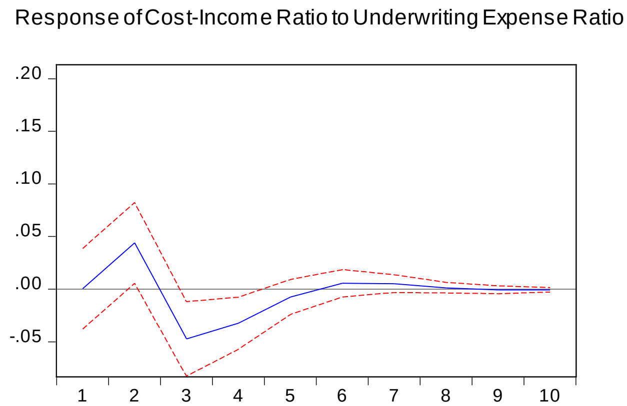
South Africa





South Korea





4.5.6 Life Insurance and Banking Spillovers

We starts off by looking at the impact of shocks to the insurance and banking variables in the system. The functions displayed above for life insurance show a set of mixed results, with most variables showing either a positive impact or asymmetry. For developed countries, we begin by noting the response of solvency ratio's, in the Canadian life insurance sector, to a one standard deviation shock to capital adequacy ratios of Canadian banks. In the first response function, initially from period 1 to 2 solvency ratios decrease in response to innovations in capital adequacy ratios, from period 2 to 3 the is a steady increase in solvency ratios then from period 3 to 10 there is stability, with period 9 to 10 showing steady state at 0.

The response of Canadian capital adequacy ratios to solvency ratios shows a similar effect and as such on average, we note that each variable has an overall negative impact on each other. For France the impact of capital adequacy ratios on solvency ratios and vice versa display asymmetric impacts in both the short-run and long-run. The Japanese financial system is impacted the most by life reserves and loan loss provisions, the response of reserves to loan loss provisions is asymmetric, whilst banks loan loss provisions increase at a decreasing rate in response to innovations in Japanese life insurance reserves.

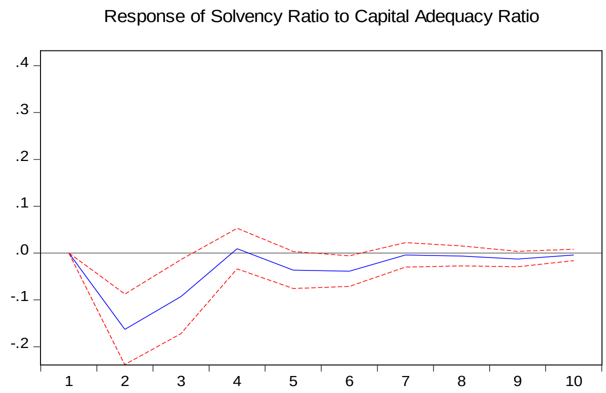
We note no impact on Switzerland's life underwriting expense ratios as a result of shocks to cost-income ratios, as opposed to the causality results in section 7.2. In other words cost-income ratios granger cause underwriting expense ratios, however shocks to cost-income ratios do not have an impact on underwriting expense ratios. Finally cost-income ratios have an asymmetric impact on underwriting expense ratios in the United Kingdom. Again, as noted in section 7.2, banking variables have the most impact on life insurance variables in developed countries, this is to be expected, as the banking sector is generally larger in size and activity (Beck et al., 2000).

In emerging market countries, in Malaysia in particular, the response of underwriting expense ratios to cost income ratios is initially at 0, it then decreases from period 2 to 5 and eventually reaches steady state stability from period 6 onwards. The impact of underwriting expense ratios for Malaysia moves on the opposite direction initially displaying a negative response, then increasing and finally stabilising at 0.

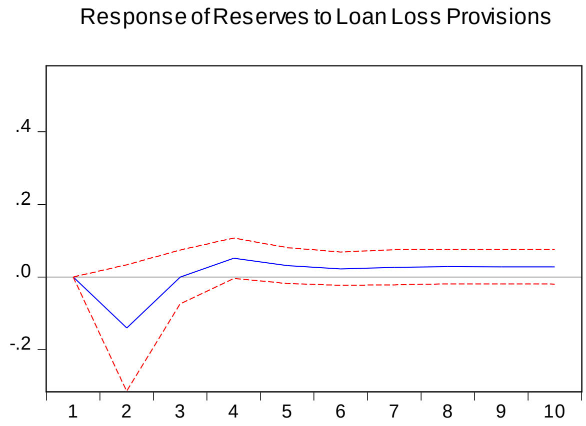
On the other hand, the same relations, in South Korea, are asymmetric, whereas most volatility can be observed in the capital adequacy ratios of South African banks, in response to solvency ratios. We note that South Africa's banking and life insurance markets behave in a similar manner as those for developed countries, in terms of spill over effects. This phenomena can partly be explained by the stability of both banking and insurance in South Africa and, in particular, the expansion of the banking sector in the 1990's as a result of the entry of foreign banks (Hawkins; 2004). Furthermore, of particular interest in the case of South Africa, life insurance companies controlled two of the three largest commercial banks (Jones and Inggs; 2003).

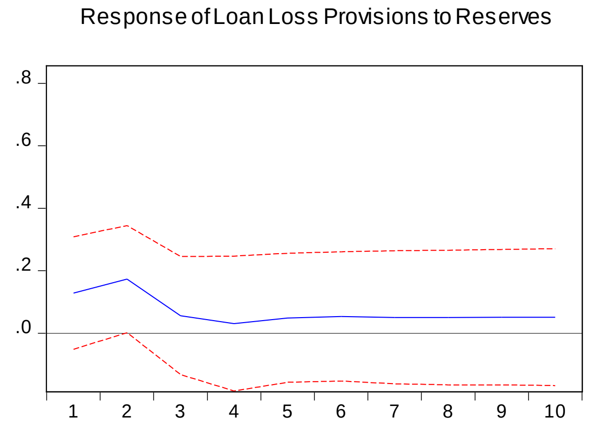
Non-Life Insurance and Banking-Developed Countries

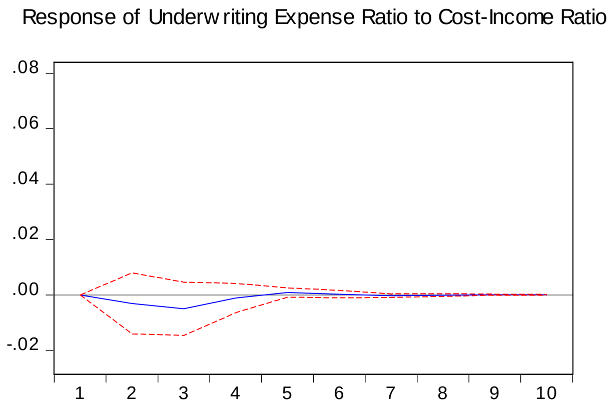
Canada

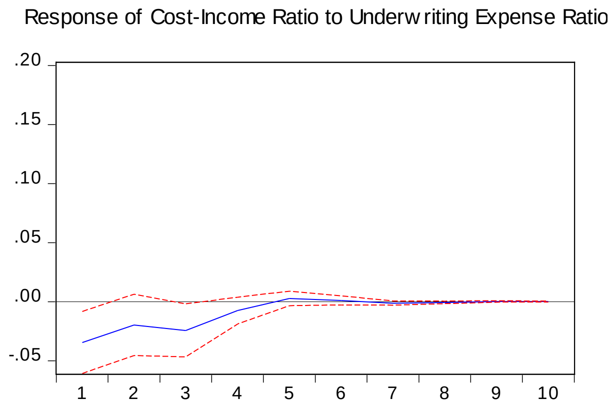


France



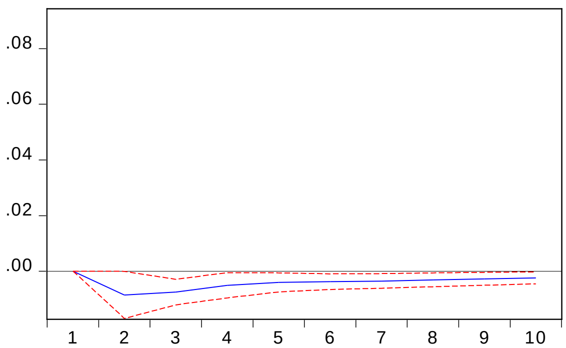




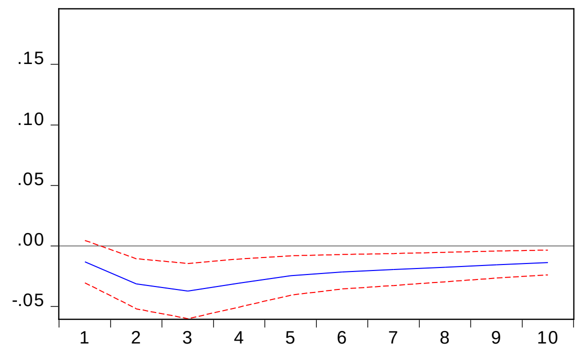


Switzerland

Response of Underwriting Expense Ratio to Cost-Income Ratio

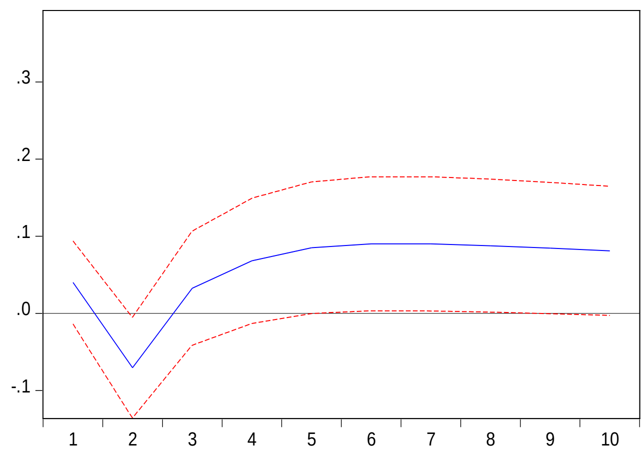


Response of Cost-Income Ratio to Underwriting Expense Ratio

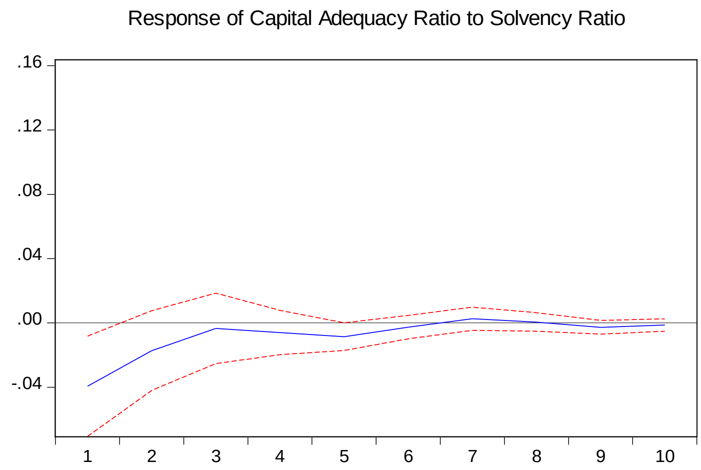


United Kingdom

Response of Cost-Income Ratio to Underwriting Expense Ratio

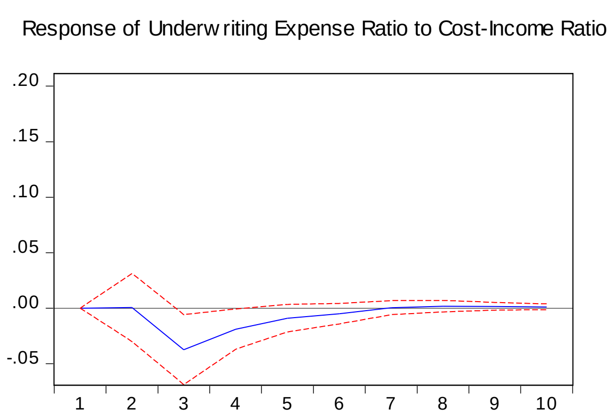


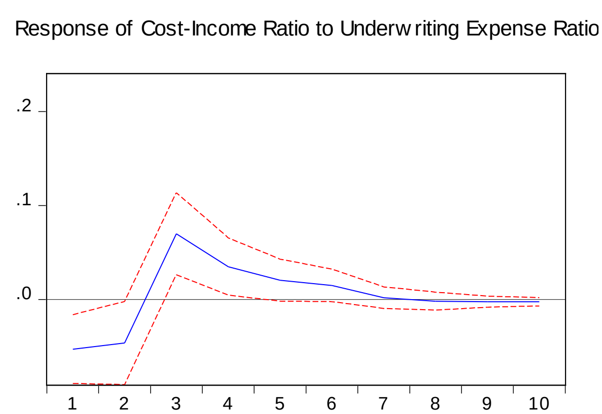
United States



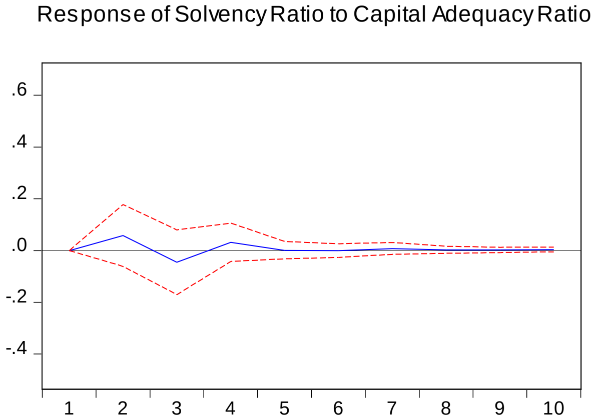
Non-Life Insurance and Banking-Emerging Market Countries

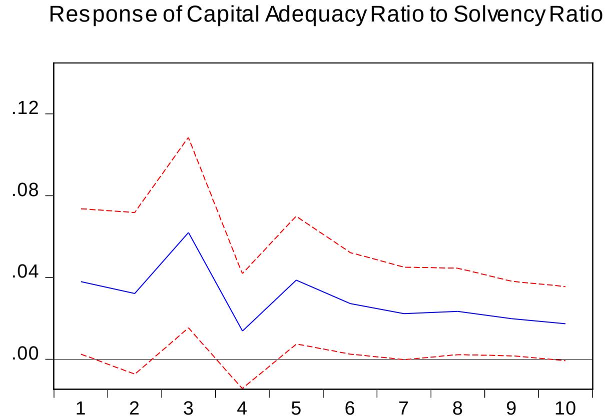
Malaysia



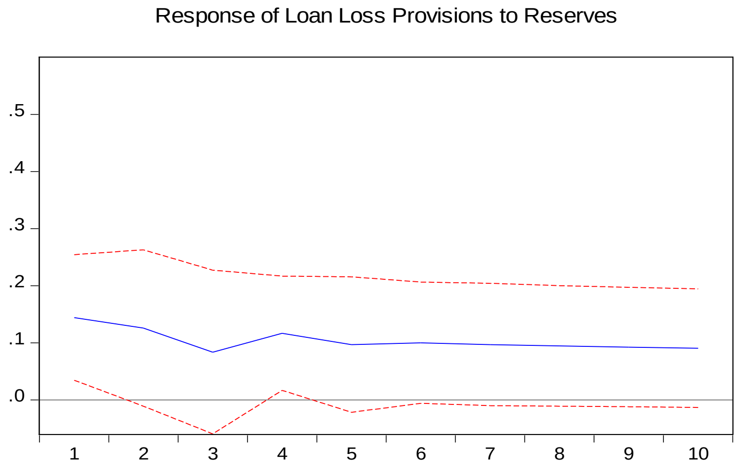


South Africa





South Korea



4.5.7 Non-Life Insurance and Banking Spillovers

In the non-life, insurance and banking sector most of the responses fluctuate either around zero or return to steady state. In Canada and South Africa the response of solvency ratios to innovations in the banks' capital adequacy ratios, initially decreases in period 1 for Canada and stabilises at zero. Although for South Africa, the impact of capital adequacy ratios on non-life solvency ratios has a stabilising effect at around zero as well. On the other hand changes to solvency ratios initially induce a gradual increase, from period 1 to 3, in the capital adequacy ratios of United States banks but reaches steady state at zero.

In South Africa, the same relations linger between 0 and 0.06, this can be explained by the regulatory changes that have been implemented post the 1990's (Hawkins; 2004).

Responses of non-life insurers' underwriting expense ratios to the cost-income ratios of banks in France, Switzerland, Malaysia and the United States all display a stabile response fluctuating around zero, with France, Switzerland and Malaysia showing a slight decrease at first. The inverse of this relationship in France shows a negative impact initially but a steady state over time. For the United Kingdom at first deviations in underwriting expense ratios have a positive impact on the cost-income ratios, followed by a gradual decrease in period 2 and finally stabilises above zero.

In Malaysia, the relationship is asymmetric whilst in Switzerland the response hovers between 0 and -0.05, showing a negative impact, Gugler (2005) argues that the lack of supervisory integration of financial markets in Switzerland may cause problems. Gugler (2005) further suggests that more work is needed to ascertain risks caused by all financial institutions. Finally, we look at the responses of loan loss provisions in banks to non-life reserves we note that shocks to the system fluctuate around 1.

4.6 Robustness Tests

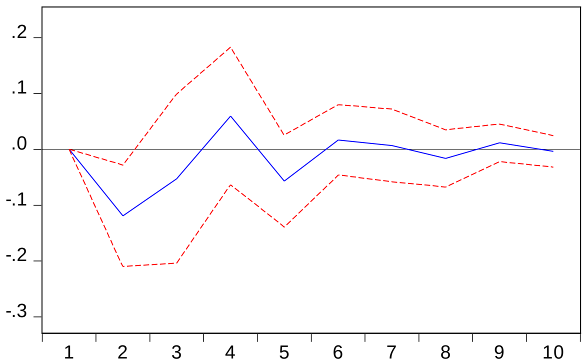
The role of banks and insurance companies during the financial crisis is important, Baluch et al. (2011) note that this role finds expression in the products created by insurers linking both sectors such as Mortgage Payment Protection Insurance and credit insurance through products such as Credit Default Swaps (CDS), which is the "underwriting of credit risk by insurers". This type of hedging of bank loans adds to the rise of credit risk, contributes in creating price bubbles and increases systematic risk and the rate of spill overs between the two sectors (Baluch et al., 2011). The link between these two sectors and the recorded history on the contribution of these sectors to the financial crisis of 2008/09 creates a need to conduct robustness checks that look at the spill overs between these sectors pre and post the 2008/09 financial crisis.

Life Insurance and Banking-Developed Countries

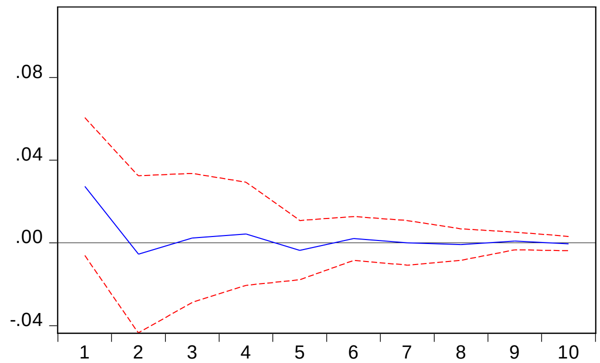
Canada

Pre 2008/09 Financial Crisis

Response of Solvency Ratio to Capital Adequacy Ratio

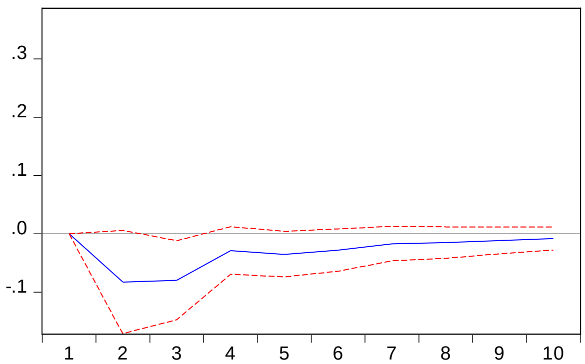


Response of Capital Adequacy Ratio to Solvency Ratio

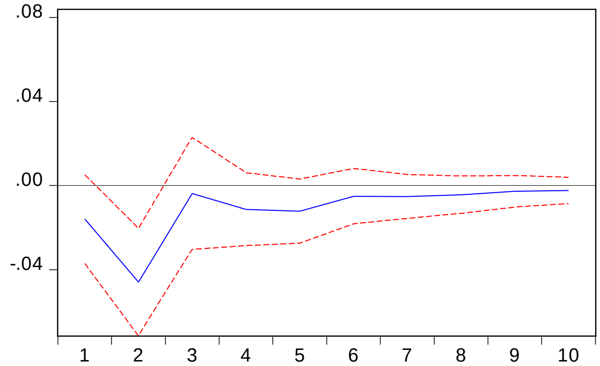


Post 2008/09 Financial Crisis

Response of Solvency Ratio to Capital Adequacy Ratio

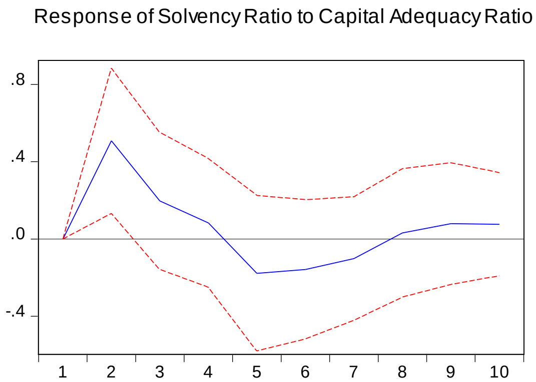


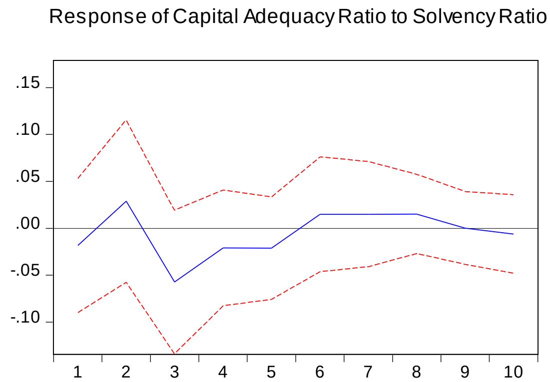
Response of Capital Adequacy Ratio to Solvency Ratio



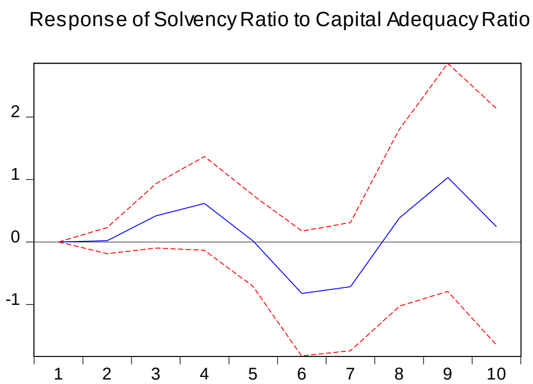
France

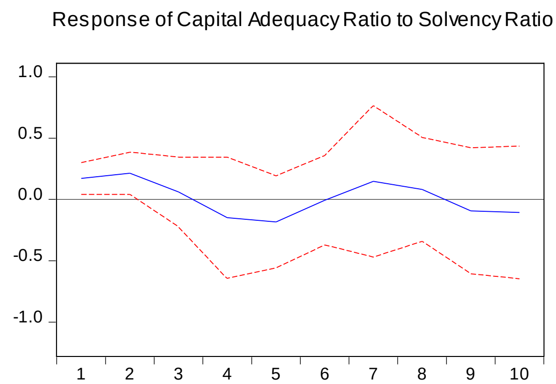
Pre 2008/09 Financial Crisis





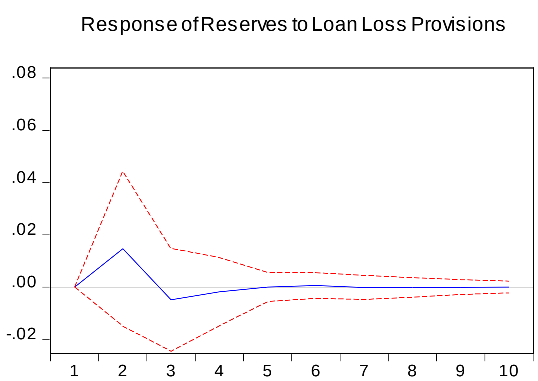
Post 2008/09 Financial Crisis

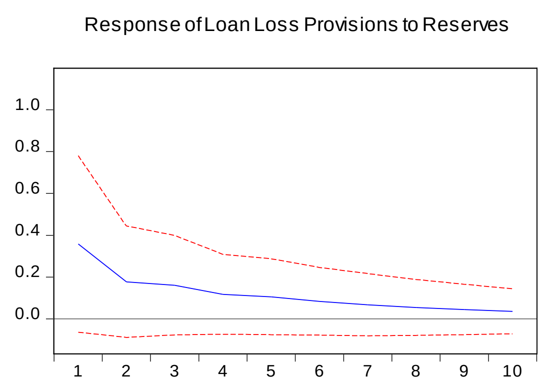




Japan

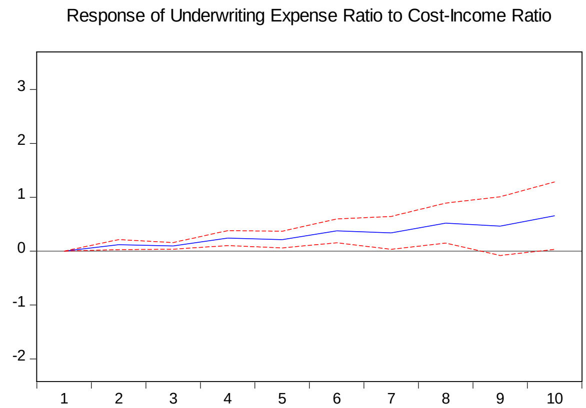
Pre 2008/09 Financial Crisis





Switzerland

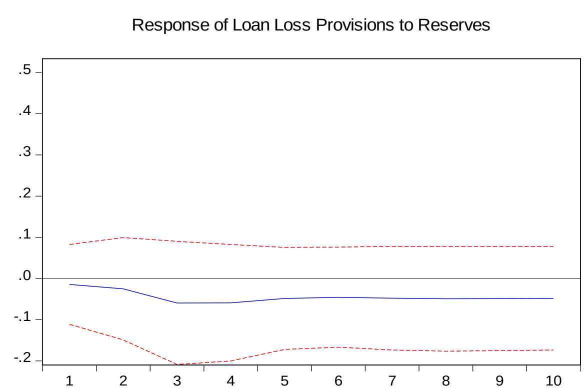
Pre 2008/09 Financial Crisis



Post 2008/09 Financial Crisis

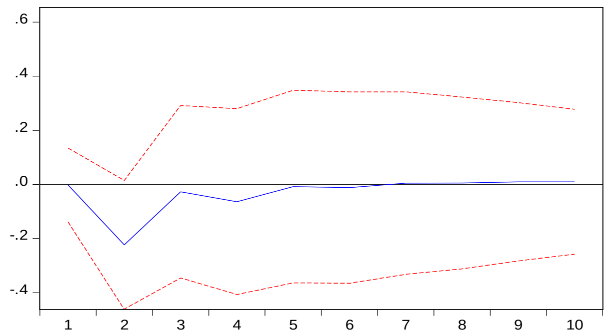
United Kingdom

Pre 2008/09 Financial Crisis



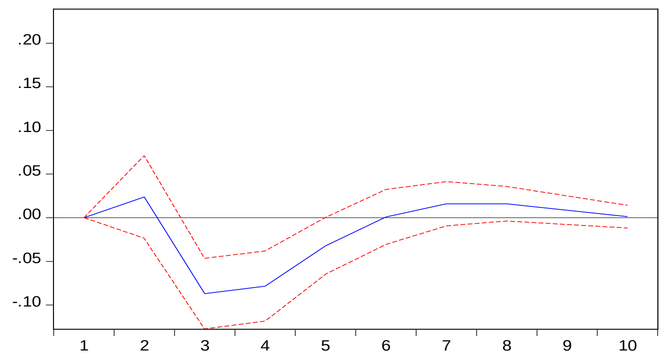
Post 2008/09 Financial Crisis

Response of Loan Loss Provisions to Reserves



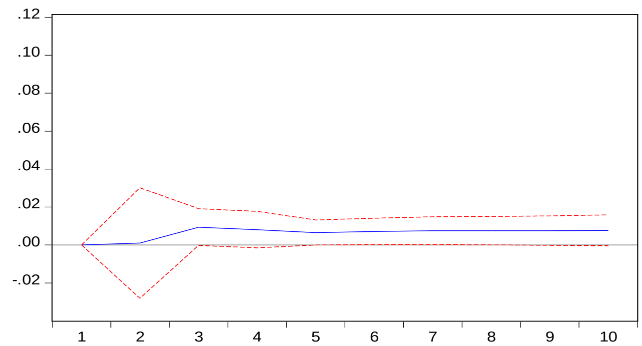
Pre 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio



Post 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio

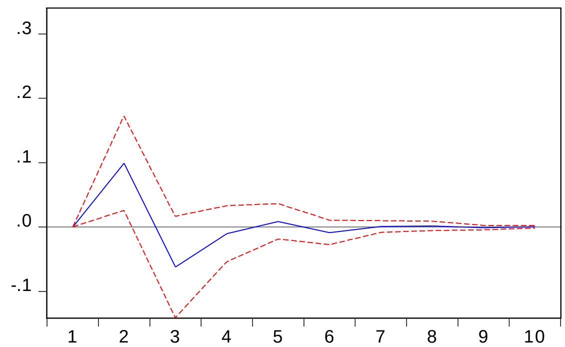


Life Insurance and Banking-Emerging Market Countries

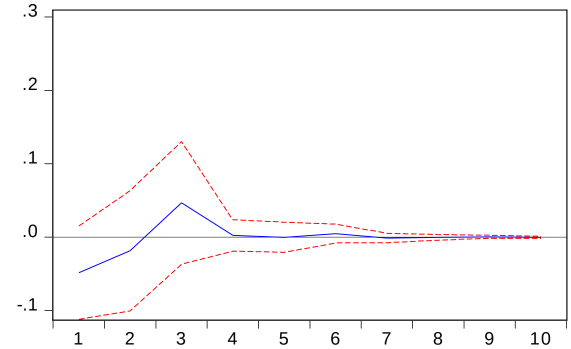
Malaysia

Pre 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio

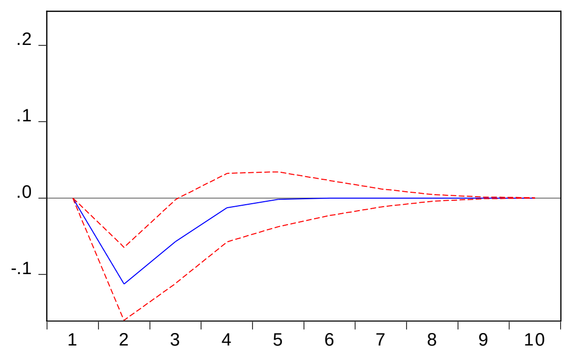


Response of Cost-Income Ratio to Underwriting Expense Ratio

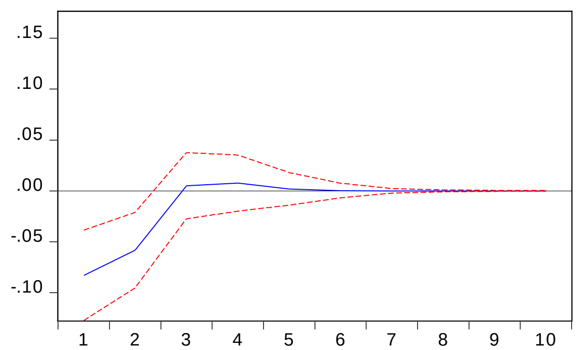


Post 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio



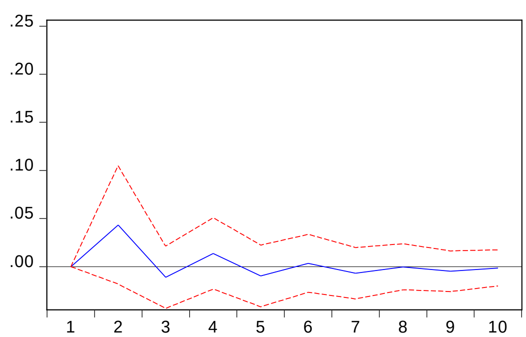
Response of Cost-Income Ratio to Underwriting Expense Ratio



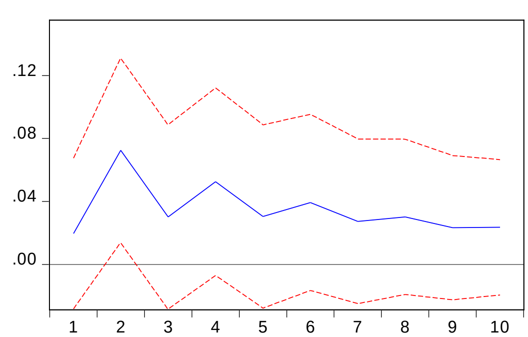
South Africa

Post 2008/09 Financial Crisis

Response of Solvency Ratio to Capital Adequacy Ratio



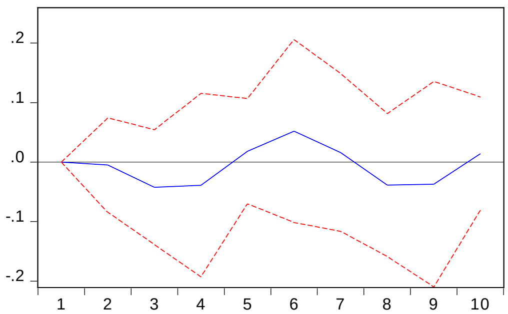
Response of Capital Adequacy Ratio to Solvency Ratio



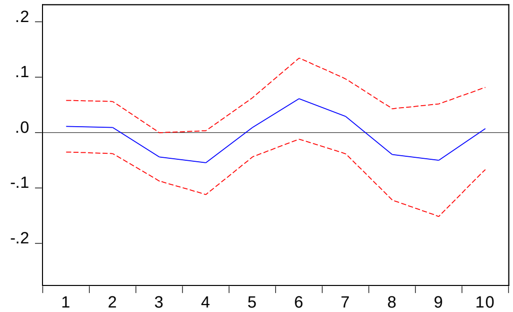
South Korea

Pre 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio

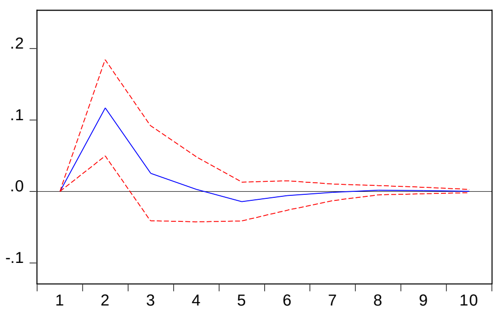


Response of Cost-Income Ratio to Underwriting Expense Ratio

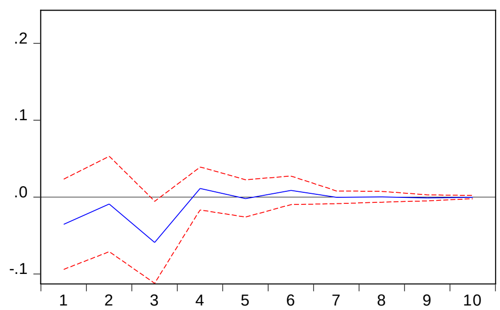


Post 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio



Response of Cost-Income Ratio to Underwriting Expense Ratio



4.6.1 Life Insurance and Banking

The developed country variables show a similar pattern pre and post the 2008/09 financial crisis, with most risk variables either hovering around 0 or showing high volatility and variance pre the financial crisis. From this observation, we notice a pattern of possible pre crisis indication from the risk pairs, the variables seem to be very close to zero showing possible depletion or they are in a high volatile state showing possible eruption. We argue that these patterns can be used as likely indicators of a looming crisis.

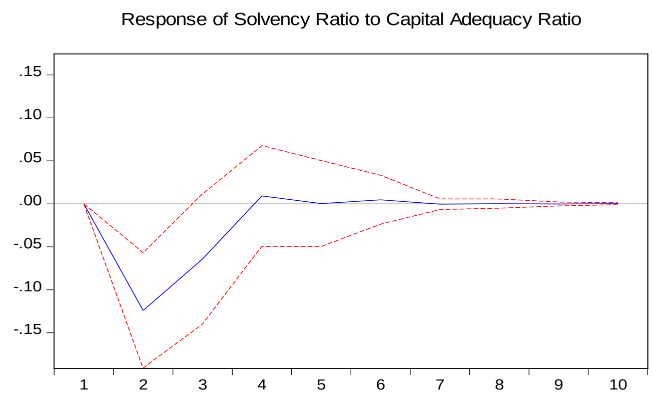
Immediately post the financial crisis most risk pairs drop below 0, becoming negative after the initial shock but stabilising around 0 further away from the crisis, with the exception of Japan's life insurance reserves, which shows a positive initial move post the crisis but stabilising around 0 after the preliminary crisis shock. This could simply be a lag effect on Japan, with the market reacting at a slower pace because of Japan's high life insurance reserves and 90% market penetration rate (Inoue; 2009).

For the developing countries, the risk pairs initially respond positively to each other but drop to around 0 just before the financial crisis, with the exception of South Korea which shows a large variance pre the crisis for the response of underwriting expense ratios to South Korean banks cost-income ratios. Post the crisis we notice a positive or negative for most developing countries followed by stability around 0. These patterns of defined increases or decreases could be the result of the high market concentration in the Asian countries, with the top 5 firms having a market share of more than 66% and the top player moving the market in particular direction without any dilution (Milo; 2003).

4.6.2 Non-Life Insurance and Banking-Developed Countries

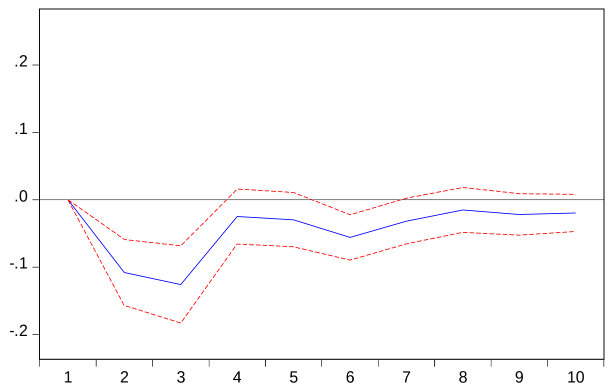
Canada

Pre 2008/09 Financial Crisis



Post 2008/09 Financial Crisis

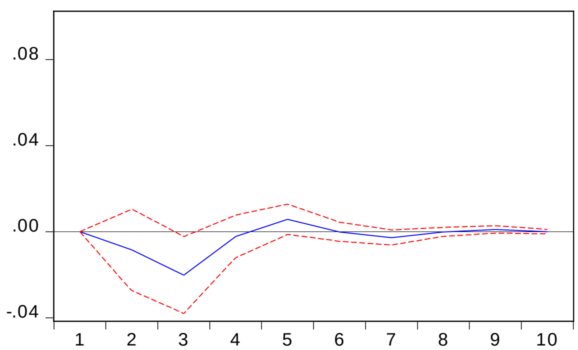
Response of Solvency Ratio to Capital Adequacy Ratio



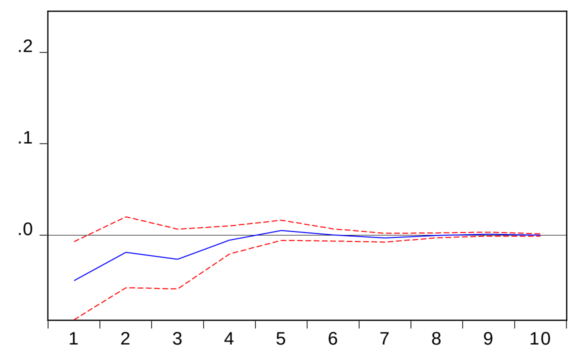
France

Pre 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio

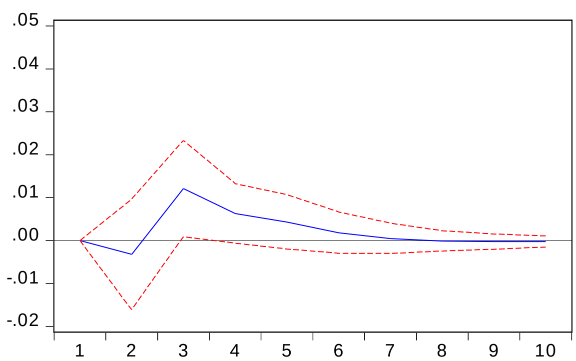


Response of Cost-Income Ratio to Underwriting Expense Ratio

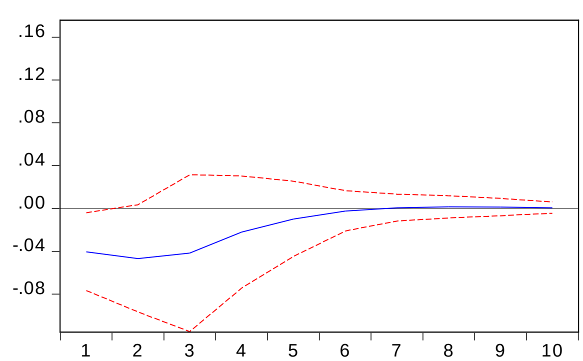


Post 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio



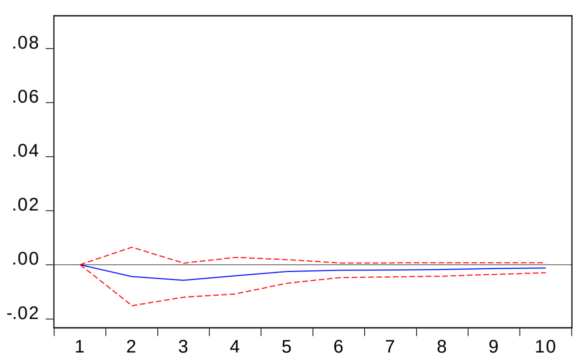
Response of Cost-Income Ratio to Underwriting Expense Ratio



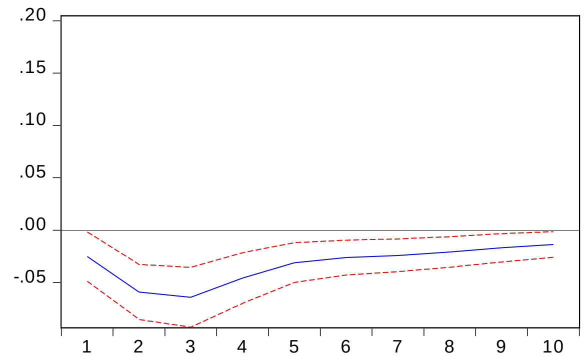
Switzerland

Pre 2008/09 Financial Crisis

Response of Underw riting Expense Ratio to Cost-Income Ratio

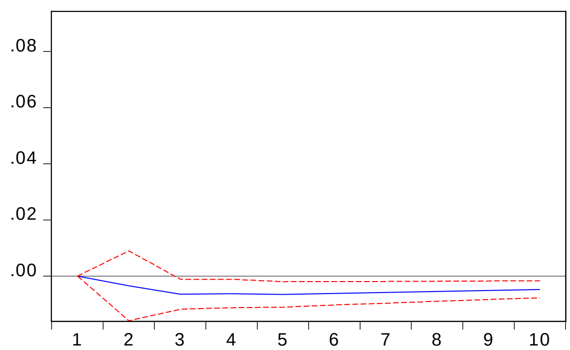


Response of Cost-Income Ratio to Underw riting Expense Ratio

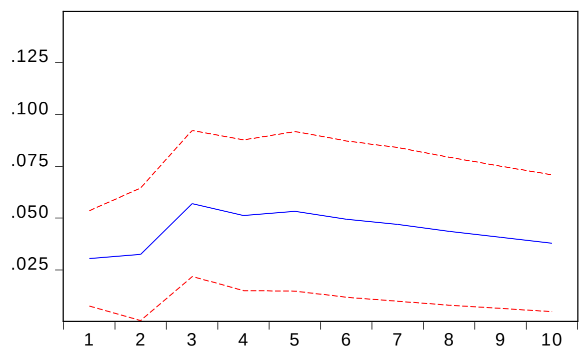


Post 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio



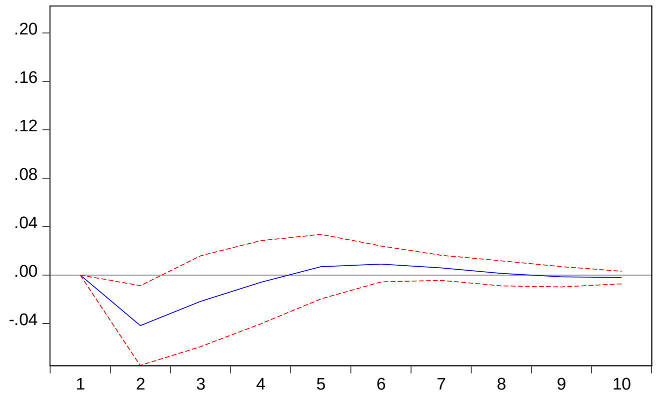
Response of Cost-Income Ratio to Underwriting Expense Ratio



United Kingdom

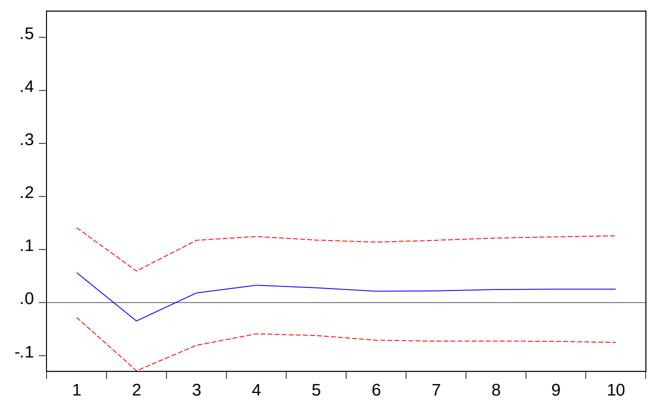
Pre 2008/09 Financial Crisis

Response of Cost-Income Ratio to Underwriting Expense Ratio



Post 2008/09 Financial Crisis

Response of Cost-Income Ratio to Underwriting Expense Ratio



United States

Pre 2008/09 Financial Crisis

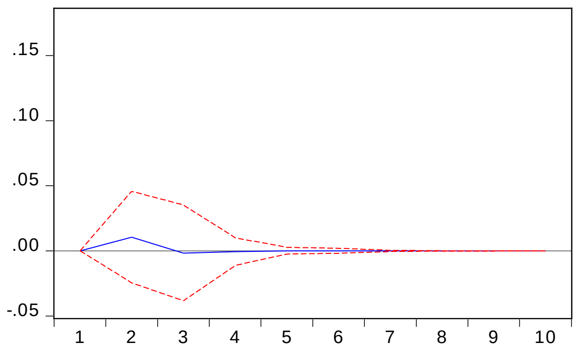
Post 2008/09 Financial Crisis

Non-Life Insurance and Banking-Emerging Market Countries

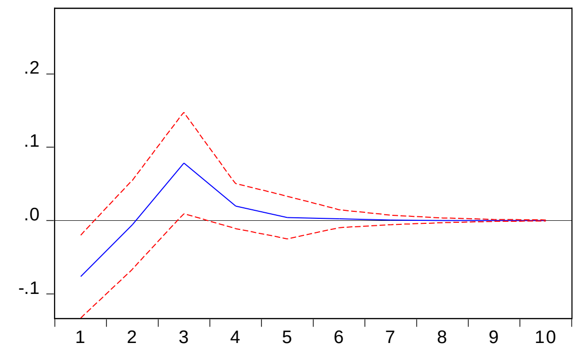
Malaysia

Pre 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio

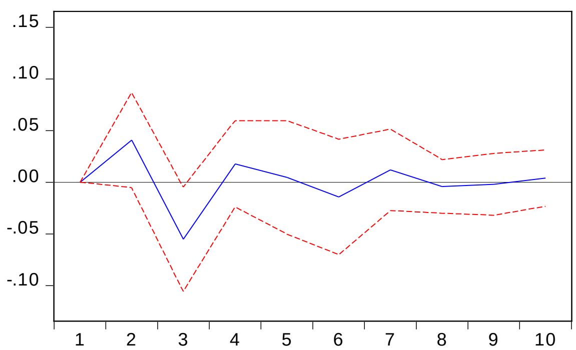


Response of Cost-Income Ratio to Underwriting Expense Ratio

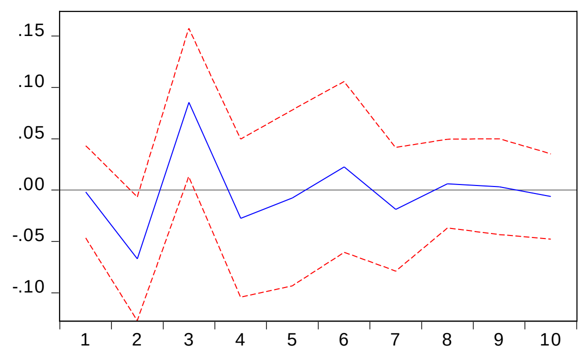


Post 2008/09 Financial Crisis

Response of Underwriting Expense Ratio to Cost-Income Ratio



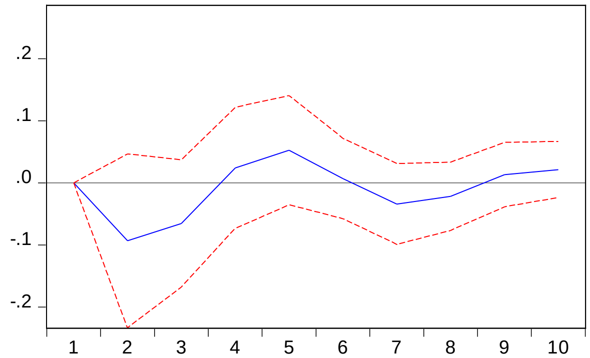
Response of Cost-Income Ratio to Underwriting Expense Ratio



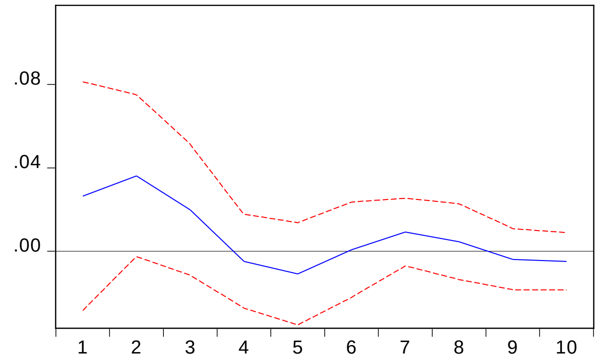
South Africa

Pre 2008/09 Financial Crisis

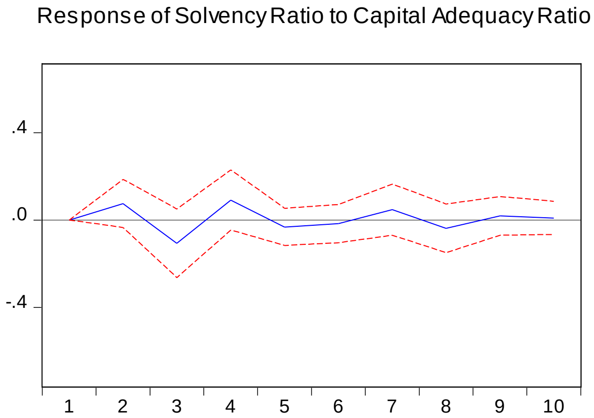
Response of Solvency Ratio to Capital Adequacy Ratio

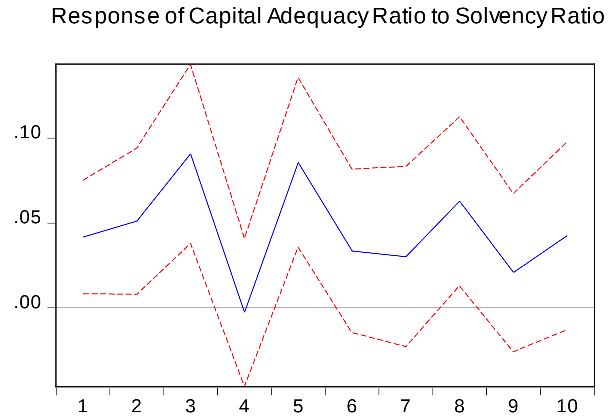


Response of Capital Adequacy Ratio to Solvency Ratio



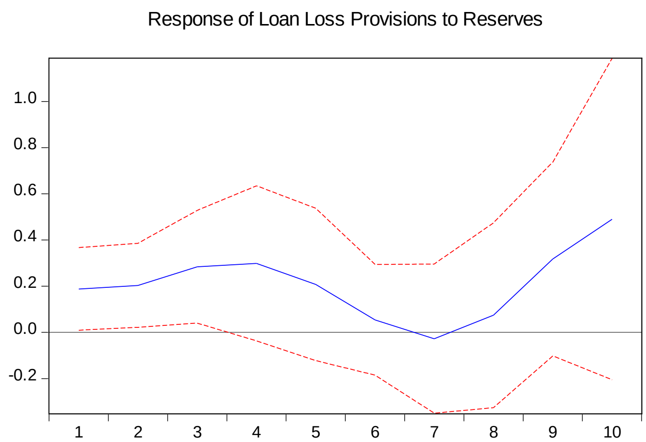
Post 2008/09 Financial Crisis



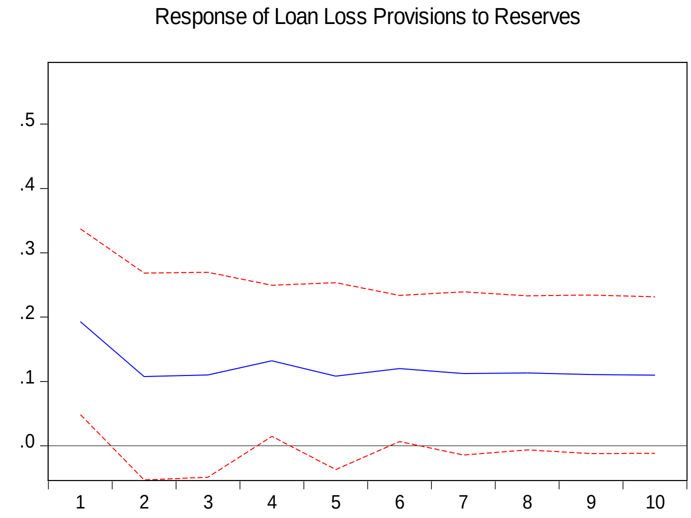


South Korea

Pre 2008/09 Financial Crisis



Post 2008/09 Financial Crisis



4.6.3 Non-life Insurance and Banking

In the developed countries, we notice a similar asymmetric pattern between the risk pairs initially followed by a consistent pattern of the variables hovering around zero in the period immediately before the crisis; this seems to be the calm before the storm. This pattern is observable in four out of the five countries, with the exception of Switzerland. The responses of Switzerland in the pre-crisis period are either consistently stable around 0 for the response of underwriting expense ratios to cost-income ratio, and initially negative but followed by stability around 0, for the response of cost-income ratio to shocks in the underwriting expense ratio.

Post the crisis period 60% of the risk pairs display a decrease after the initially crisis shock which is generally followed by a period of stability as we move further away from the crisis shock. This stability in the period post the initial financial crisis shock can partly be explained by the extent of credit loss exposures and the quality of assets in the two sectors in developing countries (Baluch et al., 2011). Of particular interest is the response of cost-income ratios, in Switzerland, to underwriting expense ratio post the crisis, these two risk pairs exhibit a large but positive variance initially, followed by what seems to be a downward trend as we move further away from the initial crisis shock.

The developing countries seem to be the most affect by the crisis, the risk pairs are already volatile in the pre-crisis period but seem to be even more inferior post the crisis period. In Malaysia, the responses of underwriting expense ratios and cost-income ratios to each other is either variant or showing a positive trend initially, then followed by a 0 trend in the period close to the financial crisis. However, this pattern of calmness is disrupted by the financial crisis shock, as we observe a period of high asymmetrical volatility post the crisis.

In South Africa, the risk pairs of particular interest, as noted in the VAR estimations as well, is the responses of the solvency ratios and the capital adequacy ratios to each other. For these pairs we note that initially their responses to each either, is either asymmetrical or showing a large variation but both responses move towards 0 in the just before the crisis. An interesting response to note is the response of the South African banks capital adequacy ratios to the non-life insurers' solvency ratios post the crisis period, which asymmetrical but very volatile. More concerning is the extent of volatility, asymmetric and variant patterns that are noted long after the financial crisis, well into 2016 and 2017 indicating a slower recovery in the non-life sectors of developing countries.

4.7 Conclusion

We set out to directly test the linkages between bank and insurance risk measures, the potential common driers of risk in these two sectors, the causality relationships between these risks and spill over effects, if any. In summary, our results show that there are linkages between banks and insurance risk variables, with the most notable link being between banks and non-life insurers. This correlation can be explained by the short-term nature of the products sold in both sectors. From the causality results, on average, the causality is unidirectional from banks to both life and non-life insurers, in other words banks granger cause life and non-life insurance variables and therefore contain useful information in predicting the risk variables in insurance. However, 5 of the 10 countries display a bidirectional granger causality feedback in both banking and non-life.

We also tested for potential common drivers of risk; our results revealed that GDP, long-term interest rates and exchange rates are the common risk drivers in the variables of life insurers, at the same time long-term interest rate had the most effect on Swiss banks. In addition, all the tested macroeconomic variables have the most significant granger causality effect on non-life insurance variables. Looking at the spill over effects, the results indicated spill over effects between life insurance and banks, with most life risk variables responding to shocks in the banking risk variables. However, the spill over effects are minimal between banks and non-life insurance, with the response of most risk variables to each other hovering around 0.

The results from this paper allow us to make certain policy recommendations and to reflect on the significance of this paper. The first policy consideration is around the types of macroeconomic variables that policymakers in banking, insurance, financial market regulation and the economy at large can start focusing on. In terms of the common risk drivers in the two sectors, we have seen from the results that sector regulators, investors and government's need to monitor the effects of GDP, long-term interest rate and exchange rates on banks and insurers. Central banks and governments in setting monetary and fiscal policy respectively need to have due regard of the effects of these policies on the financial services sector, the contribution of financial markets to world trade and in the long run the transmission effects into the economy.

A further consideration is the extent of financial market integration, which we have seen evidence of from our correlation and causality results. The rise of bancassurance products, merges, acquisitions, and ownership patterns between the two sectors is also indicative of this integration pattern. A final policy consideration is the amount and effects of systematic risks, internally, within sectors in the financial services, within the domestic economies as well the transmission of risk from one domestic economy to another. These internal sector transmission effects exists, as seen from our spill over results, in the panel of countries we have looked at thereby making it vital for governments to monitor the effectiveness of solvency assessment and management and Basel regulation policies in accurately managing the risks in these two sectors.

The research on the relationship between insurances and banks give us a delicate view as well as the extent of the complexities of the spillover effects past the concept of interconnectedness of the two sectors. Our results facilitate a microscopic view of how these two systems are possibly interconnected if at all and not just whether or not they are connected but rather how. There are other relations between these two sectors that can be explored further in answering the question of how, opening up the space for future research. Our paper has numerous implications for future research. For example, we look at the spillover effects between banks and insurance risk variables; this can be extended to domestic market spillovers as well as international market spillovers. Another area that can be investigated further is the existence of asymmetric spillovers and their implications.

CHAPTER 5: CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Key Issues and Implications

The choice to study both the developed and emerging market economies, in this thesis, is based on our intention to test whether or not our models works in the same way in different economies and the regulatory diversity in these regions. In chapter 2, we look at the macroeconomic determinants of insurance risk indicators of life and non-life insurance companies. Our results show that the most influential macroeconomic variables, on insurance risks, are exchange rates, interest rates and the variable on the consumption of other goods, across all countries in both the life and non-life subsectors.

The implications of the results from chapter 2, are that insurance risks are highly likely to change, in either direction, with changes made by monetary policy authorities to interest rates and exchange rates policies. This sensitivity of insurance risks to exchange rates, interest rates and consumption of other goods has multiple implications on the underwriting profits of insurers, from investors reacting to interest rate and exchange rate changes via share prices to insurance regulators adjusting capital requirements and policyholders altering their insurance demand.

Chapter 3 looks at the sensitivity of the share prices of life and non-life insurance companies to macroeconomic variables. We use a single linear equation to estimate the sensitivity of insurance company returns to these variables. The main results highlight that most macroeconomic variables have a weak effect on share returns of most insurers, with the exception of interest rates.

The implication of the share return results are that returns have an impact on the assets and liabilities of both life and non-life insurance and the performance of this sector, which ultimately transmits to financial markets and economies. Likewise, share returns contribute to market risk, which is a risk insurers are concerned about, as changes in share prices affect the investment yield through changes in investment income and assets. Given that the results from chapter 3 show that share returns are also vastly influenced by interest rates changes, the implications for insurers are even profoundly embedded.

Moreover, financial markets are affected by insurer insolvencies via externalities; the failure of one institution can trigger a systematic collapse of other related institutions, whilst policyholder liabilities can grow exponentially. Prudent management of share returns allows insurers to continue operating by managing loss, solvency, underwriting and reserve ratios this is because market returns mirror information quicker than non-market-based measures such as accounting variables (Billio et al., 2012).

In chapter 4, we set out to directly test the linkages between bank and insurance risk measures, the potential common driers of risk in these two sectors, the causality relationships between these risks and spill over effects. The main results show that firstly, there are linkages between bank and insurance risk variables, with the most notable link being between banks and non-life insurers. Secondly, GDP, long-term interest rates and exchange rates are the common drivers of risk in these two sectors. Lastly, that bank have the most notable spillover effect on insurance, in both life and non-life, with the implication of this being that bank risk variables contain the most useful information for predicting insurance risk variables.

5.2 Policy Recommendations

On average, our analysis from chapter 2 has several important implications for policy-makers in insurance. For instance, it is important to encourage both insurers and policy-makers to monitor the response of insurance risk to macroeconomic variables such as exchange rates and interest rates.

The sensitivity of risks in the insurance market to these macroeconomic variables and the response of insurer share returns to interest rates as seen in chapters 2 and 3 respectively should be noted and communicated to other regulating authorities, such as monetary policy authorities. Of equal importance is the detailed understanding of the transmission effects of these shocks that ultimately lead to insolvencies and to potential market bubbles, as can be seen with the contribution of AIG to the 2008/09 financial crisis (Adams, Füss, and Gropp, 2014), informing the formulation of regulation policies and the management of risks in insurance markets.

Interest rate are significant across all the chapters in this thesis, highlighting the very important role that these rates play in insurance companies from solvency determination, to share return movements, combined banking, and insurance dynamics. Equally important are exchange rates and GDP, which show up in banking and insurance risk across chapter 2 and 4.

The overall inference that we can draw for policy from these results is that Central banks and governments in setting monetary and fiscal policy respectively need to have due regard of the effects of these policies on the financial services sector, the contribution of financial markets to world trade and in the long run the transmission effects into the economy.

A further consideration is the extent of financial market integration. The rise of bancassurance products, merges, acquisitions, and ownership patterns between the two sectors is also indicative of this integration pattern. A final policy consideration is the amount and effects of systematic risks internally within sectors in the financial services, within domestic economies as well the transmission of risk from one domestic economy to another, especially trade partners and regions. These transmission effects make it vital for governments to monitor the effectiveness of solvency assessment and management rules and practices and Basel regulation policies, in accurately managing the risks in these two sectors

5.3 Suggested Areas for Further Research

There are at least two directions in which future research can be undertaken on the basis of the model derived in chapter 2. One line of research would be to examine the other forms of risk based capital models against both the macroeconomic variables and country or firm specific factors, given the relative performance of the models in this paper. Another line of research to which our model can contribute relates to the detailed examination of the effects of the exchange rates on both the life and non-life lines of business.

From chapter 4, there are other relations between banks and insurances that can be explored further in answering the question of how these two systems are interconnected, opening up the space for future research. For example, the study can be extended to domestic market spillovers as well as international market spillovers. Another area that can be further investigated is the existence of asymmetric spillovers and their implications.

CHAPTER 6: APPENDIX

6.1 Chapter 2

The tables 1A-B below show the unit root test results for chapter 2, all the variables are stationary. Panel data methodology uses time and cross sectional analyses as such it is important that the variables should be stationary in order to avoid possible spurious relationships amongst the variables (Levin, Lin and Chu; 2002 and the Im, Pesaran and Shin; 2003). We use the Levin, Lin and Chu (2002) and the Im, Pesaran and Shin (2003) unit root tests to test for the presence of a unit root in the panel.

Table 2A: Unit Root Test Results for Life Insurance

Panel 1A: Life				
	Developed Countries		Emerging Markets	
Var.	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat
$LR_{i,t}$	-8.58* (0.00)	-9.00* (0.00)	-5.51* (0.00)	-6.28* (0.00)
$UER_{i,t}$	-8.72* (0.00)	-10.46* (0.00)	-4.34* (0.04)	-6.17* (0.00)
$SR_{i,t}$	-2.47* (0.01)	-3.93* (0.00)	-6.49* (0.00)	-8.50* (0.00)
$IY_{i,t}$	-8.28* (0.00)	-7.76* (0.00)	-5.37* (0.00)	-6.05* (0.00)
$\Delta K_{i,t}$	-10.08* (0.00)	-11.84* (0.00)	-8.14* (0.00)	-7.68* (0.00)
$p_{i,t}$	-7.56* (0.00)	-7.80* (0.00)	-5.29* (0.00)	-6.44* (0.00)
$c_{i,t}$	-6.44* (0.00)	-4.98* (0.00)	-6.40* (0.00)	-7.98* (0.00)
$q_{i;t}$	-9.81* (0.00)	-10.05* (0.00)	-6.22* (0.00)	-7.31* (0.00)
$x_{i,t}$	-2.74* (0.00)	-3.30* (0.00)	-3.54* (0.00)	-4.92* (0.00)
$e_{i,t}$	-4.83* (0.00)	-6.20* (0.00)	-3.61* (0.00)	-4.64* (0.00)
$r_{i;t}$	-7.80* (0.00)	-7.60* (0.00)	-6.69* (0.00)	-5.06* (0.00)
$y_{i,t}$	-9.32* (0.00)	-9.77* (0.00)	-8.49* (0.00)	-10.01* (0.00)

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

Table 2B: Unit Root Test Results for Non- Life Insurance

Panel 1A: Non-Life				
	Developed Countries		**Emerging Markets**	
Var.	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat
$LR_{i,t}$	-3.98* (0.00)	-3.00* (0.00)	-7.97* (0.00)	-9.43* (0.00)
$UER_{i,t}$	-6.90* (0.00)	-5.82* (0.00)	-7.47* (0.04)	-8.49* (0.00)
$SR_{i,t}$	-39.64* (0.00)	-73.45* (0.00)	-8.48* (0.00)	-8.14* (0.00)
$IY_{i,t}$	-2.17* (0.01)	-2.18* (0.01)	-2.94* (0.01)	-3.76* (0.00)
$\Delta K_{i,t}$	-7.91* (0.00)	-8.544* (0.00)	-7.51* (0.00)	-8.09* (0.00)
$p_{i,t}$	-5.21* (0.00)	-2.23* (0.01)	-3.86* (0.00)	-4.32* (0.00)
$c_{i,t}$	-10.06* (0.00)	-10.92* (0.00)	-3.29* (0.00)	-4.35* (0.00)
$q_{i;t}$	-12.58* (0.00)	-13.52* (0.00)	-8.95* (0.00)	-10.88* (0.00)
$x_{i,t}$	-4.76* (0.00)	-4.47* (0.00)	-12.10* (0.00)	-14.38* (0.00)
$e_{i,t}$	-7.20* (0.00)	-7.57* (0.00)	-3.75* (0.00)	-2.87* (0.00)
$r_{i;t}$	-6.97* (0.00)	-6.48* (0.00)	-1.87* (0.03)	-2.60* (0.00)
$y_{i,t}$	-11.11* (0.00)	-12.29* (0.00)	-3.24* (0.00)	-4.13* (0.00)

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

6.2 Chapter 3

Tables' 3A-B below show a list of all the companies whose share returns were used in estimating the response of insurance share returns to macroeconomic fundamentals, in each of the countries in the sample, for both the life and non-life insurance sectors.

Table 3A and 3B

Can.	Fr.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S.Kor.
					LIFE INSURANCE				
MANULIFE FINANCIAL	CNP ASSURANCES	ADVANCE CREATE	SWISS LIFE HOLDING	CHESNARA PLC	PRINCIPAL FINL GROUP	PANIN FINANCIAL TBK	MAA GROUP	DISCOVERY L	SAMSUNG LIFE
INDUSTRIAL ALLIANCE		T&D HOLDINGS INC		STANDARD LIFE ABER	PRUDENTIAL FINANCIAL			CLIENTELE LIMITED	TONG YANG LIFE INS
SUN LIFE FINANCIAL		SONY FINANCIAL		OLD MUTUAL PLC	YADKIN VALLEY CO			SOUTH AFRICAN NAT'L	HANWHA LIFE INS
GREAT-WEST LIFECO		ANICOM HOLDINGS INC		PHOENIX GROUP	CNO FINANCIAL			MMI HOLDINGS LTD	MIRAE ASSET
POWER CORP OF CANADA		DAI-ICHI LIFE HOLD		ST. JAMES'S	AMERICAN EQUITY INV			LIBERTY HOLDINGS	ING LIFE INSURANCE
POWER FINANCIAL CORP -		LIFENET INSURANCE CO		AVIVA PLC	ASSURANT INC			AFRICAN PHOENIX	
		JAPAN POST		LEGAL & GEN'L GRP	GENWORTH FIN'L, INC.				
		JAPAN POST IN		PRUDENTIAL PLC	METLIFE INC				
				JUST GROUP PLC	AMERISAFE, INC				
				GBGI LTD	INSPRO TECH				
					MAJESTIC CAPITAL				
					CITIZENS FINANCIAL				
					EHEALTH, INC				
					EMPLOYERS HOLDINGS				
					CITIZENS, INC.				
					INDEPENDENCE HOLDING				
					UTG INC				
					PRIMERICA, INC				
					UNUM GROUP				
					GRAND HAVANA INC				
					FBL FINANCIAL GROUP				
					HEALTH INSURANCE				
					GWG HOLD				
					LINCOLN NAT'L CORP				
					AFLAC INCORPORATED				
					KANSAS CITY LIFE INS				
					KENTUCKY CENTRL LIFE				
					NATIONAL WESTERN				
					INVESTORS HERITAGE				
					TORCHMARK CORP				
					ATLANTIC AMERICAN				

Source: Thompson Reuters DataStream

Can.	Fr.	Jap.	Swi.	US	UK	Ind.	Mal.	S.Afr.	S.Kor.
				NON-LIFE INSURANCE COMPANY					
INTACT FINANCIAL	EULER HERMES	TOKIO MARINE	WAADT VERSICHERUNGEN	DONEGAL GROUP INC	BEAZLEY PLC	ASURANSI JASA TANIA	PACIFIC & ORIENT BHD	INDEQUITY GROUP LTD	SAMSUNG FIRE & MARIN
ECHELON FINANC	SCOR SE	SOMPO HOLDINGS INC	SWISS RE	SAFETY INSURANCE GP	PERSONAL GROUP	ASURANSI MULTI ARTH	LPI CAPITAL BHD	CONDUIT CAPITAL	HYUNDAI M & F INS.
BOW ENERGY LTD	APRIL SA	NEWTON FINANCIAL	ZURICH INSURANCE	AXIS CAPITAL HLDG -	ADMIRAL GROUP PLC	MASKAPAI REASUR	ALLIANZ MALAYSIA	SANTAM	HEUNGKUK FIRE
FAIRFAX FIN'L HLDGS	COFACE SA	CHUOU INTERNA	BALOISE HOLDING	KINGSTONE CO	LANCASHIRE HLDGS	ASURANSI BINA DANA	MNRB HOLDINGS BHD		DB INSURANCE CO LTD
E L FINANCIAL CORP	AXA SA	MS&AD INSURANCE	HELVETIA HOLDING	GLOBAL INDEMNITY LTD	HISCOX PLC	PANINVEST TBK	TUNE INS HOLDI		KOREAN REINSURANCE
KINGSWAY FINANCIAL				ASSURED GUARANTY LTD	ACHP PLC	ASURANSI DAYIN MITRA	MPHB CAP		HANWHA GENERAL
WESTAIM CORPORATION				HILLTOP HOL	HELIOS UNDERWRITING	ASURANSI RAMAYANA	SYARIKAT TAKAFUL		LOTTE NON-LIFE
ATLAS FINANCIAL HOLD				ERIE INDEMNITY 'A'	RANDALL AND QUILTER	ASURANSI BINTANG TBK	MANULIFE HOLDINGS		MERITZ FINANCIA
				EVEREST RE GROUP	DIRECT LINE	ASURANSI HARTA			
				HANOVER INSURANCE	ESURE GROUP PLC	ASURANSI KRESNA			
				RENAISSANCERE HDG	RSA INSURANCE GROUP	LIPPO GENERAL			
				HORACE MANN EDUCATRS	JARDINE LLOYD	VICTORIA INSURANCE			
				REINSURANCE GROUP	HASTINGS GROUP				
				ALLSTATE CORP	SABRE INSURANCE				
				UNIVERSAL INSURANCE					
				AMERICAN OVERSEAS GROUP					
				CHUBB					
				SYNCORA HOLDING					
				ARCH CAPITAL GROUP					
				ENSTAR GROUP LIMITED -					
				HALLMARK FINANCIAL					
				GREENLIGHT CAPITAL					
				UNITED INSURANCE					
				NATIONAL SECURITY					
				ARGO GROUP INTERN					
				HCI GROUP INC					
				KEMPER					
				STATE AUTO FINANCIAL					
				PROASSURANCE CORP					
				FEDNAT HOLDING CO					
				MERCURY GENERAL CORP					
				WHITE MOUNTAIN INSUR					
				MBIA INC					
				GAINSCO INC					
				MARKEL CORP					
				HARTFORD FINANCIAL					
				AMBAC FINANCIAL					
				AMERICAN FIN'L GROUP -					
				W. R. BERKLEY CORP					
				CNA FINANCIAL CORP					
				AMERICAN INT'L GROUP					
				FIRST ACCEPTANCE COR					
				LOEWS CORPORATION					
				AMERICAN NATIONAL					
				AON PLC					
				OLD REPUBLIC INTL					
				PROTECTIVE INSURANCE					
				ALLEGHANY CORP					
				TRAVELERS COS					
				PROGRESSIVE CORP					
				RLI CORP					
				EMC INSURANCE GROUP					
				CINCINNATI FINL CORP					
				UNICO AMERICAN CORP					
				UNITED FIRE					
				SELECTIVE INSURANCE					

Table 3 C: Market share of foreign companies in the domestic market

	LIFE		NON-LIFE	
	2014	**2015**	**2014**	**2015**
Can.	26.0	21.0	44.8	41.6
Fra.	-	-	0.1	0.1
Jap.	20.1	20.6	-	-
Swi.	27.9	26.9	19.6	20.3
UK	16.0	16.9	57.8	57.5
US	21.0	17.4	9.4	9.5
Ind.	-	-	-	-
Mal.	68.8	69.6	46.6	47.8
S.Afr	35.2	33.3	39.5	34.6
S.Kor.	13.2	12.4	3.7	3.7

Source: OECD Global Insurance Market Trends

6.3 Chapter 4

Table 4A: Seemingly Unrelated Regression Results for the Life Insurance System

	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S. Kor.
Sample	88-17	88-17	88-17	88-17	88-17	88-17	94-16	94-16	94-16	94-16
LIFE INSURANCE AND BANKING										
Panel A-Growth in Reserves and Loan Loss Provisions										
β^b_{LLP}	0.00	-0.04	0.02	0.02	-0.00	-0.01	0.02**	-0.10	-0.01	-0.01
	(0.84)	(0.11)	(0.53)	(0.48)	(0.78)	(0.65)	(0.09)	(0.16)	(0.80)	(0.90)
β_y	1.42	5.94*	21.94*	7.21*	-1.85*	1.59*	0.54*	-1.51*	1.41**	12.46*
	(0.17)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.02)	(0.00)	(0.09)	(0.02)
β_R	-1.63	17.56*	82.93*	-4.50	2.89	-3.37**	-17.48*	3.01	-44.90*	71.51*
	(0.47)	(0.00)	(0.00)	(0.49)	(0.38)	(0.09)	(0.00)	(0.71)	(0.00)	(0.00)
β_r	-0.45	-13.05	57.51	-2.44	5.14*	14.11*	0.02	1.09	0.05	1.92
	(0.87)	(0.19)	(0.35)	(0.88)	(0.01)	(0.00)	(0.98)	(0.83)	(0.98)	(0.71)
β_e	-2.03*	-1.16	3.94*	-7.43*	1.24*	-1.32*	2.79*	0.97	-2.48*	1.49
	(0.00)	(0.54)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.34)	(0.02)	(0.11)
R^2	0.13	0.16	0.43	0.31	0.24	0.44	0.89	0.38	0.41	0.30
Panel B-Solvency Ratio and Capital Adequacy Ratio										
β^b_{CAR}	2.05*	-0.44*	-0.00	-0.02	0.10	0.00	-	-0.12	-0.07	0.02
	(0.00)	(0.03)	(0.98)	(0.47)	(0.24)	(0.58)	(-)	(0.64)	(0.55)	(0.12)
β_y	-4.57	15.76**	34.64*	1.52*	-10.16*	0.26	-	-1.86*	2.12*	24.90*
	(0.30)	(0.06)	(0.00)	(0.00)	(0.00)	(0.31)	(-)	(0.00)	(0.00)	(0.00)
β_R	-96.74*	7.83	500.16*	13.44*	40.74*	-14.57*	-	49.08*	7.57	113.55*
	(0.00)	(0.73)	(0.00)	(0.00)	(0.00)	(0.00)	(-)	(0.00)	(0.32)	(0.00)
β_r	-0.68	-0.39	-711.27*	0.24	7.02*	2.70*	-	1.81	-0.43	0.13
	(0.20)	(0.99)	(0.00)	(0.95)	(0.02)	(0.00)	(-)	(0.78)	(0.82)	(0.44)
β_e	-0.68	-22.71*	-8.41*	3.54*	2.34*	-0.69*	-	3.97*	0.12	0.68*
	(0.20)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(-)	(0.01)	(0.86)	(0.02)
R^2	0.85	0.33	0.93	0.62	0.73	0.90	-	0.61	0.22	0.99
Panel C-Underwriting Expense Ratio and Cost-Income Ratio										
β^b_{CIR}	0.00	0.31*	-	0.10	-0.01	-0.04	0.00	-0.06	0.03	-0.34*
	(0.73)	(0.00)	(-)	(0.18)	(0.63)	(0.28)	(0.96)	(0.67)	(0.60)	(0.01)
β_y	-2.66*	0.25	-	-4.58*	2.35*	1.10*	0.23	1.68*	-1.57*	-1.95**

	(0.02)	(0.64)	(-)	(0.00)	(0.00)	(0.01)	(0.13)	(0.00)	(0.00)	(0.09)
β_R	-7.80*	-18.95*	-	-2.96	1.08	-4.40*	-15.68*	40.22*	-23.61*	-2.78
	(0.00)	(0.00)	(-)	(0.30)	(0.38)	(0.00)	(0.00)	(0.00)	(0.00)	(0.44)
β_r	1.63	2.17	-	-1.45	3.08*	2.18*	-0.08	-0.35	0.42	1.66
	(0.17)	(0.40)	(-)	(0.90)	(0.00)	(0.00)	(0.87)	(0.90)	(0.62)	(0.20)
β_e	-0.71*	-0.43	-	6.96*	-0.50*	1.12*	4.28*	2.00*	0.86*	-0.59*
	(0.00)	(0.41)	(-)	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
R^2	0.25	0.67	-	0.32	0.38	0.40	0.95	0.58	0.57	0.19

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

Panel A shows the results of the relationship between the growth rate in reserves in life insurance and loan loss provisions in banking

Panel B shows the results of the relationship between the solvency ratio in life insurance and the capital adequacy ratio in banking

Panel C shows the results of the relationship between the underwriting expense ratio in life insurance and the cost income ratio in banking.

Table 4B: Seemingly Unrelated Regression Results for the Banking System

	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S. Kor.
Sample	88-17	88-17	88-17	88-17	88-17	88-17	94-16	94-16	94-16	94-16
BANKING AND LIFE INSURANCE										
Panel A-Loan Loss Provisions and Growth in Reserves										
$\alpha^i_{\Delta k}$	-0.22	-0.28**	0.20	0.08	-0.18	-0.10	1.45**	-0.13	0.10	-0.08
	(0.27)	(0.08)	(0.53)	(0.51)	(0.72)	(0.65)	(0.08)	(0.25)	(0.72)	(0.68)
α_y	3.28	-1.43	8.05	-0.43	3.04	5.57**	0.30	-0.60**	-5.03*	-8.20
	(0.28)	(0.79)	(0.50)	(0.85)	(0.49)	(0.09)	(0.89)	(0.09)	(0.02)	(0.28)
α_R	5.54	19.48*	-98.31	24.69**	-9.86	-25.11*	8.17	13.89	18.62	-23.86
	(0.41)	(0.03)	(0.16)	(0.08)	(0.69)	(0.01)	(0.76)	(0.19)	(0.37)	(0.40)
α_r	-33.91*	-59.85*	136.72	-1.19	20.55	-20.62*	-16.77*	-19.47*	-10.63*	-15.93**
	(0.00)	(0.02)	(0.45)	(0.97)	(0.16)	(0.00)	(0.01)	(0.00)	(0.04)	(0.08)
α_e	-0.45	-0.35	5.92*	2.06	0.88	-5.62*	-6.24	-1.74	5.40*	0.68
	(0.70)	(0.94)	(0.04)	(0.31)	(0.80)	(0.00)	(0.14)	(0.19)	(0.05)	(0.83)
R^2	0.08	0.04	0.08	0.02	0.08	0.26	0.12	0.15	0.13	0.06
Panel B-Capital Adequacy Ratio and Solvency Ratio										

α_{SR}^{i}	-0.00	-0.12*	0.03	-0.06	0.10	0.22	-0.03	-0.01	-0.12	6.65
	(0.97)	(0.04)	(0.95)	(0.69)	(0.25)	(0.58)	(0.91)	(0.70)	(0.45)	(0.11)
α_y	-4.54*	-0.03	-4.47	-0.04	-0.38	-0.34	0.00	0.28*	-1.63*	-161.68
	(0.00)	(0.99)	(0.83)	(0.96)	(0.72)	(0.84)	(0.98)	(0.01)	(0.03)	(0.12)
α_R	-8.20*	0.60	-118.35	-12.94	-9.88	1.58	-0.54	-0.09	-7.46	-738.62
	(0.00)	(0.96)	(0.67)	(0.14)	(0.14)	(0.81)	(0.92)	(0.98)	(0.40)	(0.11)
α_r	-0.96	60.17*	73.60	-17.54*	-5.48**	-0.35	-1.35	10.53*	9.54*	-4.16
	(0.36)	(0.00)	(0.86)	(0.02)	(0.06)	(0.89)	(0.25)	(0.00)	(0.00)	(0.11)
α_e	-0.10	0.39	-1.05	-1.05	-0.03	-0.33	0.09	-0.09	1.45*	-4.67
	(0.37)	(0.90)	(0.82)	(0.31)	(0.96)	(0.55)	(0.95)	(0.89)	(0.05)	(0.12)
R^2	0.54	0.36	0.08	0.05	0.39	0.03	0.02	0.28	0.44	0.28
Panel C-Cost Income Ratio and Underwriting Expenses Ratio										
α_{UER}^{i}	-2.70	0.27*	-	0.03	-0.49**	0.03	-	-0.01	0.07	-0.13*
	(0.31)	(0.00)	(-)	(0.21)	(0.07)	(0.56)	(-)	(0.83)	(0.73)	(0.03)
α_y	-50.92**	-2.23*	-	-1.54*	-0.40	0.13	-	-0.20*	-3.11*	-3.97*
	(0.07)	(0.00)	(-)	(0.00)	(0.78)	(0.74)	(-)	(0.05)	(0.00)	(0.00)
α_R	74.02	12.43*	-	9.41*	11.76	5.20*	-	6.70*	10.77	-12.13*
	(0.20)	(0.00)	(-)	(0.00)	(0.19)	(0.00)	(-)	(0.03)	(0.16)	(0.00)
α_r	79.88*	-4.02**	-	6.67	-11.72*	-2.68*	-	-1.29	-0.52	-2.06*
	(0.01)	(0.09)	(-)	(0.31)	(0.03)	(0.00)	(-)	(0.42)	(0.75)	(0.01)
α_e	-0.74	-3.10*	-	0.46	0.08	-0.50*	-	-0.87*	0.15	-0.22
	(0.90)	(0.00)	(-)	(0.21)	(0.94)	(0.00)	(-)	(0.01)	(0.83)	(0.12)
R^2	0.06	0.32	-	0.27	0.09	0.07	-	0.27	0.30	0.32

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

Panel A shows the results of the relationship between loan loss provisions in banking and the growth rate in reserves in life insurance

Panel B shows the results of the relationship between the capital adequacy ratio in banking and the solvency ratio in life insurance

Panel C shows the results of the relationship between the cost income ratio in banking and the underwriting expense ratio in life insurance

Table 4C: Seemingly Unrelated Regression Results for the Non-Life Insurance System

	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S. Kor.
Sample	88-17	88-17	88-17	88-17	88-17	88-17	94-16	94-16	94-16	94-16
NONLIFE INSURANCE AND BANKING										
Panel A-Growth in Reserves and Loan Loss Provisions										
β^b_{LLP}	-0.00	-0.02	-0.00	0.04	-0.01	-0.00	-0.01	-0.01	-0.09	0.02
	(0.84)	(0.47)	(0.89)	(0.26)	(0.62)	(0.65)	(0.38)	(0.81)	(0.19)	(0.51)
β_y	0.34	-1.03	9.16*	3.01	-2.06	1.59	-1.71*	0.32*	10.57*	10.78*
	(0.71)	(0.69)	(0.00)	(0.15)	(0.43)	(0.03)	(0.00)	(0.01)	(0.00)	(0.00)
β_R	-6.66**	-4.03	-15.11*	75.88*	-29.24*	-3.37**	-11.71*	-44.27*	16.29*	14.20
	(0.07)	(0.70)	(0.00)	(0.00)	(0.02)	(0.09)	(0.00)	(0.00)	(0.04)	(0.31)
β_r	23.07*	23.28*	24.06*	-26.82*	12.84**	14.11*	-4.11*	44.41*	-23.44*	-0.99
	(0.00)	(0.00)	(0.00)	(0.01)	(0.08)	(0.00)	(0.00)	(0.00)	(0.03)	(0.94)
β_e	0.16	-9.30*	-0.31	-0.70	-3.08	-1.32*	2.19*	-0.87	-4.89*	-1.72*
	(0.56)	(0.00)	(0.20)	(0.68)	(0.12)	(0.00)	(0.00)	(0.19)	(0.00)	(0.00)
R^2	0.46	0.28	0.88	0.21	0.12	0.44	0.34	0.41	0.43	0.28
Panel B-Solvency Ratio and Capital Adequacy Ratio										
	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S.Kor.
β^b_{CAR}	1.83*	0.03*	-0.01	-0.01	-0.04	-0.20	-0.01	0.11**	0.15	0.00
	(0.00)	(0.03)	(0.85)	(0.85)	(0.78)	(0.47)	(0.39)	(0.09)	(0.36)	(0.99)
β_y	6.32	2.51*	-4.47*	5.28*	-14.77*	-13.11	1.41*	-0.71*	-9.32*	-26.29*
	(0.37)	(0.04)	(0.01)	(0.00)	(0.00)	(0.37)	(0.00)	(0.00)	(0.00)	(0.00)
β_R	-87.30*	5.82*	97.50*	6.39	49.25*	58.32*	1.59*	-13.78*	-8.24	-56.98*
	(0.00)	(0.01)	(0.00)	(0.45)	(0.00)	(0.00)	(0.03)	(0.01)	(0.38)	(0.00)
β_r	-10.18	0.43	83.35*	-14.09*	14.84*	-136.10	-3.97*	23.22*	6.06	-91.34*
	(0.24)	(0.85)	(0.03)	(0.00)	(0.00)	(0.16)	(0.00)	(0.00)	(0.63)	(0.00)
β_e	-0.12	0.29	-2.23*	0.70	5.68*	10.25*	0.35*	-3.86*	1.21	-1.45*
	(0.85)	(0.54)	(0.00)	(0.43)	(0.00)	(0.00)	(0.00)	(0.00)	(0.57)	(0.00)
R^2	0.85	0.65	0.62	0.58	0.67	0.20	0.95	0.61	0.60	0.97
Panel C-Underwriting Expense Ratio and Cost-Income Ratio										
	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S.Kor.
β^b_{CIR}	-0.01	-0.01	-0.04	0.04*	0.03**	0.01	-0.36*	0.20*	0.00	0.04
	(0.62)	(0.83)	(0.19)	(0.01)	(0.09)	(0.77)	(0.00)	(0.00)	(0.94)	(0.68)
β_y	-6.11*	0.83*	0.47	0.73*	-0.44	-1.64*	-1.22*	0.70*	0.70*	3.73*
	(0.01)	(0.01)	(0.02)	(0.00)	(0.21)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)
β_R	-22.54*	-9.26*	-8.26*	1.48	-6.64*	0.24	9.25*	17.94*	-9.85*	29.28*

	(0.00)	(0.00)	(0.00)	(0.33)	(0.00)	(0.78)	(0.00)	(0.00)	(0.00)	(0.00)
β_r	10.64*	2.23*	4.20*	1.13	-10.69*	-1.09*	-0.92	-9.51*	-0.54	-8.41**
	(0.00)	(0.02)	(0.05)	(0.17)	(0.00)	(0.03)	(0.16)	(0.00)	(0.71)	(0.09)
β_e	-0.06	1.59*	0.01	-0.61*	0.25	-0.91*	2.46*	0.71*	0.29	-1.67*
	(0.85)	(0.00)	(0.90)	(0.00)	(0.32)	(0.00)	(0.00)	(0.03)	(0.23)	(0.00)
R^2	0.68	0.43	0.67	0.21	0.81	0.10	0.58	0.32	0.58	0.74

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

Panel A shows the results of the relationship between the growth rate in reserves in non-life insurance and loan loss provisions in banking

Panel B shows the results of the relationship between the solvency ratio in non-life insurance and the capital adequacy ratio in banking

Panel C shows the results of the relationship between the underwriting expense ratio in non-life insurance and the cost income ratio in banking.

Table 4D: Seemingly Unrelated Regression Results for the Banking System

	Can.	Fra.	Jap.	Swi.	UK	US	Ind.	Mal.	S.Afr.	S. Kor.
Sample	88-17	88-17	88-17	88-17	88-17	88-17	94-16	94-16	94-16	94-16
BANKING AND NONLIFE INSURANCE										
Panel A-Loan Loss Provisions and Growth in Reserves										
$\alpha_{\Delta k}^i$	-0.69**	-0.08	-0.13	0.12	-0.15	-0.10	-0.39	-0.12	-0.26**	0.15
	(0.08)	(0.64)	(0.89)	(0.19)	(0.67)	(0.65)	(0.34)	(0.59)	(0.08)	(0.63)
α_y	7.14	-0.36	7.43	-6.78*	9.16	5.57**	-0.08	-0.93*	1.03	-9.35
	(0.17)	(0.96)	(0.51)	(0.04)	(0.26)	(0.09)	(0.96)	(0.01)	(0.77)	(0.20)
α_R	3.96	3.54	-74.94	-41.86	17.06	-25.11*	-14.82	-14.36	-10.17	-21.23
	(0.85)	(0.90)	(0.19)	(0.19)	(0.68)	(0.01)	(0.42)	(0.43)	(0.41)	(0.66)
α_r	8.68	9.71	16.46	40.14*	-6.50	-20.62*	-3.45	21.70	6.07	-13.53
	(0.60)	(0.61)	(0.84)	(0.01)	(0.78)	(0.00)	(0.55)	(0.19)	(0.71)	(0.75)
α_e	-0.35	2.46	4.90*	3.78	1.32	-5.62*	-2.24	-1.49	1.55	-0.02
	(0.83)	(0.69)	(0.05)	(0.16)	(0.83)	(0.00)	(0.34)	(0.41)	(0.56)	(0.99)
R^2	0.03	0.03	0.05	0.06	0.09	0.26	0.02	0.11	0.06	0.02
Panel B-Capital Adequacy Ratio and Solvency Ratio										
α_{SR}^i	0.01	1.83*	-0.07	-0.02	-0.03	-0.02	-0.15	0.18**	0.05	-

	(0.51)	(0.01)	(0.85)	(0.80)	(0.57)	(0.47)	(0.55)	(0.09)	(0.59)	(-)
α_y	-2.39*	-16.11*	5.85	-0.27	-1.81**	2.21	0.18	0.47*	-2.79	-
	(0.01)	(0.05)	(0.34)	(0.78)	(0.08)	(0.61)	(0.68)	(0.00)	(0.15)	(-)
α_R	-2.95	-21.88	-48.66	-16.77**	-1.21	-4.55	-2.08	5.94	-8.84	-
	(0.13)	(0.16)	(0.51)	(0.07)	(0.85)	(0.27)	(0.55)	(0.36)	(0.19)	(-)
α_r	-3.73*	25.17	-33.60	2.53	-6.61*	-2.70	-2.67**	-21.28*	10.43	-
	(0.00)	(0.10)	(0.81)	(0.63)	(0.05)	(0.93)	(0.09)	(0.00)	(0.25)	(-)
α_e	0.02	4.75	-1.78	-1.01	0.70	-1.60	-0.14	2.52*	2.25	-
	(0.87)	(0.12)	(0.32)	(0.30)	(0.35)	(0.12)	(0.78)	(0.00)	(0.15)	(-)
R^2	0.55	0.13	0.11	0.03	0.39	0.08	0.04	0.22	0.09	-
Panel C-Cost Income Ratio and Underwriting Expenses Ratio										
α_{UER}^i	1.79	-0.02	-0.40	0.30*	0.54*	-0.03	-0.30*	0.21*	-0.03	0.05
	(0.60)	(0.87)	(0.19)	(0.01)	(0.02)	(0.77)	(0.00)	(0.01)	(0.92)	(0.48)
α_y	30.08	-2.54*	-1.98*	-2.49*	-2.39**	-2.53*	0.01	-0.66*	-2.11*	-3.96*
	(0.54)	(0.00)	(0.00)	(0.00)	(0.06)	(0.00)	(0.93)	(0.00)	(0.03)	(0.00)
α_R	103.21	2.53	-17.62*	0.55	9.37	3.74*	4.66*	-14.47*	8.77**	8.18**
	(0.28)	(0.28)	(0.00)	(0.89)	(0.30)	(0.00)	(0.00)	(0.00)	(0.07)	(0.07)
α_r	-26.42	2.29	7.92	4.49*	-2.11	3.74*	1.90*	15.37*	-4.85	-21.23*
	(0.69)	(0.12)	(0.25)	(0.05)	(0.68)	(0.00)	(0.00)	(0.00)	(0.28)	(0.00)
α_e	9.03	-3.02*	0.40**	0.77*	0.76	-2.79*	0.67*	-1.35*	-0.55	0.20
	(0.20)	(0.00)	(0.07)	(0.02)	(0.48)	(0.00)	(0.01)	(0.00)	(0.47)	(0.22)
R^2	0.13	0.24	0.25	0.28	0.08	0.24	0.28	0.38	0.29	0.46

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%

Panel A shows the results of the relationship between loan loss provisions in banking and the growth rate in reserves in non-life insurance.

Panel B shows the results of the relationship between the capital adequacy ratio in banking and the solvency ratio in non-life insurance.

Panel C shows the results of the relationship between the cost income ratio in banking and the underwriting expense ratio in non-life insurance.

Table 4E: Unit Root Test Results for Life Insurance and Banking

	Can.		Fra.		Jap.		Swi.		UK		USA	
	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat
ΔK_t^i	-7.47*	-2.31*	-9.49*	-7.46*	-4.66*	-7.46*	-8.53*	-8.61*	-6.25*	-4.53*	-8.20*	-5.95*
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
SR_t^i	-10.93*	-13.78*	-12.67*	-13.29*	-5.38*	-9.54*	-22.57*	-25.79*	-6.91*	-10.87*	-9.07*	-14.27*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
UER_t^i	-6.66*	-5.46*	-21.59*	-24.65*	0.41	1.94	-12.54*	-16.80*	-20.86*	-19.61*	-7.63*	-1.35*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.82)	(0.97)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.09)
LLP_i^b	-2.64*	-3.35*	-2.61*	-2.74*	-5.33*	-8.44*	-1.618*	-3.24*	-3.36*	-4.24*	-3.17*	-5.20*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CAR_t^b	-19.22*	-65.06*	-8.62*	-10.35*	-3.48*	-14.25*	-4.58*	-20.94*	-4.38*	-7.21*	-3.28*	-12.51*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CIR_t^b	-5.66*	-10.01*	-3.52*	-4.10*	-10.39*	-11.36*	-4.11*	-4.85*	-6.81*	-31.67*	-3.45*	-6.06*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
y_t	-6.23*	-6.13*	-6.31*	-8.69*	-9.10*	-11.16*	-4.90*	-3.23*	-2.49*	-1.60**	-8.94*	-9.26*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)	(0.00)	(0.00)
r_t	-1.39**	-3.91*	-4.16*	-4.44*	-30.39*	-29.63*	-4.04*	-2.94*	-9.69*	-8.12*	-3.56*	-8.22*
	(0.08)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.00)	(0.00)	(0.00)	(0.08)	(0.00)
R_t	-29.70*	-29.63*	-15.19*	-16.92*	-9.24*	-9.59*	-28.18*	-28.94*	-13.06*	-13.34*	-33.21*	-37.31*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
e_t	-8.06*	-7.84*	-13.94*	-16.76*	-6.60*	-1.63*	-19.58*	-22.24*	-11.21*	-13.56*	-14.42*	-17.03*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Ind.		Mal.		S.Afr.		S.Kor					

	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat
ΔK_t^i	-12.80*	-17.26*	-5.78*	-9.25*	-14.02*	-16.45*	-4.76*	-8.24*
	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.04)	(0.00)	(0.04)
SR_t^i	-12.29*	-19.12*	-12.65*	-10.32*	-1.40**	-3.93*	-2.45*	-4.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.00)	(0.01)	(0.00)
UER_t^i	-2.10*	-4.75*	-7.76*	-10.96*	-7.05*	-9.70*	-2.46*	-3.71*
	(0.02)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.01)	(0.00)
LLP_i^b	-1.46**	-4.46*	-2.94*	-3.71*	-5.63*	-8.17*	-2.91*	-4.18*
	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CAR_t^b	-3.31*	-5.82*	-9.24*	-12.51*	-1.86*	-4.21*	2.83	1.86
	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.99)	(0.97)
CIR_t^b	-5.26*	-7.43*	-4.91*	-4.40*	-8.89*	-10.95*	-5.49*	-5.25*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
y_t	-7.25*	-5.47*	-8.71*	-10.62*	-3.35*	-4.33*	-1.84*	-4.82*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
r_t	-4.80*	-5.28*	-2.71*	-2.41*	-10.08*	-8.47*	-1.59**	-1.61*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)	(0.05)
R_t	-31.65*	-34.18*	-10.23*	-10.66*	-2.05*	-4.30*	-12.15*	-12.30*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
e_t	-10.85*	-12.66*	-8.19*	-11.25*	-7.87*	-10.76*	-3.96*	-4.86*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

Table 4F: Unit Root Test Results for Non-Life Insurance and Banking

	Can.		Fra.		Jap.		Swi.		UK		USA	
	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat
ΔK_t^i	-4.88*	-5.34*	-9.01*	-11.50*	-20.75*	-26.02*	-11.77*	-13.88*	3.22	11.16	-8.20*	-5.95*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.99)	(1.00)	(0.00)	(0.00)
SR_t^i	-10.10*	-13.67*	-12.03*	-14.33*	-21.61*	-15.36*	-12.00*	-6.13*	-52.84*	-47.12*	-3.08*	-12.54*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
UER_t^i	-13.66*	-16.58*	-13.39*	-12.42*	-19.53*	-15.02*	-13.02*	-16.03*	-19.15*	-22.52*	-39.01*	-38.37*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LLP_i^b	-2.64*	-3.35*	-2.61*	-2.74*	-5.33*	-8.44*	-1.618*	-3.24*	-3.36*	-4.24*	-3.17*	-5.20*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CAR_t^b	-19.22*	-65.06*	-8.62*	-10.35*	-3.48*	-14.25*	-4.58*	-20.94*	-4.38*	-7.21*	-3.28*	-12.51*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CIR_t^b	-5.66*	-10.01*	-3.52*	-4.10*	-10.39*	-11.36*	-4.11*	-4.85*	-6.81*	-31.67*	-3.45*	-6.06*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
y_t	-6.23*	-6.13*	-6.31*	-8.69*	-9.10*	-11.16*	-4.90*	-3.23*	-2.49*	-1.60**	-8.94*	-9.26*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)	(0.00)	(0.00)
r_t	-1.39**	-3.91*	-4.16*	-4.44*	-30.39*	-29.63*	-4.04*	-2.94*	-9.69*	-8.12*	-3.56*	-8.22*
	(0.08)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.00)	(0.00)	(0.00)	(0.08)	(0.00)
R_t	-29.70*	-29.63*	-15.19*	-16.92*	-9.24*	-9.59*	-28.18*	-28.94*	-13.06*	-13.34*	-33.21*	-37.31*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
e_t	-8.06*	-7.84*	-13.94*	-16.76*	-6.60*	-1.63*	-19.58*	-22.24*	-11.21*	-13.56*	-14.42*	-17.03*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Ind.		Mal.		S.Afr.		S.Kor					

	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat	IPS W-stat	LLC t*-stat
ΔK_t^i	-10.26*	-14.75*	-8.24*	-10.71*	-1.82*	-2.89*	-14.31*	-11.67*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.04)
SR_t^i	-25.97*	-31.62*	-2.92*	-1.93*	-21.39*	-25.82*	-14.31*	-11.67*
	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
UER_t^i	-21.29*	-25.35*	-17.42*	-15.99*	-8.94*	-10.35*	-3.22*	-1.88*
	(0.02)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.03)
LLP_i^b	-1.46**	-4.46*	-2.94*	-3.71*	-5.63*	-8.17*	-2.91*	-4.18*
	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CAR_t^b	-3.31*	-5.82*	-9.24*	-12.51*	-1.86*	-4.21*	2.83	1.86
	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.99)	(0.97)
CIR_t^b	-5.26*	-7.43*	-4.91*	-4.40*	-8.89*	-10.95*	-5.49*	-5.25*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
y_t	-7.25*	-5.47*	-8.71*	-10.62*	-3.35*	-4.33*	-1.84*	-4.82*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
r_t	-4.80*	-5.28*	-2.71*	-2.41*	-10.08*	-8.47*	-1.59**	-1.61*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)	(0.05)
R_t	-31.65*	-34.18*	-10.23*	-10.66*	-2.05*	-4.30*	-12.15*	-12.30*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
e_t	-10.85*	-12.66*	-8.19*	-11.25*	-7.87*	-10.76*	-3.96*	-4.86*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: p-values in parentheses, *Significant at 5%, **Significant at 10%.

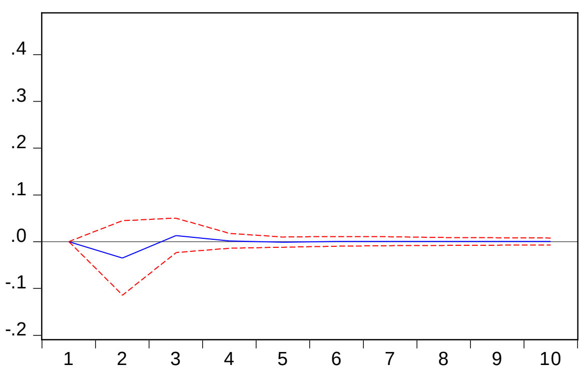
Spill over Effects

The impulse response function graphs below show, the full set of results, of the residual spill over effects, in both the banking and insurance sectors.

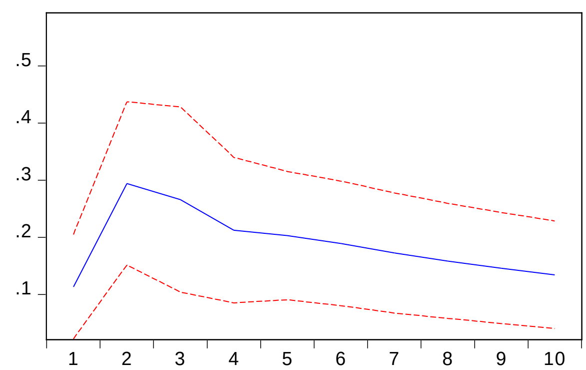
Life Insurance and Banking-Developed Countries

Canada

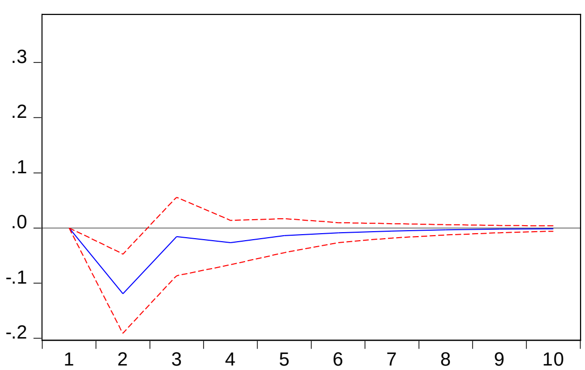
Response of Reserves to Loan Loss Provisions



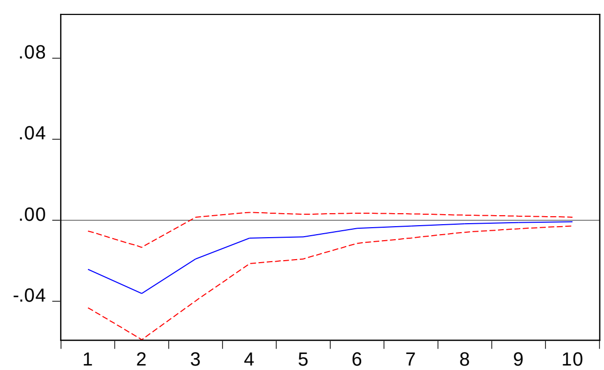
Response of Loan Loss Provisions to Reserves



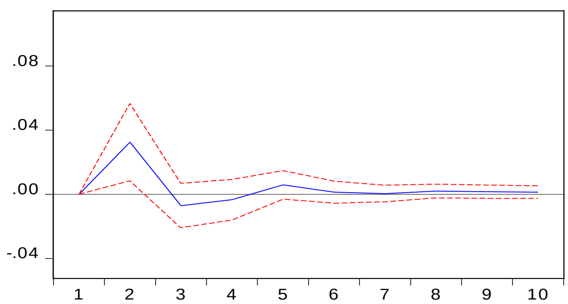
Response of Solvency Ratio to Capital Adequacy Ratio



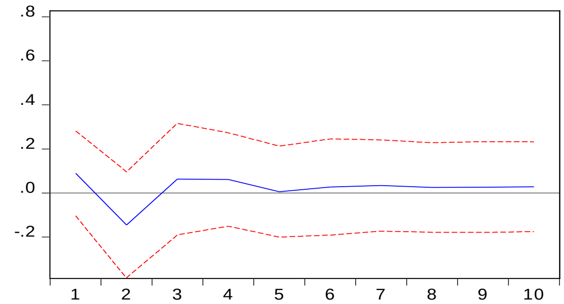
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

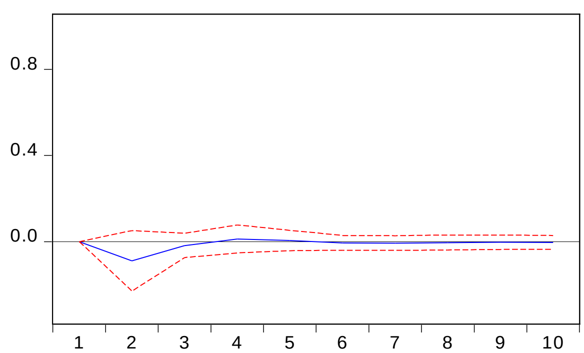


Response of Cost-Income Ratio to Underwriting Expense Ratio

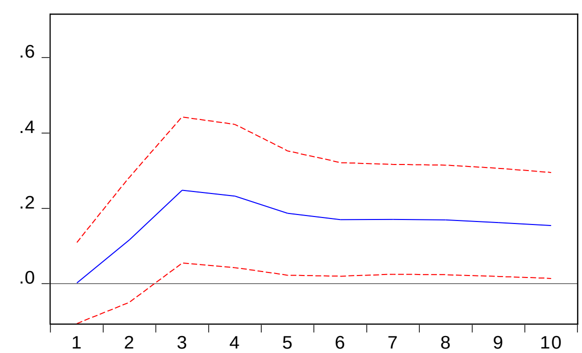


France

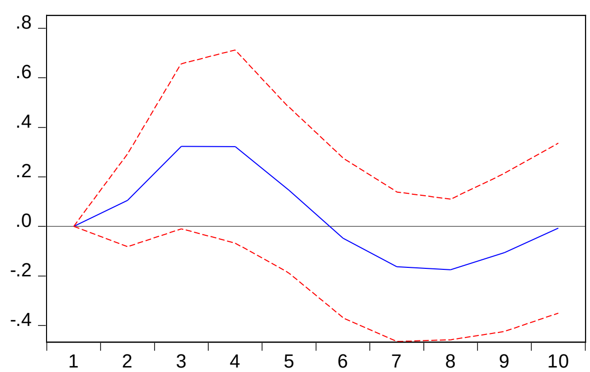
Response of Reserves to Loan Loss Provisions



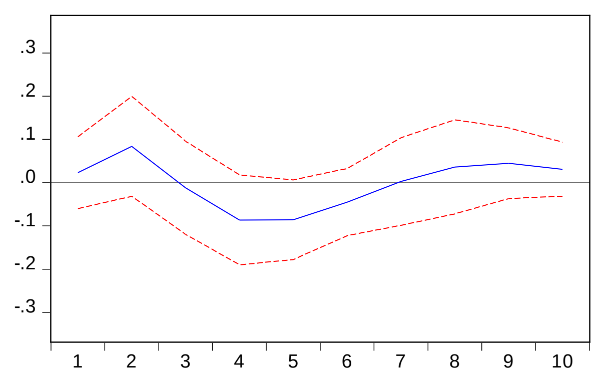
Response of Loan Loss Provisions to Reserves



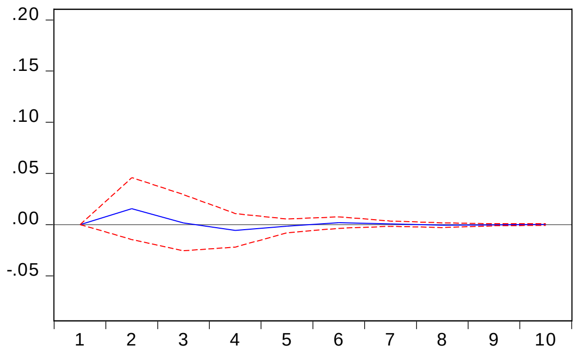
Response of Solvency Ratio to Capital Adequacy Ratio



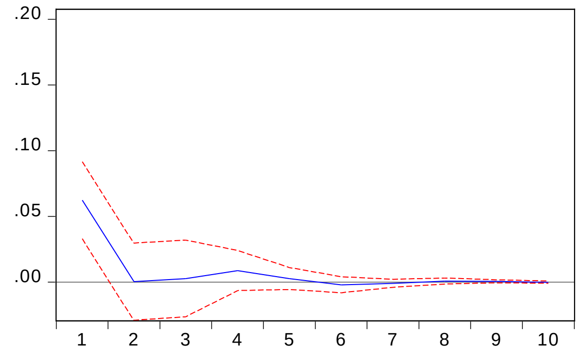
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

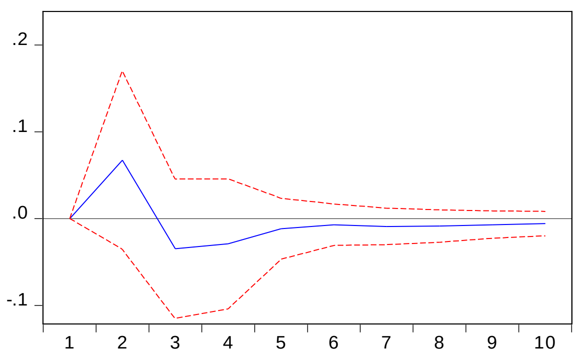


Response of Cost-Income Ratio to Underwriting Expense Ratio

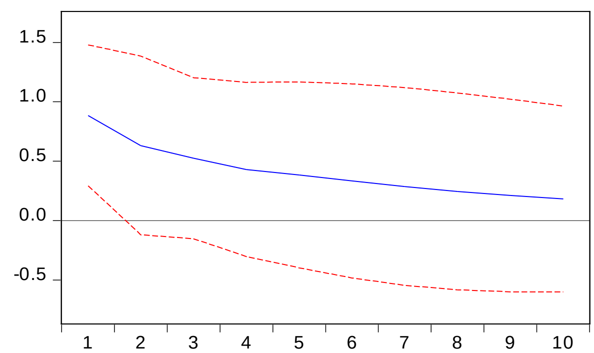


Japan

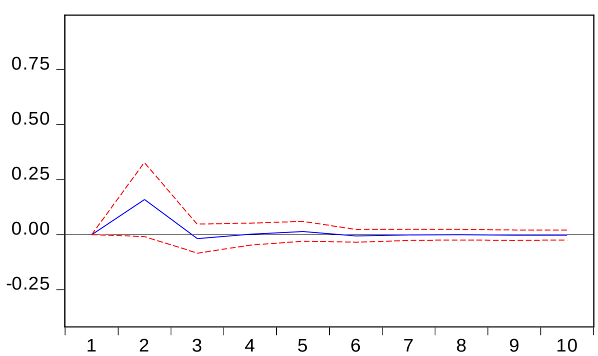
Response of Reserves to Loan Loss Provisions



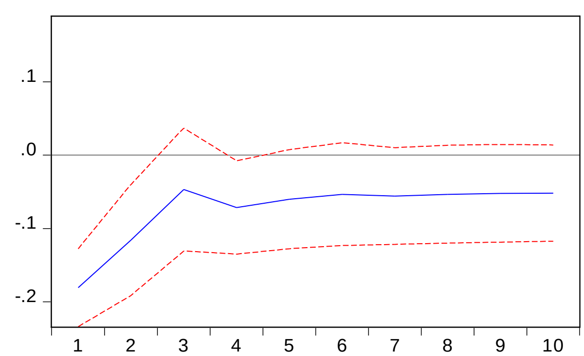
Response of Loan Loss Provisions to Reserves



Response of Solvency Ratio to Capital Adequacy Ratio

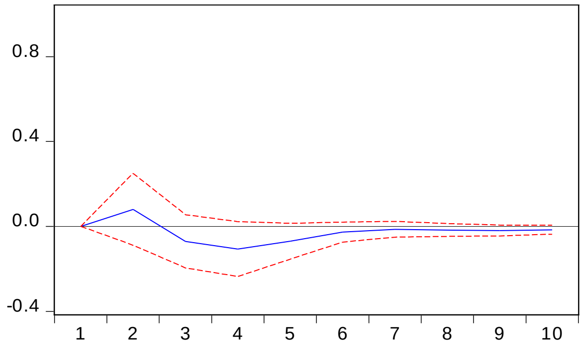


Response of Capital Adequacy Ratio to Solvency Ratio

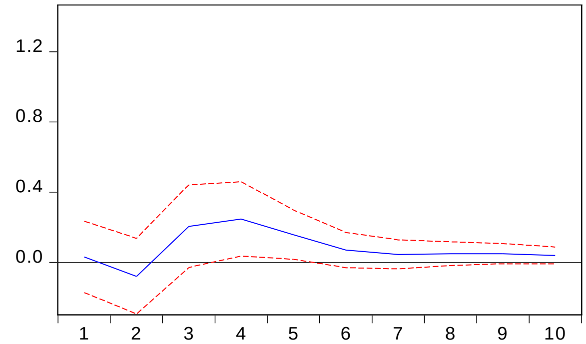


Switzerland

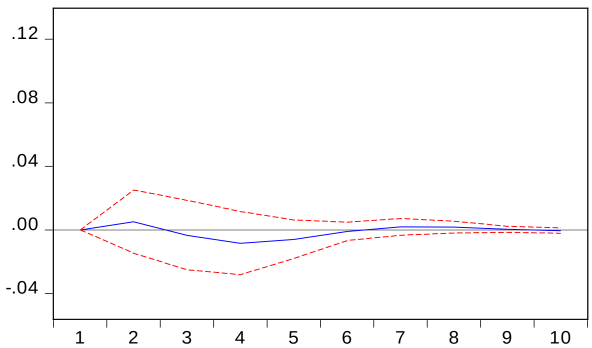
Response of Reserves to Loan Loss Provisions



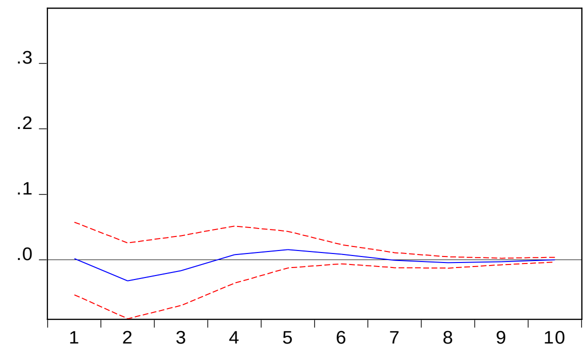
Response of Loan Loss Provisions to Reserves



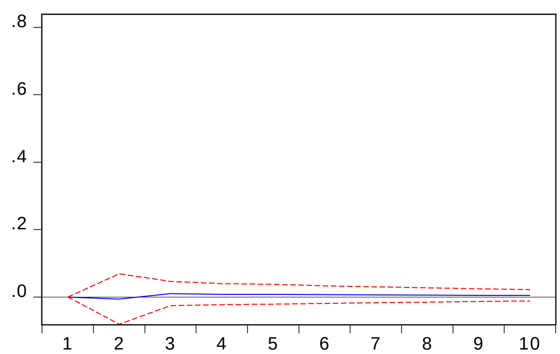
Response of Solvency Ratio to Capital Adequacy Ratio



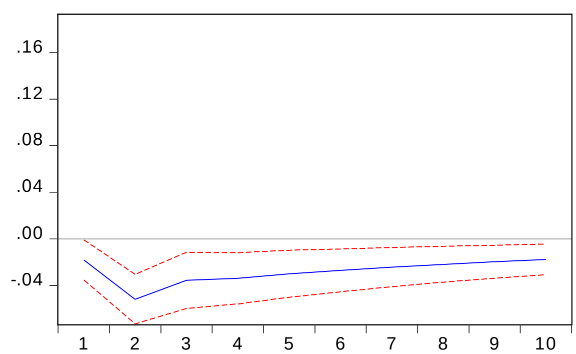
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

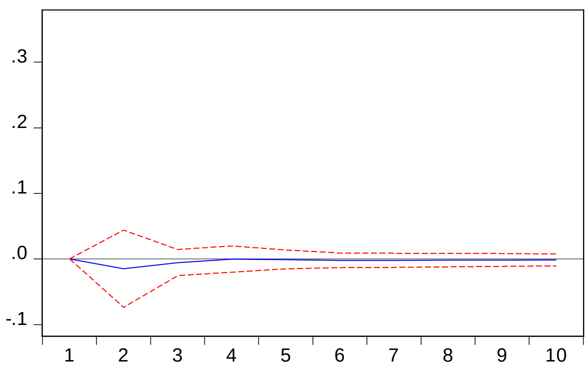


Response of Cost-Income Ratio to Underwriting Expense Ratio

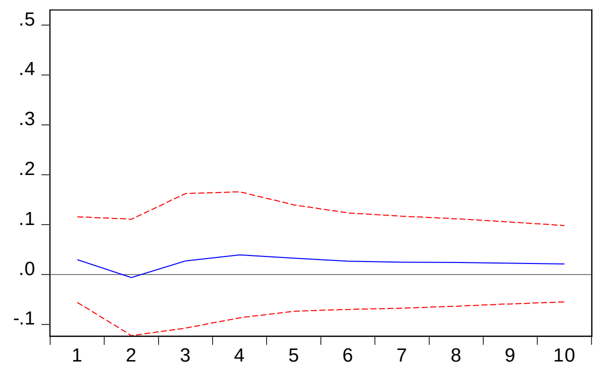


United Kingdom

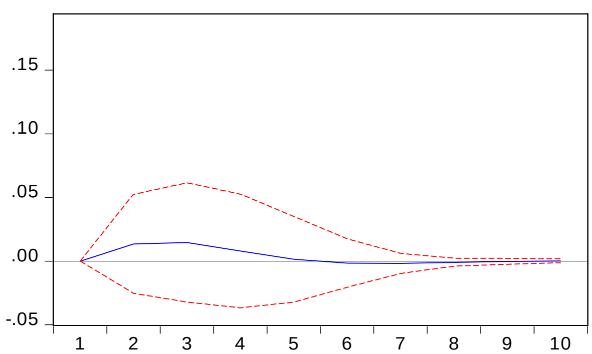
Response of Reserves to Loan Loss Provisions



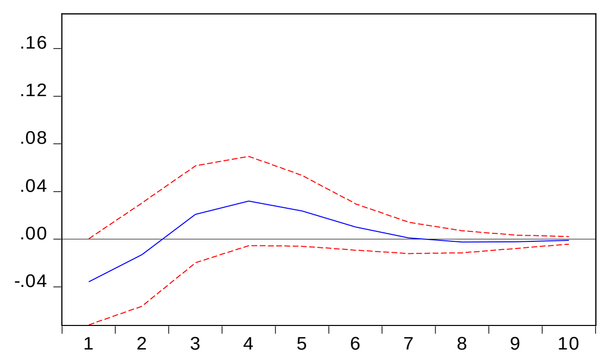
Response of Loan Loss Provisions to Reserves



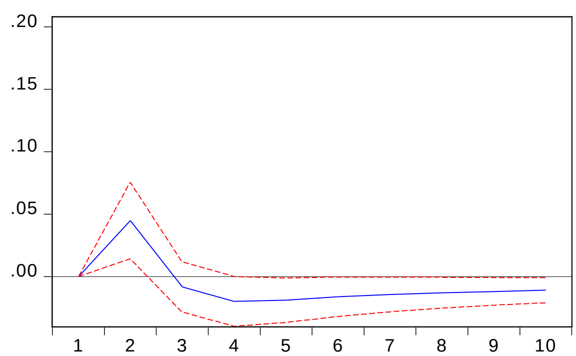
Response of Solvency Ratio to Capital Adequacy Ratio



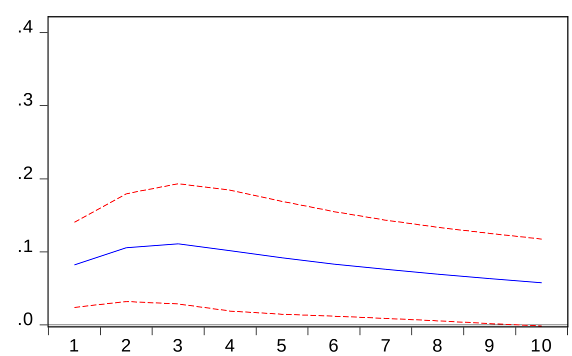
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

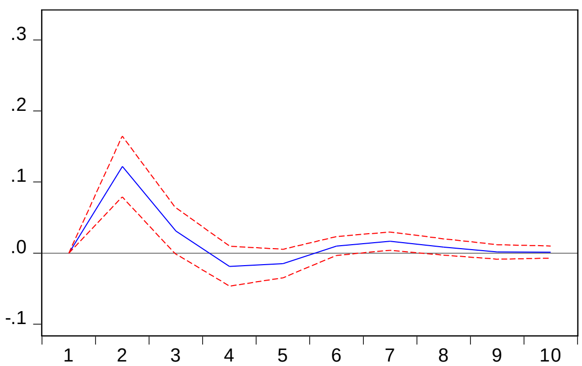


Response of Cost-Income Ratio to Underwriting Expense Ratio

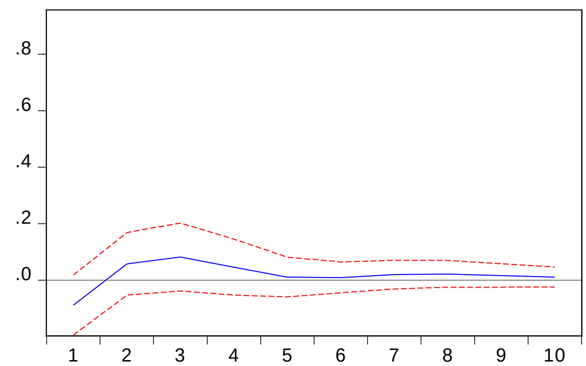


United States

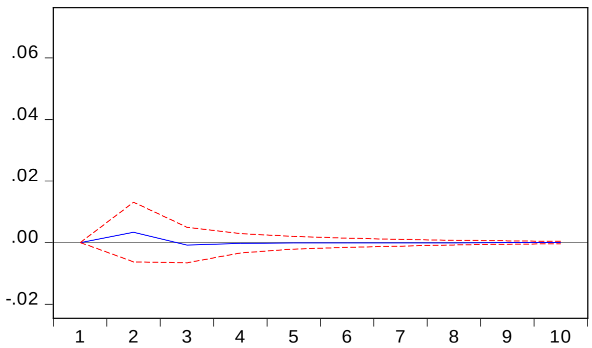
Response of Reserves to Loan Loss Provisions



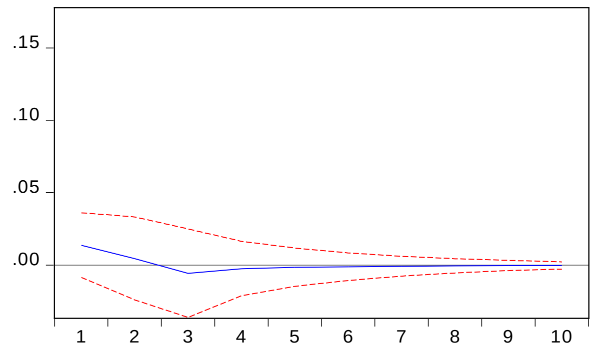
Response of Loan Loss Provisions to Reserves



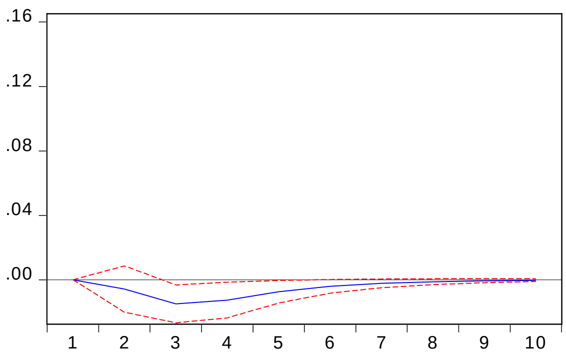
Response of Solvency Ratio to Capital Adequacy Ratio



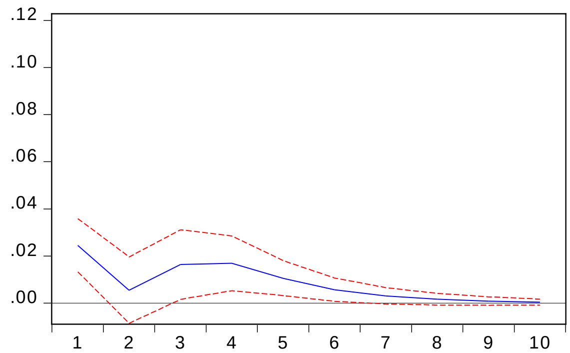
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

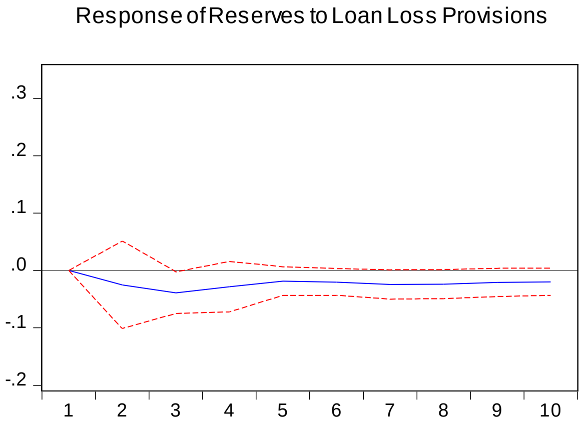


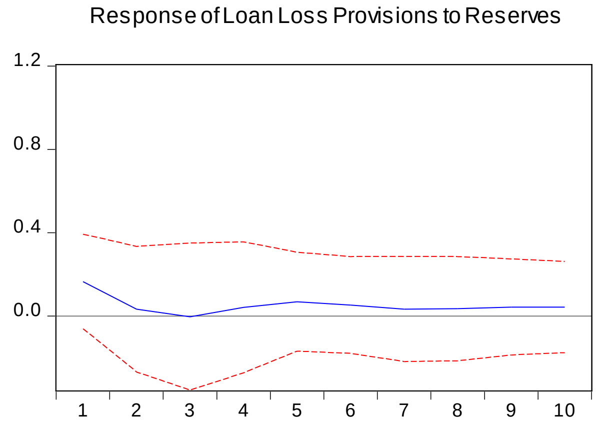
Response of Cost-Income Ratio to Underwriting Expense Ratio

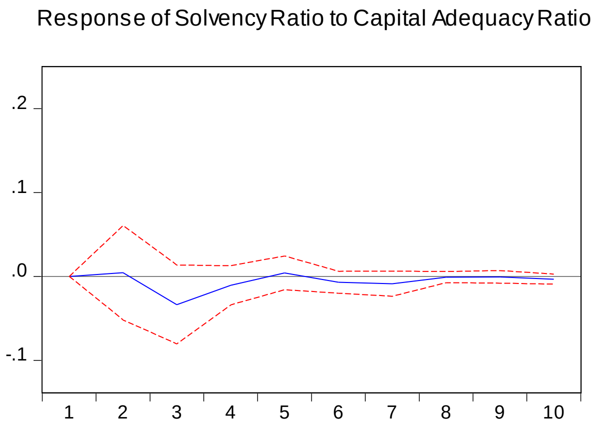


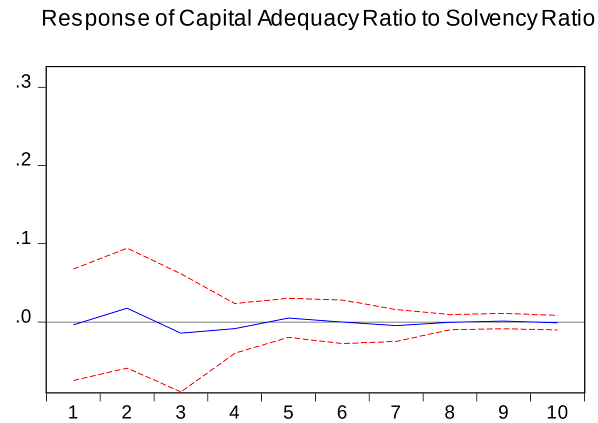
Life Insurance and Banking-Emerging Market Countries

Indonesia

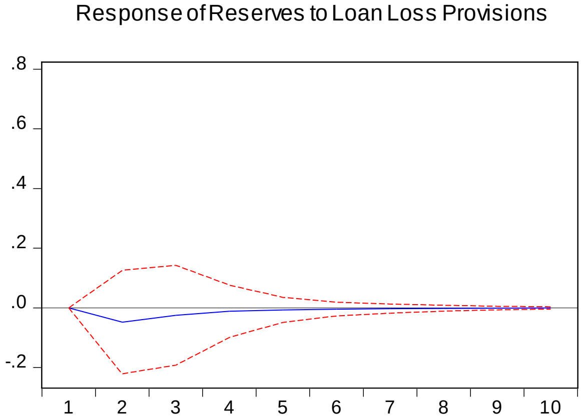


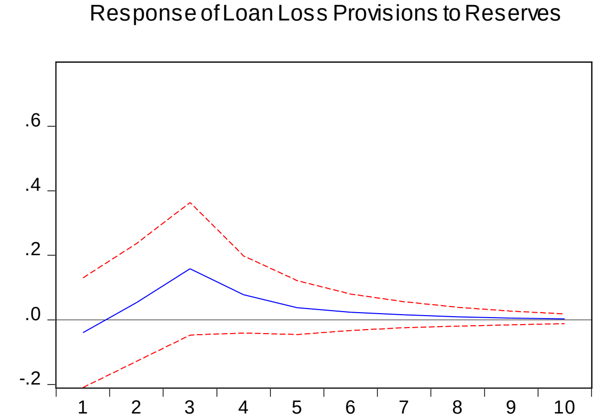




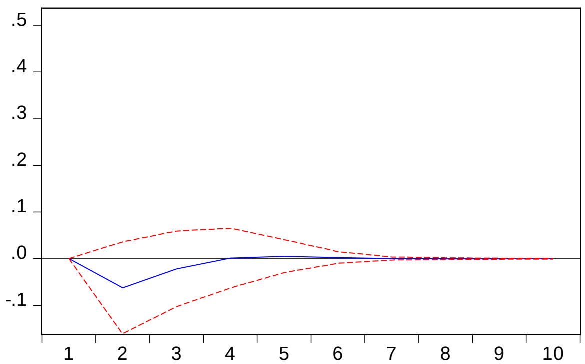


Malaysia

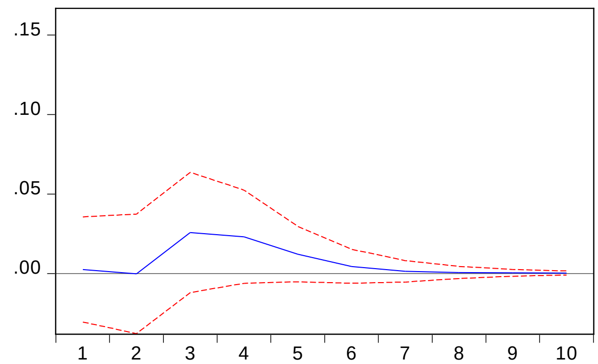




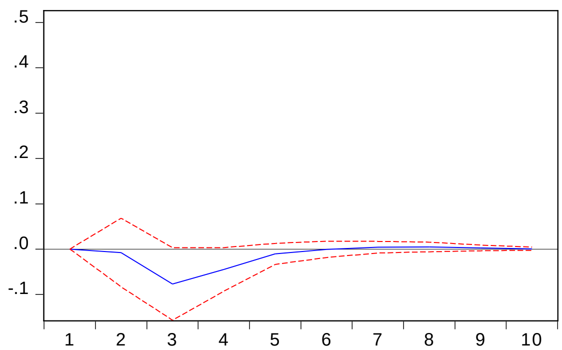
Response of Solvency Ratio to Capital Adequacy Ratio



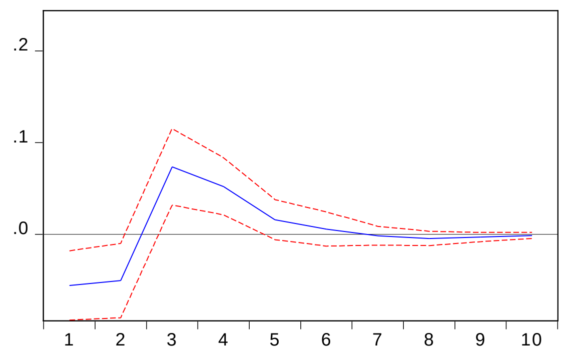
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

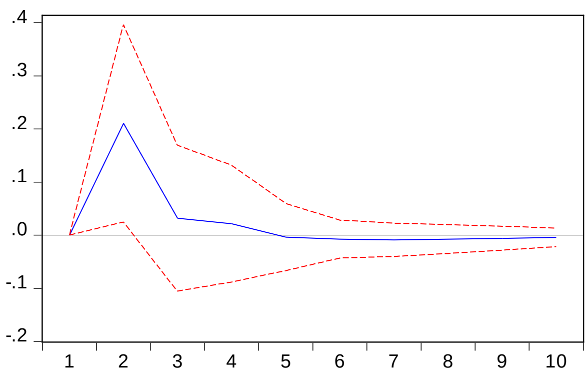


Response of Cost-Income Ratio to Underwriting Expense Ratio

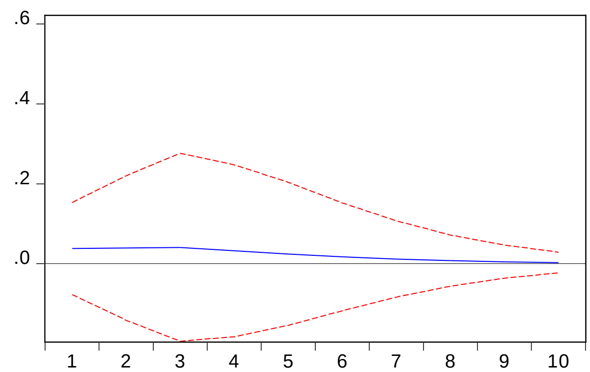


South Africa

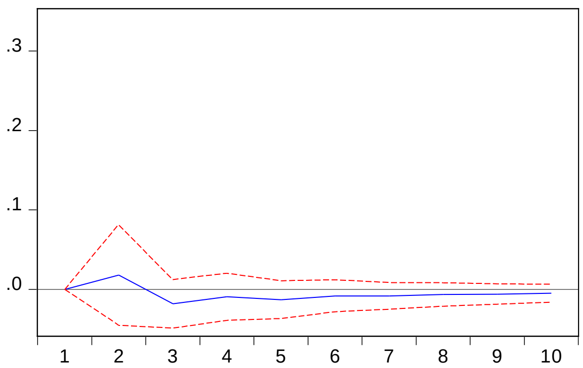
Response of Reserves to Loan Loss Provisions



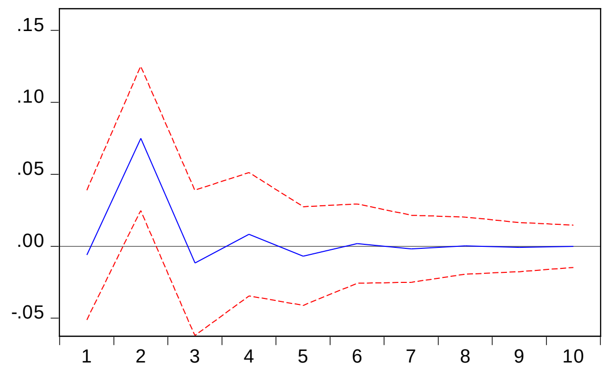
Response of Loan Loss Provisions to Reserves



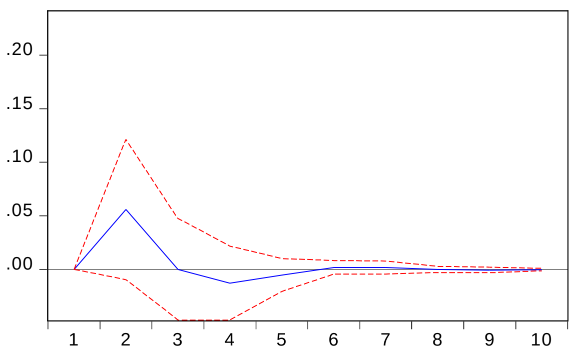
Response of Solvency Ratio to Capital Adequacy Ratio



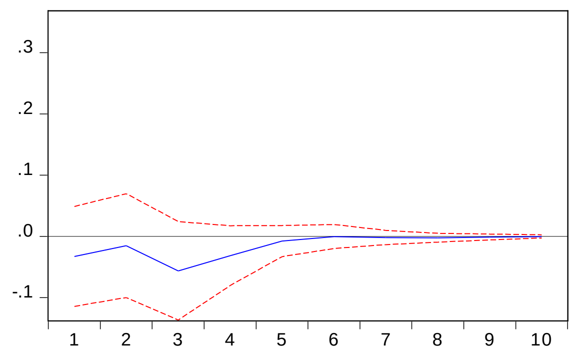
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

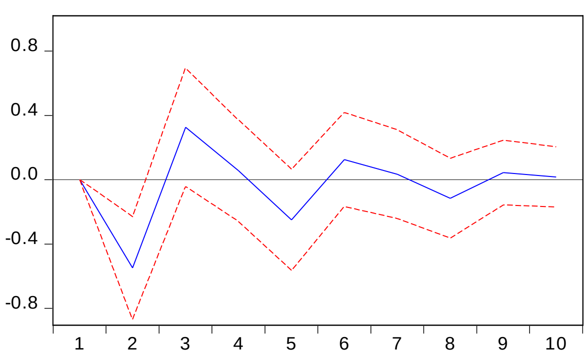


Response of Cost-Income Ratio to Underwriting Expense Ratio

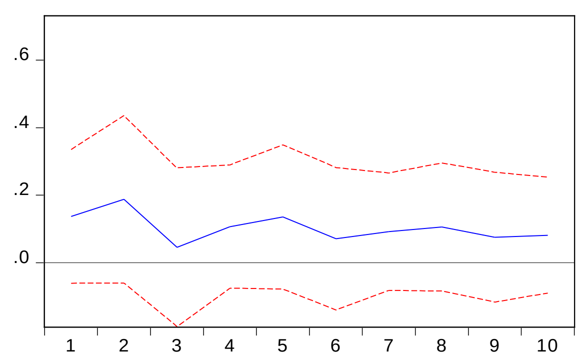


South Korea

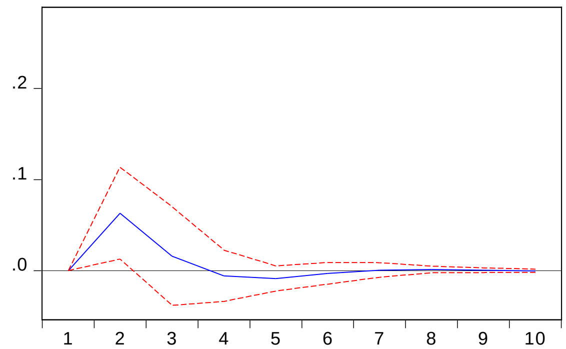
Response of Reserves to Loan Loss Provisions



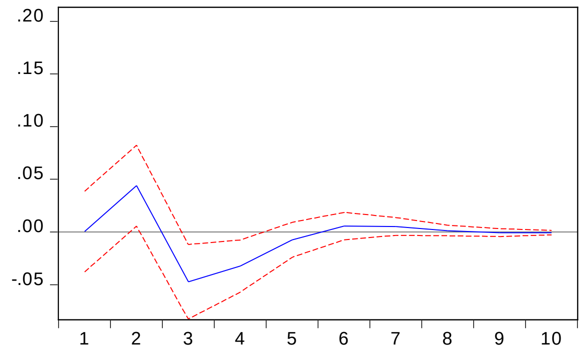
Response of Loan Loss Provisions to Reserves



Response of Underwriting Expense Ratio to Cost-Income Ratio



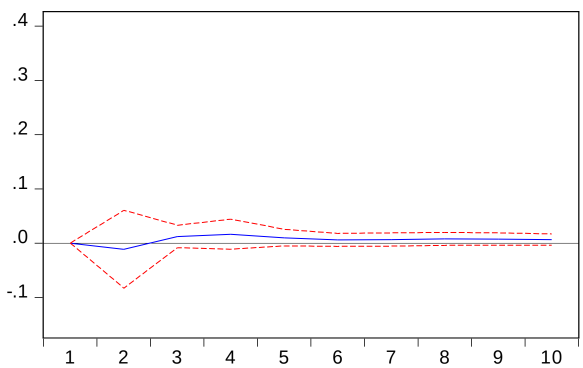
Response of Cost-Income Ratio to Underwriting Expense Ratio



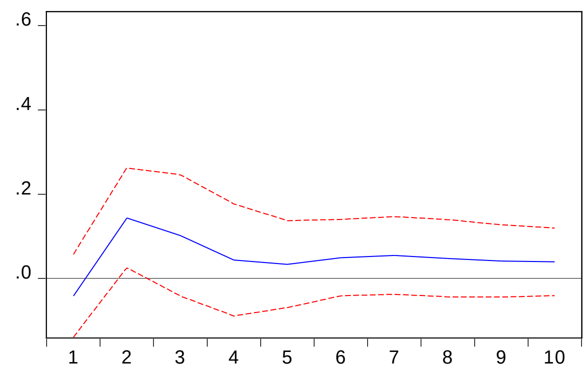
Non-Life Insurance and Banking-Developed Countries

Canada

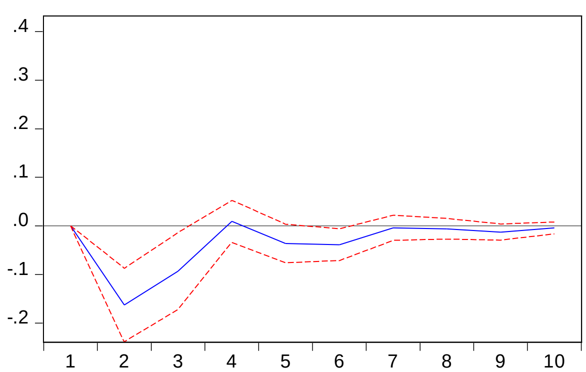
Response of Reserves to Loan Loss Provisions



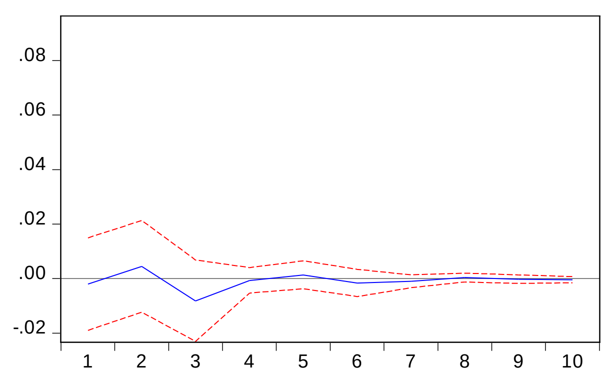
Response of Loan Loss Provisions to Reserves



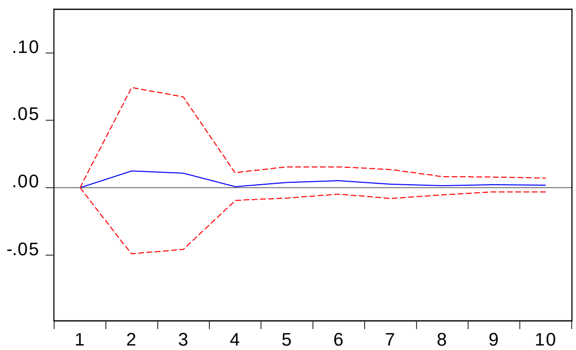
Response of Solvency Ratio to Capital Adequacy Ratio



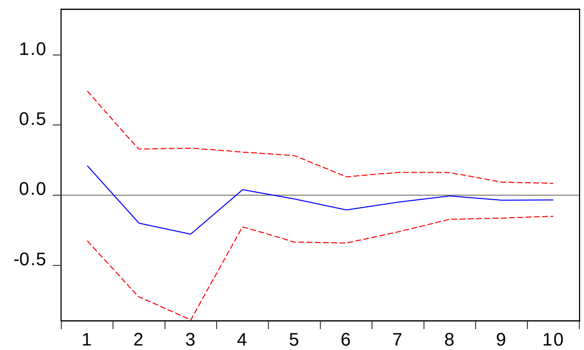
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

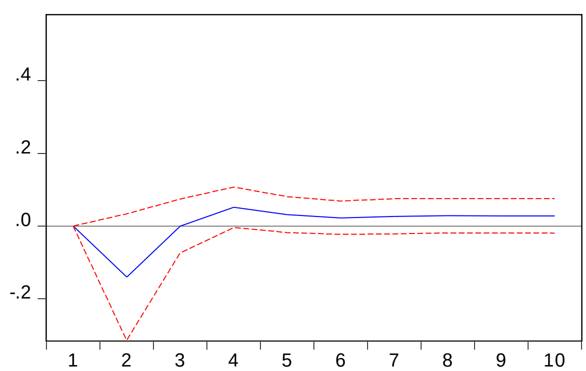


Response of Cost-Income Ratio to Underwriting Expense Ratio

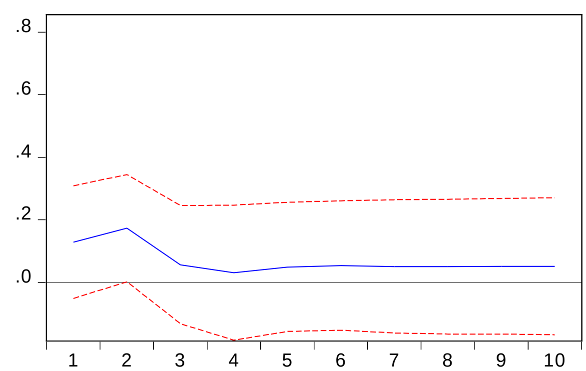


France

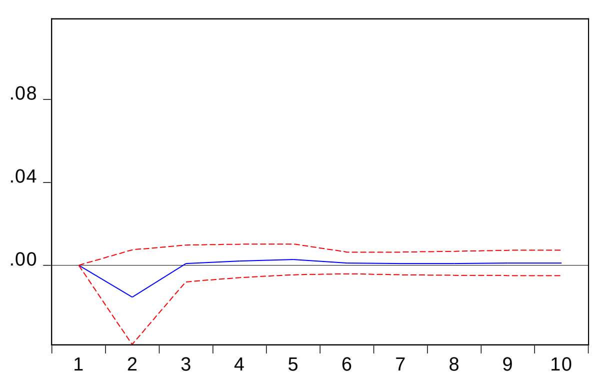
Response of Reserves to Loan Loss Provisions



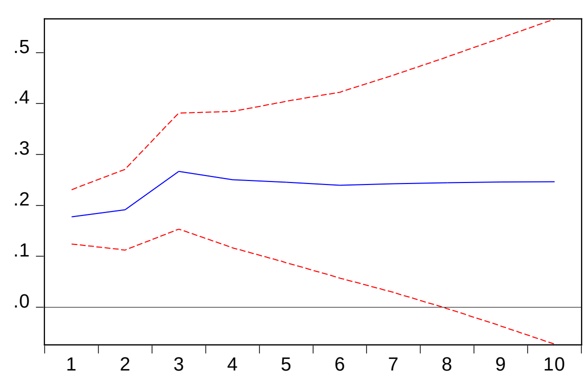
Response of Loan Loss Provisions to Reserves



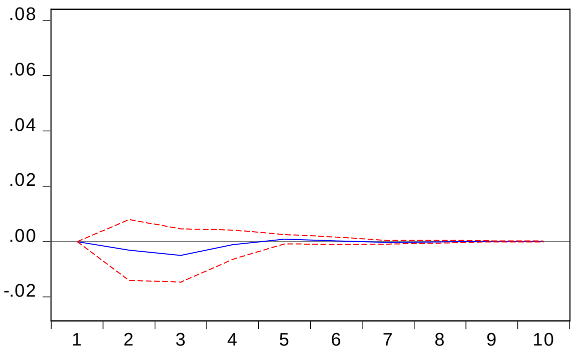
Response of Solvency Ratio to Capital Adequacy Ratio



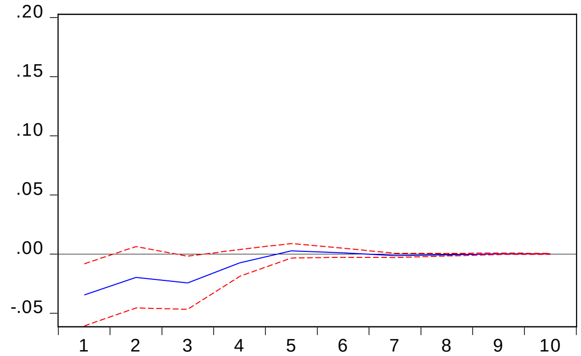
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

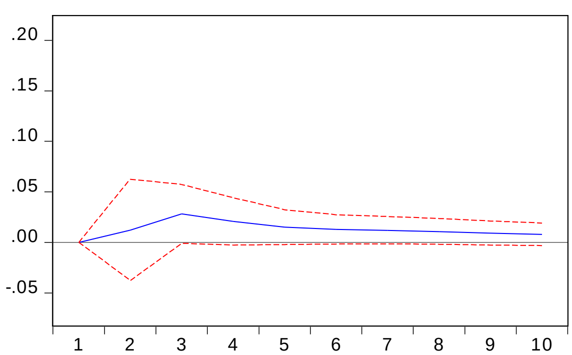


Response of Cost-Income Ratio to Underwriting Expense Ratio

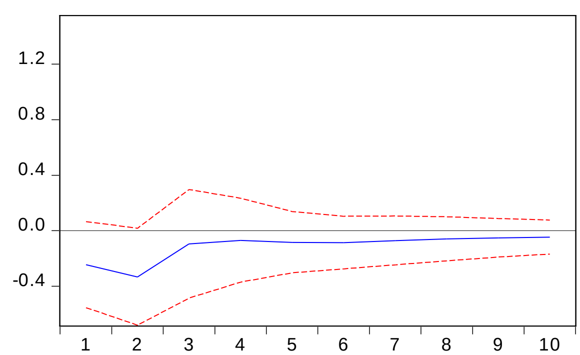


Japan

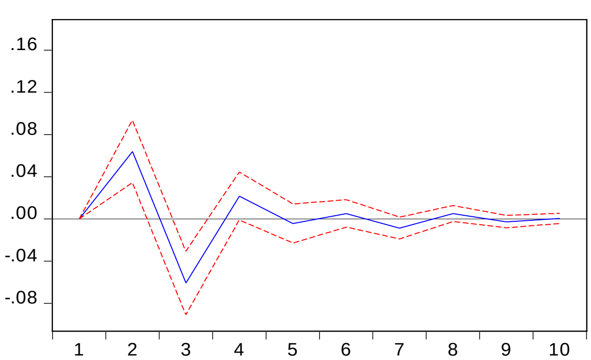
Response of Reserves to Loan Loss Provisions



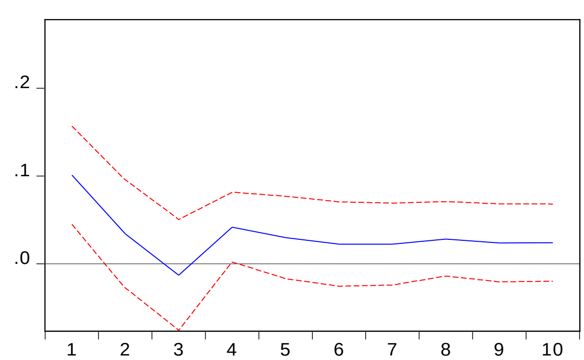
Response of JAP_SPRESLOAN to JAP_SPRESRESERVES



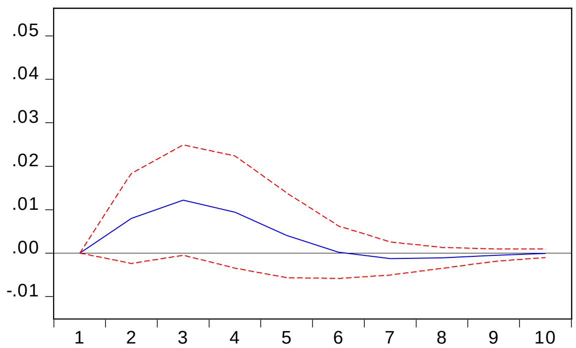
Response of Solvency Ratio to Capital Adequacy Ratio



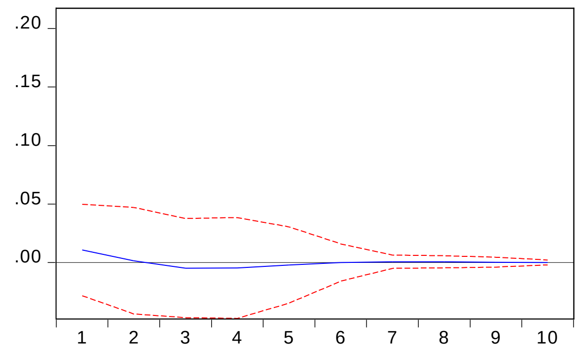
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

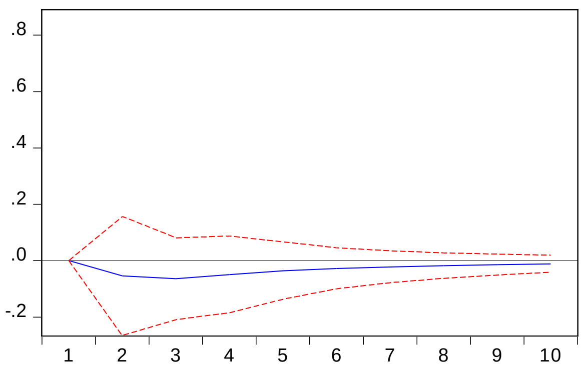


Response of Cost-Income Ratio to Underwriting Expense Ratio

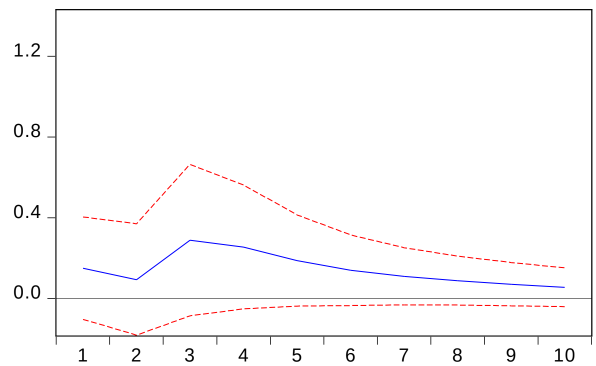


Switzerland

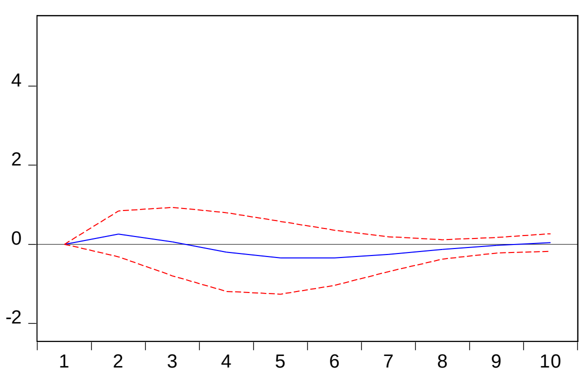
Response of Reserves to Loan Loss Provisions



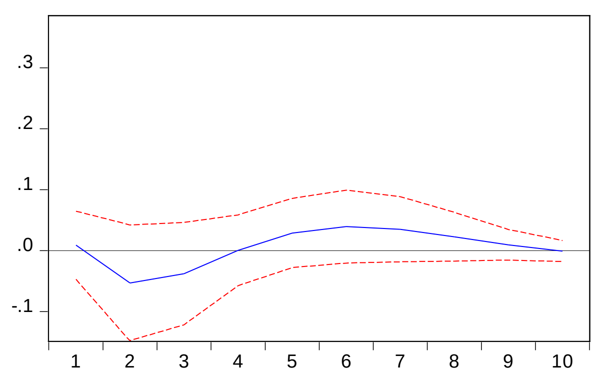
Response of Loan Loss Provisions to Reserves



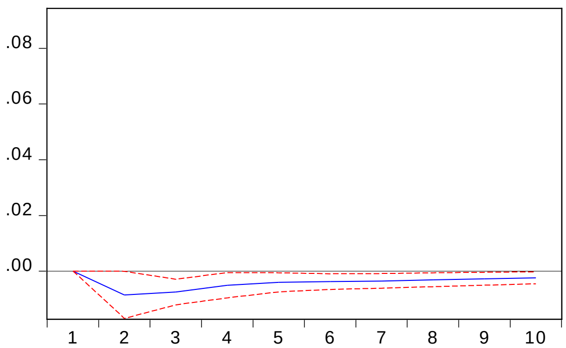
Response of Solvency Ratio to Capital Adequacy Ratio



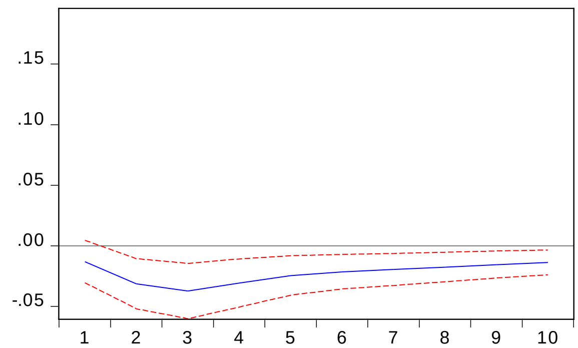
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

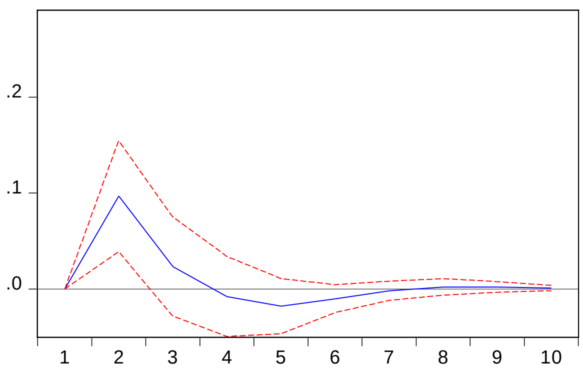


Response of Cost-Income Ratio to Underwriting Expense Ratio

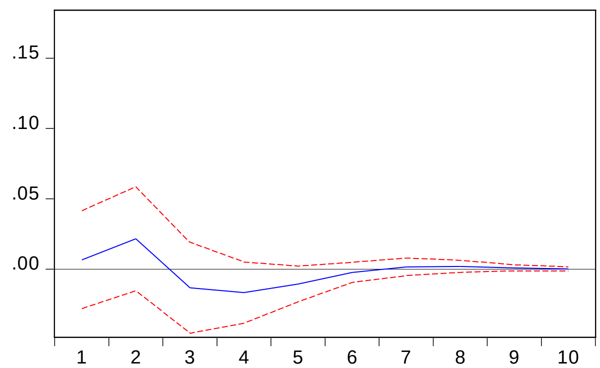


United Kingdom

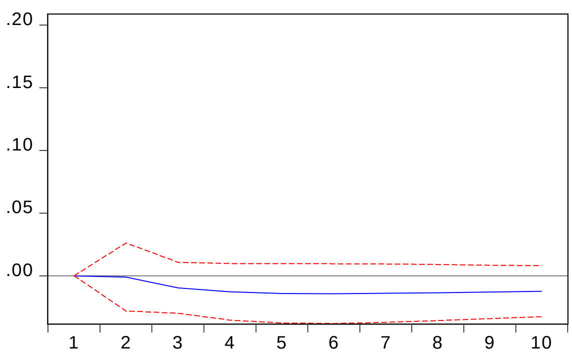
Response of Solvency Ratio to Capital Adequacy Ratio



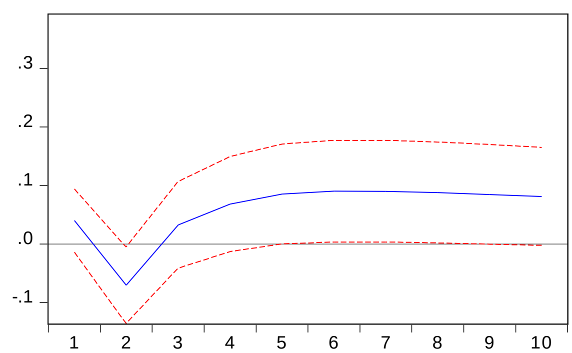
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

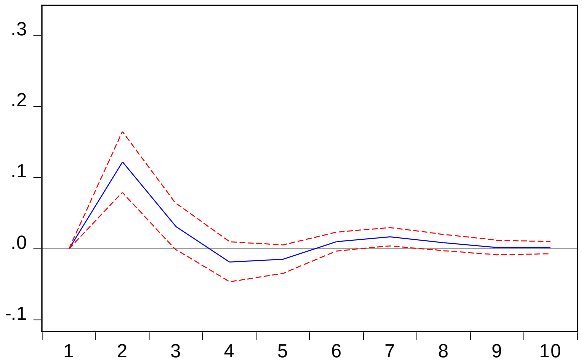


Response of Cost-Income Ratio to Underwriting Expense Ratio

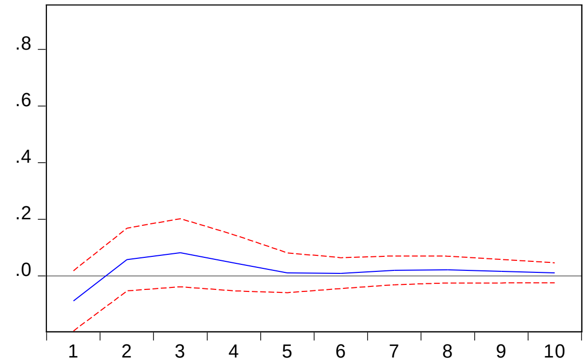


United States

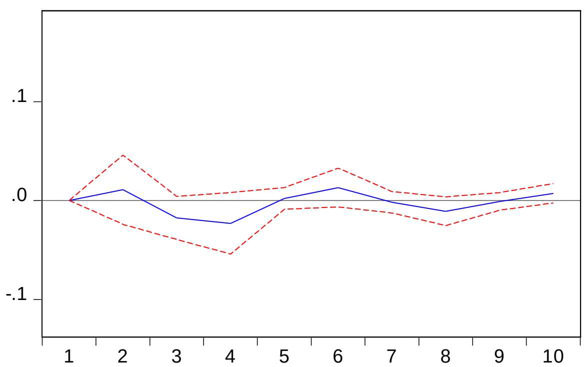
Response of Reserves to Loan Loss Provisions



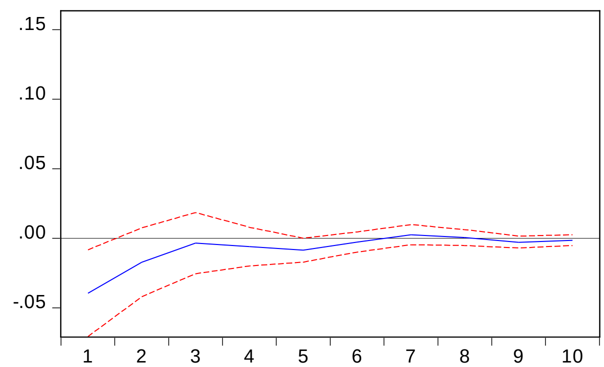
Response of Loan Loss Provisions to Reserves



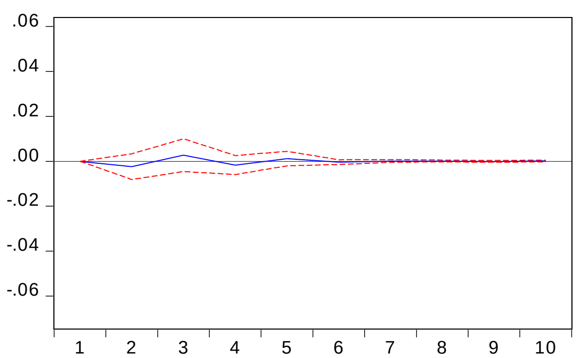
Response of Solvency Ratio to Capital Adequacy Ratio



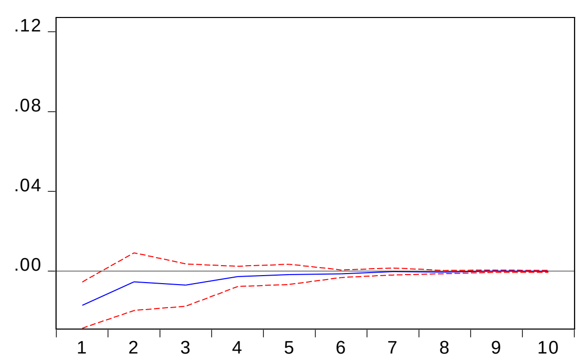
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio



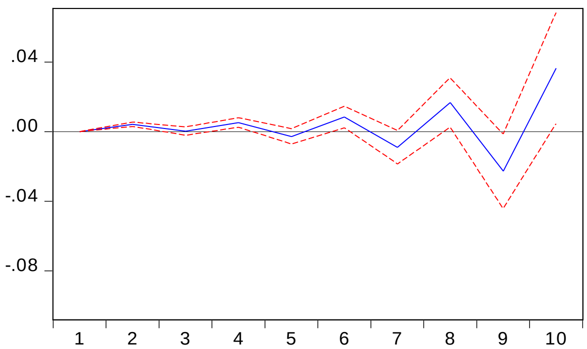
Response of Cost-Income Ratio to Underwriting Expense Ratio



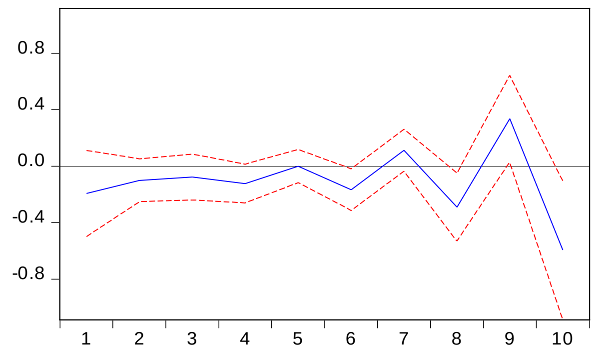
Non-Life Insurance and Banking-Emerging Market Countries

Indonesia

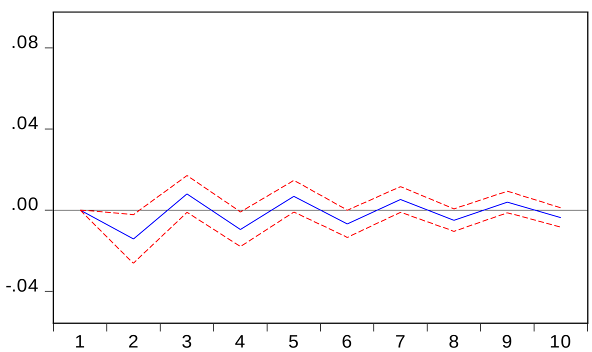
Response of Reserves to Loan Loss Provisions



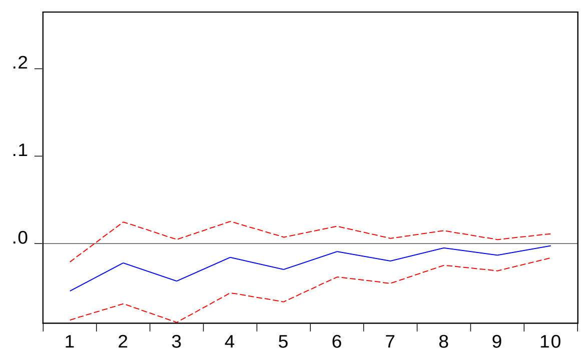
Response of Loan Loss Provisions to Reserves



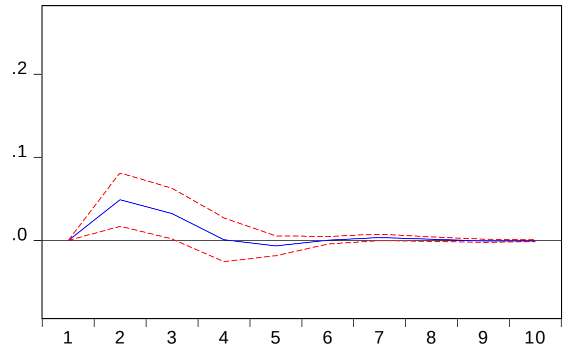
Response of Solvency Ratio to Capital Adequacy Ratio



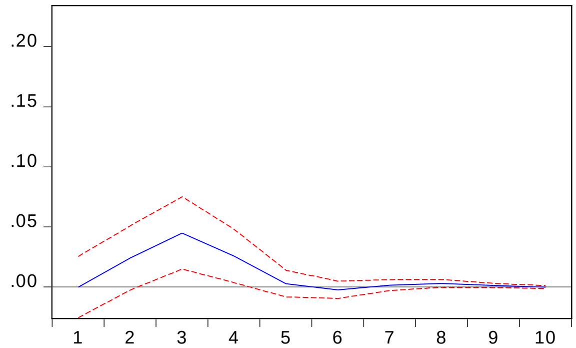
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

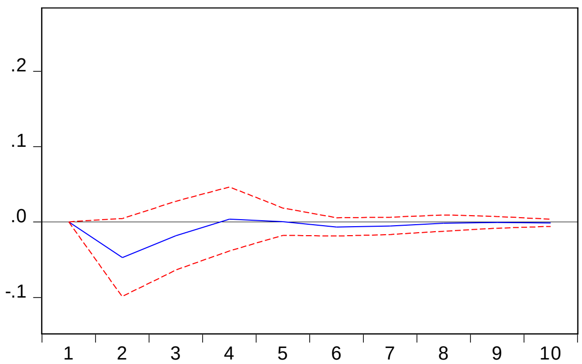


Response of Cost-Income Ratio to Underwriting Expense Ratio

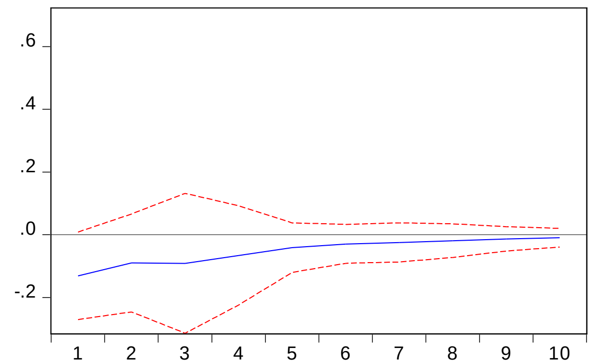


Malaysia

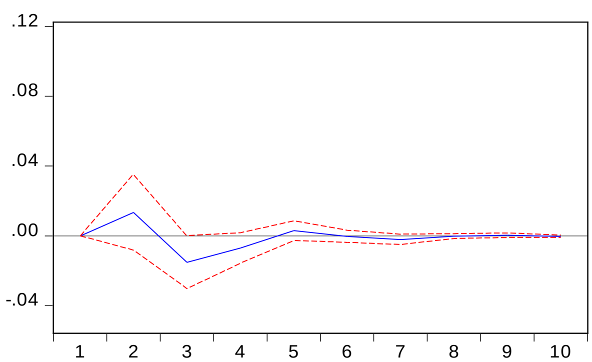
Response of Reserves to Loan Loss Provisions



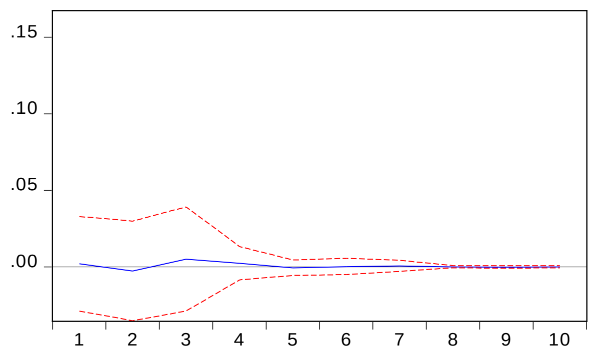
Response of Loan Loss Provisions to Reserves



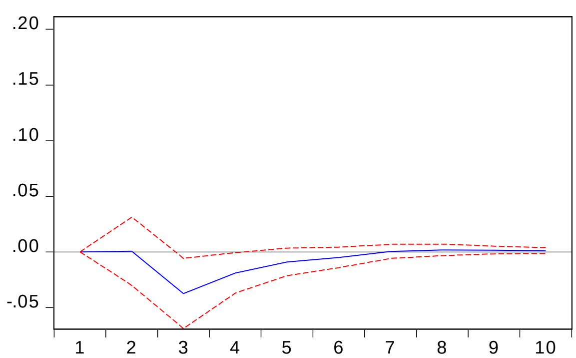
Response of Solvency Ratio to Capital Adequacy Ratio



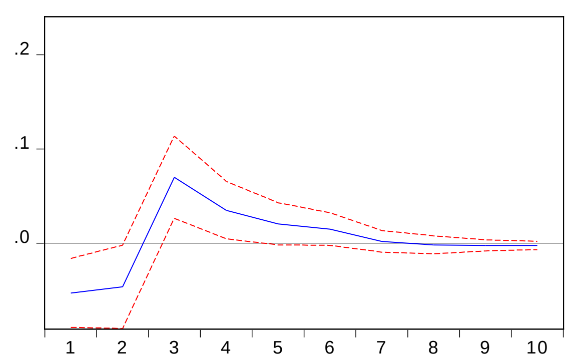
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

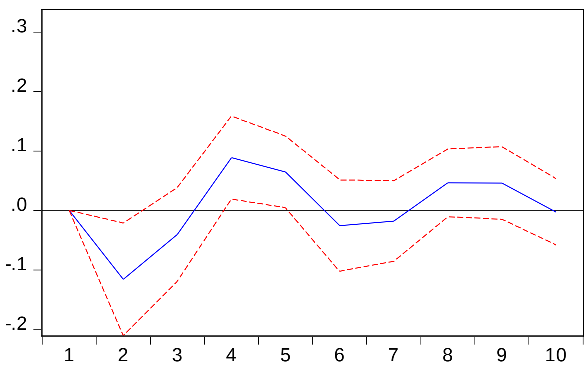


Response of Cost-Income Ratio to Underwriting Expense Ratio

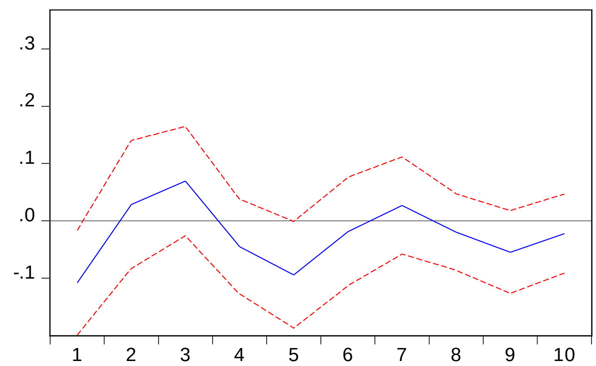


South Africa

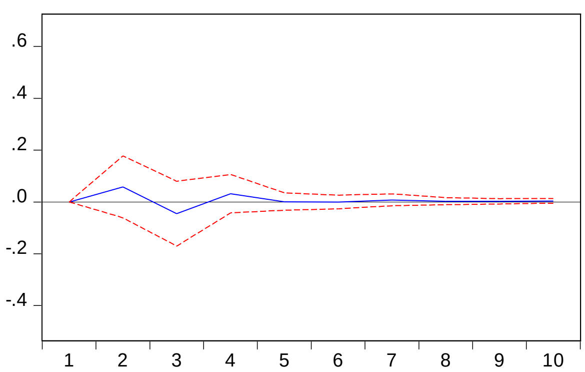
Response of Reserves to Loan Loss Provisions



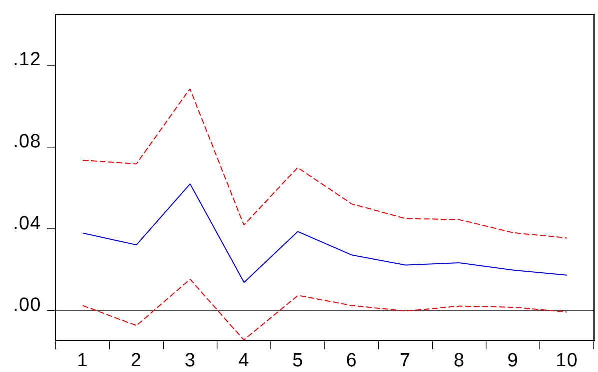
Response of Loan Loss Provisions to Reserves



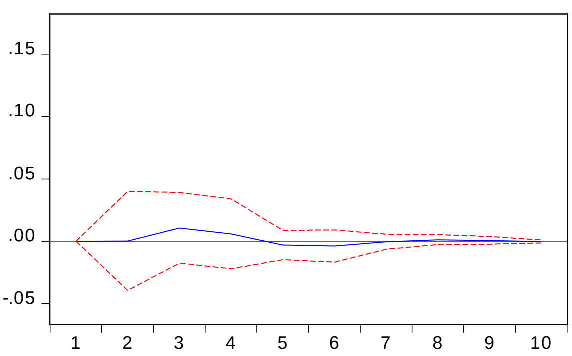
Response of Solvency Ratio to Capital Adequacy Ratio



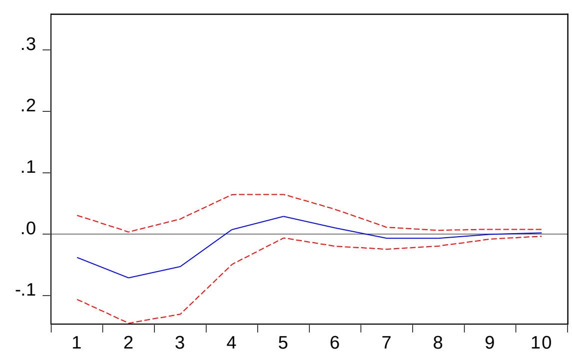
Response of Capital Adequacy Ratio to Solvency Ratio



Response of Underwriting Expense Ratio to Cost-Income Ratio

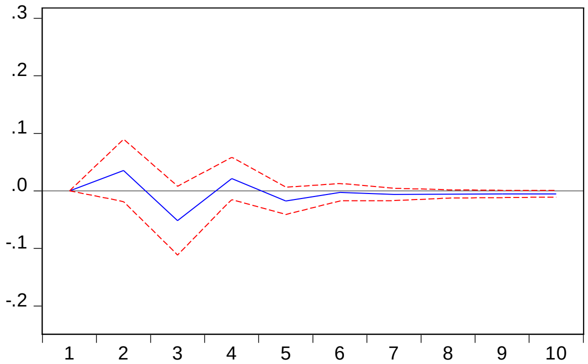


Response of Cost-Income Ratio to Underwriting Expense Ratio

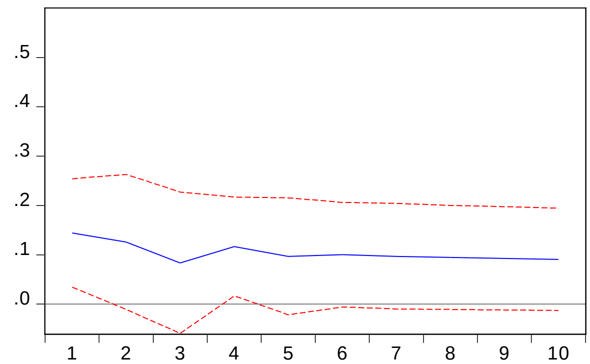


South Korea

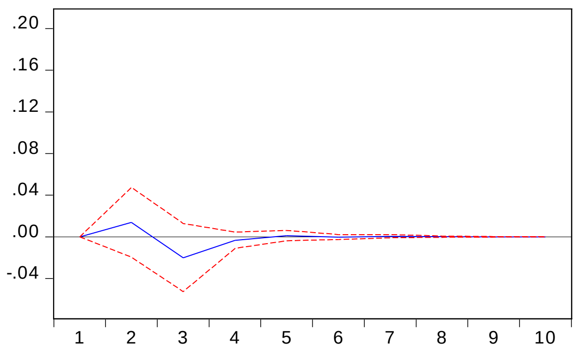
Response of Reserves to Loan Loss Provisions



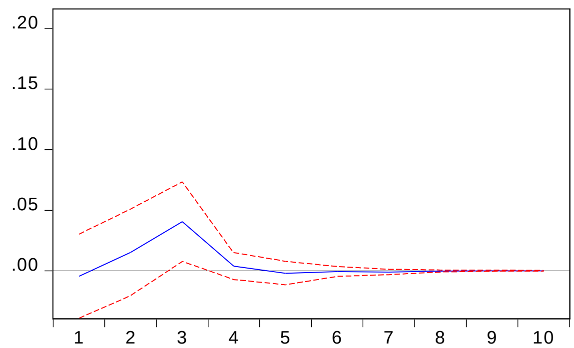
Response of Loan Loss Provisions to Reserves



Response of Underwriting Expense Ratio to Cost-Income Ratio



Response of Cost-Income Ratio to Underwriting Expense Ratio



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