The Effect of Capital Ratio on Risk, Efficiency and Profitability of Insurance Companies: Evidence from Singapore and Thailand

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การศึกษาผลกระทบของอัตราส่วนของเงินกองทุนต่อความเสี่ยง ประสิทธิภาพ และความสามารถในการทำกำไรของบริษัทประกันในประเทศสิงคโปร์และไทย

น.ส.ศุภนุช ลิ้มวิศิษฏ์สกุล

สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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ศุภนุช ลิ้มวิศิษฏ์สกุล : การศึกษาผลกระทบของอัตราส่วนของเงินกองทุนต่อความเสี่ยงประสิทธิภาพ
และความสามารถในการทำกำไรของบริษัทประกันในประเทศสิงคโปร์และไทย. (The Effect of Capital Ratio on Risk, Efficiency and Profitability of Insurance Companies: Evidence from Singapore and Thailand) อ.ที่ปรึกษาหลัก : ผศ. ดร.รัฐชัย ศีลาเจริญ

การศึกษานี้เป็นการศึกษาถึงความสำคัญของอัตราส่วนของเงินกองทุนต่อสุขภาพทางการเงินของบริษัทประกันในประเทศสิงคโปร์และไทย วัตถุประสงค์หลักคือศึกษาเกี่ยวกับความสามารถของอัตราส่วนของเงินกองทุนในการสะท้อนข้อมูลเกี่ยวกับความเสี่ยง ประสิทธิภาพและความสามารถในการทำกำไรของบริษัทประกัน การศึกษานี้ครอบคลุมทั้งบริษัทประกันชีวิตและบริษัทประกันภัยระหว่างปี พ.ศ. 2560 ถึง 2564

ผลการศึกษาพบว่าอัตราส่วนของเงินกองทุนที่สูงสามารถช่วยลดความเสี่ยงด้านสภาพคล่อง เพิ่มประสิทธิภาพและความสามารถในการทำกำไร และผลการศึกษายังเน้นถึงความสำคัญของการรักษาเงินกองทุนที่เพียงพอเพื่อให้เกิดความมั่นคงทางการเงินและเสริมสร้างประสิทธิภาพการดำเนินงานในภาคประกัน

อัตราส่วนของเงินกองทุนนอกจากช่วยสะท้อนความสามารถในการดำเนินธุรกิจแล้วยังช่วยสะท้อนความเสี่ยงด้านสภาพคล่อง ประสิทธิภาพ และความสามารถในการทำกำไร การดำรงเงินกองทุนที่เพียงพอเป็นสิ่งสำคัญสำหรับความมั่นคงทางการเงินของบริษัทประกัน การศึกษานี้เสริมสร้างความเข้าใจในความสัมพันธ์ระหว่างอัตราส่วนของเงินกองทุนและตัวชี้วัดประสิทธิภาพซึ่งให้ข้อมูลที่เป็นประโยชน์กับผู้มีส่วนได้ส่วนเสียในการจัดการและการประเมินสุขภาพทางการเงิน

สาขาวิชา การเงิน ลายมือชื่อนิสิต .....

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This research study examines the importance of capital ratios in assessing the financial health of insurance companies in the context of Singapore and Thailand. The primary objective is to investigate the extent to which capital ratios provide informative insights into the risk, efficiency, and profitability of insurance companies. The study covers both life and non-life insurance companies during the period from 2017 to 2021.

The findings show that higher capital ratios correspond to lower liquidity risk, improved efficiency, and increased profitability. These results emphasize the importance of maintaining adequate capital reserves to ensure financial stability and enhance operational performance in the insurance sector.

In conclusion, risk-based capital ratios not only serve as indicators for solvency but also reflect liquidity risk, efficiency, and profitability. Adequate capital reserves are crucial for the financial stability of insurance companies. This research study expands the understanding of the relationship between capital ratios and performance metrics, providing valuable insights for stakeholders involved in managing and assessing the financial health.

Field of Study: Finance
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Student's Signature .....

Advisor's Signature .....

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Supanuch Limvisitsakul

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1. Introduction

1.1 Background

Financial institutions play a vital role in the financial services sector, encompassing a diverse array of business operations. This sector comprises various entities such as bank companies, insurance companies, brokerage firms, and investment dealers. These institutions serve multiple functions, including the mobilization of funds, allocation of economic resources, and provision of payment and settlement services. Consequently, their stability and effective functioning are crucial for both the financial sector and the broader real economy.

When financial institutions face the risk of failure or insolvency, the consequences reverberate far beyond the confines of the financial sector. The ramifications can permeate into the real economy, affecting businesses, consumers, and overall economic stability. Therefore, regulatory authorities have a crucial responsibility to closely monitor financial institutions and implement preventive measures to avert insolvency. One such proactive measure to control the insolvency risk of financial institutions is the use of Capital Ratio. Through proactive supervision and oversight, regulators strive to safeguard the health and stability of these institutions, mitigating potential systemic risks and protecting the interests of various stakeholders.

The effectiveness of the Capital Rule has been investigated in the previous literature. It has predominantly concentrated on analyzing the operations and performance of banks conducted by Mohammad Bitar, Kuntara Pukthuanthong and Thomas Walker (2018). However, this leaves a noticeable gap in the literature when it comes to the insurance sector. Not only do banks and insurance companies have distinct characteristics and different business models, but the calculation of capital ratios also varies between these institutions. While both sectors utilize capital ratios as a

crucial monitoring tool, it is essential to recognize these differences. Consequently, it is reasonable to hypothesize that the findings obtained from studies conducted within the banking industry may not necessarily translate directly to the insurance business.

The insurance business purpose is to spread the risk and cost of unforeseen loss in the future over a wide base of policyholders and the confidence of financial markets in general. To protect the benefits of the policyholders, the insurance business is subject to regulation for monitoring. As insurer insolvency can lead to a big impact on policyholders. For instance, policyholders are faced with large losses from incidents and may be bankrupted if the insurance company fails and cannot make a payment on claim. Moreover, the insurance business is also important to the economy. For example, through marine insurance, it facilitates international trade by providing coverage for shipments and vessels. This boosts exports, supports job creation, and generates revenue, directly contributing to GDP. Additionally, insurance coverage enables businesses to manage risks, promoting economic stability and productivity. It attracts investments, ensures business continuity, and protects lenders, fostering economic growth and enhancing overall GDP figures. Therefore, the insurance business is very important to all stakeholders. Moreover, when there are many solvency problems, the insurance business will be less confident in society. Confidence is essential in affecting an insurance contract and it is also essential for the overall insurance business that all insurance companies are sufficiently solvent. To avoid the deficiency and default risk of insurance companies that are unable to meet financial commitments and ensure that the capital is available to an acceptable degree of uncertainty, both increasing in liabilities and decreasing in the assets, the regulator has the regulation to monitor the company's risk by using capital adequacy or solvency ratio by setting a specific level of capital and surplus to ensure the company can continue operating without encountering any going concern issues.

The capital ratio is utilized to measure a company's capacity to fulfill financial commitments or maintain solvency, particularly for insurance companies. Additionally, it serves as a means to guarantee that the company possesses adequate capital to address potential risks stemming from its business activities.

Researchers have raised questions regarding this relationship due to the inherent difficulty in directly measuring solvency. As a result, alternative measures are employed to represent solvency. By examining the association between the capital ratio and indicators like liquidity risk, operating efficiency, and profitability, we aim to shed light on whether the capital ratio effectively reflects the financial health of insurance companies.

The scope of this paper will focus on the insurance companies operating within Singapore and Thailand. Both countries use risk-based capital regimes by assess the assets on a market value basis.

1.2 Motivation

The motivation behind our research stems from the importance of the capital adequacy ratio in ensuring the financial stability of insurance companies. This ratio, mandated by regulators, serves as a key measure to assess an insurer's ability to meet its financial obligations. However, there are certain questions that warrant investigation. Firstly, we seek to determine whether the capital ratio provides sufficient information to accurately reflect the level of solvency risk faced by insurance companies. By examining this, we aim to evaluate the effectiveness of the capital ratio as an indicator of solvency risk. Secondly, we aim to explore the potential operational benefits associated with maintaining a strong capital ratio. We question whether insurance companies with a robust capital ratio, indicating lower risk, experience improved operational performance. Addressing these questions will provide valuable insights into the relationship between the capital adequacy ratio, solvency risk, and operational outcomes, ultimately

benefiting insurance industry stakeholders and regulators in their assessment and regulation of insurance companies.

Previous research has focused on identifying factors that determine the profitability of non-life insurance companies, as demonstrated by Zainudin et al. (2018). Alarussi and Alhaderi (2018) investigated the firm-specific factors that affect the profitability of insurance companies. Additionally, Tan (2012) highlighted that financial distress can have an impact on the performance of insurance firms. Previous studies have primarily concentrated on examining the impact of capital ratios on the risk, efficiency, and profitability of banks, while other industries have received less attention. Mohammad Bitar, Kuntara Pukthuanthong and Thomas Walker (2018). Given this, there is a crucial need to investigate how capital ratios indicating insolvency affects the risk, efficiency and profitability of insurance companies. Therefore, this study aims to address the research gap and provide the evidence supporting the relationship between the capital ratio that is set by the Insurance Regulator and financial ratios (risk, efficiency and profitability) that are derived from a company's financial statements. We contend that measuring in financial ratios can reflect the sustainable performance of the company.

1.3 Research questions

The focus of our research paper pertains to the impact of the capital ratio. This metric plays a crucial role in preventing potential losses and acts as a safeguard to mitigate the spread of financial distress, thereby contributing to the overall solvency of the company. We would like to investigate whether capital ratio could reflect financial health of insurance companies, such as financial risk and profitability. Although a higher capital ratio implies a lower insolvency risk, maintaining a high capital ratio could also depress companies' performance. Any trade-off occurs when taking low solvency risk and holding a high capital ratio? The performance includes underwriting efficiency and profitability. Underwriting efficiency is measured by a combined ratio, while

profitability is measured by return on equity. And in terms of liquidity risk, the capital ratio is used to measure the failure of the company, which may not capture the level of operation risk undertaken. A company that has a high capital ratio means a high buffer to absorb losses. They will take more risk than a company with a lower capital ratio by increasing capital to maintain a high capital ratio. Therefore, the capital ratio may not reflect the real liquidity risk because an increase in capital can be held as any kind of asset.

To clarify these associations, we will establish a series of testable hypotheses in the next section to test the relationship between capital ratio affect risk, efficiency and profitability.

1.4 Contribution

The primary objective of this research is to enhance comprehension of the insurance industry within the selected country, encompassing both regulatory aspects and financial performance. By conducting a thorough examination, we aim to shed light on the relationship between capital ratio, risk, and performance. Specifically, we seek to demonstrate that maintaining a high capital ratio does not necessarily impede the operational flexibility of insurance companies. Furthermore, we intend to highlight the varying levels of this relationship when different levels of confidence are applied.

The insights derived from our investigation hold significant value for investors and shareholders in the insurance sector. By elucidating the intricate connections between capital ratios, risk management, and financial performance, our research equips these stakeholders with valuable knowledge to make informed decisions. Investors can gain a clearer understanding of how capital levels affect an insurance company's risk exposure and overall operational capabilities. This understanding, in turn, can inform investment strategies and risk assessment approaches, enabling investors to make more informed choices regarding their portfolios.

Additionally, our research will provide a comparative analysis of the regulatory environments in Singapore and Thailand. By examining how these countries apply different levels of confidence in their regulatory frameworks, we aim to showcase the divergent impact on the relationship between capital ratios, risk, and performance. This comparison will be instrumental in identifying the nuances and potential trade-offs associated with varying regulatory approaches.

Overall, our research endeavors to contribute to the broader understanding of the insurance sector, provide actionable insights for investors and shareholders.

2. Literature review

In this section, we conducted a comprehensive review of the existing literature pertaining to insurance regulation, focusing on two distinct aspects: insurance regulation and solvency, as well as risk, efficiency, and profitability. By exploring previous studies, we aimed to identify and introduce the key variables that will form the foundation for developing our hypotheses.

2.1 Insurance regulation and solvency

The insurance regulator is an intermediary in regulating the operations of an insurance company, both financing and control of risk. It is normally for the insurance industry to support regulatory policies that confer advantages upon it, while opposing those impose restrictions. It is postulated that the industry's capacity to sway regulations is contingent upon its political resources, that is, its size and company’s wealth. On the other hand, it is expected that consumer groups will push for stricter regulations and policies that limit the operations of the industry, Meier (1998). Hence, we expect that proper regulatory policies will have benefits for insurance companies and consumer groups.

The concept of the capital ratio originated as a regulatory measure designed to ensure the financial stability and soundness of financial institutions. It serves as a key indicator of an institution's ability to absorb potential losses and meet its financial obligations. The capital ratio is typically calculated by dividing a financial institution's capital, which includes both equity and certain forms of debt that can absorb losses, by its risk-weighted assets.

When examining the differences in capital ratio among different types of financial institutions, such as banks and insurance companies, it is important to consider their distinct characteristics and business models. Banks and insurance companies operate in different sectors of the financial industry and face unique risks.

In the banking sector, capital ratio is primarily focused on managing credit risk. Banks lend money and are exposed to the risk of borrower defaults. Therefore, their capital ratio emphasizes the adequacy of capital to absorb potential loan losses. Additionally, banks are subject to various regulatory requirements that specify the minimum capital ratio they must maintain to ensure their solvency and protect depositors.

On the other hand, insurance companies have a different risk profile. They collect premiums from policyholders in exchange for assuming specific risks. The capital ratio for insurance companies takes into account the potential liabilities arising from insurance policies and the need to maintain sufficient capital to cover these obligations. This includes factors such as policy claims, investment risks, and underwriting risks. The calculation of capital ratio in the insurance sector involves assessing the adequacy of capital to meet potential insurance claims and other obligations. Furthermore, insurance companies often face longer-term liabilities compared to banks. They may have to pay claims or provide coverage over an extended period, which necessitates a different approach to capitalization and risk management.

2.2 Risk-based capital ratio (RBC)

The RBC standards were introduced by the National Association of Insurance Commissioners (NAIC) in 1994 to determine capital requirements for insurers, taking into account their size and risk profiles. The framework includes separate formulas for property/casualty, life, and health insurance to calculate the required capital, considering the differences between lines of business. Each formula aggregates individual risk charges for specific risk categories, such as underwriting, credit, asset, and growth risk. The risk charges are calculated using factor-based methods, multiplying specific factors with volume numbers based on the insurer's reserves and premiums written. In addition to RBC-based capital requirements, insurers must also comply with state-specific rules. Assessing the insurer's financial strength involves comparing its available capital, represented by total adjusted capital or total surplus, with the required capital. Depending on the comparison, regulators apply various action levels ranging from no action to liquidation or rehabilitation of the insurer.

The framework of the capital ratio in the insurance business is continually developing. It started from a fixed minimum amount and currently, it is risk-based capital 2 (RBC2). The reason for changes in each step is to improve the capital ratio by adding more risk exposures related to the insurance business. The fixed minimum considers only insurance risk, RBC 1 adds credit risk, market risk and concentration risk and RBC 2 adds operation risk.

The regulator for the insurance business in Singapore is The Monetary Authority of Singapore (MAS). All insurance companies shall maintain a minimum capital of Singapore Dollars 10 million. The solvency regime in Singapore is risk-based capital 2 (RBC2). The primary modifications introduced in the new regime entail the evaluation of liabilities, assessment of capital requirements and recognition of available capital. The optimization of reinsurance and asset liability management (back up the long duration

liabilities with good quality assets) are being focused on this regime. (Deloitte, 2022). The minimum CAR ratio is 100 percent.

For Thailand, the regulator is the Office of Insurance Commission (OIC), under the supervision of the Ministry of Finance. All insurance companies shall maintain a minimum registered capital of Baht 500 million for life insurance companies and Baht 300 million for general insurance companies. The risk-based capital 2 (RBC2) is also the solvency regime in Thailand. Currently, Thailand uses confident level at 95%. The fully implementation will be 99.5%. The purpose of risk-based capital is to establish a regulatory capital minimum, which may not necessarily represent the complete amount of capital that an insurer should maintain in order to attain safety and competitiveness objectives. RBC encompasses five major categories of risk: First, insurance risk – risk that arises from volatility of frequency severity and timing of loss occurrence that deviates from assumptions used in insurance pricing, reserving and underwriting. Second, market risk – risk that arises from changes in market prices of investment assets, interest rate, foreign exchange rate, equity instruments and commodities. Third, credit risk – risk that arises from failure of another party to perform according to the terms of agreement and the probability that the counterparty's credit risk will be downgraded. Forth, concentration risk (for a general insurance company) – risk that arises from similar loss events could involve multiple matters of insurance insured or surrender risk (for a life insurance company) – risk that arises from policyholders deciding to use the right to exchange insurance contracts for cash surrender. Fifth, operational risk – risk that arises from failure, inadequacy or improperness of personnel, operation process in the internal system or external factors. The minimum CAR ratio is 140 percent.

Thailand uses RBC2 at 95 percent confidence level since 31 December 2019 while Singapore uses RBC2 at 99.5 percent confidence level since 1 Jan 2022. Therefore, this study will cover RBC1 and RBC2 for both countries.

The risk-based capital (RBC) ratio is calculated by dividing an insurer's available capital by its required capital, providing a measure of the insurer's

financial strength and ability to absorb potential losses. The calculation involves comparing an insurer's total adjusted capital (or total surplus) with its capital requirement determined by regulatory standards.

The total capital available for insurance companies is derived from the combination of three key components: tier 1 capital, tier 2 capital, and regulatory adjustments. Each component contributes to the overall capital position of the insurer, providing a comprehensive assessment of its financial strength and resilience.

Tier 1 capital encompasses various elements, including paid-up ordinary share capital, surplus/retained earnings, irredeemable and non-cumulative preference shares, reinsurance adjustment, and other financial resource adjustments. This component reflects the insurer's core capital base and includes resources such as loans to or guarantees granted for the insurer, other unsecured amounts owed to the company, deferred tax assets, and intangible assets. Tier 1 capital represents the highest quality capital and plays a vital role in supporting the insurer's financial stability and risk absorption capacity.

Tier 2 capital consists primarily of irredeemable and cumulative preference shares. This component serves as supplementary capital, providing an additional layer of financial protection to the insurer. While tier 2 capital is considered less secure than tier 1 capital, it still contributes to the overall capital adequacy of the insurance company and enhances its ability to withstand potential financial shocks.

In the context of Singapore, regulatory adjustments are an additional element in the calculation of total capital available. These adjustments specifically apply to insurers operating in Singapore and include the allowance for provision for non-guaranteed benefits and the allowance for recognition of negative reserves. These adjustments reflect specific regulatory considerations within the Singaporean insurance framework and help ensure that the capital calculations align with local regulatory requirements.

The total capital required for insurance companies encompasses three primary categories of risk: insurance risks, market and credit risks, and operational risks. These risks collectively contribute to the determination of the necessary capital reserves that insurance companies must maintain to mitigate potential financial vulnerabilities and ensure their solvency.

Insurance risks represent the uncertainties associated with the insurer's policy liabilities and claim liabilities. These risks arise from the insurer's obligation to pay claims and fulfill policyholder commitments. Policy liability risk encompasses the potential mismatch between policyholder obligations and the premiums collected by the insurer. Claim liability risk, on the other hand, relates to the uncertainty surrounding the amount and timing of future claim payments. These risks are fundamental to the insurance industry and must be carefully managed to avoid potential financial strain on the company.

Market and credit risks pertain to the potential adverse impacts resulting from market fluctuations and credit exposures. Market risks encompass the exposure of the insurer's investments to equity market fluctuations, interest rate mismatches, currency exchange rate volatility, and other market-related factors. Credit risks, on the other hand, arise from the potential default or deterioration in creditworthiness of counterparties, such as bond issuers or financial institutions. These risks can significantly impact an insurer's financial position and capital adequacy, necessitating the allocation of appropriate capital to mitigate their potential consequences.

Operational risks encompass a broad range of potential disruptions arising from internal processes, systems, or human factors within the insurance company. These risks include failures or inefficiencies in operational procedures, inadequate internal controls, technological vulnerabilities, legal and regulatory compliance issues, and human errors. Operational risks can have a significant impact on an insurer's financial stability and reputation. Proper risk management practices and robust internal controls are essential

for mitigating operational risks and ensuring the insurer's capital is sufficient to withstand potential operational disruptions.

By considering these three key categories of risk—insurance risks, market and credit risks, and operational risks—the total capital required for an insurance company is determined. This calculation provides a comprehensive assessment of the risks faced by the insurer and helps ensure that appropriate capital reserves are maintained to support the company's solvency and financial stability. Understanding and managing these risks are crucial for insurance companies to operate in a prudent and sustainable manner.

Grace, Harrington, and Klein (1993) conducted research on the effectiveness of the property-liability insurance risk-based capital formula in identifying distressed insurers. They estimated the RBC results for insurers in 1990 and 1991 who later failed from 1991 to 1993. The study found that although the ratio of actual capital to RBC had a strong negative correlation with insolvency risk in both univariate tests and multiple logistic regressions, only a small number of failed companies had RBC ratios that would have prompted regulatory action before their eventual collapse. From the result, we can see that the RBC ratio may not represent the performance of the company because before the company failed, the RBC could not signal to the regulator or policyholders. Nonetheless, Grace, Harrington, and Klein (1998) discovered that even though the actual capital to RBC ratio was strongly and negatively linked to the likelihood of eventual failure, only a small number of companies that ultimately failed had ratios falling within the regulatory action ranges established by the NAIC.

Furthermore, Cummins, Harrington, and Klein (1994) conducted a study on the effectiveness of the RBC formula in accurately identifying failed and surviving insurers. Using a dataset and a multiple logistic regression model, they examined insolvency risk and concluded that adjusting the weights of the basic RBC components could significantly enhance the accuracy of the formula in classifying insurers. They also incorporated firm size and other

variables into the formula to improve its predictive power. Interestingly, they discovered that the NAIC's risk-based capital formula is more effective in accurately categorizing small firms compared to large ones. In the same result, Munch and Smallwood (1980) also found that minimum capital requirements can decrease the number of insolvencies, but only by reducing the presence of small firms in the market. They concluded that such requirements disproportionately affect small companies and are often a significant burden for them.

2.3 Risk, efficiency and profitability

The literature review related to the relationship between solvency-insolvency ratio and company operation in terms of risk, efficiency and profitability is as follows.

Cummins et al. (1995, 1999), Grace et al. (1998), and Pottier and Sommer (2002) conducted empirical studies on the effectiveness of current solvency models such as U.S. RBC standards and A.M. Best's capital adequacy ratios. Their research suggests that these ratios have limited predictive power in identifying financially weak insurers, and alternative measures developed by the private sector may be more effective. The proxy for the financial strength of a firm is various financial ratios, such as liquidity ratios and profitability ratios.

Kim et al. (1995) and Kramer (1996) discovered a negative correlation between investment performance and the rate of insolvency. Investment performance discloses the effectiveness and efficiency of investment decisions, which is one major part of an insurance company’s performance that can show the ability of the insurance company to manage its assets. In contrast, Browne and Hoyt (1995) find that the combined ratio is positively correlated to insolvency rate. The combined ratio is calculated by taking the sum of incurred losses and expenses (underwriting expenses and other

operating expenses) and then dividing them by the earned premium, which indicates only an underwriting profit for an insurance company. So, this ratio can also represent efficient management and an insurer's profitability.

Moreover, we also found the result from the study by Gede Eky Kharisma, Edy Sujana and I Gusti Ayu Purnamawati (2015) that conducted a study on the impact of risk-based capital, underwriting, investment returns, and the ratio of claims expense to insurance income on insurance companies listed on the Indonesia Stock Exchange between 2010 and 2014. The findings revealed that risk-based capital, underwriting, and investment returns had a positive effect on corporate earnings, while the ratio of claims expenses had a significant negative impact on corporate earnings.

In terms of the liquidity ratio that we will use to represent risk, the result from previous studies is concluded in the same way, which is that a current liquidity ratio can indicate the solvency of the company. Lee and Urrutia (1996) discovered that the current liquidity ratio is a meaningful predictor of solvency. Similarly, Renbao Chen and Kie Ann Wong (2004) revealed that the liquidity ratio has a positive correlation with the financial health of general insurers in Singapore.

According to Munch and Smallwood (1981), the Public Interest Theory, which considers the challenges of costly information and agency problems, suggests that the owners of insurance companies may lack sufficient motivation to maintain a high level of safety if their personal assets are not at risk for unfunded obligations to policyholders that may arise from insolvency.

Most evidence from researchers is aligned in which we conclude that the insurance regulation has a positive impact on efficiency and profitability and negative impact on risk. The gap in existing studies is the lack of evidence to clarify the ambiguity between the relationship between the capital ratio and the result of a company’s operations. In addition, there is no comparison between different definitions for capital ratio. Therefore, we will propose the hypothesis to fill this gap in the next section.

3. Hypothesis Development

The precise relationship between the capital ratio and risk, efficiency, and profitability remains a subject of ongoing research. To shed light on these associations, we will present a series of hypotheses that can be tested. Our study will focus on the impact of two distinct definitions of the capital ratio: the risk-based capital ratio and the non-risk-based capital ratio.

3.1 Risk and capital ratio

Previous research on bank business has shown that there is a negative relationship between capital ratios and bank risk. Specifically, when the capital ratio is increased, the bank risk decreases. For instance, Jacques and Nigora (1997) established that greater risk-based capital measures may reduce bank risk. Similarly, Ediz et al. (1998) examined the link between regulation and banking stability and found that a minimum capital requirement has a positive association with the safety and soundness of banks and does not distort their lending activities. Aggarwal and Jacques (1998) conducted a study using data from 2552 FDIC-insured commercial banks between 1990 and 1993 and found that banks tend to maintain capital ratios above the minimum capital requirement to avoid failure during times of stress. Berger and Bouwman (2013) further observed that smaller banks with higher capital ratios have a greater chance of surviving. Anginer and Demirguc-Kunt (2014) argue that banks aim to maintain high capital ratios to ensure their ability to withstand earnings shocks and honor deposit withdrawals and other obligations. They also suggest that higher capital buffers encourage bank owners to make more prudent investment decisions. Ultimately, better management practices can help align the interests of shareholders and depositors and reduce agency problems.

As a higher capital ratio means the company has a high buffer to absorb unexpected losses. When big claims occur, if the company has a high buffer,

they will have a low chance of being unable to settle claim payment. Therefore, it means that the liquidity risk should be low or the company has enough liquid assets for claim settlement. This can also imply management behavior on undertake risk because normal management that hold high capital ratio should manage low liquidity risk. But there is a chance that management that hold a high capital ratio also have high liquidity risk, since they are remaining a buffer to take more risk. Accordingly, we propose the following hypothesis:

Hypothesis 1:

- Higher risk-based capital ratio is associated with lower liquidity risk.
- Higher non risk-based capital ratio is associated with lower liquidity risk.

3.2 Efficiency and capital ratio

Several studies provide evidence of a positive relationship between capital and efficiency. For instance, Chortaresra et al. (2012) found that higher capitalization can increase efficiency and reduce costs by addressing agency problems between managers and shareholders. This incentivizes shareholders to monitor the performance of the bank, leading to greater efficiency. Banker et al. (2010) demonstrated a positive correlation between capital ratio and efficiency when analyzing 14 Korean banks. Additionally, Carvallo and Kasman (2005) and Ariff and Can (2008) showed that more efficient banks retain higher capital buffers. Furthermore, J. David Cummins and David W. Sommer's (1996), insurance buyers have an incentive to monitor the solvency of insurance companies. The demand for safe insurance creates an equilibrium level of solvency risk in insurance markets, meaning that insurance companies are expected to select risk levels and capitalization to achieve target solvency levels in response to the demand for safety. As the number of buyers increases, insurance companies will have a competitive advantage in the market. The cost of insurance can be estimated to set the price of insurance.

Additionally, the fixed cost may improve due to economies of scale, resulting in improved company efficiency. We can measure company efficiency using a combined ratio (sum of loss incurred and underwriting expense divided by premium earned). Based on this, the following hypothesis is proposed:

Hypothesis 2:

- Higher risk-based capital ratio is associated with higher insurance efficiency.
- Higher non risk-based capital ratio is associated with higher insurance efficiency.

There is limitation to this hypothesis for the Business-to-Consumer model because consumers will not focus on capital ratio when deciding on insurance companies. But advertising and promotion are factors that they will focus on. As we cannot collect data by channel of sales, this is our weakness in this study.

3.3 Profitability and capital ratio

The literature provides conflicting evidence on the relationship between capital ratio and profitability. Some studies, such as Berger (1995), suggest that highly capitalized banks have lower bankruptcy costs, reducing funding costs and generating higher profits. Tan (2016) also finds that more capitalized banks are more profitable due to their higher creditworthiness and engagement in prudent lending. Demirguc-Kunt and Huizinga (2000) find a positive correlation between equity to assets ratio and bank profits in a sample of developed and developing countries. Additionally, a higher capital ratio indicates good health, which can increase customer trust and result in more income from premiums while reducing promotion and marketing costs. This positive impact on insurance results contributes to profitability. Furthermore, high capital supports prudent investment choices, leading to positive investment results. Lannotta et al. (2007) suggest that more

capitalized banks have better management quality, leading to higher income and lower costs. Given these mixed findings, we propose the following hypothesis regarding the relationship between capital ratio and profitability.

Hypothesis 3:

- Higher risk-based capital ratios are associated with higher profitability.
- Higher non risk-based capital ratios are associated with higher profitability.

There is limitation to this hypothesis for the Business-to-Consumer model because consumers will not focus on capital ratio when deciding on insurance companies. But advertising and promotion are factors that they will focus on. As we cannot collect data by channel of sales, this is our weakness in this study.

4. Methodology

4.1 Measure of capital ratio

In our study, we employ two definitions of capital ratios to comprehensively analyze the financial health and risk exposure of insurance companies. Firstly, we calculate the capital ratios based on the Risk-Based Capital (RBC) framework, which involves dividing the total available capital by the total capital required. This calculation provides a measure of the adequacy of an insurance company's capital reserves in relation to its risk exposure. A higher RBC capital ratio indicates a stronger financial position and a greater ability to absorb potential losses.

Additionally, we calculate a variation of the capital ratio by utilizing total assets instead of total capital required. This alternative calculation, known as the capital to asset ratio, provides an inverse measure of leverage without taking into account the specific risk exposure of the insurance company. This ratio is derived by dividing the policyholder surplus by the total assets of the

company. A higher capital to asset ratio signifies lower liabilities for the insurance company, reflecting a greater level of precautionary reserves. Conversely, increased leverage, indicated by a lower capital to asset ratio, implies higher company liabilities and a potentially elevated risk of bankruptcy. This is because companies with greater liabilities must focus more on generating sufficient future cash flows to meet those obligations. Failure to generate adequate cash flows could lead to insolvency.

By utilizing both the RBC capital ratio and the capital to asset ratio, we aim to capture different aspects of an insurance company's capital position and risk exposure. These ratios provide valuable insights into the financial strength, risk management practices, and potential solvency risks of insurance companies. Through our analysis of these capital ratios, we can evaluate the relationship between capital levels, risk exposure, and financial performance, ultimately contributing to a deeper understanding of the factors influencing the stability and profitability of insurance companies.

In summary, our study employs two distinct capital ratios—the RBC capital ratio and the capital to asset ratio—to assess the capital adequacy and risk profile of insurance companies. These ratios enable us to examine the relationship between capital levels, risk exposure, and company performance, shedding light on the potential implications for solvency and financial stability in the insurance industry.

1) Risk-based capital ratio = Total capital available / Total capital required
2) Non-risk-based capital ratio = Total capital available / Total assets

4.2 Measure of risk

In our study, we employ a specific ratio, namely the claim reserve to total assets ratio, to measure risk in the insurance industry. This ratio bears similarities to the liquidity ratio. Chen, R. and Wong, K.A. (2004) The liquidity ratio is among the most straightforward gauges of an institution's financial well-being, prompting regulators to potentially employ it as an initial indicator of potential financial difficulties.

The claim reserve to total assets ratio enables us to assess an insurer's ability to fulfill its obligations and repay policyholders. Higher values of this ratio can be justified as precautionary reserves, indicating that the insurer has set aside a significant amount of funds to cover potential claims. By using the claim reserve as the numerator in the ratio, we focus on the key liability balance of the insurance company. The claim reserve represents the amount earmarked to fulfill policyholders' claims when incidents occur, reflecting the insurer's financial commitment and liability.

To ensure the ratio accurately reflects liquidity, we chose to use liquid assets as the denominator. Liquid assets are those that can be easily converted into cash or cash equivalents. By utilizing liquid assets as the denominator, we capture the insurer's ability to access funds readily, ensuring that it can fulfill its obligations promptly when claims arise.

By employing this ratio, we can gain insights into the risk profile of insurance companies and their financial preparedness to handle potential claims. It helps us understand the level of reserves set aside and the liquidity position of insurers, allowing us to assess their ability to fulfill policyholder obligations and absorb unexpected financial shocks. The calculation of the claim reserve to total assets ratio is straightforward as equation below.

Claim reserve to total liquid assets ratio = Claim reserve / Total liquid assets

4.3 Measure of efficiency

In the insurance business, underwriting efficiency is measured by a combined ratio (the sum of the ratio of losses and loss adjustment expenses to premium earned and the ratio of underwriting expenses to premium earned). A higher combined ratio means lower underwriting profitability. A company with a low combined ratio can imply that they have an efficient underwriting policy because they have the ability to set the price of a premium, which price is based on the best estimation of future losses and costs related to the insurance contract. The combined ratio is employed to gauge discrepancies in efficiency among insurance companies, with larger values indicating reduced efficiency. According to Chortareasa et al. (2012) and Bitar et al. (2017), higher expenses may signify managerial insufficiency, which could have an adverse effect on insurance efficiency. The formula for calculating the combined ratio is presented below.

Combined ratio = (Loss incurred + Underwriting expense) / Premium earned

4.4 Measure of profitability

In our study, we employ the ratio of net income to total equity, commonly known as return on equity (ROE), as a measure of insurance profitability. This ratio serves as an important indicator of managerial performance and provides insights into the overall financial health and profitability of the insurance company.

The net income used in the calculation of ROE is derived from both the underwriting result and the investment result. The underwriting result reflects the profitability or loss incurred from the core insurance operations of the company, including the premiums collected and the claims paid out. It represents the financial outcome of the insurance company's main business activity. The investment result, on the other hand, pertains to the returns

generated from the management of the company's investment portfolio. Since investments often represent a significant portion of an insurance company's assets, the ability to generate profits from these investments is crucial for overall profitability.

By combining the underwriting result and the investment result in the net income, we obtain a comprehensive measure of the insurance company's profit-generating ability. This approach recognizes the dual focus of insurance companies on both underwriting profitability and investment returns, considering them as integral components of overall profitability.

The ROE ratio provides a measure of the return generated by the company's equity investment, indicating the profitability of the company's operations in relation to the capital invested by shareholders.

By utilizing ROE as a profitability measure, we can evaluate the effectiveness of managerial performance in generating profits for the insurance company. A higher ROE indicates better profitability and suggests that the company is utilizing its equity effectively to generate returns for shareholders. Conversely, a lower ROE may indicate lower profitability and may warrant further investigation into the underlying factors impacting the company's performance. The formula for return on equity is as follows.

ROE = Net income / Total equity

4.5 Empirical model

From our hypothesis, we postulate that the association between capital ratio and risk, efficiency and profitability is linear. Consequently, we utilize the following ordinary least squares (OLS) regression to investigate this association.

Risk and capital ratio

$$Risk_{it} = \alpha + \beta_1 \times \text{Capital ratio}_{it} + \beta_2 \times \text{Capital ratio}_{it} * \text{Period} + \beta_3 \times Size_{it} + \beta_4 \times \text{Type of insurance}_{it} + \beta_5 \times \text{Organization Structure}_{it} + \varepsilon_{it}$$

Efficiency and capital ratio

$$Efficiency_{it} = \alpha + \beta_1 \times \text{Capital ratio}_{it} + \beta_2 \times \text{Capital ratio}_{it} * \text{Period} + \beta_3 \times Size_{it} + \beta_4 \times \text{Type of insurance}_{it} + \beta_5 \times \text{Organization Structure}_{it} + \varepsilon_{it}$$

Profitability and capital ratio

$$Profitability_{it} = \alpha + \beta_1 \times \text{Capital ratio}_{it} + \beta_2 \times \text{Capital ratio}_{it} * \text{Period} + \beta_3 \times Size_{it} + \beta_4 \times \text{Type of insurance}_{it} + \beta_5 \times \text{Organization Structure}_{it} + \varepsilon_{it}$$

The dependent variables are insurance company i's risk indicators, efficiency indicators and profitability in year t, measured by claim liabilities to total liquid assets ratio, combined ratio and return on equity. Capital ratios represent two definitions of capital ratio, as defined in section 4.1.

To address dissimilarities in insurance characteristics, we incorporate a series of control variables, which are as follows:

- Size - The natural logarithm of total assets (Calculations based on insurance company' financial statements). The variable is utilized to control the disparity in capitalization and risk across firm size. It is anticipated that larger firms exhibit greater diversification and, consequently, require less capital to achieve a specified solvency threshold (J.D. Cummins and D.W. Sommer, 1996).
- Organization structure – Two variables are included to account for the effect of group structure: a dummy variable equal to 1 if the firm is affiliated with a multi-insurance holding company and 0 otherwise. Shrieves and Dahl (1992) observed that banks operating within multibank holding companies may manage both their capital and portfolio risk at

the holding company level. Consequently, these banks tend to maintain lower target capital ratios and higher target portfolio risk levels than independent banks.

- Type of insurance - Two variables are included to account for the effect of insurance business: a dummy variable equal to 1 if the firm is non-life insurance and 0 if the firm is life insurance. It is important to note that non-life and life insurance companies, even within the same economy, operate under distinct constraints and necessitate tailored management and regulatory frameworks. (Chen, R. and Wong, K.A., 2004).

Furthermore, we are investigating whether the relationship between capital, risk, efficiency, and profitability varies among insurance companies before and after applying for RBC phase 2 in 2020. This involves incorporating an interaction term between capital ratios and the period dummy variable. To account for the implementation of RBC phase 2, we employ a period dummy variable that takes on a value of 1 for the period after RBC phase 2 in 2020 and 0 otherwise.

5. Sample data

In our study, we have collected primary data from the Singapore Insurance Commissioner for insurance companies in Singapore and the Office of Insurance Commission for insurance companies in Thailand. The sample data encompasses insurance companies operating in Singapore and Thailand between the years 2017 and 2021. The database contains the calculated capital ratio and essential financial information. Therefore, we utilize the available financial data to conduct further calculations and derive the variables necessary for our study.

We specifically chose to focus on these two countries, Singapore and Thailand, due to their adoption of the same regulatory regime, which is the formula risk-based approach. This regulatory framework provides a standardized

basis for assessing capital requirements and risk management practices across insurance companies in both countries. By focusing on these two countries, we aim to analyze and compare the financial performance and regulatory dynamics within a consistent regulatory context.

It is worth noting that the limitation of data availability constrained our ability to cover insurance companies across multiple countries. As a result, we concentrated our research efforts on Singapore and Thailand. These countries were selected due to their shared regulatory regime and the availability of primary data from the respective regulatory authorities.

Furthermore, it is important to highlight that most insurance companies in our sample are not listed companies. This distinction implies that our analysis primarily focuses on non-publicly traded insurance companies. While the financial data for listed insurance companies may be more readily available, analyzing non-listed insurance companies offers valuable insights into a segment of the industry that may differ in terms of size, market presence, and reporting requirements.

The information used is solely derived from financial statements obtained at the firm level. While financial statements provide crucial quantitative data on the financial performance of insurance companies, it is important to note that they do not encompass qualitative aspects of each individual company. This reliance on financial data alone could present a potential limitation to our study, as it may not capture the full range of factors that can influence the performance and risk profiles of insurance companies.

Qualitative data, such as management practices, corporate governance structures, market positioning, and industry-specific factors, can provide valuable insights into the operations and strategies of insurance companies. However, since our study primarily relies on financial statements, we are unable to incorporate such qualitative data into our analysis. This limitation should be taken into consideration when interpreting the results of our study, as it may restrict the depth of understanding regarding the factors influencing insurance performance and risk.

Furthermore, the frequency of our data collection is limited to an annual basis. By utilizing annual financial statements, we capture the financial performance of insurance companies over a one-year period. While this provides an overview of the companies' performance, it may not capture short-term fluctuations or dynamic changes within the insurance industry that occur within shorter time frames.

Lastly, it is worth noting that the number of listed insurance companies is limited within our sample. This restriction implies that we cannot utilize market data for benchmarking purposes, as we lack a sufficient number of publicly traded insurance companies. Consequently, our study primarily focuses on analyzing the financial performance and regulatory dynamics of non-listed insurance companies. The absence of market data benchmarks may limit the ability to compare our findings with broader market trends or industry benchmarks. Given these limitations, it is important to interpret our study's findings within the context of the available data and the specific focus on financial statements at the firm level.

The number of insurance companies is broken down by country and type.

Year	Singapore				Thailand		
	Life	General	Life and General	Total	Life	General	Total
2017	19	84	18	121	23	61	84
2018	18	72	18	108	23	59	82
2019	17	67	17	101	23	58	81
2020	16	59	16	91	22	57	79
2021	16	59	14	89	22	54	76
Total	**86**	**341**	**83**	**510**	**113**	**289**	**402**

Table 1 Total insurance companies by country and type of insurance

Please note that the available information on insurance companies in both Singapore and Thailand is limited. Nevertheless, we were able to collect a sample of 403 companies for Singapore and 323 companies for Thailand. The descriptive statistics, including the sample size, mean, median, and standard deviation, are presented in Table 2 for Singapore and Table 3 for Thailand.

6. Descriptive statistics

	N	Mean	Std. Dev.	Min	Median	Max
Risk-based capital ratio	403	8.868	14.251	.844	3.607	87.74
Non risk-based capital ratio	403	.335	0.249	.002	.297	2.158
Claim reserve to total liquid assets ratio	403	.029	0.026	.02	.02	.21
Premium earned to insurance expenses	403	1.628	1.623	.284	1.216	14.856
Return on equity	403	-.01	0.240	-1.096	.036	.876
Size	403	20.057	1.860	15.643	19.93	25.039
Organization structure	403	.849	0.359	0	1	1
Type of insurance	403	.633	0.483	0	1	1

Table 2 Summary statistics for insurance companies in Singapore

Table 2 presents a comprehensive overview of statistical data pertaining to insurance companies in Singapore. In order to facilitate meaningful comparisons with other variables, the risk-based capital ratio has been rescaled by dividing it by 100. The median value of the risk-based capital ratio stands at 3.607, which significantly surpasses the minimum requirement of 1 (the original requirement before rescaling was 100). Based on the data statistics, it was observed that certain companies have risk-based capital ratios that fall below the regulatory requirement. In such cases, these companies will be subject to monitoring by regulatory authorities, who may take various actions to address the situation. These actions can include implementing corrective measures, intervening in the company's operations, or imposing potential restrictions on their activities. The purpose of these actions is to ensure that the companies improve their capital positions and maintain compliance with the regulatory standards. The median

value of the non risk-based capital ratio is approximately 12 times lower than that of the risk-based capital ratio. This discrepancy arises from the fact that the risk-based capital ratio considers both assets and liabilities, incorporating specific risk charges. On the other hand, the non risk-based capital ratio solely takes into account the total assets, disregarding any associated risk charges.

Upon examining the ratio of claim reserves to total liquid assets, we note a significantly low rate. This is primarily attributed to the practice followed by insurance companies, where claims are typically settled within relatively short time frames. For instance, in Singapore, claims are settled within 10 days, while in Thailand, the timeframe extends to 14 days. As a result, the proportion of claim reserves relative to the overall liquid assets remains relatively small.

When examining the median of premium earned to insurance expense, we find it to be approximately 1.2. This indicates that, on average, insurance companies generate a gross profit of around 20% from their insurance operations.

With a median of return on equity (ROE) of approximately 3.6%, it suggests that insurance companies are generating a modest profitability in relation to their shareholders' equity. This implies that for every Baht 100 of equity invested, the company is generating a return of Baht 3.6. Nevertheless, there exist certain companies with a return on equity (ROE) of less than -100%, indicating that these companies have incurred losses despite maintaining positive total equity.

	N	Mean	Std. Dev.	Min	Median	Max
Risk-based capital ratio	323	4.327	2.698	.202	3.46	15.073
Non risk-based capital ratio	323	.359	0.279	0	.266	1.414
Claim reserve to total liquid assets ratio	323	.235	0.307	0	.178	2.71
Premium earned to insurance expenses	323	1.201	1.500	.249	1.03	17.065
Return on equity	323	-.033	0.363	-2.76	.041	1.769
Size	323	22.586	2.128	18.215	22.56	27.687
Organization structure	323	.418	0.494	0	0	1
Type of insurance	323	.681	0.467	0	1	1

Table 3 Summary statistics for insurance companies in Thailand

Table 3 provides a detailed representation of the statistical data relevant to insurance companies operating in Thailand. To enable meaningful comparisons across variables, the risk-based capital ratio has been rescaled by dividing it by 100. Remarkably, the median value of the risk-based capital ratio is 3.601, significantly exceeding the minimum requirement of 1.4 (prior to rescaling, the original requirement was 100). Upon analyzing the data statistics, it is evident that certain companies exhibit risk-based capital ratios that deviate from the regulatory requirement, possibly indicating outlier data. In these instances, regulatory authorities closely monitor these companies and may undertake appropriate actions to address the situation. Conversely, the median value of the non risk-based capital ratio is approximately 13 times lower than that of the risk-based capital ratio, similar to the findings observed in the Singapore data.

When comparing the ratio of claim reserves to total liquid assets between Singapore and Thailand, it is evident that Thailand exhibits a higher level of liquidity risk. The average ratio in Thailand is 23.5 percent, whereas in Singapore, it is only 2.9 percent. Consequently, it can be expected that the liquidity risk factor holds greater significance when interpreting the data from Thailand compared to Singapore.

Upon analyzing the median of premium earned to insurance expense, we observe a value of around 1.03, which is comparable to the situation in Singapore. This indicates that, on average, insurance companies in this context are generating premiums that are roughly in line with their incurred expenses.

With a median return on equity (ROE) of approximately 4.1%, we observe that it is slightly higher than the corresponding figure of 3.6% in Singapore. This suggests that, on average, insurance companies in Thailand are generating a relatively higher level of profitability in relation to their shareholders' equity compared to insurance companies in Singapore. However, there are some companies where the return on equity (ROE) falls below -100%, indicating that these companies have incurred losses despite maintaining positive total equity.

There is a notable distinction in the organizational structure of insurance companies between Singapore and Thailand. In Singapore, a majority of the

insurance companies are multinational corporations, while in Thailand, the majority are local companies. This variation in the organizational structure reflects differing market dynamics and strategies adopted by insurers in the two countries.

However, it is worth mentioning that apart from this significant difference, there are not many notable distinctions between Singapore and Thailand in terms of other variables or factors. This implies that financial indicators or risk profiles may exhibit similarities between the insurance industries in both countries.

7. Empirical result

7.1 Correlation coefficient and Multicollinearity

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Risk-based capital ratio	1.000							
(2) Non risk-based capital ratio	0.010	1.000						
(3) Claim reserve to total liquid assets ratio	-0.126	-0.004	1.000					
(4) Premium earned to insurance expenses	0.007	0.099	-0.029	1.000				
(5) Return on equity	0.015	-0.000	-0.026	0.049	1.000			
(6) Size	-0.069	-0.377	0.170	0.104	0.293	1.000		
(7) Organization structure	0.123	-0.122	0.009	-0.082	-0.111	0.036	1.000	
(8) Type of insurance	0.097	0.279	-0.248	-0.193	-0.037	-0.513	0.023	1.000

Table 4 Correlation coefficient for insurance companies in Singapore

The correlation matrix presented above shows the pairwise correlations between different variables of insurance companies in Singapore. Each cell in the matrix represents the correlation coefficient between two variables, ranging from -1 to 1.

The correlation values between the risk-based capital ratio and other variables provide insights into their relationships. The risk-based capital ratio shows a weak positive correlation with the non-risk-based capital ratio, indicating a slight tendency for them to move in the same direction. In contrast, it has a moderate negative correlation with the claim reserve to total liquid assets ratio, suggesting that higher risk-based capital ratios are associated with lower relative claim reserves. The correlation with the premium earned to insurance expenses

ratio and return on equity is very weak, indicating little to no meaningful relationship. Furthermore, there is a weak negative correlation between the risk-based capital ratio and the size of the insurance company, implying that larger companies tend to have slightly lower risk-based capital ratios. On the other hand, the risk-based capital ratio exhibits a moderate positive correlation with the organization structure and type of insurance variables, indicating that certain organizational structures and types of insurance may be linked to higher risk-based capital ratios.

The correlation values provided shed light on the relationships between the non-risk-based capital ratio and other variables. The non-risk-based capital ratio shows a very weak negative correlation with the claim reserve to total liquid assets ratio, indicating minimal association between the two variables. In contrast, it exhibits a moderate positive correlation with the premium earned to insurance expenses ratio, suggesting that higher non-risk-based capital ratios may be linked to increased profitability or better expense management. The correlation with the return on equity is negligible, indicating no notable relationship between the non-risk-based capital ratio and profitability as measured by return on equity. Moreover, there is a moderate negative correlation between the non-risk-based capital ratio and the size of the insurance company, suggesting that larger insurers tend to have lower non-risk-based capital ratios. Similarly, the non-risk-based capital ratio shows a moderate negative correlation with organization structure, implying that certain organizational structures are associated with lower non-risk-based capital ratios. Conversely, there is a strong positive correlation between the non-risk-based capital ratio and the type of insurance offered, suggesting that specific insurance lines may require higher non-risk-based capital allocations.

Importantly, the absence of strong correlations exceeding 0.7 between any pair of variables suggests a relatively low presence of multicollinearity. However, it is worth noting that some moderate correlations within the range of 0.3 to 0.7 do exist. For instance, a moderate negative correlation of -0.377 is observed between size and the non risk-based capital ratio, while a moderate positive correlation of 0.279 is evident between type of insurance and the non risk-based

capital ratio. While these correlations are not overly pronounced, they still deserve attention and warrant further investigation to determine their potential impact on the model's performance and interpretation.

To address the issue of multicollinearity effectively, we have decided to employ variance inflation factor (VIF) analysis. This analysis will provide insights into the extent of multicollinearity and guide appropriate remedial measures.

The VIF analysis results will be presented in tabular format below, providing the VIF values for each variable. These values will serve as indicators of the degree of multicollinearity, with higher values suggesting stronger correlations with other variables.

Independent variable - Risk-based capital ratio

Variance inflation factor	**VIF**	**1/VIF**
Risk-based capital ratio	1.025	.976
Size	1.363	.733
Type of insurance	1.367	.731
Organization structure	1.019	.982
Mean VIF	1.194	

Table 5 VIF of independent variable - Risk-based capital ratio (Singapore)

For the independent variable "Risk-based capital ratio", the VIF value is 1.025, indicating a relatively low level of multicollinearity. The reciprocal value of 0.976 suggests that approximately 97.6 percent of the variance in the risk-based capital ratio is independent of other variables in the model. Similarly, the other independent variables, such as Size, Type of insurance, and Organization structure, exhibit VIF values ranging from 1.019 to 1.367, indicating no significant multicollinearity. The reciprocal values (1/VIF) range from 0.731 to 0.982, indicating that approximately 73.1 percent to 98.2 percent of the variance in these variables can be uniquely explained by other factors in the model. The mean VIF value of 1.194 further confirms the absence of substantial

multicollinearity among the independent variables related to the risk-based capital ratio.

Independent variable - Non risk-based capital ratio

Variance inflation factor	VIF	1/VIF
Non risk-based capital ratio	1.205	.83
Risk-based capital ratio	1.487	.673
Size	1.38	.725
Type of insurance	1.018	.982
Mean VIF	1.273	

Table 6 VIF of independent variable - non risk-based capital ratio (Singapore)

Similarly, for the independent variable "Non risk-based capital ratio," the VIF values range from 1.018 to 1.487, indicating no major issues with multicollinearity. The reciprocal values (1/VIF) range from 0.673 to 0.982, implying that approximately 67.3 percent to 98.2 percent of the variance in these variables is independent of other factors in the model. The mean VIF value of 1.273 confirms the absence of significant multicollinearity among the independent variables related to the non risk-based capital ratio.

Overall, the VIF analysis reveals that there is no substantial multicollinearity among the independent variables associated with both the risk-based capital ratio and the non risk-based capital ratio. These findings provide confidence in including these variables in the model, as their presence does not compromise the accuracy and interpretability of the results.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Risk-based capital ratio	1.000							
(2) Non risk-based capital ratio	0.267	1.000						
(3) Claim reserve to total liquid assets ratio	-0.118	-0.089	1.000					
(4) Premium earned to insurance expenses	0.040	0.205	-0.147	1.000				
(5) Return on equity	0.208	0.122	-0.192	0.077	1.000			
(6) Size	-0.109	-0.504	-0.325	-0.129	0.184	1.000		
(7) Organization structure	0.091	-0.309	-0.012	-0.064	-0.129	0.161	1.000	
(8) Type of insurance	0.229	0.388	0.503	0.005	-0.048	-0.545	-0.053	1.000

Table 7 Correlation coefficient for insurance companies in Thailand

The correlation coefficients between the variables reveal various degrees of association. The Risk-based capital ratio, being the focal variable, has a correlation coefficient of 1.000 with itself, as expected. The Non risk-based capital ratio shows a moderate positive correlation of 0.267 with the Risk-based capital ratio. The Claim reserve to total liquid assets ratio exhibits a weak negative correlation of -0.118 with the Risk-based capital ratio. The Premium earned to insurance expenses and return on equity variables have weak correlations with the Risk-based capital ratio, with coefficients of 0.040 and 0.208, respectively.

Moving to the Size variable, it demonstrates weak negative correlations with the Risk-based capital ratio, Non risk-based capital ratio, Claim reserve to total liquid assets ratio, and Premium earned to insurance expenses, with correlation coefficients ranging from -0.109 to -0.504. The Organization structure variable exhibits a weak positive correlation of 0.091 with the Risk-based capital ratio and a moderate negative correlation of -0.309 with the Non risk-based capital ratio. The Type of insurance variable shows weak to moderate positive correlations with the Risk-based capital ratio, Non risk-based capital ratio, and Claim reserve to total liquid assets ratio, with coefficients ranging from 0.229 to 0.503.

These correlation coefficients provide valuable insights into the relationships among the variables, shedding light on potential connections and dependencies. It is crucial to note that none of the correlations exceed 0.7, indicating a relatively low level of multicollinearity. This suggests that the variables are not strongly interrelated, allowing for a more reliable analysis. However, certain

moderate correlations between pairs of variables, such as the Type of insurance and Size, merit closer attention and further investigation to better understand the underlying dynamics.

To delve deeper into the presence of multicollinearity and ensure the accuracy of the analysis, the variance inflation factor (VIF) was employed. The VIF values were calculated for each variable, providing a measure of the degree of multicollinearity among the variables. By assessing the VIF values, it becomes possible to evaluate the potential impact of interdependencies and identify any variables that may be contributing to multicollinearity issues. This step is crucial in maintaining the integrity of the analysis and ensuring the reliability of the results.

Independent variable - Risk-based capital ratio

Variance inflation factor	**VIF**	**1/VIF**
Risk-based capital ratio	1.068	.937
Size	1.46	.685
Type of insurance	1.486	.673
Organization structure	1.04	.962
Mean VIF	1.263	.

Table 8 VIF of independent variable - Risk-based capital ratio (Thailand)

The VIF analysis reveals the level of multicollinearity among the independent variables in relation to the risk-based capital ratio. For the variable "Risk-based capital ratio," the VIF value is 1.068, indicating a relatively low degree of multicollinearity. The reciprocal value of 0.937 suggests that approximately 93.7 percent of the variance in the risk-based capital ratio is independent of other variables included in the model.

Similarly, the other independent variables, namely Size, Type of insurance, and Organization structure, exhibit VIF values ranging from 1.04 to 1.486, signifying the absence of significant multicollinearity. The reciprocal values (1/VIF) range from 0.673 to 0.962, indicating that approximately 67.3 percent to 96.2 percent of

the variance in these variables can be attributed to factors other than multicollinearity within the model.

The mean VIF value of 1.263 further reinforces the conclusion that there is no substantial multicollinearity among the independent variables pertaining to the risk-based capital ratio. This indicates that each independent variable contributes distinct information and is not overly influenced by the presence of multicollinearity, thereby ensuring the reliability and accuracy of the model.

Independent variable - Non risk-based capital ratio

Variance inflation factor	VIF	1/VIF
Non risk-based capital ratio	1.205	.83
Risk-based capital ratio	1.487	.673
Size	1.38	.725
Type of insurance	1.018	.982
Mean VIF	1.273	.

Table 9 VIF of independent variable - non risk-based capital ratio (Thailand)

The VIF analysis of the independent variable "Non risk-based capital ratio" reveals no significant concerns regarding multicollinearity. The VIF values for this variable range from 1.018 to 1.487, indicating a minimal presence of multicollinearity. The reciprocal values (1/VIF) range from 0.673 to 0.982, suggesting that approximately 67.3 percent to 98.2 percent of the variance in these variables is independent of other factors included in the model.

Furthermore, the mean VIF value of 1.273 reinforces the conclusion that there is no substantial multicollinearity among the independent variables associated with the non risk-based capital ratio. This implies that each independent variable contributes unique information to the model, and the presence of multicollinearity does not significantly influence their relationships.

Overall, these findings affirm the reliability and accuracy of the model, indicating that the independent variables related to the non risk-based capital ratio are not strongly interdependent. Therefore, the model can be utilized confidently for analysis and interpretation without significant multicollinearity concerns.

These results demonstrate that there is no substantial multicollinearity among the independent variables associated with both the risk-based capital ratio and the non risk-based capital ratio in the context of Singapore and Thailand. These findings enhance the reliability and accuracy of the analysis, ensuring that the relationships observed among the variables are robust and not unduly influenced by multicollinearity.

7.2 Heteroskedasticity

The assessment of heteroskedasticity holds significant importance in statistical analysis, specifically when dealing with linear regression models. It plays a pivotal role in guaranteeing the reliability and precision of the obtained results. Heteroskedasticity occurs when the assumption of constant variance of the error term is violated across different levels of the independent variables. Such a violation can result in biased and inefficient estimates of the regression coefficients, leading to inaccurate inferences. Therefore, conducting tests for heteroskedasticity is imperative to ensure the validity and accuracy of the statistical analysis.

The identification of heteroskedasticity is crucial as it enables us to recognize the violation and implement necessary measures to mitigate its impact. Failure to account for heteroskedasticity can result in inaccurate standard errors, inefficient parameter estimates, and incorrect model specifications, jeopardizing the reliability and validity of the statistical analysis. Heteroskedasticity introduces unequal variability in the error term across different levels of the independent variables, which can distort the significance of coefficients and lead to misleading conclusions.

When heteroskedasticity is present, the standard errors of the regression coefficients become biased, compromising the precision and reliability of the estimated effects of the independent variables on the dependent variable. This can impact hypothesis testing, as incorrect standard errors can result in erroneous p-values and misleading conclusions about the statistical significance of the relationships.

Moreover, heteroskedasticity can lead to inefficient parameter estimates, reducing the efficiency of the model. Inefficient estimates imply that the model is not making optimal use of the available data, which can hinder the accuracy and reliability of predictions and inferences.

By addressing heteroskedasticity, such as through the use of robust standard errors or transformation techniques, we can correct the bias in standard errors, obtain more efficient parameter estimates, and ensure accurate model specifications. This allows for robust statistical tests and valid inferences, providing a more accurate understanding of the relationships and effects being studied. Ultimately, the detection and appropriate treatment of heteroskedasticity play a vital role in enhancing the reliability and validity of statistical analyses.

The Breusch-Pagan test was conducted to examine the presence of heteroskedasticity within the dataset. The test's outcome provided a summary of the results.

Risk and capital ratio

$$Risk_{it} = \alpha + \beta_1 \times Capital\ ratio_{it} + \beta_2 \times Capital\ ratio_{it} * Period + \beta_3 \times Size_{it} + \beta_4 \times Type\ of\ insurance_{it} + \beta_5 \times Organization\ Structure_{it} + \varepsilon_{it}$$

Capital ratio	chi2(1)	Prob > chi2	Interpret
Singapore			
Risk-based capital ratio	5,318.17	0.0000	Reject
Non risk-based capital ratio	5,314.63	0.0000	Reject
Thailand			
Risk-based capital ratio	2,609.53	0.0000	Reject
Non risk-based capital ratio	2,630.19	0.0000	Reject

Table 10 Breusch-Pagan test for equation of risk and capital ratio

Efficiency and capital ratio

$$Efficiency_{it} = \alpha + \beta_1 \times Capital\ ratio_{it} + \beta_2 \times Capital\ ratio_{it} * Period + \beta_3 \times Size_{it} + \beta_4 \times Type\ of\ insurance_{it} + \beta_5 \times Organization\ Structure_{it} + \varepsilon_{it}$$

Capital ratio	chi2(1)	Prob > chi2	Interpret
Singapore			
Risk-based capital ratio	72,661.55	0.0000	Reject
Non risk-based capital ratio	72,892.97	0.0000	Reject
Thailand			
Risk-based capital ratio	12,477.72	0.0000	Reject
Non risk-based capital ratio	11,553.66	0.0000	Reject

Table 11 Breusch-Pagan test for equation of efficiency and capital ratio

Profitability and capital ratio

$$\text{Profitability}_{it} = \alpha + \beta_1 \times \text{Capital ratio}_{it} + \beta_2 \times \text{Capital ratio}_{it} * \text{Period} + \beta_3 \times \text{Size}_{it} + \beta_4 \times \text{Type of insurance}_{it} + \beta_5 \times \text{Organization Structure}_{it} + \varepsilon_{it}$$

Capital ratio	chi2(1)	Prob > chi2	Interpret
Singapore			
Risk-based capital ratio	116.88	0.0000	Reject
Non risk-based capital ratio	99.23	0.0000	Reject
Thailand			
Risk-based capital ratio	900.96	0.0000	Reject
Non risk-based capital ratio	815.96	0.0000	Reject

Table 12 Breusch-Pagan test for equation of profitability and capital ratio

The Breusch-Pagan test was conducted to examine the null hypothesis of constant variance in the residuals variable. The results revealed significant findings with p-values of 0.0000 for both variables in Singapore and Thailand, indicating the rejection of the null hypothesis. These results provide evidence of heteroskedasticity in the residuals variable, suggesting that the variance of the residuals is not constant across all levels of the independent variables.

The presence of heteroskedasticity can have implications for the reliability and accuracy of statistical analysis results. To ensure valid statistical inferences and reliable conclusions, it is important to address heteroskedasticity through appropriate modeling techniques or the use of robust standard errors.

In this study, we have employed the use of Robust standard error, specifically White's robust standard error, to address the issue of heteroskedasticity. This robust standard error method provides a reliable and efficient approach to handle heteroskedasticity in statistical analysis. By including the "robust" command after the regression command in STATA, the

standard errors are automatically adjusted to robust standard errors, taking into account the potential heteroskedasticity present in the data.

By incorporating the robust standard error method into our analysis, we can have confidence that the results are robust and less prone to biases caused by heteroskedasticity. This approach enhances the reliability and validity of the findings and contributes to the overall quality and credibility of the study. Further steps should be taken to address heteroskedasticity in the analysis of the residuals variable, such as exploring alternative modeling approaches or employing other heteroskedasticity-robust methods, to obtain accurate estimates and reliable statistical tests.

7.3 Risk and capital ratio

We utilized Ordinary Least Squares (OLS) regression models to investigate the relationship between capital ratios and risk. These regression models allow us to analyze the potential associations and effects of capital ratios on risk.

Singapore

Model 1:

$Risk_{it} = \alpha + \beta_1 \times \text{Risk-based capital ratio}_{it} + \beta_2 \times \text{Capital ratio}_{it} * \text{Period} + \beta_3 \times \text{Size}_{it} + \beta_4 \times \text{Type of insurance}_{it} + \beta_5 \times \text{Organization Structure}_{it} + \varepsilon_{it}$

Model 2:

$Risk_{it} = \alpha + \beta_1 \times \text{non risk-based capital ratio}_{it} + \beta_2 \times \text{Capital ratio}_{it} * \text{Period} + \beta_3 \times \text{Size}_{it} + \beta_4 \times \text{Type of insurance}_{it} + \beta_5 \times \text{Organization Structure}_{it} + \varepsilon_{it}$

Thailand

Model 3:

$Risk_{it} = \alpha + \beta_1 \times \text{Risk-based capital ratio}_{it} + \beta_2 \times \text{Capital ratio}_{it} * \text{Period} + \beta_3 \times \text{Size}_{it} + \beta_4 \times \text{Type of insurance}_{it} + \beta_5 \times \text{Organization Structure}_{it} + \varepsilon_{it}$

Model 4:

$Risk_{it} = \alpha + \beta_1 \times \text{non risk-based capital ratio}_{it} + \beta_2 \times \text{Capital ratio}_{it} * \text{Period} + \beta_3 \times \text{Size}_{it} + \beta_4 \times \text{Type of insurance}_{it} + \beta_5 \times \text{Organization Structure}_{it} + \varepsilon_{it}$

	(1) LIQ	(2) LIQ	(3) LIQ	(4) LIQ
Risk-based capital ratio	-.0002***		-.035***	
	(.000)		(.007)	
Non risk-based capital		.004**		-.521***
ratio		(.004)		(.094)
PERIOD#c.Risk-based	.000		.016	
capital ratio	(.000)		(.011)	
PERIOD#c.Non risk-based		.006		.058
capital ratio		(.004)		(.095)
PERIOD	-.006*	-.01**	-.116**	-.079*
	(.003)	(.004)	(.054)	(.041)
Size	.003	.003	-.01	-.034***
	(.001)	(.001)	(.008)	(.007)
Type of insurance	-.009**	-.01***	.344***	.357***
	(.003)	(.003)	(.037)	(.023)
Organization structure	.004	.004	.031	-.052*
	(.002)	(.002)	(.029)	(.03)
_cons	-.027	-.036	.387*	.999***
	(.027)	(.029)	(.197)	(.192)
Observations	403	403	323	323
R-squared	.137	.134	.327	.401

Robust standard errors are in parentheses

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

Table 13 Result of capital and risk model. The dependent variable is the ratio of claim liabilities and total liquid assets (LIQ).

The table 13 presents the results of four regression models, denoted as (1), (2), (3) and (4) with the dependent variable "LIQ" (Claim liabilities to total liquid assets ratio) in each model. The coefficients of the independent

variables and their corresponding standard errors are reported in the table. The results are based on a sample of 403 observations for models (1) and (2), and 323 observations for models (3) and (4).

In Model (1), we investigate the relationship between the Risk-based capital ratio and liquidity from data of Singapore insurance companies. The coefficient for the Risk-based capital ratio is highly significant at the 1% level (***), with a value of -0.0002. This indicates that an increase in the risk-based capital ratio is associated with a decrease in liquidity. The estimation of this coefficient is based on a robust standard error of 0.000, ensuring the reliability of the results.

Moving on to Model (2), our objective is to explore the impact of the Non risk-based capital ratio on liquidity from data of Singapore insurance companies. The coefficient for the Non risk-based capital ratio is statistically significant at the 5% level (**), with a value of 0.004. This suggests a positive relationship between the Non risk-based capital ratio and liquidity. The estimation of this coefficient is conducted using a robust standard error of 0.004, accounting for potential heteroskedasticity.

In Model (3), we continue our investigation into the relationship between the Risk-based capital ratio and liquidity from data of Thai insurance companies. The coefficient for the Risk-based capital ratio is found to be -0.035, which is statistically significant at the 1% level (***). This indicates a strong association between the Risk-based capital ratio and liquidity. Specifically, as the risk-based capital ratio increases, liquidity tends to decrease. The estimation of this coefficient is supported by a robust standard error of 0.007, ensuring the accuracy of the findings.

In Model (4), our attention shifts to the influence of the Non risk-based capital ratio on liquidity from data of Thai insurance companies. The coefficient associated with the Non risk-based capital ratio is highly significant at the 1% level (***), with a value of -0.521. This reveals a negative impact of the Non risk-based capital ratio on liquidity. The estimation of this coefficient

is carried out using a robust standard error of 0.094, enhancing the reliability of the results.

The interaction term PERIOD#c.Risk-based capital ratio in model (1) and (3) is included to examine the combined effect of the risk-based capital ratio and the period indicator on liquidity. However, the coefficient for this interaction term is not statistically significant, indicating that the interaction between the risk-based capital ratio and the period indicator does not have a significant impact on liquidity.

Likewise, in model (2) and (4), the interaction term PERIOD#c.Non risk-based capital ratio is introduced to investigate the joint impact of the non risk-based capital ratio and the period indicator on liquidity. However, similar to the previous model, the coefficient for this interaction term is not statistically significant, suggesting that the interaction between the non risk-based capital ratio and the period indicator does not have a significant effect on liquidity.

The control variable "PERIOD" in the analysis shows a significant negative relationship with liquidity risk. This means that the period during which RBC phase 2 has been implemented has a notable impact on reducing liquidity risk for insurance companies. The RBC phase 2 introduces more stringent regulatory requirements and guidelines for insurers. These requirements could include higher capital adequacy standards, stricter liquidity management practices, and enhanced risk assessment processes. By complying with the regulations and standards set forth in RBC phase 2, insurance companies are better equipped to manage liquidity risk. They are more likely to maintain sufficient liquid assets and establish robust risk management frameworks, ensuring that they can fulfill their financial obligations in a timely manner.

The control variable "Type of insurance" in the analysis exhibits a significant positive relationship with liquidity risk in the context of the Thailand data. Non-life insurance poses an increased liquidity risk due to several factors specific to this sector. The higher frequency of claims in non-life insurance policies leads to more frequent and immediate claim payouts,

potentially straining liquidity. Additionally, the unpredictable and volatile nature of losses in non-life insurance, such as property damage and liability claims, makes it challenging to estimate and set aside sufficient reserves, further affecting liquidity. The collection cycle of non-life insurance premiums, often on an annual or semi-annual basis, creates a timing mismatch between cash inflows and outflows, creating liquidity challenges.

The constant term, represented by "_cons," is included in all models. It captures the expected value of liquidity when all independent variables are zero. The constant term varies across the models, with different coefficients and robust standard errors.

The R-squared values for each model indicate the proportion of the variation in liquidity explained by the independent variables. Model (4) has the highest R-squared value of 0.401, indicating a relatively better fit compared to the other models.

Overall, the results of the analysis indicate a consistent negative relationship between the risk-based capital ratio and non risk-based capital ratio, and liquidity in both Singapore and Thailand. A higher risk-based capital ratio suggests that an insurance company possesses a greater amount of capital in proportion to its risk exposure. This signals financial strength and stability to various stakeholders, including investors, regulators, and counterparties. However, the findings of our analysis diverge from prior studies, as previous research indicated no impact of capital ratios on risk. In contrast, our findings do not support this conclusion. It is important to note that the specific dynamics and contexts of the Singaporean and Thai insurance markets may contribute to these differing results.

By maintaining a higher risk-based capital ratio, insurance companies are better equipped to support their operations and meet liquidity needs without relying heavily on short-term borrowing or external financing, especially during times of financial stress. This reduces their vulnerability to liquidity shocks in the financial markets. In the face of unexpected liquidity demands, these

institutions can rely on their capital reserves to bridge any short-term liquidity gaps, thereby avoiding hasty asset sales or the need for additional funding.

The presence of a robust capital base enhances an insurance company's ability to navigate through challenging market conditions and effectively manage liquidity risks. It provides a cushion against unforeseen liquidity challenges and ensures the availability of adequate resources to meet policyholder obligations. Furthermore, a strong risk-based capital ratio enhances market confidence and fosters trust in the insurance company's ability to fulfill its financial commitments.

The findings highlight the importance of maintaining an appropriate level of capitalization in the insurance industry to ensure financial stability and resilience. Regulators often impose minimum capital requirements to safeguard policyholders' interests and maintain the overall soundness of the insurance sector. Adequate capitalization contributes to the industry's ability to fulfill its role as a financial intermediary and effectively manage risks, ultimately benefiting policyholders and the broader economy.

7.4 Efficiency and capital ratio

We utilized Ordinary Least Squares (OLS) regression models to investigate the relationship between capital ratios and efficiency in business risk. These regression models allow us to analyze the potential associations and effects of capital ratios on efficiency.

The models included in this session are models 5, 6, 7 and 8. These models have the same equations as models 1, 2, 3 and 4, respectively, but with a change in the dependent variable from risk to efficiency.

	(5) RCOMB	(6) RCOMB	(7) RCOMB	(8) RCOMB
Risk-based capital ratio	.001		.012*	
	(.004)		(.024)	
Non risk-based capital		.396		.523**
ratio		(.262)		(.577)
PERIOD#c.Risk-based	.007		.017	
capital ratio	(.012)		(.045)	
PERIOD#c.Non risk-based		.041		0.017
capital ratio		(.738)		(0.427)
PERIOD	.046	.041	.194	-.412
	(.21)	(.285)	(.363)	(.328)
Size	.009	-.007	-.123	-.062
	(.04)	(.043)	(.088)	(.061)
Type of insurance	-.627***	-.597***	-.266**	-.428**
	(.215)	(.21)	(.109)	(.172)
Organization structure	-.372	-.379	-.113	.018
	(.295)	(.292)	(.085)	(.063)
_cons	2.114**	2.58**	4.202*	2.645*
	(.994)	(1.095)	(2.168)	(1.439)
Observations	403	403	323	323
R-squared	.047	.047	.027	.078

Robust standard errors are in parentheses

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

Table 14 Result of capital and efficiency model. The dependent variable is the ratio of premium earned and total loss and underwriting expense (RCOMB).

The table 14 provides the results of four regression models, labeled as (5), (6), (7) and (8), investigating the relationship between the dependent variable "RCOMB" (Premium earned to total loss and underwriting expense) and various independent variables. The coefficients and standard errors of the independent variables are reported. The analysis is based on a sample size of 403 observations for models (5) and (6), and 323 observations for models (7) and (8).

Model (5) examines the relationship between the Risk-based capital ratio and efficiency using Singapore data. The coefficient for the Risk-based capital ratio is not statistically significant, with a value of 0.001. This suggests that an increase in the risk-based capital ratio is associated with a minor increase in efficiency. The estimation of this coefficient incorporates a robust standard error of 0.004, ensuring the reliability of the results.

In Model (6), the focus is on exploring the impact of the Non risk-based capital ratio on efficiency in Singapore data. The coefficient for the Non risk-based capital ratio is not statistically significant, with a value of 0.396. This indicates a positive relationship between the Non risk-based capital ratio and efficiency. The estimation of this coefficient employs a robust standard error of 0.262, accounting for potential heteroskedasticity.

Continuing to Model (7), the investigation revolves around the relationship between the Risk-based capital ratio and efficiency using Thailand data. The coefficient for the Risk-based capital ratio is -0.035, which is statistically significant at the 10% level (*). This indicates an association between the Risk-based capital ratio and efficiency, where an increase in the risk-based capital ratio corresponds to an increase in efficiency. The estimation of this coefficient is supported by a robust standard error of 0.024, ensuring the accuracy of the findings.

In Model (8), the focus shifts to the influence of the Non risk-based capital ratio on efficiency using Thailand data. The coefficient associated with the Non risk-based capital ratio is highly significant at the 5% level (**), with a value of 0.523. This reveals a positive impact of the Non risk-based capital

ratio on efficiency. The estimation of this coefficient incorporates a robust standard error of 0.577, enhancing the reliability of the results.

The interaction terms, PERIOD#c.Risk-based capital ratio in models (5) and (7) and "PERIOD#c.Non risk-based capital ratio" in models (6) and (8), explore the combined effects of the respective capital ratios and the period indicator on efficiency. However, the coefficients for these interaction terms are not statistically significant, suggesting that the interaction between the capital ratios and the period indicator does not have a significant impact on efficiency.

The control variable "Type of insurance" in the analysis exhibits a significant negative relationship with efficiency. The decrease in efficiency among non-life insurance companies can be attributed to several factors. These include the complexity of managing diverse risks, higher claims frequency and severity, specific underwriting practices or product offerings, and regulatory requirements. These factors collectively impact the ability of non-life insurers to effectively manage risks, process claims, and maintain insurance efficiency.

The constant term, represented by "_cons," is included in all models. It captures the expected value of efficiency when all independent variables are zero. The constant term varies across the models, with different coefficients and robust standard errors.

The R-squared values for each model indicate the proportion of the variation in efficiency explained by the independent variables. Model (8) has the highest R-squared value of 0.078, suggesting a relatively better fit compared to the other models.

In summary, the findings of the analysis consistently demonstrate a positive relationship between the risk-based capital ratio, non risk-based capital ratio and efficiency in both Singapore and Thailand. A higher capital ratio signifies financial robustness and stability, which in turn could have attracted customers and business partners. This increased market reputation and trust can lead to various benefits, including expanded market share,

improved business opportunities and economies of scale, all of which contribute to enhanced efficiency.

Additionally, a higher capital ratio provides insurance companies with greater flexibility in pricing their products. They can more accurately assess the risks associated with policies and charge appropriate premiums, ensuring a better balance between income and potential losses. This ability to effectively manage risk enables insurers to optimize their financial performance and maintain stability in challenging market conditions.

Overall, the positive relationship between capital ratios and efficiency underscores the importance of sound capital management practices in the insurance industry. Adequate capital resources not only signal financial strength and attract stakeholders but also empower insurers to navigate market dynamics more effectively, promote growth, and achieve optimal operational efficiency. These findings align with previous studies, which also highlight the positive impact of risk-based and traditional capital ratios on efficiency. Thus, it is evident that maintaining robust capital ratios is essential for enhancing operational performance and overall efficiency in insurance companies.

7.5 Profitability and capital ratio

We employed Ordinary Least Squares (OLS) regression models to examine the correlation between capital ratios and profitability. By utilizing these regression models, we were able to explore the potential connections and impacts of capital ratios on the profitability of the entities under study.

The models included in this session are models 9, 10, 11 and 12. These models have the same equations as models 1, 2, 3 and 4, respectively, but with a change in the dependent variable from risk to profitability.

	(9) ROE	(10) ROE	(11) ROE	(12) ROE
Risk-based capital ratio	.001		.031***	
	(.001)		(.011)	
Non risk-based capital		.086		.315**
ratio		(.094)		(.134)
PERIOD#c.Risk-based	0		.006	
capital ratio	(.002)		(.014)	
PERIOD#c.Non risk-based		.156		.027
capital ratio		(.118)		(.115)
PERIOD	.035	-.001	-.017	.004
	(.025)	(.049)	(.094)	(.076)
Size	.048***	.052***	.044***	.059***
	(.008)	(.008)	(.01)	(.014)
Type of insurance	.079**	.072**	.018	.03
	(.034)	(.034)	(.049)	(.048)
Organization structure	-.089***	-.074**	-.141***	-.078*
	(.028)	(.029)	(.044)	(.043)
_cons	-.966***	-1.083***	-1.107***	-1.482***
	(.183)	(.191)	(.276)	(.388)
Observations	403	403	323	323
R-squared	.127	.14	.122	.107

Robust standard errors are in parentheses

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

Table 15 Result of capital and profitability model. The dependent variable is the ratio of return of equity (ROE).

Table 15 presents the findings of four regression models, denoted as (9), (10), (11) and (12), which aim to investigate the relationship between the dependent variable "ROE" (Return on equity) and various independent variables. The coefficients and standard errors of the independent variables are reported. The analysis is based on a sample size of 403 observations for models (9) and (10) and 323 observations for models (11) and (12).

Model (9) examines the association between the Risk-based capital ratio and profitability using data from Singapore. The coefficient for the Risk-based capital ratio is not statistically significant, with a value of 0.001. This implies that an increase in the risk-based capital ratio is linked to a marginal improvement in efficiency. The estimation of this coefficient incorporates a robust standard error of 0.001 to ensure the reliability of the results.

In Model (10), the focus is on exploring the impact of the Non risk-based capital ratio on profitability using Singapore data. The coefficient for the Non risk-based capital ratio is not statistically significant, with a value of 0.086. This indicates a positive relationship between the Non risk-based capital ratio and profitability. The estimation of this coefficient employs a robust standard error of 0.094, taking into account potential heteroskedasticity.

Continuing to Model (11), the investigation centers around the relationship between the Risk-based capital ratio and profitability using data from Thailand. The coefficient for the Risk-based capital ratio is 0.031, which is statistically significant at the 1% level (***). This implies a correlation between the Risk-based capital ratio and profitability, where an increase in the risk-based capital ratio corresponds to an increase in profitability. The estimation of this coefficient is supported by a robust standard error of 0.011, ensuring the accuracy of the findings.

In Model (12), the focus shifts to the influence of the Non risk-based capital ratio on profitability using data from Thailand. The coefficient associated with the Non risk-based capital ratio is highly significant at the 5% level (**), with a value of 0.315. This reveals a positive impact of the Non risk-based capital ratio on profitability. The estimation of this coefficient

incorporates a robust standard error of 0.134, enhancing the reliability of the results.

The interaction terms, PERIOD#c.Risk-based capital ratio in models (9) and (10), and "PERIOD#c.Non risk-based capital ratio" in models (11) and (12), investigate the combined effects of the respective capital ratios and the period indicator on efficiency. However, the coefficients for these interaction terms are not statistically significant, suggesting that the interaction between the capital ratios and the period indicator does not have a significant impact on efficiency.

The control variable "Size" in the analysis demonstrates a significant positive relationship with profitability. This can be attributed to the fact that larger insurance companies often benefit from economies of scale, which enable them to distribute their operational costs across a broader asset base. As a result, they can achieve lower expense ratios and enhanced profitability. Moreover, the size of these insurers grants them access to a wider range of resources and expertise, facilitating the diversification of their product offerings and allowing them to seize market opportunities. This diversification contributes to increased revenues and improved profitability.

The control variable "Organization structure" in the analysis shows a significant negative relationship with profitability. This can be attributed to higher operational costs associated with managing a global presence, adapting to diverse market dynamics, dealing with regulatory compliance complexities, and allocating resources for international operations. These challenges have a direct impact on the financial performance of multinational companies and often result in lower profitability.

The constant term, represented by "_cons," is included in all models. It captures the expected value of efficiency when all independent variables are zero. The constant term varies across the models, with different coefficients and robust standard errors.

The R-squared values for each model indicate the proportion of the variation in efficiency explained by the independent variables. Model (10) has

the highest R-squared value of 0.14, suggesting a relatively better fit compared to the other models.

In conclusion, the analysis consistently reveals a positive correlation between the risk-based capital ratio, non risk-based capital ratio, and profitability in both Singapore and Thailand. A higher capital ratio benefits insurance companies by bolstering their financial standing, inspiring confidence among policyholders and business partners and setting them apart from competitors. This competitive advantage attracts more customers, drives business growth, and potentially enables higher premium rates, ultimately leading to increased profitability. Moreover, a high capital ratio empowers insurers to assume larger risks and expand their underwriting capacity. With a larger capital base, insurers can confidently underwrite policies with higher limits and increased exposure, resulting in higher premium income and improved profitability. Furthermore, the ability to underwrite larger risks may lead to economies of scale and enhanced efficiency in the underwriting process. Another significant aspect of insurance companies' profitability stems from investments. A strong capital ratio grants insurers greater flexibility and capacity to invest in a wider range of assets and opportunities. Effective investment management can generate higher investment income, thereby contributing to overall profitability. Additionally, a robust capital position allows insurers to take calculated risks in pursuit of potentially higher investment returns, further bolstering profitability. The results are consistent with prior studies, indicating that both risk-based and traditional capital ratios have a positive effect on profitability.

In relation to the control variables, our analysis reveals that larger companies tend to generate higher profits compared to smaller companies. This can be attributed to the concept of economies of scale, whereby larger companies are able to spread their fixed costs over a greater number of policies. By doing so, they can achieve operational efficiencies and reduce the cost per policy. This advantage allows larger companies to operate more efficiently and ultimately enhance their profitability.

Furthermore, diversification also plays a significant role in the profitability of large companies. These companies have the ability to spread their risks across different lines of business. By diversifying their operations, they can reduce their exposure to individual risks and mitigate the impact of losses in specific segments. This risk reduction strategy contributes to their overall profitability and financial stability.

On the other hand, our findings indicate that multinational companies tend to have lower profitability compared to local companies. This can be attributed to the multinational companies' lack of local expertise. Local companies, in contrast, possess a deeper understanding of the local market dynamics, customer preferences, and regulatory environment. This local knowledge provides them with a competitive advantage in product development, pricing strategies, and customer service. As a result, local companies are better positioned to meet the specific needs and demands of the local market, leading to higher profitability.

8. Conclusion

The primary objective of this research study is to thoroughly investigate the impact of capital ratios on the risk, efficiency, and profitability of insurance companies operating in Singapore and Thailand. This scholarly inquiry significantly contributes to the existing body of literature by shifting the focus from the banking industry to the insurance industry. By doing so, this study expands the current knowledge base and provides a comprehensive understanding of the intricate relationship between capital ratios and key performance indicators in the insurance context.

The findings of this study shed light on the noteworthy influence of both risk-based and non-risk-based capital ratios on liquidity risk. Remarkably, the results demonstrate that a higher capital ratio corresponds to a lower liquidity risk. This outcome is supported by the notion that a robust financial position allows

insurance companies to effectively manage risks and maintain sufficient cash flow for seamless business operations. By having substantial capital reserves, these companies are better equipped to weather financial uncertainties and ensure the timely settlement of claims, instilling confidence among policyholders and business partners.

Moreover, the study reveals that higher capital ratios are associated with improved efficiency and profitability. The heightened efficiency can be attributed to the increased volume of sales, primarily driven by the trustworthiness instilled in policyholders and business partners due to the insurance company's sound financial strength. Furthermore, insurance companies with ample capital reserves enjoy the advantage of pricing premiums more competitively, without the need to lower premiums excessively to match or surpass their competitors. This strategic advantage bolsters their profitability, as they can generate sustainable revenue streams while maintaining favorable profit margins.

The augmented profitability also stems from factors such as strong brand recognition, a well-established market presence, and enhanced investment capabilities. Insurance companies with higher capital ratios often possess greater financial stability, enabling them to build a reputable brand image and secure a significant market share. Additionally, their robust financial position empowers them to make strategic investments that yield substantial returns, further augmenting their profitability.

This research study provides a comprehensive understanding of the multifaceted relationship between capital ratios and various performance indicators in the insurance industry. It highlights the significant role of capital ratios in mitigating liquidity risk, driving efficiency, and enhancing profitability. These findings offer valuable insights for policymakers, regulators, and industry practitioners, enabling them to make informed decisions and effectively manage the financial health and stability of insurance companies operating in Singapore and Thailand.

Consequently, we can conclude that risk-based capital ratios, which serve as indicators to assess the solvency of insurance companies, not only represent the

risk of insolvency but also reflect liquidity risk, efficiency, and profitability. These results highlight the importance of maintaining adequate capital reserves in the insurance sector to ensure financial stability, minimize liquidity risk, and enhance operational efficiency and profitability. By expanding the understanding of the relationship between capital ratios and various performance metrics, this study provides valuable insights for policymakers, regulators, and industry practitioners in effectively managing and assessing the financial health of insurance companies in Singapore and Thailand.

Furthermore, based on the data from Singapore and Thailand, the differences in the minimum regulatory requirements between the two countries can influence regulators to reconsider the threshold for enhancing the performance of insurance companies. Upon analyzing the various testing models, it becomes evident that Thailand consistently exhibits higher coefficients in terms of risk, efficiency, and profitability metrics compared to Singapore. As a result, despite Singapore setting a lower minimum requirement than Thailand, it still has a similar negative impact on liquidity risk. Moreover, Singapore demonstrates lower levels of efficiency and profitability compared to its Thai counterparts. These findings suggest that the minimum requirement imposed by Singapore may have a detrimental effect on insurance companies, leading to lower efficiency and profitability when compared to Thai insurance companies.

Moreover, it is important to note that this research study specifically concentrates on the capital ratio within the context of the risk-based capital regime. However, it is crucial to acknowledge that the insurance industry employs various regulatory regimes, each with its own distinct features and implications. Therefore, it is imperative to conduct comparative analyses across different regulatory regimes to gain a comprehensive understanding of their respective strengths and weaknesses.

Furthermore, it is worth mentioning that this study primarily relies on accounting data, which may not always be the most current or provide an accurate representation of the underlying figures. To enhance the accuracy and relevance of the findings, it is recommended to incorporate market data

alongside the accounting data. This integration will enable a more holistic assessment of the insurance companies' financial positions.

Additionally, it is advisable to supplement the quantitative analysis with qualitative data, thereby capturing a broader range of insights. Qualitative data can provide valuable context and deeper understanding of the factors influencing the relationship between capital ratios and risk, efficiency, and profitability.

Moreover, to augment the depth of analysis, exploring detailed data breakdowns, such as customer-specific information, can offer valuable insights into specific segments or policyholder behaviors. Additionally, considering additional control variables that are relevant to the dependent variables can enhance the robustness and quality of the study's results.

By incorporating these improvements, such as utilizing market data, including qualitative analysis, and expanding the scope of variables, the research study can yield more comprehensive and accurate findings, thus enhancing its overall value and contribution to the existing literature.

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