EVALUATING THE EFFECT OF FAIR VALUE ACCOUNTING ON FINANCIAL STATEMENT ANALYSIS USING DATA ENVELOPMENT ANALYSIS AND FINANCIAL RATIO ANALYSIS: THE STUDY OF THAI INSURANCE AND BANKING COMPANIES

KEERTIMAN SHARMA

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy (Management)
International College,
National Institute of Development Administration
2023

EVALUATING THE EFFECT OF FAIR VALUE ACCOUNTING ON FINANCIAL STATEMENT ANALYSIS USING DATA ENVELOPMENT ANALYSIS AND FINANCIAL RATIO ANALYSIS: THE STUDY OF THAI INSURANCE AND BANKING COMPANIES

KEERTIMAN SHARMA

International College,

.... Major Advisor
(Assistant Professor Marisa Laokulrach, Ph.D.)

The Examining Committee Approved This Dissertation Submitted in Partial Fulfillment of Requirements for the Degree of Doctor of Philosophy (Management).

.... Committee Chairperson
(Assistant Professor Sid Suntrayuth, Ph.D.)

.... Committee
(Assistant Professor Marisa Laokulrach, Ph.D.)

.... Committee
(Associate Professor Vesarach Aumeboonsuke, Ph.D.)

.... Committee
(Assistant Professor Nopphon Tangjitprom, Ph.D.)

.... Committee
(Zhuoran Zhang, Ph.D.)

ABSTRACT

Title of Dissertation	EVALUATING THE EFFECT OF FAIR VALUE ACCOUNTING ON FINANCIAL STATEMENT ANALYSIS USING DATA ENVELOPMENT ANALYSIS AND FINANCIAL RATIO ANALYSIS: THE STUDY OF THAI INSURANCE AND BANKING COMPANIES
Author	Mr. KEERTIMAN SHARMA
Degree	Doctor of Philosophy (Management)
Year	2023

Historical cost accounting has guided the accounting for assets and liabilities in many countries. It is rooted in the conservatism principle that records the actual cost of a financial item. In contrast, fair value accounting is based on current market values of assets and liabilities. Fair value is an exit price, not an entry price for accounting purpose. Fair value accounting has been adopted for certain assets and liabilities such as available-for-sale securities and derivatives in several jurisdictions due to the harmonization of accounting standards with International Financial Reporting Standards (IFRS) issued by the International Accounting Standards Board (IASB).

There has been a lack of research on determining and evaluating the firm efficiency and financial performance using Data Envelopment Analysis (DEA), based on the two valuation basis, fair value and historical cost, for Thai insurance and banking Public Companies Limited (PCLs). The practical implications of the restatement from historical cost to fair value basis, especially for the Thai insurance and banking sector, remain under-explored. There has also been scarce research on evaluating and comparing fair value based DEA efficiency with Financial Ratio Analysis (FRA) as well as total stock returns of Thai companies. This research endeavors to fill these research gaps. It considers panel data for five financial years (FYs) from FY 2015 to FY 2019 for both Thai insurance and banking companies to help achieve robust findings and conclusions.

The study evaluates the effect of fair value versus historical cost accounting on financial statement analysis of Thai insurance and banking companies using DEA.

DEA, a non-parametric, linear-programming-based technique, has been used to evaluate the relative efficiency of companies. The study evaluates and explores the relationship between fair value based DEA scores and financial ratios. It also provides insights into companies' total stock returns and whether there is a positive relationship between DEA score and total stock returns.

Refinitiv Eikon financial platform, companies' annual reports, DEA software DEAP and SPSS software have been used to collect and analyze the data sets and test the hypotheses. Various statistical methods, techniques and tests employed include descriptive statistics, Kolmogorov-Smirnov test, Wilcoxon signed-rank test, DEA constant-returns-to-scale, Malmquist DEA, simple observation method, simple ranking method, rank normalization method, Spearman's rank correlation, quantile regression analysis and test of significance.

The findings obtained suggest statistically significant changes in many financial items on restatement, along with noticeable changes in companies' efficiency scores and overall rankings. This research reveals positive relationship between the fair value based DEA and FRA. When comparing components of FRA with DEA scores, a positive correlation is observed between profitability performance and DEA scores for insurance companies, as well as between efficiency and risk ratios and DEA scores for banking companies. Furthermore, DEA scores are more predictive of stock returns for the banks but not so for insurance companies.

This study underscores the theoretical debate between fair value and historical cost, and suggests that fair value can be used to complement historical cost. This research will help the organizations, accounting standard setters and economy, by suggesting a better way of financial statement analysis and the use of fair value accounting. It will help managers, analysts and investors in better decision making. It will aid in improving the efficiency and performance of companies and thereby contribute towards the betterment of society's standard of living. Furthermore, the findings reveal that DEA technique can either complement or replace FRA.

ACKNOWLEDGEMENTS

I would like to convey my deep gratitude to the following individuals who have contributed significantly to the success of my PhD research.

At the outset, I want to express sincere thanks to my dissertation advisor and dissertation committee member, Assistant Professor Marisa Laokulrach, Ph.D. for her guidance and encouragement during this process. Her research expertise and insightful suggestions have significantly contributed to my research and academic progress.

Additionally, I appreciate the suggestions and constructive critique provided by the dissertation committee chairperson, Assistant Professor Sid Suntrayuth, Ph.D., committee members Associate Professor Vesarach Aumeboonsuke, Ph.D., Assistant Professor Nopphon Tangjitprom, Ph.D. and Zhuoran Zhang, Ph.D. Their in-depth expertise of accounting and finance has greatly raised the standard of my study.

I sincerely appreciate my father, mother, wife and daughter for their ceaseless motivation and confidence in me. Throughout difficult circumstances, I have been inspired by their compassion and encouragement.

I would also like to thank my friends and colleagues, especially Asst. Dean Kristian Luciani at Stamford International University, Bangkok who encouraged me to complete Ph.D. successfully. This journey has been made more pleasant by his companionship and kind words.

KEERTIMAN SHARMA

January 2024

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION

1.1 Research Background

Financial statements are documented records that convey an organization's financial performance to its stakeholders, including shareholders, prospective investors, lenders, government entities, etc. They provide a collection of data about a company's business activities, its financial health, profitability, and cash flows during a financial year. Financial statements include statements of financial position (balance sheet), of profit or loss and other comprehensive income, of changes in equity, of cash flows and notes to financial statements.

A statement of financial position or balance sheet reflects an organization's financial position at a certain date. This statement shows the assets, liabilities and equity of an organization. Assets are the resources owned or controlled by a firm and that have expected future benefits; for example, cash, receivables, machinery, merchandise inventory etc. Liabilities are the claims by creditors against the assets of a company; in other words, liabilities are the obligations of an organization to transfer assets or provide products or services to other entities in the future. Simply stated, liabilities are the money that a company owes to others, including long term loans, accounts payable, corporate taxes payable, etc. Equity is the claims of owners or shareholders on the assets of a firm. An accounting equation states that the assets are equal to liabilities plus equity.

A statement of profit or loss and other comprehensive income or income statements contain information about a company's revenues and expenses and help determine its income or loss for an accounting period. An accounting period is typically a year, six months, or three months. A statement of changes in equity explains the changes made to owners' equity through investments made by the owners, income or loss made by an organization and any dividends declared or paid to shareholders for an accounting period.

A statement of cash flows identifies the cash inflows or receipts and cash outflows or payments of a firm during a period of time. Notes to financial statements are supplemental notes that contain information about a company's assumptions and accounting policies used to prepare the financial statements. They help users interpret the numbers in the financial statements.

Historical cost basis has guided accounting for assets and liabilities in many countries; it indicates the accounting information is based on actual cost. The Framework of International Accounting Standards Board (IASB) defines historical cost as follows:

> The historical cost of an asset when it is acquired or created is the value of the costs incurred in acquiring or creating the asset, comprising the consideration paid to acquire or create the asset plus transaction costs. The historical cost of a liability when it is incurred or taken on is the value of the consideration received to incur or take on the liability minus transaction costs (International Accounting Standards Board, 2018, p. A62).

For instance, if a building is purchased for $1,000,000, it will be recorded at $1,000,000 now and in the future even if the market value of the building changes. However, in line with accounting standards, historical costs require some adjustment with time. Depreciation expense is recorded in each accounting period for long-term assets, which reduces their original value over their estimated useful lives. Historical costs are normally perceived as more reliable.

In contrast, fair value accounting (FVA) provides more relevant information to the stakeholders, such as prospective investors, shareholders, creditors and managers. Fair value is the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date or an estimated value when it is difficult to determine the current price (IASB, 2013). This means that fair value is an exit price, not an entry price, for accounting purposes. In FVA, financial instruments, such as available-for-sale securities (AFS), are measured at fair value on the balance sheet of a financial institution. The changes in fair value of such financial instruments are generally reported in other comprehensive income (OCI) or equity. However, if there is an impairment, such a change (an impairment loss) is recognized in the income statement. Impairment refers to a decline in the fair value of an asset below its present book value that is expected to be permanent in nature.

The following discussion will deal with fair value and historical costs and the importance of FVA in financial statement analysis. The reasons for studying FVA in this research are also discussed.

The use of FVA is attaining acceptance, as more countries are harmonizing their accounting standards with the International Financial Reporting Standards (IFRS) prepared by International Accounting Standards Board (IASB). Fair value estimates of investment securities provide significant explanatory power beyond that provided by historical costs. Strikingly, historical costs provide no significant explanatory power incremental to fair values (Barth, 1994). Explanatory power refers to the extent of the positive relationship between the valuation basis (either fair value or historical cost) and the market capitalization and profitability of a firm. This explanatory power provides users information to make right decisions, including investing in a firm. In other words, a higher or more significant explanatory power would mean that one valuation basis (either historical or fair value) is more positively related to a firm's market capitalization and profitability than the other. Historical cost requires partial and less regular updating of variables as opposed to fair value, which requires frequent updating. The typical updating of historical cost uses the depreciation method of accounting to depreciate Property, Plant and Equipment (PPE). Depreciation is the process of allocating the cost of an item of property, plant and equipment as an expense in the accounting period when the organization benefitted from its use. FVA is more relevant for assets that are actively traded and assets or liabilities whose value is likely to change frequently, even if they are not actively traded. For example, the fair value of available-for-sale (AFS) securities may change from year to year.

FVA is important for accounting standard setting purposes. It provides a higher degree of transparency to the financial information. It should lead to a higher value relevance of financial information and allow financial markets to reflect the actual value of an organization (Palea, 2014). Palea (2014) also suggested that the use of FVA should increase the quantity of private information brought into the public domain, thereby leading to efficient resource allocation and capital formation. Both IASB and TFAC, Thailand (Thai Federation of Accounting Professions) have issued standards that mandate, recommend or permit the use of FVA in disclosing or recognizing of financial statement items. Buachoom (2022) mentioned that in Thailand, listed companies use FVA and corporate governance (CG) performance rankings to ensure that publicly disclosed information faithfully represents the correct value of assets and liabilities and provides insights into future economic prospects of a listed firm. Use of FVA will, therefore, make publicly disclosed information more relevant and faithfully represent economic realities. Fair value is specifically relevant to financial instruments. IFRS 13 fair value measurement (its equivalent is TFRS 13) provides a single framework for measuring fair value while IFRS 9 financial instruments (its equivalent is TFRS 9) extends the use of fair value for financial instruments. Changes in asset or liability values over time generate unrealized gains or losses for assets held and liabilities outstanding, increasing or reducing net income, as well as equity, on the balance sheet.

The Securities Exchange Commission (SEC), Thailand, in cooperation with TFAC (Thai Federation of Accounting Professions), has gradually revised all Thai accounting standards to be in line with IFRS and mandated listed firms to apply FVA to their assets and liabilities (Buachoom, 2022). Buachoom (2022) also noted that it has been almost a decade since the application of FVA has been required for Thai listed firms. Thai financial companies state some financial information at fair value, including available-for-sale investments. Available-for-sale investments in Thailand generally include government and state enterprise securities, private enterprises debt securities, foreign debt securities, domestic equity securities and foreign equity securities. The cost of these investments is disclosed in the notes to the financial statements. Investments in held-to-maturity investments are recorded at the amortized cost. In other words, held-to-maturity investments are recorded at historical cost. When held-to-maturity investments are recorded at the amortized cost, they are initially recorded at their acquisition price, which aligns with the principles of historical cost. The subsequent adjustments made to the historical cost such, as amortizing the premium or discounts or accruing the interest income, are based on the original transaction and the passage of time. To explain this concept in a simple way, it can be considered as resembling accounting for noncurrent assets, such as machinery. Machinery is initially recognized when it is purchased at its acquisition price (historical cost). Then, depreciation is charged yearly based on a method, such as straight line, which reduces the value of machinery over time and the machinery is recorded at the end of each year after deducting the accumulated depreciation from the original cost. The fair value of held-to-maturity investments is normally disclosed in the notes to the financial statements. Held-to-maturity securities are securities that a firm intends to hold until the maturity date. They are noncurrent assets. Held-to-maturity-investments in Thailand generally include government and state enterprise securities, private enterprise debt securities, foreign debt securities and deposits at financial institutions. Available-for-sale investments and held-to-maturity securities comprise a considerable portion of Thai finance companies' assets. Trade receivables are initially recognized at their fair value. Trading investments, interest rate swaps contracts and foreign exchange contracts are also measured at fair value. Financial liabilities, such as cross currency and interest rate swap contracts, are recognized at fair value. In notes to the financial statements, a comparison between fair values and the carrying amounts of some financial instruments, such as available-for-sale investments, is disclosed, so users can comprehend the differences and make suitable decisions. Globally, companies continue to use FVA extensively in accounts concerning financial assets, goodwill impairment testing, derivatives and hedges and employee stock options.

The two distinct characteristics of financial reporting are 'reliability' and 'relevance'. These are the two primary qualities that accounting information should have for decision-making; that is, for accounting information to be useful, it should be reliable and relevant. Accounting information may possess both these characteristics to varying degrees. For some scholars, reliability refers to correct information, while for others it conveys verifiability. It refers to the quality of information that is free from errors and faithfully represents what it ought to represent. Financial information must have relevance, i.e., it should be capable of making a difference in the decisions made by users and help in predicting the outcome of past, present or future events or to confirm expectations. Johnson (2005) suggested that the U.S. Financial Accounting Standards Board (FASB) preferred loss of reliability to greater emphasis on relevance of accounting information.

It is believed that historical cost provides 'reliable' information to investors and stakeholders while FVA provides 'relevant' information. Globally, accounting practitioners had long advocated ‘reliability’ over ‘relevance’. However, the last few decades have seen significant changes in business, such as greater use of complex financial products and intangibles. This has led to a perceptible shift in favor of the ‘relevance’ of financial reporting to investors and other stakeholders (Eckstein, 2004). While reliably recording historical cost lends credence to the verifiability of past performance of a firm, it does not provide stakeholders, such as shareholders and debt holders, with relevant information for predicting a firm’s expected future performance.

A firm’s expected future performance, specifically its firm value, is also important to the shareholders and prospective investors. If it is based on FVA, this value may be more relevant to the interested parties. The business world will always require managers to improve firm performance. To do that, they should value the firm appropriately, among other things, which will help improve firm performance.

1.2 International Accounting Body and Standards relevant to Fair Value Accounting

The IASB is a global, independent and private organization that issues the IFRSs, and it previously issued the International Accounting Standards (IAS). It operates under the oversight of the IFRS foundation. It is headquartered in London, UK. There are 42 IFRS and IAS standards issued by the IASB, which provide standards and guidance to corporations worldwide. There are also interpretations of some of these standards issued by IASB to provide a clear and detailed account of complex accounting matters. IFRSs are now required in more than 140 jurisdictions, with many others permit their use. The IASB has also issued IFRSs for small- and medium-sized entities (SMEs) and expanded its board to 16 members in 2009.

IFRS 13, IAS 39 and IFRS 9 are the standards that will be referred to in this research, as they pertain to FVA and financial instruments, respectively, and are relevant to this research. IFRS 13 Fair Value Measurement is an accounting standard on fair value measurement prepared by the IASB. It defines fair value and how to estimate it. It provides guidance to corporations on fair value disclosures on assets and liabilities. This standard applies when another standard requires measuring an item at its fair value or requires a company to disclose fair value of an item. There are three levels for determining the fair value of a financial item. Level 1 inputs have the highest priority in hierarchy while Level 3 inputs have the lowest. Level 1 is the fair value determination using quoted prices of identical assets or liabilities in an active market at the measurement date. Level 2 inputs refer to observable information of similar assets or liabilities in an active or inactive market. Level 3 inputs can be used for determining fair values when Level 1 and 2 inputs are not available. They are unobservable inputs used because either markets do not exist or they are illiquid, such as in case of a financial crisis.

IAS 39 Financial Instruments: Recognition and Measurement establishes principles for recognizing and measuring financial assets, financial liabilities and some contracts to buy or sell nonfinancial items. It also prescribes principles for derecognizing financial instruments and for hedge accounting. A financial instrument is recognized in financial statements when the company becomes a party to a financial instrument contract. A company removes a financial liability from its statement of financial position when its obligation is extinguished. It removes a financial asset from its statement of financial position when its contractual rights to the asset’s cash flows expire on transferring the asset. A financial asset or financial liability is measured initially at fair value. Subsequent measurement depends on the category of financial instrument. Some categories are measured at the amortized cost while others are measured at fair value. Held to maturity investments, loans and receivables and financial liabilities that are not carried at fair value through profit or loss (FVTPL) are measured at the amortized cost. Financial assets and financial liabilities held for trading and available for sale financial assets are measured at fair value.

IAS 39 has largely been superseded by IFRS 9 Financial Instruments. In Thailand, the effective date of implementation of IFRS 9 is from 1 January 2020. IFRS 9 financial instruments sets the requirements for the recognition and measurement of various financial instruments. It also includes impairment, derecognition and general hedge accounting. According to this standard, all financial instruments are initially measured at fair value. Transactions costs directly related to acquisition or issue are also considered for financial assets or financial liabilities that are not classified as at FVTPL.

Financial assets with contractual terms that give rise to cash flows from interest on principal amount and payments of principal on specified dates are classified according to the objective of the organization's business model. If the objective is to hold such assets to collect the contractual cash flows, then they are measured at the amortized historical cost, unless the firm decides to measure them at fair value. If the objective of the firm is to collect the contractual flows as well as sell financial assets, they should be measured at fair value through other comprehensive income (FVTOCI). At the time of disposal, such assets are reclassified as profit or loss. All other financial assets should be measured at FVTPL.

Financial liabilities held for trading are measured at FVTPL. All other financial liabilities are generally measured at the amortized historical cost unless the company decides to apply the fair value option. The fair value option can be exercised if the firm determines that it will eliminate or reduce an accounting mismatch or the firm manages a group of financial instruments on fair value basis.

1.3 Statement of the Problem

Historical cost has been used by several organizations as it is considered a reliable method of recognizing financial items; however, FVA is gaining momentum due to revisions of the IFRSs and the stakeholders' preference for relevance in accounting information. The chairman of the IASB, Hoogervorst (2015), mentioned that historical cost updates are less frequent and less comprehensive, which may lead to problems in the balance sheet going unnoticed for a long time. This may lead to damaging consequences, such as misleading results in financial statement analysis. When the problems are noticed later, it may be too little too late. The stability of historical costs may be affected adversely because of this reason, which may jeopardize stakeholder decision-making by investors and shareholders in the company. Historical cost is not free from subjective adjustments (Hoogervorst, 2015) and is vulnerable to abuse as well. Manea (2013) mentioned that historical cost accounting ignores economic factors, such as inflation and evolution of purchasing power. The author mentioned that this accounting basis was needed by postwar industrial enterprises but should no longer be needed in modern times. Manea (2013) emphasized that value creation, financial instruments and swaps are the new economic reality. Therefore, the author has suggested that FVA should be a preferred alternative, as it takes into consideration the present economic realities, some of which have been mentioned in the discussion above. Zamel, Behery and Hefny (2020) gave credence to this Manea's (2013) assertion and suggested that historical-cost financial statements prepared under inflationary conditions could be misleading. The authors further stated that inflation impairs the financial accounting role in decision-making. In other words, it t becomes imperative to adjust the historical cost basis to reflect current economic realities. FVA is considered more updated and recent when compared to the historical cost. The IASB officially introduced fair value reporting as an alternative approach to historical cost accounting (HCA) in the 1970s (Shanklin et al., 2011), primarily to provide a more relevant perspective to accounting information.

Historical cost provides ‘reliable’ information to investors and stakeholders whereas FVA provides ‘relevant’ information. In the past few decades, the ‘relevance’ of financial information has been ‘favored’ over reliability. Therefore, the pertinent question arises about whether analyzing financial statements based on fair value instead of historical costs is more meaningful and beneficial to investors and other stakeholders. Most global studies in the past have been unable to provide a specific solution if the purported advantages of FVA over historical cost accounting can help the stakeholders in altering their insights into financial statements. The present research has been motivated by this problem to bring greater clarity to these issues and provide a realistic solution.

Traditionally, financial ratio analysis (FRA) has been widely used by research scholars as a tool of financial statement analysis. Financial ratios are used to analyze and compare the accounts or financial items on financial statements to arrive at conclusions pertaining to a company’s efficiency and financial health. Armen (2013) suggested that the traditional ratios used for evaluating the risk and profitability of an enterprise are insufficient to reveal its full state-of-affairs. The reason is that although financial ratios are easy to compute, their interpretation is subjective and challenging. For instance, there is a possibility that two different ratios may provide conflicting conclusions. Another drawback is that financial ratios take into account only one resource to one output at a time. Yu et al. (2014) suggested that ratio analysis has failed in efficiency assessment of firms because it cannot simultaneously consider multiple inputs and outputs. Thanassoulis et al. (1996) suggested that ratio analysis, unlike data envelopment analysis (DEA), is not suitable in setting targets; thus, it will not help much to improve the efficiency of the organizations.

On the other hand, DEA can also be used as a tool of financial statement analysis. It involves relating simultaneous resources to multiple outputs in assessing the performance of a firm and is suitable in setting the targets. It is a typical nonparametric method for measuring the relative performance of organizational units with the presence of multiple inputs and outputs, using linear programming. Thanassoulis et al. (1996) and Berger and Humphrey (1997) suggested that DEA might be better for conducting traditional financial ratios analysis or at least complement it. The main reason for this is that DEA avoids the problems of parametric methods, such as the difficulty in determining the functional form of ratios. This information is not provided by ratio analysis. Another reason is that it can help in setting the targets so that inefficient units can become more efficient. However, its use in financial statement analysis has been comparatively limited so far. Julnes (2000) proposed that DEA can be used as an alternative tool by the public sector enterprises and considers it as a more appropriate tool of financial analysis vis-à-vis Financial Ratios. One of the main reasons mentioned by Julnes (2000) for its aptness is that it indicates which companies or decision-making units (DMUs) are inefficient and the amount of resource savings and/or output augmentation they should achieve to meet the level of the best-in-class company or DMU. While ratio takes into account only one resource to one output at a time, DEA involves relating simultaneous resources to multiple outputs in assessing the performance of a firm.

This dissertation explores whether there will be major impact on the face of financial statements in the Thai insurance public companies limited (PCL) and Thai banking PCL, if there is a modification from historical cost to FVA. Furthermore, it addresses the degree to which the users' insight into the company's efficiency and profitability will be altered using DEA analysis. It will then compare and evaluate the FRA results of these companies and the relationship between the FRA and fair-value-based DEA scores. It will also provide insights into firms' stock returns and whether they have a relationship with the fair-value-based DEA scores. Some global studies in the past have been unable to provide a specific solution to whether the supposed advantages of FVA can help the stakeholders in altering their insight of the financial statements. On the other hand, some studies also suggest that users' insights into financial statements can change with the use of FVA. Khurana and Kim (2003) suggested that they were unable to identify any apparent difference in the informativeness or quality of financial information of fair value measures relative to the historical costs for a sample of United States (U.S.) bank holding companies (BHC) from the period 1995–1998. On the other hand, Harris and Ohlson (1987) and Barth (1994) suggested that, compared to historical cost, the fair value of assets explained the market value of companies and profitability significantly better. Harris and Ohlson (1987) had conducted this research on U.S. oil and gas companies while Barth (1994) researched a sample of U.S. banks.

There has been lack of studies on how to enhance firm efficiency using the DEA technique pertaining to the Thai financial industry. There is also a dearth of research on the relationship between the present efficiency of companies i.e., DEA based on fair values and the results derived from FRA. There has been a lack of research that evaluates and compares the DEA scores of firms based on fair value with their stock returns. The present research endeavors to fill this research gap.

This research will be carried out for Thai insurance and banking companies because there has been little research using the DEA model to analyze financial statements of these companies. Furthermore, the insurance and banking companies have substantially more financial investments whose fair value and historical information is readily available, which can help in comparison and financial statement analysis. Therefore, it will help in undertaking DEA analysis for efficiency and stock return analysis for company performance and relationship with the firm's efficiency.

For the purpose of this research, Thai insurance and banking together are also referred to as ‘Thai financial companies’ or the ‘Thai financial sector’.

1.4 Research Questions

The research questions of this dissertation are as follows:

1) What will be the change in selected financial items when there is a change from historical cost to FVA for Thai insurance and banking companies? The selected financial items are total expenses, available-for-sale investments, held-to-maturity investments and general (other) investments-net as input variables and total comprehensive income as an output variable in the DEA model. The study will analyze the changes in available-for-sale investments, held-to-maturity investments, and general (other) investments-net, resulting from the transition from a historical cost to a fair value basis.

2) Will the company’s analysis of its efficiency and profitability be altered when FVA is used instead of historical costs?

3) Will the change from historical cost to FVA lead users and analysts to rank a company different from other companies in the financial sector?

4) Will the comparison of FRA results of financial companies with that of the fair-value-based DEA scores reveal a positive relationship?

5) Is there a relationship between the company’s efficiency using the fair-value-based DEA score with its stock’s return?

1.5 Objectives of the Study

The main objective of this research is to evaluate whether the change to fair value from the historical cost basis will affect the financial statement analysis of Thai insurance and banking companies. The research examines the extent to which efficiency and profitability change as reflected through financial statements of these companies. If the two valuation methods (fair value and historical cost) convey different financial information, then the users' interpretation of a company's performance and efficiency will be different based on the method the company use.s The point here is to analyze whether FVA instead of historical costs lead users to position a company different from its competitors. Fair value may provide more relevant financial information to stakeholders, such as investors and creditors, although historical cost is typically perceived as more reliable (Barth & Clinch, 1998; Dietrich et al., 2000; Carroll et al., 2003; Kanagaretnam et al., 2009; Wier 2009).

Ratio analysis is often used for financial statement analysis. It is a useful tool, providing information on the performance of a company on a specific aspect or aspects, such as liquidity or profitability. DEA can provide better results by considering more factors, both input variables and output variables, and can enhance the analysis of financial statements. It may be a preferred technique for public decision-making under the right circumstances (Julnes, 2000) as it is a more appropriate tool for financial analysis than the commonly used techniques, such as ratio and regression analysis. DEA has been used in financial statement analysis in the past. Kaffash and Marra (2017) studied the financial services sector—banking, insurance and money market funds—and mentioned that DEA was successfully employed for analyzing the efficiency of firms in this sector. The authors examined 620 papers published in the journals indexed in the Web of Science database from 1985 to April 2016 that applied the DEA methods. Based on this analysis, Kaffash and Marra (2017) suggested that although no unique methodological preferences emerged from these different papers, the use of new methods in the DEA, such as slack-based and network models, evidently lead the recent research. The authors comment that its theoretical use in the financial sector has served as an example to demonstrate the numerical results of the new techniques. Geographical analysis of the papers showed that the banking sector is the most studied sector using DEA methods, particularly in the U.S., China, Taiwan, Japan, and Arab countries.

For the purpose of financial statement analysis in this research, DEA has been used. Before the DEA analysis is applied, a set of peer units, DMUs, are chosen. DMUs are the units under evaluation for the purpose of benchmarking. DEA Analysis has been performed on financial statement items commonly used in a DuPont analysis (equity multiplier, asset-turnover and profit margin ratios) and the results of fair value have been compared with the historical cost for the same sample of Thai companies.

The research will also compare and evaluate the fair-value-based DEA scores (efficiency scores) with that of the FRA results to know whether the latter technique (FRA), which is conventional, brings out a positive relationship with the former or not. It will help to know if a relationship exists between the two. The research will also explore the relationship of firm's efficiency using fair-value-based DEA score with its stock returns to assist in the investor decision-making. Carroll et al. 2003 mentioned that even after controlling for the historical costs, there was a significant association between stock prices and fair value securities gains and losses of the closed-held U.S. mutual funds.

Based on the discussion, the objectives of this study are as follows:

1) Evaluate the change, if any, in financial statements items of Thai insurance companies and Thai banking companies when the basis is changed from historical cost to FVA.

2) Analyze and interpret the degree to which users' insight into the company's efficiency and profitability will be altered on restatement to fair value basis and therefore how it will lead them (users) to position a company different from its competitors. This analysis and interpretation will be done using DEA, a nonparametric linear programming based technique.

3) Benchmark the companies, and compare the less efficient companies with the benchmark.

4) Compare and analyze the FRA results of the companies under consideration with that of the fair-value-based DEA scores.

5) Explore the relationship of company's efficiency using fair-value-based DEA score with its stock's return.

1.6 Contribution of the study

This research will help the economy, organizations and people by suggesting a better way of financial statement analysis. It will help managers, analysts and investors in better decision-making, improve efficiency of the companies and thereby contribute toward the improvement of the standard of living of society.

1.6.1 Practical contribution

Investors, both individual and institutional, and company management are interested in safety and higher return on firm's investments. The investors seek to compare financial statements of the companies within a region and transnationally also. The stakes are high particularly for institutional investors, such as mutual fund companies, insurance and banking companies as they have a large amount of funds that must be invested with purpose. This research will help investors make sound financial decisions based on the analysis of financial statements.

The research will contribute toward the policy making in the area of accounting and finance. This will help the global organizations, such as the IASB and International Federation of Accountants (IFAC) as well as national accounting bodies and standard setters, such as the Federation of Accounting Professions (FAP) in Thailand in formulating better policies and standards toward the fair value measurement for financial items for companies, particularly insurance and banking companies. More effective financial statements and analysis will be made possible through this.

Financial statement analysts and preparers of financial information i.e., accounting departments, will gain an understanding of the value of financial items and relevance of fair values better. This research will also help them evaluate firms' stock returns with firm efficiency based on fair value.

There has been a controversy for the past few decades with regard to the relevance and benefits of FVA vis-vis historical cost basis, as has been addressed in the previous sections. For instance, Jarolim and Oppinger (2012) suggested that fair value measurement in banking sector led to high price estimates and high assessments during boom but more pessimistic earning expectations during the downturn. This research will provide practical insights for company management, investors, accounting department, regulators and analysts about the relevance of FVA and financial statement analysis.

An analysis of financial statements by considering both these valuation bases (historical cost and fair value) and using DEA will help analysts, preparers and investors make sound financial decisions, understanding the relevance of FVA better and analyzing the effectiveness of DEA. In this research, it will be analyzed whether DEA technique can complement or even be used instead of the traditional financial ratio, helping investors make better investment decisions and managers make sound managerial decisions.

1.6.2 Academic contribution

This study will analyze two valuation methods, historical cost and FVA, and their effect on efficiency and performance of firms through DEA and FRA. This interdisciplinary approach is novel and, therefore, the research design itself is a contribution of this study.

This research will provide an in-depth evaluation of two important sectors of the Thai financial industry, namely insurance and banking, and offer a pertinent understanding of the effect of accounting valuation methods on the efficiency and financial performance of each sector. Rodríguez-Pérez et al. (2011) found that only in the case of a few Spanish insurance companies did the DEA scores change when fair value was used instead of historical cost. These findings suggest that the change in valuation basis from historical cost to fair value may alter the efficiency and profitability of only a few companies without affecting most of them. This study will enhance the existing body of knowledge by evaluating the Thai financial sector.

Furthermore, this study will endeavor to relate the fair-value-based DEA scores with FRA and stock returns and will be vital to the academic discourse, providing insights into potential linkages between them. Feroz et al. (2003) applied DEA to the U.S. oil and gas industry and concluded that DEA can be used effectively to complement the ratio analysis and can provide additional information. Kirkwood and Nahm (2006) suggested that the efficiency of Australian banks based on DEA scores was reflected in their stock price.

This research contributes toward the FVA area, which has been focused more by the IASB in the last two decades. IFRS 13 has been revised and its value in financial accounting and financial statement analysis has been emphasized. This research will contribute toward the efficacy of IFRS standards. This will be made possible through restating financial statements based on fair value and evaluating the effect on financial statement analysis and how tusers will benefit from it.

1.7 Scope of the Study

This study has been carried out on insurance and banking companies (together called financial companies in this study). The rationale behind undertaking this research on these companies is that they have considerable a proportion of financial investments, which are likely to reveal significant deviation between their fair value and historical cost measures. Therefore, the effects on financial statements based on fair value will be contrasted with that of the historical cost basis, providing insights into the performance and efficiency of companies. Rodríguez-Pérez et al. (2011) mentioned that the historical cost and fair value can be compared better on tangible and financial investments of Spanish insurance companies. Such assets reflected significant differences between the historical and fair value basis. Another reason for undertaking research on these financial companies is that the fair value and historical cost based valuations for different assets, particularly those used in this research, are available for this industry or sector.

Furthermore, the Thai financial sector forms a significant portion of Thailand's economy. It contributed nearly 1.27 trillion Thai Baht (THB) toward the Gross Domestic Product (GDP) in Thailand in the year 2019. The contribution of this sector to Thailand GDP in 2015, 2016, 2017 and 2018 was nearly 1.04 trillion THB, 1.12 trillion THB, 1.18 trillion THB and 1.24 trillion THB respectively. One hundred and sixty (160) fintech companies (financial technology) have been registered as of 2019 in Thailand, which will further boost this sector. It will be intriguing to undertake a financial statement analysis of this sector to understand more about its efficiency and performance. The adoption of IFRS in Thailand has had a pronounced effect on the Thai insurance sector especially given its significant financial investments. Despite these intricate characteristics, there has been a notable gap in the academic literature exploring the interplay of FVA and HCA within this context.

If financial statements of financial companies are prepared based on FVA, the accounting numbers will change in contrast to their preparation based on historical costs. It may also have effect on analysis of the financial statements. According to

Sharma (2018), this could alter the decision-making of analysts and stakeholders in the companies in which they may be planning to invest.

For this purpose, a nonparametric, linear programming-based technique called DEA has been used in this research. This techniques aids in turning any number of variables into one overall score, relative to best-in-class observations. Before the DEA analysis is applied, a set of peer units, called DMUs, are chosen. DMUs are the units under evaluation for benchmarking. In this research, DEA is performed on financial statement items commonly used in a DuPont analysis (equity multiplier, asset-turnover and profit margin ratios) and the results of fair value have been compared with the historical cost for the same sample of Thai companies. While ratios take into account only one resource to one output at a time, DEA involves relating simultaneous resources to multiple outputs in assessing firm performance. It has been suggested by some authors in the management-science and operations-research literature, such as Thanassoulis et al. (1996), Berger and Humphrey (1997) and Feroz et al. (2003), that DEA might be better than traditional financial ratios analysis or at least complement it.

The study will also determine if there is any link between the FRA and the fair-value-based DEA efficiency scores of the firms. Therefore, the important financial ratios such as return on equity (ROE), return on assets (ROA), total asset turnover, and the leverage ratio of all the firms under study will be considered. These ratios will be discussed in detail in chapter 3, review of relevant literature.

Total stock returns or total return (TR) of these firms will also be determined and evaluated with their fair-value-based DEA efficiency scores to know whether any relationship exists between the two. TR is a popular technique related to determining the stock returns of a company. Barth (1994) from Harvard University investigated how the fair value estimates of investment securities and their realized securities gains or losses are reflected in their share prices when compared to the historical costs. The author suggested that investment securities in the banking sector provide prospects of evaluating the fair value and historical cost measurements. The author also mentioned that the fair values of the securities gains and losses are calculable for banks.

1.8 Definition of Terms

1) Fair value: It relates to the price that would be paid to transfer a liability or price received to sell an asset in an orderly transaction at arm's length between market participants or an estimated value when it is difficult to determine the current price (IASB, 2013).

2) Historical cost: The Framework of International Accounting Standards Board (IASB) defines historical cost as "A measurement basis according to which assets are recorded at the amount of cash or cash equivalents paid or the fair value of the consideration given to acquire them at the time of their acquisition. Liabilities are recorded at the amount of proceeds received in exchange for the obligation, or in some circumstances (for example, income taxes), at the amounts of cash or cash equivalents expected to be paid to satisfy the liability in the normal course of business."

3) Financial Statement Analysis: An analysis of a firm's financial information using techniques, such as financial ratio analysis, common-size financial statements, DEA, etc., to aid users in decision-making. It helps in assessing a firm's financial performance and position.

4) Financial Ratio Analysis (FRA): Relationships determined from a firm's financial information and used for comparison purposes between companies or through time.

5) Data Envelopment Analysis (DEA): It is a nonparametric, linear-programming-based technique that turns any number of variables into one overall score, relative to best-in-class observations (Rodríguez-Pérez et al., 2011).

6) Malmquist DEA: Malmquist DEA (M DEA) is a DEA method. It represents the total factor productivity (TFP) growth over time by comparing the productivity change of decision-making units.

7) Technical efficiency (TE) in DEA: Technical efficiency is the ability of a firm to reduce the inputs by holding the outputs constant or increase the outputs by holding the inputs constant. In other words, TE refers to how well a firm utilizes its resources (inputs) to produce output/s, given the existing technology.

8) TR: Measures the market performance of a stock through both the stock price movement and dividend payment.

9) Firm efficiency: It refers to optimal utilization of a firm's resources to produce required or more amount of output/s.

10) DEAP: DEA software developed by The University of New England, Australia, which helps in efficiency analysis of firms.

11) Kolmogorov-Smirnov (KS) test: This test is a nonparametric goodness-of-fit test. It is used to compare a sample or two samples with a reference probability distribution.

12) Rank normalization method: It is a nonparametric method that can transform raw data into a ranked scale. It is a way of normalizing data and in the context of financial ratios, it can generate cumulative score (rank) by adding the computed rank of each ratio of a firm. Likewise, a cumulative score can be obtained of other firms.

13) Quantile regression: It is a type of regression analysis that estimates the conditional median or other quantiles of the dependent variable. It examines the effect of independent variable/s on the various quantiles of the dependent variable's distribution.

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

2.1 Financial Statements

Financial statements are prepared to express the financial performance of an entity for a particular accounting period and its financial position at the end of accounting period. Lessambo (2018) stated that the main purpose of preparing financial statements is to provide information about a company's financial position to its external users, such as investors and creditors.

IAS 1 (International Accounting Standards 1) issued by the IASB states that a complete set of financial statements includes the following:

1) Statement of profit or loss and other comprehensive income

2) Statement of changes in equity

3) Statement of financial position

4) Statement of cash flows

5) Notes to the financial statements

An entity may use different titles for the statements. For instance, the title balance sheet is traditionally used instead of statement of financial position.

A statement of profit or loss and other comprehensive income is also referred to as an income statement or statement of income and expense. Lessambo (2018) mentioned that this statement summarizes the results of an entity's operations for a specific period. It includes revenues, expenses, gains, losses, net profits, and earning per share. Other comprehensive income refers to additional income that may not be a direct result of an entity's operations, including gains or losses from foreign currency translations from the changes in fair value of an available-for-sale investments and other accounts.

Wild and Shaw (2019) observed that statement of changes in equity or the statement of owner's equity reports how the equity changes over the reporting period. This statement reflects the beginning capital, events that increase it, such as investments made by the owner, and net profit and events that decrease it, such as withdrawals and net loss, to arrive at the ending capital. This ending capital is carried over and reported in the statement of financial position.

A statement of financial position shows an entity's financial position at the close of business on December 31 (Wild & Shaw, 2019). December 31 is the end of the accounting year of a company, although an entity's accounting year may end on another day also, such as June 30. A statement of financial position can be prepared in account form or report form. In account form, the left side of the statement of financial position shows all the assets, such as accounts receivables, cash, and machinery. Its right side shows the liabilities, such as accounts payable, bank loan, and wages payable followed by the equity balance. Another way of representing this statement is in report form, with assets on top, followed by liabilities and then equity at the bottom. The accounting equation will always balance according to the following equation: assets = liabilities + equity.

A statement of cash flows shows information on how a company obtains its cash, how it spends it and what explains the change in the cash balance from the beginning to the end of an accounting year. According to Williams et al. (2018), this statement classifies the different cash flows into three activities—operating, investing and financing activities—and relates them with the beginning and ending cash balances. Williams et al. (2018) explained these activities as well. The author stated that the cash effects of revenue and expense transactions included in the income statement are referred to as the cash flows from operating activities. Cash flows from investing activities are the cash effects of the purchase and sale of assets or investments, such as land and buildings. Cash flows from financing activities are the cash effects of investments made by the company owners or loans provided by creditors to the company. Financing activities also include dividends paid to shareholders or the interest paid and repayments made to the creditors.

Williams et al. (2018) explained that a set of financial statements is usually accompanied by several notes known as notes to the financial statements. Such notes provide useful information to interpret a financial statement and can include accounting policies and methods, unused lines of credit, current or fair values of financial instruments, if they are different from the carrying amount shown in financial statements and material disclosures. Users, such as investors and creditors, should view these notes as an integral part of the financial statements.

2.2 Fair Value vs. Historical Costs (in Financial Statement Analysis)

FVA is based on current market values to recognize certain assets and liabilities (Chea, 2011). The prices offered in an active market are considered for determining an ideal fair value of these assets and liabilities. An active market will normally have a large number of arm’s length transactions. As stated earlier, fair value relates to the price that would be paid to transfer a liability or price received to sell an asset in an orderly transaction at arm’s length between the market participants or an estimated value when it is difficult to determine the current price (IASB, 2013). This price should be reported at the measurement date. On the other hand, the Historical Cost Accounting (HCA) requires that most liabilities and assets should be measured and reported at their acquisition price i.e., historical price (Rahmawati, 2006). Rahmawati (2006) further stated that, although there are weaknesses in HCA, there are more benefits that can be gained from its use.

Christensen and Nikolaev (2009) suggested that historical cost dominates the fair value in practice except for investment property used by real estate companies. If the companies can choose between the historical cost and fair value, most prefer historical cost accounting for property, plant and equipment. Companies that use FVA rely more on debt financing than the companies that use historical cost.

The relevance of historical cost accounting has been a subject of debate, particularly in the last two decades. The scholars, practitioners and accountants have advocated different views based on their knowledge and experience. The controversy seems far from over with some accounting bodies steadily shifting toward fair value basis of accounting. Barth (1994) suggested that in the banking industry, the fair value estimates of investment securities provide better explanatory power than the historical cost basis and that the historical cost basis does not provide an explanatory power incremental to fair values. However, fair value gains and losses of these investment securities of the banks did not have any significant explanatory power, but historical costs provided explanatory power incremental to fair values (Barth, 1994). That is an interesting analysis because, while fair values reflect significant explanatory power, the gains and losses on them do not. Ellul et. al (2015) mentioned that the trading incentives through interplay between HCA and capital regulations give rise to distortions in key regulatory metrics and may cause shocks in other financial markets. HCA can lead to inefficiencies; thus, financial institutions may have incentives to sell some assets for realizing the earnings early (Laux & Leuz, 2010).

Menicucci and Paolucci (2017) suggested that FVA is more reliable and useful to stakeholders when financial markets are stable than during periods of turmoil. During periods of turmoil, there are many upswings and downswings and the financial information based on FVA will be confusing and less reliable to the users. Menicucci and Paolucci (2017) also suggested that FVA had little or no role in a financial crisis and can be considered as a messenger but not the cause of it. From this perspective it can be mentioned that bankers, regulators and analysts are accountable for stability of financial markets but accounting based on FVA is only an innocent messenger. Despite some of limitations, FVA remains a preferred accounting method for reporting certain financial items on the financial statements, such as investment securities. The standard setters and accounting professionals can improve its implementation further in the future.

Zhang et al. (2012) stated that FVA has become part of the technical architecture of neoliberalism. FVA considers assumptions that are not in line with the realities of the Chinese capital markets. In other words, it has failed to address the public interest in China. In the past, use of FVA in China was not allowed. China harmonized its accounting standards with that of IFRS in 2007 and has moved toward greater use of FVA, although FVA lacks the regulatory and sociopolitical apparatus to rationalize its reliability and relevance in the Chinese context. Many Chinese accounting academics (Xuyue, 2006; Quanjun & Zhengwei, 2006; Lejin, 2006; Lu et al., 2007) have contended that the adoption of FVA in China represents a profound departure from the past. Globally, the use of FVA has been debated both among accounting practitioners and by the public (Zhang et al., 2012).

Fair value analysis provides more value-relevant information than the historical cost basis, because it has a strong association with stock market indicators (Rodríguez-Pérez et al., 2011).

Rodríguez-Pérez et al. (2011) conducted research on 85 Spanish companies to see the effect of using fair value instead of historical cost basis on financial statement analysis. They used DEA as the financial statement analysis tool and found that the DEA scores changed when fair value was used instead of the historical cost only in the case of a few insurance companies. These findings suggest that the change in valuation basis from historical cost to fair value may alter the efficiency and profitability of only a few companies without affecting most of them.

The study by Bessong and Charles (2012) aimed at critically examining the effects of historical cost and FVA on reported profits of firms. The scholars concluded that the amount charged as depreciation, taxes and dividends paid affect the profits of a firm. The accounting basis, historical or fair value, directly relates to the reported profit. Companies should prepare their financial statements on both accounting bases, so that they reflect the true financial position of firms to their users, before declaring dividends and other benefits to stakeholders (Bessong & Charles, 2012). Palea (2014) had similar views, finding that a dual measurement and financial reporting system, namely historical cost and fair value, was needed to deliver more complete and useful financial information to the users of financial statements.

Fahnestock and Bostwick (2011) studied FVA and how it was interpreted by stakeholders, such as management and auditors for financial statement analysis. Critics tried to make FVA the scapegoat for the U.S. financial crisis in 2008. However, Fahnestock and Bostwick (2011) suggested that among other things, the mortgage and financial crisis was the result of analysts, accountants, investors and auditors being uneducated or undereducated about FVA. In other words, a better understanding of FVA is required by stakeholders to be able to interpret financial statements correctly. For stakeholders to understand financial statements and operations of a company better, the cash flow statement should be used as a prominent financial statement because it transcends both the traditional and FVA models (Fahnestock & Bostwick, 2011).

Jayasekara et al. (2018) studied the FVA practices and efficiency of banks using DEA. The findings suggest that the efficiency of banks improve during the financial boom due to recognized unrealized gains arising out of fair value adjustments. But bank efficiency will deteriorate during economic downturns. Increased capital from unrealized gains during economic boom can potentially create crisis during uncertain times when the economy is sluggish. According to the authors, despite greater use of FVA in the banking industry in many jurisdictions, there are some concerns over the reliability of financial statements as they are not based on transactions.

Chao et al. (2018) analyzed the profitability and efficiency of Taiwanese banks using DEA. They opined that IFRS' use of a principles-based approach and greater emphasis on fair values may be important for addressing the operational efficiency of banks because financial reporting can change significantly and, thus, the banks' financial performance can be seen differently. The authors suggested that after Taiwan's adopting IFRS in 2013 and greater emphasis on FVA, the banks in financial holding companies (FHCs) reduce costs more than banks not in FHCs, whereas banks not in FHCs created greater market value than the banks in FHCs. FHC banks are a part of FHCs. Under the FHC Act in Taiwan, many banks were merged to reduce management costs, while there are still some non-FHC banks that are independent and not in FHCs.

Danbolt and Rees (2008) used investment fund industries and real estate in the UK to study and compare historical and FVA. The authors argued that these two industries have a majority of their assets based on fair value and, therefore, the two valuation bases can be evaluated. The authors used the value relevance test on the residual income model, which assumes that the expectations with regard to accounting results follows a clean surplus relationship. Danbolt and Rees (2008) argued that fair value income was significantly more value relevant than the historical cost basis. However, in the presence of changes in FVA balance sheet values, income measures become mostly irrelevant. The authors concluded that FVA accounting is more value relevant and unbiased when determining the values of assets that are unambiguous, such as in investment industries. There may be some bias in the real estate FVA determination as values may be more subjective.

Investors generally perceive FVA as more value relevant than historical cost amounts (Landsman, 2007; Barth et al., 2001). Muller et al. (2011) studied the European real estate firms' compulsory adoption of IAS 40-investment properties and their effect on information asymmetry across participants. The IAS 40 standard mandated the use of fair values for investment properties. Observed bid–ask spreads were used as a dependent variable to evaluate the effect of fair value on a firm's information asymmetry. The authors concluded that using fair values reduced information asymmetry but may not eliminate it. The firms that were using fair values voluntarily reflected less information asymmetry among investors than those who mandatorily adopted it.

Strouhal (2015) studied the use and issues of currently used valuation bases in financial reporting. He mentioned that the last three decades have witnessed a shift from historical cost to the fair valuation basis in financial reporting. He conducted a study on continental European firms to analyze the effects of each valuation basis on financial ratio analysis to identify which ratios were more sensitive to the changes in valuation basis. Financial ratios, namely profitability ratios (ROA, ROE, ROS), the liquidity ratio (CR), Asset-turnover ratio, debt ratios (equity/debt ratio, average leverage, interest coverage, assets/debt ratio) and capital market ratio (EPS) were used. Three valuation models, namely historical cost, revaluation and fair value, were used. According to the author, while revaluation model and fair value recognize assets at fair value, the difference between the two models was that the former impacts a firm's other comprehensive income but not its profit and loss. It was concluded that the ratios were very sensitive to fair value model but not as sensitive to the revaluation model application. Use of FVA is increasing worldwide, although the historical cost model is popular in continental Europe (Strouhal, 2015).

Herrman et al. (2006) studied the quality of fair value measures for property, plant and equipment (PPE) in the U.S. According to the authors, fair value use for PPE is not a new idea and challenged the status quo in the U.S. of following the historical cost basis for PPE. The authors concluded that fair value measures for PPE are better than historical cost in financial statement analysis, based on the accounting qualities of relevance, reliability and comparability. They arrived at this conclusion by evaluating the valuation basis with the FASB statement of concepts No. 2 (1980), a hierarchy of accounting qualities.

2.3 Evolution of Fair Value Concept and Financial Reporting

FVA has changed the way financial information is presented and reported. There was a time when most financial information was based on historical cost accounting. With extensive work done by global accounting organizations, such as the IASB, today, many financial and nonfinancial assets are reported based on their fair values. In the case of business combinations (for instance, mergers and acquisitions), the fair values of acquired assets and liabilities are taken into account to provide a more relevant and better picture of the state of affairs of the companies involved in such business combinations. There is a trend under IFRS and U.S. generally accepted accounting practices (GAAP) toward presenting or disclosing financial information at fair value. Barlev and Haddad (2003) considered that development of FVA is the logical pattern as a result of globalization, harmonization of accounting standards and international economic integration.

It has been challenging at times for the auditors, preparers, standard setters and regulators to move away from historical accounting toward the increasing use of FVA for providing the financial information (Zyla, 2009).

The FVA concept is comparatively new, from the start of the 21st century. Although FVA has been popular and debated over the past three decades or so, the concept of FVA has been evolving for more than a century. It was in use in the early part of the last century in countries, such as the U.S., but the financial recession in the 1920s in the U.S. made economists and accountants contemplate its usefulness. Many accountants in the late 1930s and thereafter preferred historical cost valuation for its reliability and accuracy.

Richard (2004) provided one of the few historical studies of FVA, showing that fair value is not a new idea in French accounting. He described its use in France following an evolutionist approach comprising three phases. The first phase was ‘static’ in the 19th century, focusing on measuring assets and liabilities at market value. It was followed by the ‘dynamic’ phase in the 20th century based on historical cost and going concern. The final phase is the ‘forward looking’ phase starting from the year 2005, which is a mixture of fair value and value in use. Value in use means that the owner must value assets based on the future income expected to be generated by the assets. This phase assumes that company valuations are based on the ability to generate future cash flows. This latter phase is sometimes referred to as forward-looking accounting.

To summarize Richard’s views, historical cost accounting is not useful for intangibles and factors, and inflation will be ignored if historical cost is used extensively; however, this does not detract from its benefits. A ‘forward looking’ accounting system or value in use was pioneered by Herman Veit Simon from Germany, in which assets are valued by discounting future cash flows (net revenues) and recognizing gains or losses in the income statement. This system is now implemented by the IASB. Richard does not offer a definite solution as to which method is best, but he is of the view that if FVA is preferred by the IASB for providing better information, it could be restricted to the notes to financial statements or consolidated financial statements. He also considers that instead of preferring the forward looking model of valuation, it would be prudent to adopt a pluralistic instead of a neutral system of information by maintaining both the old (fair value) and new measurement (value in use) methods separately.

In summary, there have been a few stages in the history of accounting bases. The period from 1850 to 1920 was characterized by the use of the ‘reflecting the business’ concept and market valuation was more popular in some countries, such as France. From the 1930s, historical cost was the method of valuation for most of the financial items because of setbacks to the economy, such as the economic meltdown in the U.S. in the 1920s, making HCA a preferred choice for the practitioners in many countries. The work of the International Accounting Standards Committee (IASC), now known as the IASB, from the 1990s and onwards, has brought back the legitimacy of FVA and value in use as a suitable method for some categories of financial items through the development of comprehensive rules and standards; however, it is still a work-in-progress in the area of intercorporate acquisitions and investments.

2.4 Financial Statement Analysis methods

2.4.1 Overview and Significance of Financial Statement Analysis

Kulchev (2017) mentioned that financial statement analysis is a necessary technique for assessing the financial position of an organization. The findings of financial statement analysis are useful for external and internal stakeholders in making decisions, such as investing, management decisions (Kulchev, 2017). Kulchev (2017) also argued that the major focus of financial statement analysis should include cash flows for different activities, such as financing, capital structure, liquidity, inventory, turnover, indebtedness and business performance. The financial items presented in financial statements are used for comparative, structural and factor analysis. Analysts can perform financial analysis soundly if they have access to both financial statements and data from capital markets. In this context, the accounting model, which is based on information obtained from financial statements, or the financial analytical model, which requires use of capital market information as well, can be deployed by analysts. The fundamental accounting research based on the accounting analytical model is considered appropriate by many scholars. Some finance practitioners consider that both the accounting and finance analytical models should complement each other for a realistic analysis. Another significant way of interpreting financial statements is through the use of consecutive financial statements of a number of financial years by analysts to provide a holistic yet more accurate view of a company's state of affairs. Buffet and Clark (2011) emphasized that Warren Buffet, the famous business magnate and investor, believes that top firms share certain financial characteristics that distinguish them from the rest. Buffet invests only in companies that have sustaining competitive advantages, creating monopolies that allow them to sell more of their products or services or charge more from customers. Subramanyam (2013) has advocated that financial statement analysis tools and techniques aid the users' decisions pertaining to lending and company valuation. He suggests that financial statement analysis is an integral part of business analysis of a company, such as analyzing its growth potential and risks. Business analysis includes analyzing an organization's strategy, business environment, its financial position and performance and potential for growth. It involves taking decisions about restructuring the business, valuing the business in an initial public offering (IPO), credit risk decisions and investing in debt securities or equity. Financial statement analysis is the application of analytical tools and techniques to general-purpose financial statements and related financial information to draw inferences that aid in the business analysis of an organization (Subramanyam, 2013). The author further suggests that financial statement analysis helps reduce the guessing, intuition and uncertainty in making decisions for business analysis.

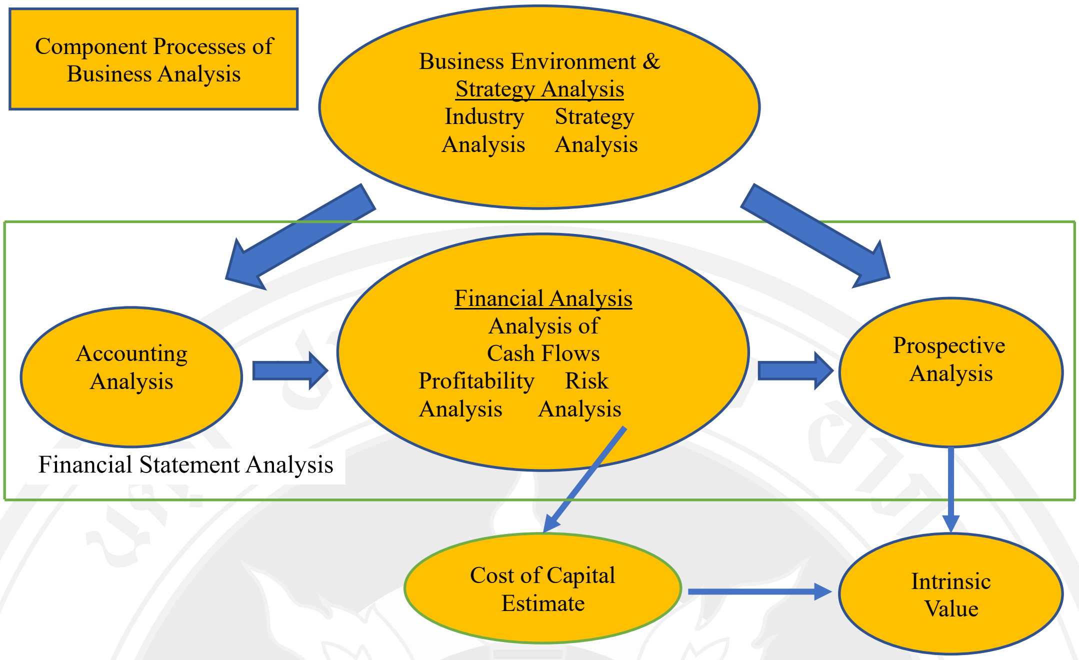

Figure 2.1 Financial Statement Analysis

Source: Subramanyam, (2013).

The figure above vividly illustrates the role of financial statement analysis in the business analysis process and is discussed below.

Accounting analysis, mentioned in the figure above, involves assessing a company's accounting and the extent to which it reflects the economic reality. Understanding business transactions and events, assessing the effect of accounting policies on financial statements and making adjustments to financial statements in line with the underlying economics are important to this analysis. Comparative analysis is an important part of accounting analysis. Accounting risk is the uncertainty that arises from accounting distortions. A major goal of accounting analysis is to reduce the accounting risk and enhance the economic content of financial statements. Therefore, restatement and reclassification of financial statements may be done to aid accounting analysis and ensure better comparability between financial information in different years.

Financial analysis includes the analysis of cash flows, profitability analysis and risk analysis, which are discussed here.

Cash flows provide information to users about the cash inflows and cash outflows of an organization. It helps analyze the solvency, liquidity and financial flexibility of an organization. Through the analysis of cash flows, an organization is able to know and distinguish its sources and uses of cash flows from its business activities, namely operating, financing and investing activities. This analysis is important to financial statement analysis and helps users address questions such as:

1) How does a company obtain its cash?

2) Where does a company spend its cash?

3) What explains the change in the cash balance?

4) How did the business fund its operations?

5) Does the business have sufficient cash to pay its debts as they mature?

6) Did the business make any dividend payments?

7) Did the business borrow any funds or repay any loans?

8) How is the increase in investments financed?

Profitability analysis is the evaluation of an organization's return on investment. It involves measuring the sources and levels of profits. It also includes an analysis of the impact of profitability drivers. The importance of this analysis lies in focusing on the reasons of changes in profitability and in the sustainability of earnings. Margins, which relate to the part of sales that is not offset by costs, and turnover are the two important sources of profitability evaluated in this analysis.

Risk analysis is critical for the creditors of a company and its shareholders. It is sometimes discussed in the context of credit and equity analysis. Risk analysis assesses a firm's ability to meet its commitments. The importance of this analysis lies in evaluating the firm's liquidity, solvency and earnings variability. It can also involve measuring the company's cost of capital.

Prospective analysis mentioned in the figure above is the final step in financial statement analysis. It includes forecasting of the statement of financial position, income statement and its cash flows. Thus, it aids in evaluating the intrinsic value of a firm, which is based on the inherent value of a business. This value also considers the price that an investor is willing to pay for an investment given the level of risk. This intrinsic value is mentioned in the figure above. Prospective analysis draws upon the accounting, financial and the strategic analysis of the firm.

Schilit (1993) has advocated that the basic purpose of financial reporting is to ensure that financial statements reflect an accurate picture of a firm's financial condition and its profits. However, Fridson and Alvarez (2011) opined that the above purpose should also include the management's duty to ensure accurate measurement. The authors further suggest that financial statement analysis is not only about cash flow or ratio analysis but also about management motivations and the dynamics of the organizations in which they operate. Analysts should consider the latter factors as well when undertaking the analysis. Robinson (2020) has suggested that the role of financial statement analysis is to take the financial reports prepared by a company and, combined with other information, analyze its past, present and future performance and financial condition. This will help stakeholders make the right decisions about investments, credit and other economic issues. When Robinson (2020) mentioned 'combined with other information', he is considering other factors, such as the management's motivation and its strategic outlook while undertaking financial statement analysis. Therefore, it is prudent to combine conventional methods of analysis with other factors as mentioned above in this fast-paced and rapidly changing world, to provide holistic yet detailed insights into ompanies and how they operate and perform. This will then lead to better decision-making for investors and other stakeholders.

2.4.2 Tools of Financial Statement Analysis

The five important tools of financial statement analysis include the common-size financial statements, comparative financial statement analysis, financial ratio analysis, cash flow analysis, and DEA for financial analysis.

1) Common-size financial statements analysis

Common-size financial statements analysis is also known as vertical analysis. According to Mautz Jr and Angell (2006), vertical analysis helps highlight the relationship among financial statement items in a year and analyze the changes in these relationships over the past few years. For instance, in an income statement, each financial item is expressed as a percentage of sales, while in a statement of financial position, each item is expressed as a percentage of total assets.

Table 2.1 Common-Size Income Statement

Company A	Income Statement	Common Size Income Statement
Sales Revenue	$100,000	100%
- Cost of goods sold	50,000	50%
Gross Profit	50,000	50%
- Selling, general and administrative expense (SG&A)	10,000	10%
Operating profit	40,000	40%
- Taxes (21%)	8,400	8%
Net income	31,600	32%

Source: Tuovila, (2019).

Common-size financial statements are useful for intercompany comparisons as financial statements of different companies are adjusted or converted to the common-size format. The comparison with other companies or industry averages helps highlight the differences in accounts or financial items and their distribution. One of the main limitations of this analysis is that it fails to reflect the relative size of the companies that are analyzed.

2) Comparative financial statement analysis

Comparative financial statement analysis is also referred to as horizontal analysis. Horizontal analysis is a method of analyzing a series of financial statement data of a company over a period of time. Its purpose is to determine the increase or decrease in the amount of financial statement items over a period of time (Weygandt et al., 2013). It is a useful tool for observing trends and is sometimes referred too as trend analysis. However, its limitation is that it cannot be used for intercompany comparisons.

Table 2.2 Comparative Income Statement

Particulars	**2016 (Amount in USD)**	**2017 (Amount in USD)**	**Absolute change**	**Percentage Change**
Net Sales	200000	250000	50000	25%
Less: Cost of goods sold	150000	180000	30000	20%
Gross Profit	50000	70000	20000	40%
Less: Selling, General and Administrative Expenses	25000	30000	5000	20%
Net Operating Profit	25000	40000	15000	60%
Add: Other Income	12000	18000	6000	50%
Earnings before Interest and Taxes	37000	58000	21000	56.76%
Less: Interest	17000	18000	1000	5.88%
Earnings before Taxes	20000	40000	20000	100%
Less: Taxes	8000	16000	8000	100%

Particulars	2016 (Amount in USD)	2017 (Amount in USD)	Absolute change	Percentage Change
Net Profit	12000	24000	12000	100%

Source: Wallstreetmojo, (2020).

3) Financial Ratio Analysis (FRA)

Financial ratio analysis (FRA) has been the most widely used technique for financial statement analysis by scholars and analysts alike for many decades. Its popularity is due to, among other factors, the simplicity of its determination and use. It generates numbers that are easy to interpret and provide a good understanding and analysis of the firm's business and its operations. Despite having some drawbacks, which are discussed later, it is a powerful yet simple medium for analyzing and forecasting a firm's performance. The evolution of ratio analysis can be traced as far back as 300 B.C. although its use as a significant tool in financial statement analysis started in the later part of the 19th century as part of the U.S.' drive toward economic and industrial development (Horrigan, 1968). Horrigan (1968) suggested the future role of ratios may be an important one. According to the author, ratios should be useful for internal analysis and to external analysts for investment and credit evaluations.

Sahu and Charan (2013) suggested that FRA is a widely used tool for financial analysis. It is used to interpret the financial statements of a company so that its strengths and weaknesses, historical performance and its present financial condition can be determined (Sahu & Charan, 2013). It helps determine solvency, profitability and operational efficiency of a firm. Some of the popular financial ratios are the net profit margin, current ratio, ROA, ROE, total asset turnover (TAT), debt ratio, and Price-to-Earnings Ratio (P/E).

Figure 2.2 Ratio Analysis

Source: Surekha (2021).

(1) Profitability ratios refer to the extent to which an organization is able to generate profits from a given level of revenue, invested capital or balance sheet assets. It also indicates how well the company manages its expenses. According to Wild et al. (2016), profitability is the ability of a firm to generate sufficient profits from the capital invested. Such ratios include the gross margin ratio, net profit margin, return on equity and return on total assets ratio.

(1.1) Gross profit ratio or gross margin ratio: It is a firm's ratio of its gross profit to net sales (Wild et al., 2016). Gross profit is net sales minus the cost of goods sold. This ratio reflects the amount of each Thai Baht left over to cover all other operating expenses and still generate a profit.

$$\text{Gross margin ratio} = \frac{\text{Gross profit}}{\text{Net sales}}$$

(1.2) Net profit margin: It expresses net income as a percentage of sales (Williams et al., 2018). This ratio looks at how office and administrative expenses, selling and distribution expenses, interest expense, and income tax expense affect the performance of a firm.

$$\text{Net profit margin} = \frac{\text{Net income}}{\text{Net sales}}$$

(1.3) Return on equity: It looks at the profits relative to the book value of average shareholders' equity. This ratio's significance is because an important objective of a company is to earn income for its owners (Wild et al., 2016).

$$\text{Return on equity} = \frac{\text{Net income}}{\text{Average total equity}}$$

Average total equity is the sum of the beginning of the year's equity and the end of year equity divided by 2.

(1.4) Return on total assets: It measures the operating performance of the firm. It reflects the firm's ability to utilize its assets effectively to generate the returns (Williams et al., 2018). Generally, the higher the ratio, the better a firm's operating performance.

$$\text{Return on total assets} = \frac{\text{Net income}}{\text{Average total assets}}$$

Average total assets are the sum of the beginning of the year total assets and the end of year total assets divided by 2.

(2) Liquidity ratios measure the amount of liquidity available with a firm. For instance, liquidity is reflected by a firm's ability to convert its assets into cash

and cash equivalents easily within a year (Garrison et al., 2018). The most popular liquidity ratios are the current ratio, acid-test ratio and cash ratio.

(2.1) Current ratio: It is the ratio of a firm's current assets to the current liabilities (Garrison et al., 2018). A high current ratio suggests a strong ability of a firm to meet its short-term obligations. A 2:1 ratio or higher is considered low risk in the short run. Current assets are used within one year or are expected to be sold or collected within one year or the firm's operating cycle. Current liabilities are the short-term obligations of a firm that are due within one year or the firm's operating cycle.

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

(2.2) Acid-test ratio: It evaluates a firm's short-term liquidity. It is also known as the quick ratio. Quick assets are cash, short-term investments, and current receivables (Wild et al., 2016).

$$\text{Acid} - \text{test ratio} = \frac{\text{Quick assets}}{\text{Current liabilities}}$$

(2.3) Cash ratio: It is the ratio of a firm's cash and cash equivalents to its current liabilities. It helps determine a firm's ability to pay its short-term debts with cash or cash equivalents (Kenton, 2021). Cash equivalents are highly liquid, such as treasury bills.

$$\text{Cash ratio} = \frac{\text{Cash and cash equivalents}}{\text{Current liabilities}}$$

(3) Solvency ratios reflect an organization's ability to recover its debts from the resources available with it. In other words, it refers to an organization's

ability to meet its long-term obligations and generate future revenues (Wild et al., 2016). If an organization does not have enough resources to pay its debts, it may be declared insolvent. Common solvency ratios are the debt ratio, debt-to-equity ratio, times-interest-earned ratio and debt-service-coverage ratio.

(3.1) Debt ratio: It reflects the ratio between total liabilities and total assets. A higher ratio may mean that the company may have difficulty in repaying its debts. In other words, this ratio is used to reflect the risk associated with a firm's debts.

$$\text{Debt ratio} = \frac{\text{Total liabilities}}{\text{Total assets}}$$

(3.2) Debt-to-equity ratio: It is another measure of solvency. It is the ratio of a firm's debts to its equity. It reflects whether a firm's capital structure has more debt than equity. As this ratio increases, it indicates that a firm is relying on more debt than equity to finance its assets (Garrison et al., 2018). A high ratio may be problematic in times of economic or industry downturn.

$$\text{Debt} - \text{to} - \text{equity ratio} = \frac{\text{Total liabilities}}{\text{Total Equity}}$$

(3.3) Times-interest-earned ratio: It measures a firm's ability to pay interest (Wild et al., 2016). A higher ratio indicates that it is less risky for creditors and the chance of nonpayment by the firm is less.

$$\text{Times interest earned} = \frac{\text{Income before interest expense and income tax expense}}{\text{Interest expense}}$$

(3.4) Debt-service-coverage ratio: It is a more comprehensive ratio than the times-interest-earned ratio. It also considers the principal payments in addition to the interest. This ratio is often used when a firm has borrowings on its balance sheet, such as loans and bonds.

$$\text{Debt service coverage ratio} = \frac{\text{Earnings before interest, tax, depreciation and amortization}}{\text{Interest} + \text{Principal}}$$

(4) Activity or efficiency ratios reflect an organization's ability to effectively use assets to generate sales or turnover (Kenton, 2021). Common efficiency ratios include the asset-turnover ratio, receivables-turnover ratio, average collection period and degree of operating leverage.

(4.1) Asset-turnover ratio: It is also known as the total asset turnover. This ratio reflects how well does a firm utilize its assets to generate the sales (Garrison et al., 2018). Management of a firm is evaluated on efficient, and effective use of its total assets by looking at its total asset turnover.

$$\text{Asset turnover ratio} = \frac{\text{Net sales}}{\text{Average total assets}}$$

Average total assets is the sum of beginning of the year total assets and ending of the year total assets divided by 2.

(4.2) Receivable-turnover ratio: It reflects how often, on average, receivables are collected during an accounting cycle of the firm (Williams et al., 2018). A low receivable turnover suggests that the firm should make its credit terms stricter and adopt more aggressive collection efforts. This will help in freeing more assets that are tied up in receivables.

$$\text{Receivables turnover ratio} = \frac{\text{Net sales}}{\text{Average net receivables}}$$

Average net receivables is the sum of beginning of the year net receivables and ending of the year net receivables divided by 2.

(4.3) Average collection period: It is computed by dividing 365 by receivable turnover ratio. This is used to evaluate receivable liquidity. For example, 365 is divided by a receivables turnover of 7, indicating a 52-day average collection period.

$$\text{Average collection period} = \frac{365}{\text{Receivables turnover ratio}}$$

(4.4) Degree of operating leverage: It refers to a measure of how a percentage change in sales leads to a percentage change in profits (Wild et al., 2016). In other words, this ratio helps to determine how effectively the fixed costs are used to generate profits. For instance, if the degree of operating leverage is 2, a change in sales will lead to twice the change in the profit of a firm.

$$\text{Degree of operating leverage} = \frac{\text{Contribution margin}}{\text{pretax income}}$$

Contribution margin = net sales – variable costs

(5) Market-value ratios or market ratios are used to evaluate the current share price of the listed company (Williams et al., 2018). These ratios are used by present and potential investors to determine whether the company’s stocks are overpriced or underpriced. Common-market ratios include the earnings-per-share (EPS) ratio, P/E ratio, dividend-yield ratio and payout ratio.

(5.1) Earnings-per-share (EPS) ratio: It is the income earned per share of outstanding common stock. A high EPS ratio indicates better profitability, growth, and performance of a firm.

$$\text{Earnings per share} = \frac{\text{Net income}}{\text{Total number of outstanding common stocks}}$$

(5.2) Price-to-earnings (P/E) ratio: It is also known as the PE ratio. It measures market expectations for future growth of a firm (Wild et al., 2016). This ratio reflects the price that the market is willing to pay for a firm's current earnings stream. A high P/E ratio may imply that investors have high expectations of future earnings of a firm.

$$\text{Price to earnings ratio} = \frac{\text{Market value (price) per share}}{\text{Earnings per share}}$$

(5.3) Dividend-yield ratio: Investors buy stocks to receive a return from stock price increase, cash dividends or both (Williams et al., 2018). Growth stocks pay little or no dividends but are attractive to investors and shareholders due to the expected price increases. In contrast, income stocks offer more dividends to investors and are attractive if they want regular cash flows. One way of knowing whether a stock is more suitable for investors as a growth or income stock strategy is to analyze its dividend-yield ratio.

$$\text{Dividend yield ratio} = \frac{\text{Annual cash dividends per share}}{\text{Market value per share}}$$

(5.4) Payout ratio: It is also known as the dividend-payout ratio. It reflects the proportion of earnings that a firm pays to its shareholders in the form of dividends (Garrison et al., 2018). The remaining amount not paid as dividends is the retained earnings of a firm, which is kept for growth purposes. For investors who want a steady stream of cash flow, a high payout ratio is preferable. A low payout ratio indicates that the company is looking more toward growth, which may be suitable for investors looking into making capital gains in future through the appreciation of the firm's stock.

$$\text{Payout ratio} = \frac{\text{Total dividends}}{\text{Net income}}$$

Few of the financial ratios relevant to the financial sector may be different from those mentioned above. Some ratios can be the same as the normal ratios also. The bank-specific ratios used in this research are as follows:

1) Profitability performance:

(1) Net interest margin: Banks act as intermediaries. They pay out a large amount in interest expense. Most of a bank's revenue is derived from collecting interest on loans (CFI, 2022). The higher the ratio, the better a bank's profitability.

$$\text{Net interest margin } = \frac{\text{interest income} - \text{ interest expense}}{\text{earning assets}}$$

(2) Return on total assets: This ratio suggests how much net income is generated per Thai baht (or another currency) of assets (Kumbirai & Webb, 2010).

$$\text{Return on total assets} = \frac{\text{Net income}}{\text{total assets}}$$

(3) Return on Equity: It is the most significant indicator of a bank's profitability and growth potential (Kumbirai & Webb, 2010). It assesses a firm's profits relative to the book value of shareholders' equity.

$$\text{Return on equity} = \frac{\text{Net income}}{\text{total equity}}$$

2) Efficiency ratios

(1) Efficiency ratio: It assesses the efficiency of a bank's operations. Noninterest expenses, such as operational and marketing expenses, are divided by ttotal revenue less interest expense for the same period. This ratio evaluates the level of noninterest expense needed to support one dollar of operating revenue (Hays et al., 2009). A lower ratio indicates that the bank has less noninterest expense per Thai Baht/dollar of revenue. A lower ratio is considered better.

$$\text{Efficiency ratio } = \frac{\text{non} - \text{interest expenses}}{\text{total revenue} - \text{interest expense}}$$

3) Ratio for leverage or solvency

(1) Leverage ratio: It is considered an important ratio in the banking industry. It is the ratio of total debts to equity in a firm's capital structure. As this ratio increases, it reflects that a firm is relying on more debt than equity to finance its assets (Garrison et al., 2018).

$$\text{Leverage ratio } = \frac{\text{debt}}{\text{equity}}$$

(2) Tier 1 Risk-adjusted Capital Ratio: This ratio evaluates the ability of a bank to cover its exposure with Tier 1 capital. In other words, it assesses a

bank's ability to meet its financial obligations. A bank may have two types of capital, Tiers 1 and 2. Tier 1 capital is considered the core capital and is defined as the sum of ordinary shareholders' equity, certain qualifying issues of preferred stock and minority interest, less intangible assets, goodwill, investments in certain subsidiaries and other adjustments. Total risk weighted assets refer to the risk weight assigned to different assets held by banks depending on the risk of potential default. For example, cash and central bank reserves may be assigned a risk weight of 0 as they are safe and free from any default while unsecured loans may be assigned a higher risk weight, such as 70%, since they are more susceptible to default. Regulatory bodies in each country may determine such risk weights. In Thailand, the regulatory requirements mandate that in FY 2019, the Tier 1 risk-adjusted capital ratio should be at least 9% of risk assets for a company, but it may change from year to year in accordance with Bank of Thailand (BOT) guidelines.

$$\text{Tier 1 Risk} - \text{adjusted Capital Ratio} = \frac{\text{Tier 1 Capital}}{\text{Total Risk Weighted Assets}}$$

Tier 2 capital is a supplementary type and includes a bank's undisclosed reserves, revaluation reserves, hybrid instruments and subordinated term debt. According to Basel III standards, this ratio should be at least 4%, although variations may differ across nations.

4) Ratio for risk

(1) Nonperforming Loans (% of Total Loans): This ratio is also known as the NPL ratio. It expresses the relationship between nonperforming loans and total loans and other real estate owned by the bank. It may be expressed in the form of a percentage. The lower the ratio, the better.

$$\text{NPL ratio} = \frac{\text{Non} - \text{performing loans}}{\text{Total Gross Loans}}$$

For the insurance sector, some ratios mentioned in the banking sector can be used, such as ROA and ROE. Financial ratios relevant to the insurance used in this research are as follows:

1) Profitability performance:

(1) Return on Assets (ROA): As in the case of banks, ROA is a good measure of assessing how an insurance company utilizes its assets to earn profit. It expresses the capacity of a firm to earn profits from the assets employed (Janjua & Akmal, 2015).

(2) Return on Equity (ROE): This ratio is useful to the insurance sector (Janjua & Akmal, 2015) and reflects returns generated by a firm on the shareholders' equity.

(3) Loss ratio: It measures an insurer's loss experience as a proportion of premium income earned during the year. It is one of the most important profitability indicators for insurance companies (Berhe & Kaur, 2017). This ratio is related to the underwriting risk in the relevant literature and demonstrates the underwriting activities of an insurance company. A high ratio may indicate that the firm's financial health is not sound, particularly when the firm has experiencing a high ratio consistently over the past few periods (Berhe & Kaur, 2017).

$$\text{Loss ratio } = \frac{\text{Net claims incurred}}{\text{Net premium earned}}$$

2) Ratio for efficiency:

(1) Total asset-turnover ratio: This ratio is used to measure the total revenues generated from the assets invested in a business (SETSMART, 2022). A high

ratio is considered good as it indicates that a firm can generate higher revenues with less capital. On the contrary, a low ratio may reflect that the firm has less earnings, invested more in the assets or may have invested in the company more to make it more competitive or modernize its processes.

$$\text{Total asset} - \text{turnover ratio} = \frac{\text{total revenue}}{\text{total assets}}$$

3) Ratio for leverage or solvency:

(1) Leverage ratio: It is considered an important ratio in the insurance industry. It is defined as the ratio of debt to equity. Berhe and Kaur (2017) suggested that the risk for an insurer may increase if it increases its leverage. Insurers with high leverage will generally have lower ROA (Harrington, 2005).

$$\text{Leverage ratio} = \frac{\text{debt}}{\text{equity}}$$

(2) Capital adequacy ratio (CAR): The Office of Insurance Commission (OIC) in Thailand implemented the risk-based capital phase 2 (RBC2) regulation to ensure that insurance companies have adequate capital to cover risks arising from business activities (Thaire Life Assurance Public Company Limited, 2020).

$$\text{Capital adequacy ratio (CAR)} = \frac{\text{total capital available (TCA)}}{\text{total capital required (TCR)}}$$

Total capital available (TCA) represents the fair adjusted value of shareholders' equity in line with OIC requirements.

TCA represents the amount of capital required to cover risks arising from business activities, such as market risk, credit risk, insurance risk, operational risk, surrender risk and concentration risk.

OIC requires insurers to maintain a CAR ratio of not lower than 140%. If an insurer has a ratio of 300% or above, it may lead to competitive advantage from reinsurance credit risk charge. If an insurer makes a reinsurance arrangement with a domestic reinsurer whose CAR is >= 300%, the insurance company will be allowed to hold capital at the lowest risk charge of 1.6%, which is equivalent to making reinsurance with an AAA-rated offshore reinsurer.

4) Ratio for liquidity:

(1) Current liquidity: This ratio indicates an insurer's ability to meet it current obligations without borrowing money or prematurely selling its long term investments (Care ratings, 2016). If this ratio is less than 1, it becomes sensitive to the cash flow from premium collections.

$$\text{Current liquidity } = \frac{\text{liquid assets}}{\text{current liabilities}}$$

Nissim and Penman (2001) mentioned that financial statement analysis has traditionally been perceived as part of the fundamental analysis needed for the equity valuation. But this has commonly been ad hoc. Thus, in their research article, the authors presented financial statement analysis as a pro forma analysis for the future, with ratio analysis providing building blocks for forecasting the pay-offs. In other words, Nissim and Penman (2001) advocated and demonstrated the use of ratio analysis as a technique for forecasting a firm's future performance and its equity valuation.

Tugas (2012) stated that financial statement analysis is a process of ascertaining the financial strengths and weaknesses of a firm by suitably establishing the relationship between the financial items in profit and loss account and the balance sheet. Financial ratio analysis is a tool of financial statement analysis. Financial statements are comprehensive and, therefore, it is better to use numbers that matter in predefined formulas developed over time by the finance scholars (Tugas, 2012). This can be done by using the different ratios, such as profitability ratios, turnover ratios, balance sheet ratios etc., to provide a better state of affairs of a company.

Tugas (2012) used this financial ratio analysis and related comparative study of the education subsector in the Philippines for the years 2009–2011. The author considers this analysis is useful and applicable not only to large firms with substantial operations but also to the education sector or any other sectors that contribute to a country's economic development. The author was able to rank the listed educational institutions in Philippines using different ratios.

Ak et al. (2013) suggested that the financial ratio models can be used to predict significant corporate events and future performance of a firm after such events. This may help investors make better decisions, such as whether to hold the stocks of that firm or not. The authors concluded that financial ratio models help investors avoid stocks of those firms that have had a significant corporate event. Investors can also differentiate good from the bad firms after a significant event has occurred (Ak et al., 2013), such as raising equity capital, financial distress and insolvency, downsizing and materials earnings misstatements. The findings reveal that investors tend to overvalue a firm before a significant event and, therefore, have less possibility of a lower return later.

Financial ratio analysis (FRA) can also help detect fraudulent reporting. Dalnial et al. (2014) investigated whether there were significant mean differences between the ratios of fraudulent and nonfraudulent companies in Malaysia. The authors also investigated which financial ratio is significant for detecting fraudulent reporting. Their findings were intriguing. Their study concluded there were significant mean differences between the fraudulent and nonfraudulent companies in ratios, such as the accounts receivable to sales and total debt to total equity. Dalnial et. al (2014) also suggested that the Z score for measuring the probability for insolvency was significant for detecting fraudulent financial reporting. The findings add to the previous studies and contribute tto the financial ratio analysis in detecting the fraudulent firms.

Barnes (1987) suggested that financial ratios can be used for different purposes, such as an organization's ability to pay its debts or assess firm performance and managerial success in achieving the objectives. It can even be used to assess the statutory regulation of a firm's performance. Financial ratios have been affirmatively used by analysts and accountants by comparing future financial variables, such as the profit to sales ratio (Barnes, 1987). Furthermore, Barnes (1987) suggested they are also of value to researchers in designing statistical models for predictive purposes, such as evaluating the risk, corporate distress or testing an economic hypothesis. In other words, financial ratios are mostly used for predictive and analytical purposes. However, the author recommends that more advances and research are needed to achieve behavioral insights into the use of financial ratios.

From a long-term perspective, empirical evidence initially produced strong evidence that market returns can be predicted using financial ratios (Lewellen, 2004). However, later studies questioned these findings. Lewellen (2004) conducted research in this area and suggested that dividend yield, book-to-market ratio and earnings-price ratio had weak power to predict the stock returns. These are significant findings and may be a departure from what has been thought earlier.

5) Cash flow analysis

Auditors, analysts and managers additionally deploy cash flow analysis to assess more about the short-term liquidity and long-term solvency of an organization (Armen, 2013). Armen (2013) suggested that traditional ratios may be insufficient for profitability and risk analysis of organizations.

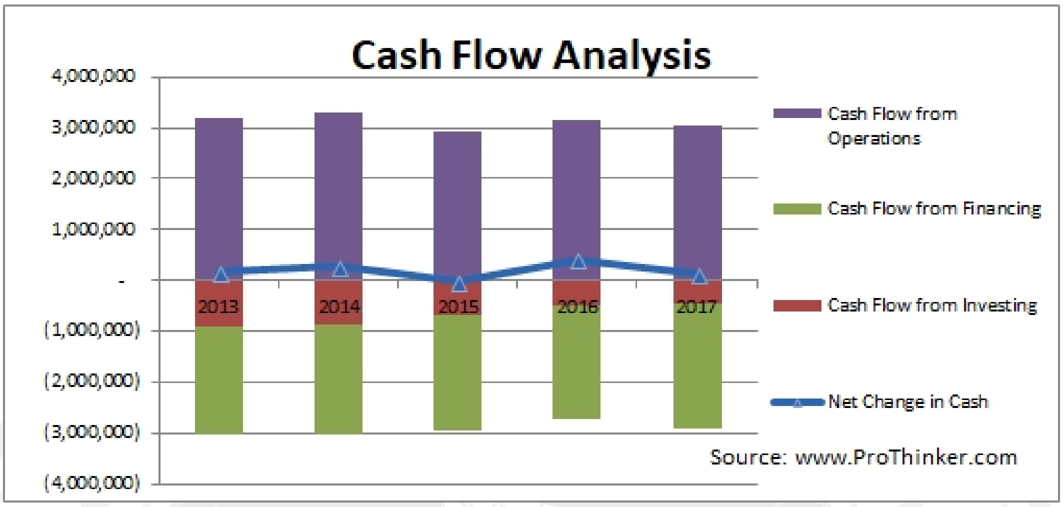

Figure 2.3 Cash Flow Analysis

Source: ProThinker (2018).

Cash, not income, is the lifeline of a business, as it needs cash to meet its operational and solvency needs. Merely increasing sales and therefore profits is insufficient. A company should also be able to generate healthy cash flows that are essential for survival and growth of an organization.

The figure above is an example of how a company conducts a cash flow analysis. It shows the increase or decrease in cash of an organization over the last 5 years. The blue line indicates the increase or decrease in cash while the colored boxes reflect which activities have caused this change. The activities of an organization that lead to cash inflow or outflow are cash flows from operating activities, investing activities and financing activities. If a colored box in this figure is above zero, it reflects an increase in cash from that activity and if it is below zero, it conveys a decrease in cash from such activity. In the last five years, the organization's cash has increased since the cash from operations increased substantially, although the cash from investing as well as financing activities decreased for this organization. The most important factor in cash flow analysis is the cash from operations and its significant increase is a good sign for this organization.

2.4.3 Use of Data Envelopment Analysis in Financial Statement Analysis

The latest technique used in financial analysis is DEA. It is a progressive method for evaluating the financial performance of an organization. DEA was first introduced by Charnes et al. (1978), based on the work of Farrell (1957). Banker et al. (1984) further developed this technique. DEA is a typical nonparametric method for measuring the relative performance of organizational units with the presence of multiple inputs and outputs, using linear programming. DEA is a nonparametric, linear-programming-based technique that converts any number of input and output variables into one overall score, relative to the best-in-class observations. It is used for comparing the performance of similar units of a firm or between firms. Sherman and Zhu (2013) have described DEA as balanced benchmarking. When this method was introduced, it was mainly used by academicians to evaluate relative efficiencies between competing organizations. J. Zhu (2014) has suggested that after the year 2000, balanced benchmarking, also known as DEA, was adapted to Excel software, making it possible for a nonexperts to use it even if the person has less knowledge on this subject.

Organizations use this analysis to enhance their efficiency and redefine performance measurement. DEA helps in performing objective and comparative analysis in a way that is more than just financial measurement of performance. It provides an ideal platform for use in banking, health services, franchising, insurance, retail, public services and other sectors of the economy. For instance, insurers and banks can use it to enhance their productivity and profits and maintain service quality. It can be used to supplement or even replace the conventional financial ratio analysis to enhance the profits or savings of a firm, thereby contributing to the firm's success. This is possible because while the financial ratio analysis compares two financial items or accounts in financial statements at a time, the DEA can evaluate multiple inputs and output variables simultaneously. Financial ratios neither satisfactorily discriminate best practices nor do they consider multiple variables at the same time. On the other hand, DEA can determine inefficient firms and by how much input variables (such as expenses) or output variables (such as revenues) should be decreased or increased to bring a firm onto the efficient frontier. This, in effect, helps increase the efficiency and profitability of a firm. DEA expresses whether a firm is operating at an optimal size or how far it is from attaining optimization. It enables the companies to benchmark and identify best practices that are not easily accomplished by the use of management techniques (Sherman & Zhu, 2013). Sherman and Zhu (2013) have also suggested that it can aid multinational companies in analyzing the performance of their offices that are located in different parts of the world and comparing them. It helps to improve productivity of organizations and complements other analytical techniques. In the case of the manufacturing sector, product quality can be tested and inspected before being sold to e customers. The service industry, such as insurance, management consulting or health care, is more complicated because not only should service be designed properly but it must also be delivered to the customer delicately. DEA analysis provides ample scope to assess and improve the quality of such professional services. It provides guidance to top performing branches, departments or services of a service organization, which can help enhance the quality of other intracompany services or units. It also aids in testing their assumptions, such as cost-cutting, in a suitable manner, before implementation. DEA, particularly for service organizations, was not previously available.

Kaplan and Norton (1996) have mentioned that DEA is an invaluable tool for performance evaluation of service organizations when used in conjunction with other performance tools, such as Balanced Scorecards and Key Performance Indicators (KPIs).

DEA models can be of different kinds, such as constant returns-to-scale (CRS) model, variable returns-to-scale (VRS) model, nonincreasing returns-to-scale (NRIS) model and nondecreasing returns-to-scale (NDRS) model. Another form of categorization is the input-oriented variable returns-to-scale and output-oriented variable returns-to-scale as well as the input-oriented CRS model and output-oriented CRS model. The latest model in use is the cross-efficiency model, developed by Sexton et al. (1986) and later refined by Doyle and Green (1994).

In DEA, there are many methods of measuring efficiency. These methods include the Malmquist index and window analysis. However, the limitations with these methods are that they consider only the current period's activities but do not consider the carry-over activities between two periods. In the dynamic world of business, short-term planning is insufficient. The companies plan long term and investment planning takes a strategic horizon. In view of this, Färe and Grosskopf (1996) suggested a dynamic DEA model for the first time. Such a model takes into account long-term optimization. Tone and Tsutsui (2010) developed the model first created by Färe and Grosskopf (2006), which is the dynamic DEA. Dynamic DEA is a slacks-based measure (SBM) framework. Tone and Tsutsui (2010) suggested dynamic SBM models that can analyze the efficiency of DMUs for individual as well as whole terms.

The advantages of DEA analysis are as follows:

1) It can relate with multiple inputs and outputs to provide suitable outcomes of the experiment, relationship or ranking.

2) It has been found to be useful to uncover relationships with multiple variables not easily detectable with other techniques or methods.

3) It has the ability to quantify and analyze outcomes precisely.

4) There is no need to categorically specify the mathematical structure of the production functions.

The DEA method has been used in the past to analzye social and economic research. Compared to financial ratio analysis, DEA in financial statement analysis has been less used by scholars and accountants. One of the reasons for this could be less awareness of this technique and its use in financial statement analysis. DEA can be applied by converting an organization's financial performance indicators into their technical efficiency equivalent. One such way is the DuPont analysis, which is an extended analysis of ROE of a company that analyses net profit margin, asset turnover, and financial leverage. It disaggregates the ROE to analyze how an organization can increase returns for their shareholders. Feroz et al. (2003) suggested that the cost of goods sold, total assets and equity can be minimized as inputs and the sales/revenues can be maximized as output. The authors suggest that by doing this, the technical efficiency of a firm can be gauged because minimum resources are used to produce maximum output. They have suggested that DEA does not work with negative numbers and, therefore, net loss cannot be explicitly modelled. Therefore, they have advocated the use of total assets, equity and total cost as inputs and revenues as output to address this issue and solve the problem of negative profit.

Return on Equity = Net Profit Margin x Asset-turnover ratio x Financial Leverage

= (Net Income / Sales) x (Sales / Total Assets) x (Total Assets / Total Equity)

Ratio analysis is a commonly used method of financial statement analysis. It has been widely used by practitioners, scholars and academicians and continues to be used today. Feroz et al. (2003) mentioned that financial ratios can be computed easily but their interpretation is challenging and subjective. The authors also explained that sometimes two or more ratios provide different signals, making it difficult to analyze a firm’s financial performance. Furthermore, the analyst may pick a few ratios according to his judgment to analyze the performance of a company. Feroz et al. (2003) advocated that DEA is a reliable and consistent technique to evaluate the operational efficiency of an organization. The authors applied DEA to the U.S. oil and gas industry and concluded that it can be used effectively to complement ratio analysis and can provide additional information. DEA can be applied to organizations by converting financial performance indicators into their technical efficiency equivalents.

Ablanedo-Rosas et al. (2010) adopted the output-oriented financial ratio-based DEA model in which no inputs were utilized to evaluate Chinese port efficiency. This model was based on the work of Femandez-Castro and Smith (1994), who had developed an innovative output-oriented DEA model. This financial ratio-based DEA model takes into consideration multiple financial ratios simultaneously and combines them into a single measure of efficiency. With the help of this model, the DEA efficiency of Chinese ports was determined. The authors analyzed the efficiency of eleven Chinese ports. The only variables considered were financial ratios, including return on equity, total asset turnover, accounts receivable turnover, inventory turnover, current ratio and quick ratio. The results suggested that the higher the efficiency ratio of a port in relation to that of other port/s, the higher the efficiency of this port. The results showed that 6 Chinese ports out of a total of 11 ports considered were efficient and included Yantian, Shenchiwan, Nanjing, Xiamen, Tianjin and Jinzhou ports. The authors concluded that financial ratio-based DEA provided clear and detailed information needed for port decision-makers to improve operating efficiency.

Chen and Ali (2002) studied the relationship between ratio analysis and DEA. The study found that financial ratio analysis fails to identify all types of dominating DMUs, as DEA does. Dominating DMU means high-ranked units based on different input and output variables. Financial ratio analysis of a single output to a single input fails to capture the total performance of an enterprise. However, the study also highlights that the best-ranked performance by the ratio analysis is a DEA frontier.

Thanassoulis et al. (1996) compared the DEA and ratio analysis as tools for evaluating the performance of organizational units, such as banks and schools. The authors suggested that both DEA and ratio analysis agree on the performance of units as a whole, if performance indicators include all variables used in DEA. However, the two tools, namely DEA and ratio analysis, can differ significantly on relative performance of the two organizational units. Furthermore, the authors' findings suggested that ratio analysis is not a suitable method for setting targets to improve the efficiency of inefficient organizational units. The reason for this is that financial ratio analysis relates only one input variable or resource to one output at a time. In contrast, DEA considers multiple inputs and outputs in assessing the performance of an enterprise. However, the authors suggest that these two methods can be used jointly to assess the performance of an enterprise and enhance organizational efficiency.

Some authors, such as Tsolas (2011), have advocated the use of DEA and ratio analysis jointly for determining firm performance. Tsolas (2011) carried out an analysis of profitability efficiency and effectiveness for a sample of Greek construction companies. The author measured the profitability efficiency of construction firms using DEA and their effectiveness by using profit margin. The findings show that the firms' profitability efficiency was corelated with effectiveness. It suggested that the firms' performance in the operational and cost-oriented side was clearly linked with the financial or profit-oriented side.

While both DEA and financial ratio analysis have their strengths and weaknesses, the theoretical connection between them has not been fully expressed (Chen and McGinnis, 2007). The authors established a mathematical relationship between the DEA efficiency score and the financial ratio analysis using the DEA framework. The authors concluded that the input–output ratio is not a proper performance index for system benchmarking. Although a relationship exists between the two, the DEA considers multiple input and output variables, making it more reliable for benchmarking the performance of firms.

Pille and Paradi (2002) suggested that the DEA model provides results on the efficiency of credit unions with large assets in Ontario, Canada that are comparable to the equity/asset ratio. DEA also provides indications to weak units on how to improve efficiency (Pille & Paradi, 2002). Therefore, it can be said that DEA not only helped in measuring efficiency but also provided with specific information on weaker units to improve their performance.

While conducting an analysis of Taiwan's electronic companies, Ho (2007) observed that a more efficient company (total assets turnover) is not always more effective (i.e., profit margin). This analysis was conducted by Ho (2007) based on the two-stage DEA model, suggesting that efficiency and effectiveness do not have an apparent correlation.

From the literature review in this section, it is clear that DEA can complement the conventional financial ratio analysis and, in some case, may be better in undertaking financial statement analysis.

Yeh (1996) opined that using the right input and output variables in DEA for the financial analysis of firms is the most important issue to measure the relative efficiency of each firm in a particular sector. If banks are viewed as service organizations, then input and output variables will be different than when they are considered revenue-generating organizations (Yeh, 2006). Also, if banks are considered financial intermediaries (Yue, 1992), then input and outputs would be related to deposits and loans. In other words, it depends on the perspective with which the banks are viewed, such as income-generating, service-producing or financial intermediaries, that the input or output variables can be selected. Outcomes based on efficiency scores for either of these ways may be different and, therefore, will depend on the objectives of the research. The DEA model itself will provide precise results; however, it is suggested that input and output variables should remain the same when analyzing and ranking the companies in the same sector. This, in effect, will produce consistency, allowing results to be compared to achieve the required research objectives. DEA analysis will be able to provide peer group analysis to identify financial institutions with 'good or 'bad' financial conditions for researchers to examine ways of improving underperforming institutions.

In the insurance sector, the choice of a DMU's inputs and outputs is diverse, complicated and debatable. Cummins and Rubio-Misas (2006) mentioned labor, business services, debt capital and equity capital as inputs, while outputs were taken as life and nonlife insurance losses incurred, reinsurance reserves, reserves for primary insurance contracts, and invested assets. In the banking sector, Sturm and Williams (2004) considered employees, deposits and borrowed funds, equity capital as inputs and loans, off-balance sheet items as outputs. Kao and Liu (2014) suggested labor, physical capital, purchased funds as input variables and demand deposits, short-term loans, medium-and-long-term loans as output variables.

In other areas of management, such as marketing, it is still unresolved which input and output variables should be taken into account. Donthu et al. (2005) deliberated on the dilemma of using customer satisfaction and profitability as indicators of success and, therefore, output variables. It is difficult to consider all factors affecting an organization as part of its input or output variables. Donthu et al. (2005) questioned the impact on benchmarking by missing any or few of these factors as part of DMUs.

An analysis of the research papers that use DEA for financial statement analysis (FSA) is shown in the table below (from most recent to earlier studies):

Table 2.3 Analysis of Past Papers that use DEA for FSA

Authors	Research Topic	Sample	Input/s used in DEA	Output/s used in DEA	Findings
Zhu et al. (2020)	Efficiency and productivity analysis of Pakistan's banking industry: A DEA approach	Banking companies in Pakistan	Interest expense and noninterest expense	Interest income and noninterest income	Public sector banks performed better than private banks. Technical efficiency and productivity of foreign banks was better than domestic ones (public sector as well as private banks).
Sharif et al. (2019)	Productivity and efficiency analysis using DEA: Evidence from financial companies Listed in Bursa Malaysia	Financial companies listed in the Malaysian stock exchange	Market capital, total volume, dividend per share, financial leverage, price-to-book ratio	Return on equity, return on assets and P/E ratio	Some financial companies were fully efficient while some were not. Productivity gain was related to positive shift in technical efficiency.
Novickytė and Droždz (2018)	Measuring the efficiency in the Lithuanian banking sector: The DEA application	Lithuanian banking sector	Model 1: Deposits Model 2: Labor expenses Model 3: Deposits, Debts to banks and other credit institutions	Model 1: Operating profit Model 2: Loans Model 3: Profit before tax	Large Lithuanian banks (foreign subsidiaries) demonstrated a better business model than the smaller (local) banks (based

Authors	Research Topic	Sample	Input/s used in DEA	Output/s used in DEA	Findings
			Model 4: Deposits Model 5: Deposits	Model 4: Loans Model 5: Net interest income	on CRS - constant returns-to-scale assumption).
Kao and Liu (2014)	Multi-period efficiency measurement in DEA: The case of Taiwanese commercial banks	Taiwanese commercial banks	Labor, physical capital, purchased funds	Demand deposits, short-term loans, medium-and-long-term loans	Relational network model based on DEA, performance of Taiwanese banks improved over a three-year period.
Tsolas (2011)	Modelling profitability and effectiveness of Greek-listed construction firms: an integrated DEA and ratio analysis	Construction firms listed on Athens exchange	Total operating cost Selling and administrative cost	Net income before taxes	Firms' profitability efficiency positively related with effectiveness. DEA and ratio analysis can be jointly used for assessing performance of firms.
Chen and McGinnis (2007)	Reconciling ratio analysis and DEA as performance assessment tools	No samples taken from a specific industry. Framework of DEA used to establish mathematical	No specific inputs from financial statements of a firm considered	No specific outputs from financial statements of a firm considered	Input–output ratios is not a proper performance index for system benchmarking;

Authors	Research Topic	Sample	Input/s used in DEA	Output/s used in DEA	Findings
		relationship between DEA and ratio analysis			DEA more reliable.
Ho (2007)	Performance measurement using DEA and financial statement analysis	Taiwan's electronic companies	Stage 1: Employees, assets and capital stock Stage 2: Sales	Stage 1: Sales Stage 2: Operating revenue, profit	Two-stage DEA analysis indicated that a firm with better efficiency is not always more effective.
Cummins and Rubio-Misas (2006)	Deregulation, consolidation, and efficiency: evidence from the Spanish insurance industry	Spanish insurance industry	Labor, business services, debt capital and equity capital	Life and nonlife insurance losses incurred, reinsurance reserves, reserves for primary insurance contracts, and invested assets	Large firms should focus on adopting best practices to improve efficiency rather than on future growth.
Sturm and Williams (2004)	Foreign bank entry, deregulation and bank efficiency: Lessons from the Australian experience	Foreign banks in Australia	Employees, deposits and borrowed funds, equity capital	Loans, off-balance sheet items	Foreign banks performed more efficiently than domestic banks; however that did not result in superior profits.

Authors	Research Topic	Sample	Input/s used in DEA	Output/s used in DEA	Findings
Feroz et al. (2003)	Financial statement analysis: A DEA approach	U.S. oil and gas industry	Total assets, common equity, cost of goods sold	Sales	DEA can complement accounting ratios for financial statement analysis. DEA avoids the limitation of one-ratio-at-a-time approach.
Chen and Ali (2002)	Output–input ratio analysis and DEA frontier	No samples taken from a specific industry. The analysis is done by presenting mathematical properties by relating ratios to DMUs at the frontier	No specific inputs from financial statements of a firm considered	No specific outputs from financial statements of a firm considered	Relationship exists between ratio analysis and DEA frontier point. Top-ranked performance by ratio analysis is DEA frontier point. However, ratio analysis fails to identify all types of dominating DMUs as DEA does.
Pille and Paradi (2002)	Financial performance analysis of Ontario (Canada) Credit Unions: An application	Credit Unions in Canada	Model 1: Noninterest expense Deposits Model 2: Noninterest expense	Model 1: 1. Loans, cash and investments 2. Equity 3. Net interest	DEA helped in measuring efficiency; also provided specific information on weaker units to

Authors	Research Topic	Sample	Input/s used in DEA	Output/s used in DEA	Findings
	of DEA in the regulatory environment		Deposits Model 3: Noninterest expense Deposits Model 4: Noninterest expense Interest expense	income and other incomes Model 2: 1. Loans, cash and investments 2. Equity 3. Net interest income and other incomes Model 3: 1. Loans 2. cash and investments 3. Net interest income and other incomes Model 4: 1. Loans, cash and investments 2. Deposits 3. Interest income and other incomes	improve performance.
Saha and Ravisankar (2000)	Rating of Indian commercial	Indian commercial banks	Branch (number of branches), staff (number of employees),	Deposits, advances, investments, spread, total	DEA could be a suitable approach to measure

Authors	Research Topic	Sample	Input/s used in DEA	Output/s used in DEA	Findings
	banks: A DEA approach		establishment expenditure, nonestablishment expenditure, (excluding interest expenditure)	income, interest income, noninterest income and working funds	relative efficiency of Indian banks.
Yeh (1996)	The application of DEA in conjunction with financial ratios for bank performance evaluation	Taiwan's banks	Interest expenses, noninterest expenses, total deposits	Interest income, noninterest income, total loans	DEA can be used with ratio analysis to better understand bank inefficiencies. DEA trends over time provide valuable information on bank performance.

2.5 Efficiency of Firms and Stock Returns

Kirkwood and Nahm (2006) suggested that efficiency of Australian banks based on DEA scores was reflected in their stock price. This was a significant finding as very few studies have linked firm efficiency with stock returns.

Chu and Lim (1998) tested and evaluated the fluctuations in Singaporean banking companies with their profit and cost efficiency. Chu and Lim (1998) concluded that changes in the stock price of banking companies in Singapore were reflected in the change in the profit efficiency of these firms rather than their cost efficiencies. The market tended to over-react to the changes in the profit efficiency of the banking firms (Chu and Lim, 1998). The scholars used DEA analysis for measuring the banking companies' efficiency. Chu and Lim (1998) also suggested that such relationship between the stock prices and profit efficiency is expected as shareholders seek dividends that are paid from a company's profits, not income.

In the collection of papers mentioned in research paper published by Kothari and Ball (1994), they suggested that stock prices incorporate all information available in the public domain. However, research on a link between stock prices and firm efficiency not been widely undertaken yet in a specific context.

Gaganis et al. (2013) conducted an extensive study to determine if a relationship existed between firm efficiency and stock returns. The scholars sampled 399 insurance companies from 52 countries to analyze this phenomenon. Their findings supported the hypothesis of a significant relationship between the profit efficiency change of insurance companies with market-adjusted stock returns. However, there is little evidence found to support the cost efficiency change with the stock returns (Gaganis et al., 2013). The scholars used the approach of Battese and Coelli (1995) to measure firm efficiency. This approach allows the step-up estimation of efficiency while controlling the regulatory factors and macroeconomic conditions in a country.

Kuo (2011) suggested that the change in cost efficiency of solar energy firms in the U.S. has a positive relationship with their stock returns. In other words, the scholar advocates that change in cost efficiency rather that cost efficiency itself leads to better stock returns. The study found that the average returns of efficient firms are lower than those of inefficient firms. (Kuo, 2011). The scholar wants to highlight that this is largely due to the improvements in the cost efficiency of inefficient firms.

Lopes et al. (2008) advocated that DEA generated a superior performance compared to both market average, proxied by the IBrX-100 index, and CDI (Brazilian interbank deposit certificate) quarterly rates. The stocks analyzed were traded at the

Sao Paulo Stock Exchange Brazil from January 2001 to June 2006, comprising 22 quarters. DEA portfolio series TRs was only marginally superior to the IBrX-100 series. However, DEA excess returns achieved a higher Jensen's alpha (Lopes et al., 2008), which is an established measure of portfolio performance and is adjusted for the risk factor.

Edirisinghe and Zhang (2008) used DEA to compile a relative financial strength (RFS) indicator. The scholars analyzed the correlation between the RFS and historical stock price returns in U.S. technology stocks. Edirisinghe and Zhang (2008) suggested that a well-informed decision can be made by investors about whether to include a firm within the equity portfolio based on this approach. The article suggested that a synchronous relationship between RFS and the stock returns of the same quarter (period) are significant. In particular, it suggests that prediction of the future performance of an enterprise is key to stock market returns. The DEA–RFS indicator can also assist in residual income valuation (RIV)-based fundamental analysis.

The relationship between the efficient use of resources and an organization's performance has been debated by research scholars for decades. Modi and Mishra (2011) investigated the relationship between marketing, production and inventory resource efficiency of firms with their financial performance. Financial performance was based on stock returns, Tobin's Q, and Returns-on-Assets. The authors evaluated this relationship for all U.S. publicly owned manufacturing firms from 1991 to 2006. Thy found resource efficiency of the firms was positively related to their financial performance (Modi & Mishra, 2011). However, the authors concluded that arguments for slack efficiency were also evidenced as the resource efficiency demonstrated diminishing returns. Their findings suggest that a sole focus on cost efficiency is often insufficient to gain competitive advantage.

Lim et al. (2014) proposed the use of DEA cross-efficiency evaluation in portfolio selection. Cross-efficiency evaluation is mostly used for peer evaluation but the authors improved it for use in portfolio selection. The authors applied this technique in the Korean stock market, demonstrating that it can be used in the selection of stock portfolios. Using this technique, Lim et al. (2014), have shown that the selected portfolio yields better risk-adjusted returns than other benchmark portfolios. Their sample was based on a 9-year period from 2002 to 2011. The study, conducted under the mean-variance (MV) framework, developed a novel method of using DEA cross-efficiency technique in the portfolio selection using the MV framework. The authors have therefore considered interdecision-making units (DMUs) risk in a portfolio with regard to change in DEA weights or multipliers. This research empirically supports the approach to stock portfolio selection. However, its financial applications will be justified when more data are used and various choices of parameter values, S and λ, are taken into account.

Anadol et al. (2014) suggested that DEA is a relatively advanced technique in valuing private firms and can potentially play a pivotal role in company valuation. Anadol et al. (2014) used this technique to classify American companies as efficient or inefficient. Valuation is often considered a subjective tool employed by investment bankers, business analysts, accountants and lawyers. Using this technique, Anadol et al. (2014) were able to predict appropriate market ranges and determine the degree of efficiency of the companies. They suggested that future studies could use other methods, such as DCF, to compare and augment the efficacy of this technique.

Hwang et al. (2010) observed that the Malmquist productivity index based on DEA can be used to make equity stock selection by a two dimension-performance shift. Hwang et al. also suggested that stock price evaluation can be performed using range adjusted measure (DEA–RAM). Using these techniques will help investors in Taiwan by segregating the stocks of companies as speculative, monitor, avoid and value. For instance, value stocks have the potential for growth in upcoming years, while avoid stocks are inferior performing and risky investments. Thus, DEA can be used in facilitating investment decisions by the investors. This will also help in reducing risks related to the equity investments. This will assist investors, both individual and institutional, to hold stocks, obtain better returns for value stocks and use a sell short-strategy for the avoid stocks. The study explored two issues; one to evaluate operating performance and its change along with stock evaluation and second is how investors can utilize stock trading strategies to generate better stock returns. One of the limitations of this study is that it uses the Malmquist productivity index that requires the sample of listed stocks be fixed for the purpose of comparability. There is a chance, therefore, that the samples may be curtailed. Some upcoming stocks doing well may have to be ignored because the Malmquist productivity index is based on the comparability factor. There is no doubt though that this study conducted by Hwang et al. (2010) effectively brings out the stock classification model and the resulting outcomes as far as selecting these stocks is concerned, based on DEA-RAM and the Malmquist productivity index.

Anadol (2000) suggested that, conventionally, DEA was used to identify the relative efficiencies in not-for-profit organizations. This technique has been further used to study the efficiency of more than 50 industries, such as banking, insurance, capital budgeting projects, infrastructure sector and credit unions (Anadol, 2000). Anadol (2000) further asserted that while DEA is primarily used for determining the relative efficiency scores between companies, it can also be used for determining peer groups. Effectively, the author suggests this technique can be used for firm valuation and efficiency.

Today, analysts as well as scholars are interested in the study and application of quantitative methods to portfolio management. The analysis helps investors in a successful investment portfolio strategy to outperform the market. Škrinjarić (2014) used DEA and a dynamic SBM to analyze a portfolio that can successfully outperform the market. Data on stocks listed on the Zagreb stock exchange, Croatia, from April

2009 to June 2012, were used. The findings analyzed by Škrinjarić (2014) indicate that the results of optimization using this technique give a portfolio of stocks that can outperform the market and generate better returns for investors. The findings also suggest that such a portfolio will be less risky. The author claims that it is the first implementation of dynamic DEA in stock trading.

Frijns et al. (2012) investigated the relationship between firm efficiency and asset pricing using a sample of U.S. publicly listed firms for the period 1988–2007. The authors investigated whether efficient and inefficient organizations performed differently. This financial statement analysis was performed using DEA. Frijns et al. (2012) used the performance attribution regression and cross-sectional/panel regressions for this purpose. The authors concluded that firm efficiency plays a major role in asset pricing and efficient firms have significantly outperformed inefficient ones even after controlling the risk factors. The authors focused on sales and market value as output measures in DEA. It can be concluded that firm efficiency plays a major role in the cross-section of stock returns and efficiency scores based on the sales produce the strongest results. In other words, the authors have suggested a long–short strategy i.e., the investors can go long in efficient firms and short in inefficient firms using DEA. Such firms significantly outperform the market. The study will act as a basis for further research in the area of asset pricing and stock returns using DEA in financial analysis.

If a firm is operating efficiently, it will have positive cash flows. This should also be reflected in the stock price of the firm. Nevertheless, the relationship between firm efficiency and stock prices has not been studied extensively. Nguyen and Swanson (2009) studied the effect of firm efficiency on average equity returns. The authors used a stochastic frontier approach to evaluate firm efficiency. It was concluded that the portfolio composed of inefficient firms outperformed that of efficient ones despite factoring in risk factors and firm characteristics. This means there is a required premium for the inefficient firms. The authors also suggested that inefficient firms improve their performance to stay competitive. The authors emphasized that a firm's efficiency is an important factor in determining stock returns and should be studied in asset pricing models.

Freeman (1984) advocated the firms have stakeholders and they should pay attention and deal with with them proactively. He also suggests that firms able to connect and relate with their stakeholders better will be able to create more value in the future. Stakeholders look toward economic as well noneconomic values generated by the firm and should cooperate with one another (Freeman, 1984). In other words, stakeholders are like customers who determine the opportunity cost of their interest in a firm; if they get more utility from a firm than what they have foregone, they are satisfied. Therefore, firms should pay attention to their stakeholders effectively and pro-actively. Firms that treat their stakeholders well and manage their interests better are able to create value along a number of dimensions, leading to better firm performance (Freeman, 1984). Financial returns is one of the most relevant measure of the value created by firms.

2.6 Fair Value Accounting and Shareholders' Value

Since this research has an important element of FVA, a brief discussion on the literature review pertaining to FVA and its relationship with the shareholders' value will be useful. As 'wealth maximization' is the key goal of finance function and the organization, shareholders' seeking to enhance their stock value and stock returns would be interested in understanding this relationship and the extent of its benefits or limitations.

Barlev and Haddad (2003) suggested that FVA-based financial reporting helps shareholders know the value of their equity and enhances the function of stewardship. Managers are accountable for protecting and enhancing the value of shareholders' equity and FVA causes a fundamental change in managers' perception of their duties (Barlev & Haddad, 2003). FVA helps bring transparency to financial reports. Financial statements based on FVA put the shareholders' equity as a focal point of interest. The authors' research methodology is primarily based on the guidelines, standards and observations of the FASB in the U.S. and is a qualitative study of it. They also based their paper on value relevant accounting research such as that done by Barth et al. (2001), Landsman (1986) and Amir (1983).

FVA also provides a complete disclosure and is compatible with transparency (Barlev & Haddad, 2003). The scholars suggest that accounting transparency means that financial statements of an organization should provide accurate, true and complete picture of its state of affairs including the financial statements. Financial statements are based on FVA provide transparent information. The income statement is based on the real economic values of the business activities while the statement of financial position reflects the fair values of equity, assets and liabilities of the organization. The importance of the FVA paradigm lies in its possible effect on current reporting modes.

When assets and liabilities are reported at FVA in the statement of financial position, it calls the attention of shareholders to the value of their equity and changes to it on a periodic basis because of the market mechanism. This helps enhance the role of stewardship in an organization. Managers will be accountable to safeguard the value of shareholders' wealth. Therefore, FVA reduces the principal–agent conflict and decreases agency costs. This helps in the effective management of an organization. Principals, i.e., shareholders want returns on their investment and agents (directors and managers) work more responsibly toward achieving it if accounting is based on FVA. Managers should use risk management techniques, such as hedging, and be able to analyze local and international environments. This will enable them to lead an organization effectively toward achieving organizational goals.

Penman (2007) mentioned that since investors are concerned with a firm's value and not costs, financial reporting should be based on fair value. Historical costs become irrelevant as time passes; thus, the fair value provides present information of financial position of an organization. It reflects true economic substance. Fair valuation works well with regard to both valuation and stewardship of an organization, such as an investment fund (Penman, 2007). But he has opined that fair valuation may not hold true when an organization holds net assets whose value comes from executing a business plan rather than fluctuations in stock prices, even when the exit prices are observable on active markets. In other words, whether FVA is better than historical cost for providing better information on shareholders' wealth is debatable. Thus, fair value will generate reverberation effects between the assessment of an organization's financial results and the market value of its assets and liabilities.

FVA has also affected the valuation of intangibles, such as goodwill, particularly in mergers and acquisitions. This will have an impact on shareholders' valuation. Lhaopadchan (2010) evaluated whether introducing FVA has contributed toward the intangibles, such as goodwill, being reflected at correct values in financial statements. In a broader sense, the question is whether it will lead to better representation to the stakeholders of a company's financials and it may, therefore, affect shareholder value. Goodwill impairment tends to be affected by managerial decisions and earnings management, but it is not clear whether it affects the decision-making of investors (Lhaopadchan, 2010). Moll (2004) suggested that value makes the world go round, especially the world of corporate law. Since shareholders desire to increase their wealth, the managers chase it and the investment community celebrates it. For a closed corporation, the measurement of fair value of its financial items is difficult, and yet more stakeholders seek to know about it.

Moll (2004) added that, although in a closed corporation the fair value buyout as a possible oppression remedy is considered a practical solution, it is difficult to agree what fair value means. There are differing opinions about the interpretation of fair value. It may mean 'fair market value' and will include the discount that fair market value analysis would apply. It also may be related to 'enterprise value,' in which case the business valuation of an entire organization can be performed and then the pro-rata shares of the minority shareholder in a closed corporation can be valued to arrive at the fair value of its shares.

Bratton (2001) considered that in the Enron fiasco, the traders abused FVA wherein over-the-counter derivative positions were 'marked to market'. No trading market set the derivative contract value at that time. This resulted in falsely increasing income and the shareholders' wealth, while the truth was far from this reality. Similarly, Enron used fair value to mark the rights under swap contracts based on the market, thereby distorting the income statement numbers. In other words, Enron scrupulously used the lack of accounting standards and regulations or lack of proper understanding of FVA, which resulted in a false increase in shareholder value. After some time, the false information was impossible to sustain or ignore and led to the end of Enron's story as the most admired company in the world and its eventual downfall. It is important for companies to use FVA by following the regulations, laws and standards set in this regard. Regulations, such as the Sarbanes-Oxley Act (SOX) in the U.S., bring an element of transparency to corporate governance and the use of FVA.

2.7 Hypothesis Development

Based on the research gaps and research questions evaluated in the introduction, this research focuses on four main issues. The first is the degree to which financial statements will be affected by a change from the fair value basis to historical cost basis. The second is that when the FVA basis is used instead of the historical cost basis, whether the conclusions drawn from financial statement analysis will be different. The third is to evaluate whether Thai financial companies' financial ratio analysis is positively related to their efficiency based on their fair value. Firm efficiency is measured in this research using the DEA technique. The final objective is to determine whether there is a relationship between firm efficiency based on the DEA score with the stock returns of those firms.

2.7.1 Changes in the Value of Financial items when Financial Statements are Restated

This research predicts that the value of financial items will change when they are restated from historical cost basis to the FVA basis in Thai financial companies. With many countries harmonizing their accounting standards with that of IFRS, several companies are now reporting some of their financial items at fair value basis. Rodríguez-Pérez et al. (2011) conducted a study of 85 Spanish insurance companies and examined the effect of altering historical cost valuation to fair value basis for tangible fixed assets and financial investments. The DEA method was applied to measure relative efficiency based on both valuation bases. The input variables used were total expenses, land and buildings, financial investments in associated and group companies, other financial investments and other assets while the output variable used was total revenues. Rodríguez-Pérez et al. (2011) observed that the financial numbers in financial statements change when they are restated from historical cost basis to the fair value basis. The authors also suggested that the extent of this change can vary from company to company and the classes of assets. Elsiefy and ElGammal (2017) evaluated the effect of the fair value model under IAS 40, accounting for investment property, on the fundamental analysis of a Qatari real estate developer, the Barwa company. The research methodology included selection of the financial items in financial statements affected by the fair value model, restating them to recognize revaluation gains or losses and then comparing with the original values. Financial market and profitability ratios were used and computed over 17 consecutive quarters from 2007 to 2011 to evaluate the impact on accounting numbers. Elsiefy and ElGammal (2017) found that the choice of fair value basis instead of historical cost resulted in a small change in the balance sheet items but a significant change in the income statement items, particularly net income. All accounting ratios were affected by this change in the valuation basis. Interestingly, it was also found that the market price of shares was not affected by the firm's recognition of fair value revaluation gains and losses. Revaluation refers to the accounting process of adjusting a fixed asset's carrying amount for any change in its fair value. The study suggested that share prices may be driven by market factors and not necessarily by a company's specific characteristics. Hellman (2011) analyzed a sample of the 132 largest listed companies in Sweden and found that European Union (EU)-regulated adoption of IFRS in 2005 led to a significant increase in net profit and balance sheet numbers, although these increases were due to other standards not previously adopted by the Swedish standard setter. In Sweden, the IFRS was voluntarily adopted during 1991–2004 but firms used the flexibility offered by soft adoption to manage shareholders' equity and earnings upward. In other words, the author suggested that a change to the fair value basis resulted in less conservative valuation of assets, therefore leading to an increase in the reported values of assets and owners' equity. The author used an index of comparability (IC) to measure differences between the Swedish GAAP and IFRS. Based on the aforementioned theoretical and empirical supports, this research generates the following hypothesis:

H1: There are significant changes in the value of financial items when the financial statements of Thai insurance and banking companies are restated at fair value basis.

2.7.2 Financial Statements Analysis using DEA when Fair Value Accounting is applied

Hitz (2007) evaluated the decision usefulness of FVA from two conceptual perspectives: information and measurement perspectives. The author adopted an a priori economic analysis as the research methodology, meaning there is a possible use to conceptual reasoning on the desirability of financial reporting alternatives. The author found that comparative analysis of FVA with historical accounting yielded mixed results. His findings indicate that the decision relevance of fair value measurement can be justified from both perspectives, measurement and information, yet the conceptual case is not strong.

Ari and Yilmaz (2015) conducted a comparataive study of the advantages and disadvantages of historical cost accounting and FVA. The author studied the financial information obtained from both valuation bases in terms of reliability, relevance, comparability, transparency, intelligibility and timeliness. This study was conducted based on the past literature results. It was concluded that FVA and historical cost should be used in tandem to eliminate the disadvantages of both methods (Ari & Yilmaz, 2015).

Missonier-Piera (2007) studied the economic motives for revaluation of fixed assets in Swiss listed companies for the periods 1994, 1997, 2000 and 2004. The authors collected a data set manually from the annual reports of these firms available at the University of Geneva and Lausanne (Switzerland). The accounts of the firms, such as fixed assets, were revalued. The author suggested that in Switzerland, companies that restate assets to fair values are those that are more indebted and have less investment opportunities. His study concludes that restatement improves the perception of international stakeholders on the financial health of a company and, thereby, improves its borrowing capacity.

The research using DEA for financial statement analysis has mostly been directed toward two areas. The first is how companies maintain solvency and achieve a sound financial position. The other concerns the efficiency with which firms use inputs in the process of generating outputs. Chhikara and Rani (2012) applied the DEA technique to measure the technical efficiency, overall technical efficiency and scale efficiency of life insurance companies in India. The authors used the 'intermediation approach' to describe input and output variables for computing the life insurers' efficiency scores. The 'intermediation approach' assumes that the objective of an insurance company is to create output defined as investments and claims payments while using the liabilities including premiums, capital and labor as inputs. The authors were able to suggest the best and most inefficient insurers based on the efficiency scores. Only a few insurance companies, such as Max New York Life, LIC of India and SBI Life scored a perfect efficiency score of 1. The overall efficiency score of all life insurers was low, with an average efficiency score of 0.510.

There are few studies on conclusions obtained in terms of firm efficiency from financial statement analysis using DEA using fair value basis instead of historical cost. However, there has been an increasing use of FVA because of the adoption of IFRS by several countries. Sharma and Senan (2020) mentioned that IFRS 13 provides a single framework to measure fair value and associated disclosures. The authors studied the use of fair value measurement in Saudi Arabia and its expected impact on the insurance sector. The DEA method was used to measure insurance firms' efficiency based on historical cost and fair value basis. All (35) listed insurance companies in the Saudi stock market were considered in this study. The findings did not identify any major difference in the equity of insurance companies before and after the adoption of IFRS. Before the adoption of IFRS, insurance companies used historical cost basis while they used fair value basis after its adoption. The authors found that IFRS is more comprehensive than the Saudi standards and its adoption enhances the reporting standards of the companies.

Rodríguez-Pérez et al. (2011) analyzed a sample of 85 Spanish companies by restating the financial investments and tangible fixed assets to their fair values. The authors used DEA for both sets of data, historical cost and fair value, to analyze firms' efficiency and profitability. Input variables included in the DEA model were total expenses, land and buildings, financial investments in associated and group companies, other financial investments and other assets. Total revenues were considered as the output variable. It was found that when the companies change from fair value to historical cost basis, the efficiency may change for a few companies but not most. The overall ranking of the profitability and efficiency for these firms suggested that under both valuation bases, majority of the firms' rankings did not change except in a few cases. Considering the above theoretical and empirical support, the present research formulates the following hypothesis and subhypotheses:

H2: There are different conclusions drawn from financial statements analysis using DEA when fair value accounting is applied instead of the historical basis.

H2.1: There are changes in efficiency scores of Thai insurance and banking companies when fair value is applied instead of historical cost.

H2.2: There are changes in ranking based on the efficiency scores obtained of the Thai insurance and banking companies when fair value is applied instead of historical cost.

2.7.3 Financial Ratio Analysis and Firm Efficiency

There has been little research that compares the financial performance of firms obtained from FRA with fair value-based DEA scores, although studies have been conducted on how DEA may be better than or complement FRA in financial statement analysis. FRA is a popular and conventional technique for analyzing financial statements and is still used by many companies and financial analysts today. Halkos and Salamouris (2004) used ratio analysis and DEA in measuring the performance of commercial banks in Greece. The analysis included 18 banks for the year 1997, 17 banks for the year 1998 and 15 banks for the year 1999. The authors included interest expenditure, total assets, operating expenses and number of employees as input variables while net profit and interest income were used as the output variables in DEA. For ratio analysis, six financial ratios that reflected the most important dimension of banks' performance were used. They included return on equity, return on total assets, profit/loss per employee, net interest margin, efficiency ratio and return difference of interest-bearing assets. Results drawn from ratio analysis were compared with those obtained from DEA. It was found that the results from both were similar. The authors suggested that DEA can be used as either an alternative or complement to ratio analysis for the evaluation of an organization's performance. The authors also mentioned that the advantage of using DEA over the ratio analysis was that it provided an overall fair numerical score, ranking and efficiency improvement targets for each of the inefficient DMUs.

Chen and Ali (2002) studied the relationship between ratio analysis and DEA. This study did not have any visible variables; rather it presented mathematical properties that indicated the inherent relationships between input–output ratios and DMUs that comprise the frontier. The study found that financial ratio analysis failed to identify all dominating DMUs as DEA does. Financial ratio analysis of a single output to a single input did not capture the total performance of an enterprise. However, the study also highlights that the best-ranked performance by the ratio analysis is a DEA frontier.

Feroz et al. (2003) studied the U.S. oil and gas industry in undertaking the financial statement analysis using both ratio analysis and DEA. The input variables used in DEA were total assets, common equity, and costs while the output was taken as revenues. The liquidity ratios, performance ratios, and solvency ratios were considered for the purpose of FRA. The authors suggested that DEA might be superior to or at least complement the FRA. While the ratio analysis provides anecdotal information, DEA simultaneously measures the efficiency of firms. Based on the aforementioned theoretical support, this research formulates the following hypothesis:

H3: There is a positive relationship between Financial Ratio Analysis (FRA) and fair value based DEA efficiency of companies.

2.7.4 DEA and Stock Returns

Kirkwood and Nahm (2006) analyzed the relationship between the efficiency of Australian banks and their stock returns between 1995 and 2002. The efficiency was measured using DEA. The authors proposed two models, model A for determining banking service efficiency and model B for determining profit efficiency. The inputs used in model A were the number of full-time equivalent employees, property, plant and equipment and interest-bearing liabilities. For this model, interest-bearing assets and noninterest income were chosen as the output variables. Input variables used for model B were the number of full-time equivalent employees, property, plant and equipment, and interest-bearing liabilities while output variables used was profit before tax and abnormal items. The stock return comprised the return from movements in stock price and the dividend return. The findings suggested that the changes in efficiency of these firms led to changes in stock returns as well (Kirkwood & Nahm, 2006). The scholars argued that the efficiency of the sample of banking companies in Australia under study was reflected in their stock price.

Chen (2008) evaluated whether DEA portfolios created higher returns than the market index in Taiwanese firms. These listed firms were considered from 8 major industries in Taiwan namely plastics, electronics and machinery, paper and pulp, cement, food, textiles, construction, and banking and insurance. The study was conducted using data obtained from the second quarter of 2004 to the second quarter of 2007. Sales cost, average asset, and average equity were used as input variables while net income, operating income and revenues were chosen as the output variables. DEA was used to analyze the efficiency of firms and prepare portfolios by selecting stocks of the companies with high efficiency. The results showed that the size effect (small-size firms or large size ones based on market equity) does not matter as a stock selection strategy for Taiwanese firms listed in the stock market. The findings also showed that the DEA portfolios achieved higher returns. Fadzlan and Muhd-Zulkhibri (2007) used DEA to evaluate the long-term trend in efficiency change of Singapore commercial banks. The authors also used panel regression analysis to analyze the relationship between share performance and cost efficiency. The scholars considered the period from 1993 to 2003 for this purpose. For DEA, input variables chosen were total deposits and interest expenses while interest income and total loans were used as output variables. They have suggested that the small commercial banks performed better than the larger ones during this period. Furthermore, the change in stock prices of the cost-efficient banks slightly outperform that of the inefficient ones, suggesting there is positive relationship between efficiency and stock returns (Fadzlan & Muhd-Zulkhibri, 2007). The inclusion of age and total assets as control variables in this study aligns with established practices in financial research. For instance, Qaisi et al. (2016) and Muslih and Marbun (2020) demonstrated the relevance of firm size and age in influencing stock returns. Consistent with these studies, total assets are included to account for the impact of company size, and age is used to control for the effects of organizational maturity on financial performance. These variables have been widely recognized as essential factors in similar analyses of organizations, providing a solid foundation for their inclusion in this study. Based on the empirical evidences, the following hypothesis is proposed:

H4: There is a positive relationship of DEA score and stock’s returns.

2.8 Conceptual Model

Total expenses, available-for-sale-investments, held-to-maturity investments and general (other) investments are input variables while total comprehensive income is the output variable in DEA. The results from DEA are then compared and evaluated with the FRA and firm stock returns.

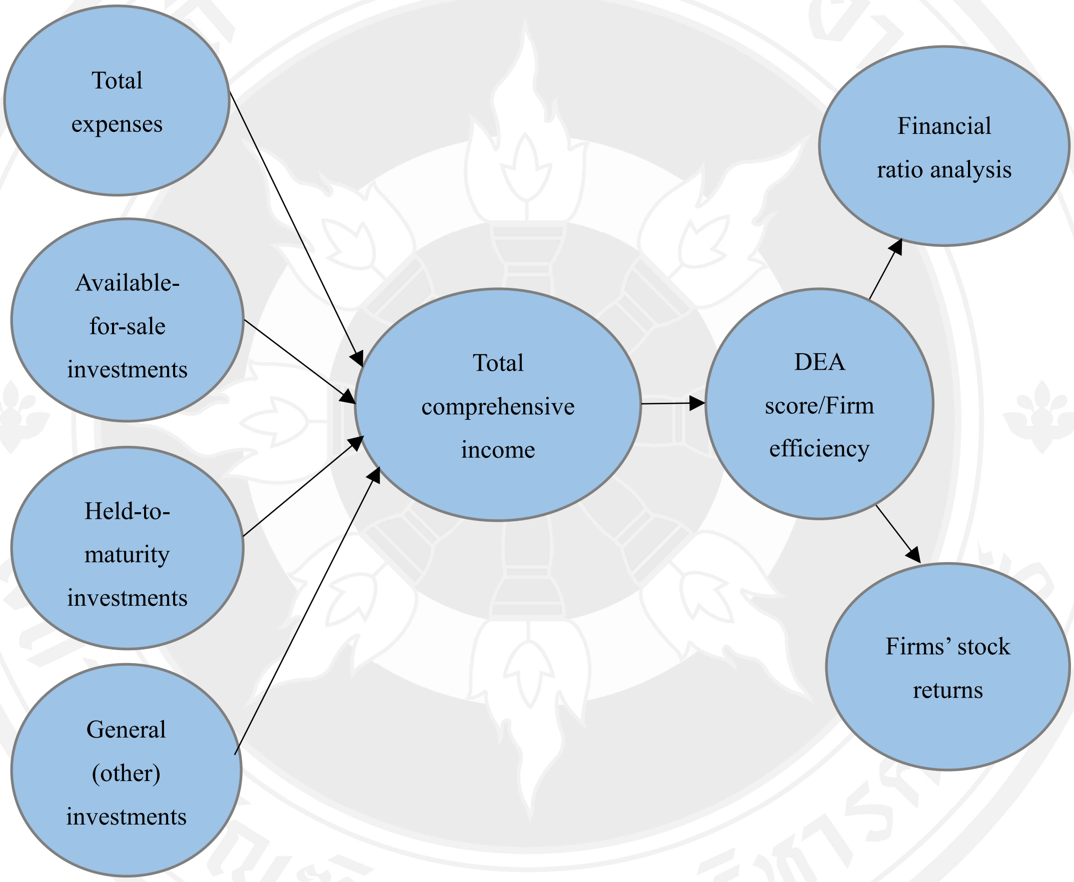

Figure 2.4 Conceptual Model

CHAPTER 3

RESEARCH METHODOLOGY

Sections 3.1 to 3.6 are dedicated to the research methodology employed in this research. This chapter elucidates the methodological choices in this study, ensuring the validity and reliability of the results obtained. It presents the research context (section 3.1), population and sample (section 3.2), data collection (section 3.3), analytical steps and measures (section 3.4), data analysis (section 3.5) and statistical methods employed (section 3.6). The data analysis section has two subsections on DEA (subsection 3.5.1) and TR (subsection 3.5.2). By explaining the research process in detail, this chapter ensures that the result, analysis and conclusion in subsequent chapters are clear, robust and aligned with the research objectives.

3.1 Research Context

The selection of a research method is pivotal as it affects the quality and relevance of the findings. This study employs a quantitative research approach and uses DEA, FRA and analysis of total stock returns. The rationale behind adopting a quantitative method stems from the study's objective to derive clear, empirical conclusions based on numerical data. Furthermore, the research utilizes secondary data obtained from the annual reports of Thai banking and insurance companies (PCL). The benefits of accessing data from annual reports is that it is accurate and reliable, as it has been prepared by company’s accountants and audited by certified auditors. By tapping into already available financial information, the study ensures comprehensive coverage while maintaining data integrity.

3.2 Population and Sample

The research involves taking financial information from financial statements and annual reports of 15 Thai insurance companies and 11 Thai banking companies. The sample of these companies has been selected as they are PCLs and all relevant financial information needed for this research is likely to be obtained from their annual reports. The first word in capital letters of these companies mentioned below is their stock symbol or ticker, and these symbols will be used in this research. The companies are as follows:

Insurance Companies:

1) AYUD - Allianz Ayudhya Capital Public Company Limited

2) BKI - Bangkok Insurance Public Company Limited

3) BLA - Bangkok Life Assurance Public Company Limited

4) BUI - Bangkok Union Insurance Public Company Limited

5) CHARAN - Charan Insurance Public Company Limited

6) TIPH - Dhipaya insurance Public Company Limited

7) INSURE - Indara Insurance Public Company Limited

8. Krung-AXA* - Krungthai-AXA* Public Company Limited

9) KWI – KWI Public Company Limited

10) MTI - Muang Thai Insurance Public Company Limited

11) NSI - Nam Seng Insurance Public Company Limited

12) SMK - Syn Mun Kong Insurance Public Company Limited

13) TSI - Thai Setakij Insurance Public Company Limited

14) TVI - Thaivivat Insurance Public Company Limited

15) NKI - The Navakij Insurance Public Company Limited

Banking companies:

1) BAY - Bank of Ayudhya Public Company Limited

2) BBL - Bangkok Bank Public Company Limited

3) CIMBT - CIMB Thai Bank Public Company Limited

4) KBANK – Kasikorn Bank Public Company Limited

5) KKP - Kiatnakin Phatra Bank Public Company Limited

6) KTB - Krung Thai Bank Public Company Limited

7) LHFG - LH Financial Group

8) SCB - The Siam Commercial Bank Public Company Limited

9) TCAP - Thanachart Capital Public Company Limited

10) TISCO - Tisco Financial Group Public Company Limited

11) TTB - TMBThanachart Bank Public Company Limited

The reasons for selecting these companies in the financial sector were elucidated in section 1.7 ‘Scope of Study’. Scholars, such as Zhu et al. (2020), Sharif et al. (2019), Novickytė and Droždz (2018), Kao and Liu (2014), and Sturm and Williams (2004), studied the financial sector to understand firm efficiency and performance. Their rationale for studying this sector was that it was important to the economic development of a nation and less research has been conducted with regard to its efficiency using the DEA method. The present research as part of this dissertation is comprehensive, as it analyzes the performance and efficiency of subsectors of the financial sector i.e., the banking and insurance companies. Previous research by other authors normally studies either banking or insurance or other financial companies but not both sectors in a single research study.

3.3 Data Collection

Essential financial information required for this research has been obtained from the official websites of selected insurance and banking companies. The methodology employed a range of research instruments, including official websites, the websites of The Securities and Exchange Commission Thailand (SEC), the Stock Exchange of Thailand (SET), settrade.com website, Bloomberg financial markets terminal and LSEG Refinitiv Eikon financial database. These websites/financial databases are used to gather financial information including the annual reports. The annual reports of fifteen (15) Thai insurance PCL are obtained and information from five financial years, from 2015 to 2019, is taken and analyzed. Similarly, the annual reports of a sample of eleven (11) Thai banking PCL are obtained and information of the most recent five financial years is taken and analyzed.

Specifically, the variables used in the DEA method, namely, total expenses, fair values and historical cost values of available-for-sale investments, held-to-maturity investments, fair values and historical cost values of general (other) investments - net and total comprehensive income, have been obtained from annual reports (including notes to the financial statements). More details on these variables and why they have been selected for this research were discussed in section 3.5 data analysis.

The financial ratios included in this research are insurance-specific and bank-specific. These ratios are obtained from financial statements in the companies' annual reports and Refinitiv Eikon. For the purpose of analyzing the firms' stock returns, the total stock returns or TRs of each insurance and banking company have been obtained from the Refinitiv Eikon database. The data were then evaluated and compared with the information obtained from fair-value-based DEA scores of companies as demonstrated in the 3.4 analysis steps and measures in this research.

There are two reasons for using the financial information or data from FY 2015 to FY 2019. At the time of writing the dissertation and commencing with the research, 2020 had already commenced. Thus, the financial information of five financial years (FYs) from 2015 to 2019 was taken into consideration. Another reason for considering financial information for these financial years is that this was prepandemic data. The pandemic started in 2020 and several firms' operational efficiency was adversely affected globally and in Thailand. The financial information for FYs 2020 to 2022 was not considered ,as this could have led to unreliable or biased results and conclusions. Furthermore, some of the input variables used in DEA are investments, such as available-for-sale investments, held-to-maturity investments. During the pandemic, these investments' returns would have been adversely affected, leading to an impact on total comprehensive income, which is the output variable. While both large and small firms' financial performance were adversely affected adversely during the pandemic, it is the smaller firms that would have had more financial issues. Therefore, analyzing these firms in a competitive market during the pandemic could have produced unreliable results.

Data of the five financial years (2015 to 2019) should be sufficient to provide comprehensive information and the related analysis should be adequate to determine results and recommendations. Thai banking and insurance companies started to adopt IFRS standards on and after January 1, 2012. Thus, it is better to take data after 2012 or so. Few firms have amalgamated or merged, so it would be suitable to collect the data for the mentioned financial years to conduct a reliable and consistent analysis within a five year time frame. Furthermore, these financial years provide consistent and complete data required for research to carry out an in-depth panel data analysis.

3.4 Analytical Steps and Measures

The analytical steps shown below vividly bring out restating financial statements items from historical costs to the fair value and then comparing the change in numbers and DEA scores. Furthermore, these steps outline the comparison and evaluation of relationship of fair-value-based DEA scores with the FRA and companies' stock returns. The steps are as follows:

1) Historical-cost-based financial statements are restated to fair-value-based financial statements.

2) Historical-cost-based financial statements are compared with fair-value-based financial statements.

3) The historical cost-based DEA scores and fair value-based DEA scores are separately analyzed.

4) The DEA scores of companies based on historical cost are evaluated and compared with DEA scores based on the fair value.

5) Benchmark the firms and compare the less efficient firms with the benchmark that may lead to improvement in their future efficiency.

6) The research compares the fair-value-based DEA scores with the companies' financial ratio analysis results and evaluates if they are positively related.

7) Fair-value-based DEA scores will also be compared and evaluated with the firms' stock returns to explore if there is a positive relationship between the two.

These analytical steps performed in this research help contribute to the efficiency and growth of Thai insurance and banking companies.

The analytical steps on the next page illustrate the objective and scope of the research.

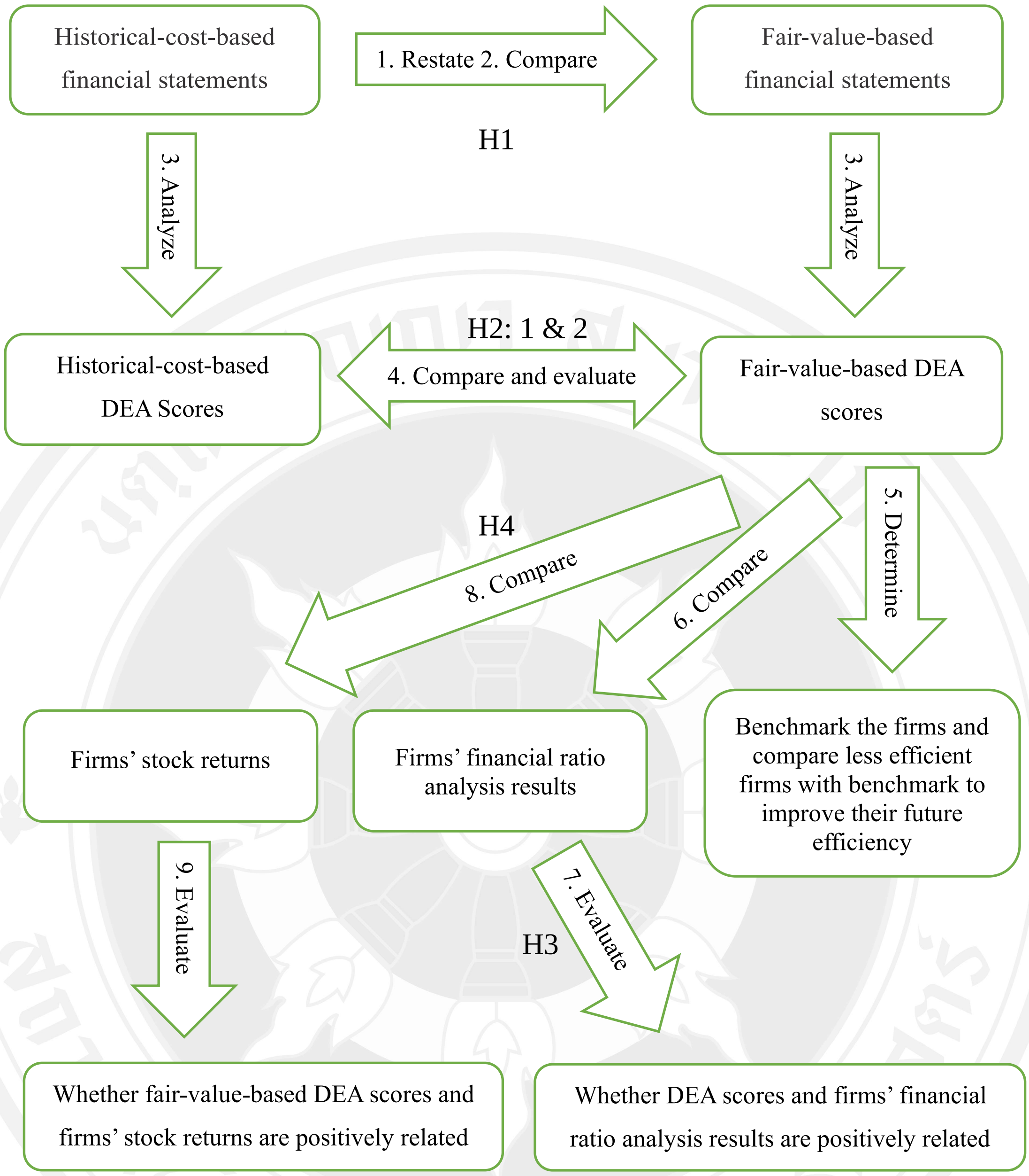

Figure 3.1 Analytical Steps

The measures and methods used in this research include the following:

1) The financial items are compared based on historical cost with that of fair value to test Hypothesis 1 (H1). All the financial information of variables has been collected and systematically put in tables for this purpose. The variables/financial items include total comprehensive income, total expenses, available-for-sale investments - cost (historical cost), available-for-sale investments - fair value, held-to-maturity

investments - amortised cost (historical cost), held-to-maturity investments - fair value, general (other) investments (net) - cost (historical cost) and general (other) investments (net) - fair value.

2) Efficiency and profitability are used to determine the financial items to be used as input and output variables for the DEA analysis. DEA is used to obtain an overall score from these variables. The historical cost and fair value of these financial items are considered separately to arrive at separate overall DEA score based on each valuation basis. To evaluate Hypothesis 2.1 (H2.1), a pair-wise comparison is performed of the DEA scores of historical costs and fair value.

3) It is also determined if the financial companies' ranking changed when DEA based fair value scores were used, to evaluate Hypothesis 2.2 (H2.2).

4) Financial ratio analysis is performed for the chosen companies. Financial ratio analysis of the financial items for each company is identified in the Du Pont analysis, namely the equity multiplier, asset-turnover and profit margin ratios. These ratios are included to evaluate the profitability performance, efficiency, leverage or solvency, liquidity and risk of the companies. Insurance-specific financial ratios that are obtained and evaluated are ROA, ROE, Loss Ratio, TAT, leverage ratio, CAR and current liquidity. Bank-specific financial ratios that are obtained and evaluated are net interest margin (NIM), ROA, ROE, efficiency ratio (ER), leverage ratio, Tier 1 risk-adjusted capital ratio (Tier 1 RAC) and NPLs. These ratios have been discussed in detail above in section 2.4.2 'Tools of Financial Statement Analysis' and are based on the literature review.

This will help in comparing and determining whether a relationship exists between FRA and the efficiency of companies obtained from DEA fair value basis, to evaluate Hypothesis 3 (H3).

5) The relationship between the fair value-based DEA scores and the stock's returns of companies has been tested and evaluated. For this, TR has been used for determining the total stock returns, to evaluate Hypothesis 4 (H4).

3.5 Data Analysis

3.5.1 DEA Analysis

DEA software DEAP and SPSS software were used to research and test the hypothesis. In the result and analysis, for computing the measures such as standard deviation, mean, median, skewness and kurtosis and the Kolmogorov-Smirnov (K-S) test, SPSS software was used. These measures will help in determining the characteristics of variables or financial items, such as its normality and dispersion of the variables from the mean.

DEA has been effectively utilized for the testing and comparative analysis of data in Hypotheses H2.1, H2.2, H3, and H4. It is a powerful tool for analyzing efficiency. The framework has been adopted from multiple-input, multiple-output production functions and has been applied in many industries such as banking, insurance, hospitality, construction, real estate and education. In the DEA model for insurance and banking companies, there were four input variables: total expenses, available-for-sale-investments, held-to-maturity investments and general (other) investments - net and one output, namely total comprehensive income. Please refer to table 3.1 after the end of the next paragraph.

Total comprehensive income and expenses were taken from the statement of comprehensive income of these companies. The fair values and historical cost information of a) available-for-sale investments b) held-to-maturity investments c) general (other) investments - net were extracted from the statement of financial position and notes to financial statements in the companies' annual reports. The cost of available-for-sale investments, amortized cost of held-to-maturity investments and cost of general (other) investments - net available in annual report can be considered as historical cost. Therefore, there are two sets of data obtained for some of these financial items, the one based on historical cost and the other based on fair values. This will help analyze and test hypotheses 1 and 2.

Thai banking and insurance companies state the available-for-sale investments at fair value. Changes in the fair value are recorded in other comprehensive income. When such investments are sold, the changes in fair value will be transferred to be recorded in profit or loss. The historical cost of these investments is normally disclosed in the notes to financial statements. For few companies where historical cost of available-for-sale investments is not available, the fair value of such investments is adjusted based on the unrealized gain/loss that is recorded in other components of equity to arrive at the historical cost. Investments in held-to-maturity investments are recorded at amortized historical cost. The premium/discount on such investments is amortized/accreted by the effective rate method with the amortized/accreted amount presented as an adjustment to the interest income. The fair value of held-to-maturity investments is disclosed in notes to the financial statements. Such investments are classified as held-to-maturity when the company has the positive intention and ability to hold them to maturity. Other (general) investments are recorded at cost with their fair value generally disclosed in notes to the financial statements. For few companies, where fair value of held-to-maturity investments and other (general) investments are not specifically disclosed, the notes to financial statements indicate that the difference between the two valuation bases is insignificant. Consequently, in these cases, the historical cost and fair value are considered equivalent.

Table 3.1 Input and Output Variables used in DEA Model

Input Variables/Financial Items	Output Variable
Total expenses	Total comprehensive income
Available-for-sale investments	
Held-to-maturity investments	
General (other) investments - net	

The input variables chosen for insurance and banking companies are total expenses, available-for-sale investments, held-to-maturity investments and general (other) investments-net. The variable ‘total expenses’ for an insurance company includes gross claims less claims recovered from reinsurance company, commissions and brokerage, other underwriting expenses and operating expenses. The variable ‘total expenses’ for a banking company refers to interest expenses and noninterest expenses. Interest expenses include interest on deposit and interest on other borrowings. Noninterest expenses include labor and related expenses, dealer trading account loss, investment securities losses, unrealized losses, other unusual expense and other expense. The variable ‘general (other) investments-net’ refers to the investments in nonlisted equity securities net of allowance for impairment (if any). The output variable chosen for insurance and banking companies is the total comprehensive income.

Expenses are incurred to generate total comprehensive income; thus, total expenses were chosen as one of the inputs. Available-for-sale investments, held-to-maturity investments and general (other) investments-net (as inputs) form a substantial portion of the total assets of an insurance and banking company and help increase its total income (total comprehensive income as output). The choice of input variables and output variable mentioned in Table 3.1 is influenced by the literature on DEA applications for financial statement analysis. Therefore, apart from the researcher’s judgment, these variables were been included based on the literature reviews conducted by different management scholars, such as Zhu et al. (2020), Novickytė and Droždz (2018), Kaffash and Marra (2017), Rodríguez-Pérez et al. (2011) in the past.

The choice of variables or the reasons for excluding other variables or financial items in this study can be clarified through the analysis of the past literature elucidated henceforth. It is intriguing to evaluate the wide variety of inputs and outputs adopted by different authors in their research to test their hypotheses and arrive at suitable recommendations. The reason for this seems to be different objectives and scope of research of these authors. Different research objectives and scopes will require different variables, both inputs and outputs, to arrive at suitable conclusions. Additionally, the researchers are from different economic regions and countries, which may influence the selection of variables appropriate for their respective regions.

Hill and Kalirajan (1993) used investments, cost of materials and personnel expenses as input variables, while Piesse and Thirtle (2000) used operating expenses and fixed assets as part of their research. In the banking sector, Avkiran (2015) used interest expenses, personnel expenses and other operating expenses as input variables. In the insurance sector, Cummins et al. (2004) included labor, financial debt capital and equity capital as inputs, while Wanke and Barros (2016) considered current assets, real assets, long term fixed assets, and other long term assets as input variables.

In the banking sector, Sathye (2001) used loans and demand deposits as output variables for Australian companies, while Avkiran (2009) considered interest income and noninterest income as outputs. For an insurance sector study in Brazil, Wanke and Barros (2016) analyzed output variables as direct premium, insurance premium, retained premium and earned premium. In the money market fund group, Murthi et al. (1997) considered returns as output variable, while Basso and Funari (2001) included expected return and stochastic dominance as the outputs in their research.

Yang and Morita (2013) suggested inputs and outputs for the banking sector should be based on four perspectives: shareholder, customer, management and employee. According to the shareholder perspective, the authors specified input as efficiency and output variables as soundness, credit quality, profitability, and valuation; from the customer point of view, the inputs were credit quality, profitability, valuation and outputs were soundness and efficiency; the management perspective included efficiency, valuation as inputs and soundness, credit quality, profitability as outputs; and from the employee side, input variables were credit quality, valuation and output variables were soundness, profitability and efficiency. Rodríguez-Pérez et al. (2011) considered expenses and assets as input variables and revenues as the output variable in the insurance sector. Their view was that the assets, such as investments, are used to produce investment income. Therefore, the former is taken as an input variable while the latter is considered as a part of output. Also, the authors suggest that expenses, such as general and administrative expenses, are used as resources to generate premiums. Therefore, expenses are considered inputs while premiums are considered part of othe utput variable. This discussion clarifies the choice of variables in this study.

Available-for-sale investments in Thailand can generally include government and state enterprise securities, private enterprises debt securities, foreign debt securities, domestic equity securities and foreign equity securities. Held-to-maturity-investments in Thailand can generally include government and state enterprise securities, private enterprise debt securities, foreign debt securities and deposits at financial institutions. Therefore, available-for-sale investments and held-to-maturity-investments in Thailand form a major chunk of the total investments.

It would be prudent to explain the meaning of available-for-sale investments, held-to-maturity and held-for-trading investments/securities. Accounting standards require that organizations classify any investments in equity or debt securities when they are purchased into available-for-sale, held-for-trading or held-to-maturity.

Available-for-sale investments are those investments that do not qualify as held-for-trading or held-to-maturity investments. An example is investment securities purchased by a company for the purpose of eventually making a capital gain. Held-for-trading securities are held by a firm for short period of time and then sold. An example is marketable securities that the company intends to sell within a year and make a profit out of it. On the other hand, held-to-maturity investments are securities that a firm intends to hold until the maturity date. They are noncurrent assets. Normally, equity securities cannot be classified as held-to-maturity securities as they don't have a maturity date. An example of held-to-maturity securities is the certificates of deposit (CD).

An example of simple DEA with one input and output is illustrated through the graph below:

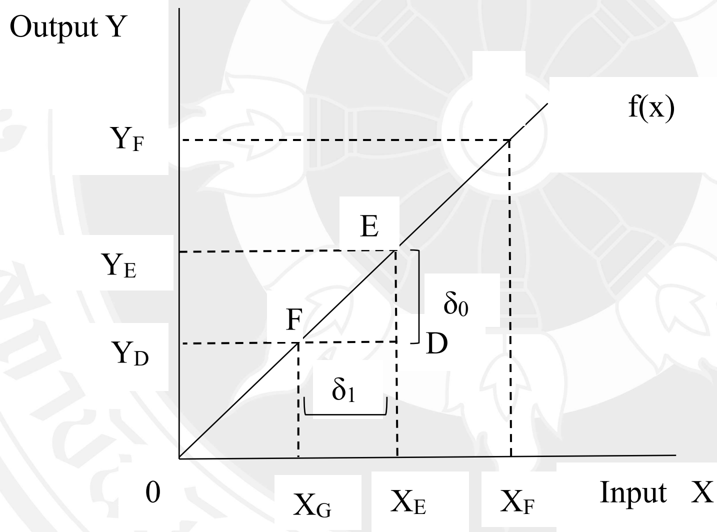

Figure 3.2 DEA Analysis

The X-axis represents the input variable and the Y-axis represents the output variable. The points E and F represent the most efficient firms among a set of observations. This curve f(x) from 0 and connecting E and F is called the efficiency frontier as it shows the interpolation of the most efficient combinations of input and output. Firm D is inefficient because its input is more (X_E) and its output is less (Y_D), than those of the firms on the efficient frontier. There are two ways for it to be efficient:

1) Firm D should improve its output by δ_0

$$\alpha = \frac{Y_E/X_E}{Y_D/X_E} > 1$$

Here, α represents the factor by which Firm D's output should be increased so that it becomes fully efficient. This approach is called the output-oriented approach because it focuses on improving output.

OR

2) Firm D should decrease its input by δ_1

$$\beta = \frac{Y_D/X_G}{Y_D/X_E} > 1$$

Here, β represents the factor by which Firm D's input should be decreased so that it becomes fully efficient. This approach is called the input-oriented approach because it focuses on decreasing input and maximizing efficiency.

An output-oriented approach and constant returns-to-scale has been assumed in this research. The general DEA Model is:

Max α_S

$$\sum_{k=1}^{K} y_m^k \geq \alpha_s y_m^s$$

where $m = 1, \ldots, M$

$$\sum_{k=1}^{K} x_n^k \leq x_n^s$$

where n = 1,…..,N and k = 1,….,K

and, α_s= efficiency score of unit *s*. It adopts values greater than or equal to 1;

α =1 indicates that the unit is on the efficient frontier;

k = 1,……,K are the observations or DMUs analyzed;

m = types of output obtained;

n = types of inputs used;

y_m^k= amount of output m obtained by unit k;

x_n^k = amount of input n used by unit k;

DEA scores were computed using historical cost values of the input variables for all selected companies, and then these calculations were replicated using the fair values of these input variables. The DEA scores obtained from the two valuation bases were compared and analyzed for relative efficiency and the efficiency change of companies. In DEA, the technical efficiency (TE) score is a measure used to evaluate the comparative (relative) efficiency of DMUs. TE refers to how well a DMU utilizes its resources (inputs) to produce output/s, given the existing technology. TE can be further decomposed into two types: pure TE and scale efficiency. Pure TE evaluates managerial and operational efficiency of a DMU, without considering its size or scale effects. Scale efficiency relates to the size or scale at which a DMU operates. It measures whether a DMU is operating at an optimal scale – that is, whether it is too large or too small given its current production technology. DMU refers to an organization or division (subunit) within an organization under consideration for its efficiency. The TE scores typically range from 0 to 1. For this research, a TE score of 1 is considered the best, meaning that the DMU is the most efficient among other DMUs (i.e., it is on the efficiency frontier), given its inputs and outputs; whereas a TE score of 0 means the DMU is the least efficient compared or relative to its peers. In other words, the technical efficiency of DMUs can have a score between 0 and 1, with 0 representing the least efficient firm, while the higher the score, the better is the relative efficiency of a DMU, with a maximum score of 1. A TE score of < 1 suggests that the DMU is not operating at the maximum efficiency level and has room for improvement. For example, if an organization or DMU has a TE score of 0.4, this indicates that its efficiency is significantly lower than the most efficient DMUs. To reach the optimal efficiency level (TE score of 1), as achieved by the best-performing DMUs, it must improve its efficiency. This improvement could be conceptualized as enhancing its output by 60% without increasing inputs, or reducing its inputs by 60% without decreasing outputs, to match the efficiency level of those on the efficiency frontier. There is no formal categorization as to what is strictly considered satisfactory or unsatisfactory efficiency; however, the TE score does suggest how much more the DMU can improve to reach the efficiency frontier. Such a categorization, if any, may depend on a researcher's analysis and research context.

In summary, the steps in the DEA calculation are as follows:

1) Identification of DMUs, which are insurance and banking companies.

2) Selection of input and output variables. The input variables are total expenses, available-for-sale investments, held-to-maturity investments and general (other) investments-net. The output variable is the total comprehensive income.

3) Data on the inputs and outputs for each DMU have been gathered. These data are accurate and comparable across all units.

4) An appropriate DEA model is chosen. The CRS output-oriented model has been selected.

5) Data have been normalized, where required, to ensure comparability. For instance, if there is negative value of output variable, they have been normalized.

6) Using DEA software DEAP 2.1, the comparative (relative) efficiency scores of each DMU have been computed. This involves solving linear programming problems that compare each DMU against a 'best practice' frontier made up of the most efficient DMU/s.

7) Relative efficiency score of each DMU range between 0 and 1. A score of 1 indicates a DMU is fully efficient (on the efficiency frontier), while scores less than 1 indicate relative inefficiency.

8) These efficiency scores are analyzed to identify which DMUs are performing well and which are not. This can also help to identify best performing DMU/s and improvement required for less efficient ones.

9) The results obtained can help stakeholders such as managers, investors and analysts in managerial and investment decision-making.

DEA is a comparative method. It does not provide an absolute measure of efficiency but rather compares each DMU against the best performer/s in the group. This comparative approach is what makes DEA a valuable tool for identifying best practices and areas for improvement.

The skewness and kurtosis of all the descriptives, such as total expenses and total comprehensive income, will be measured to determine the degree of symmetry. The K-S test will also be conducted for all the variables mentioned above in the DEA model, to determine whether significance is close to zero or not. The K-S test examines if scores are likely to follow a certain distribution in a given population. A p-value of less than 0.05 is statistically significant and indicates that the observed data/variable differ greatly from the normal distribution in the population. In other words, the above measures will help determine whether the data are normally distributed. This will determine whether using a nonparametric technique, such as DEA, is the appropriate technique for financial statement analysis.

3.5.2 Total Return

TR measures the market performance of a stock that includes its price movements and dividend payments. It assumes that the dividends are reinvested. It can also include the rights offering to the current shareholders. It is a useful measure as it states what the investors are getting back from investing in the firm. In other words, it is a strong measure of an investment's overall performance. While it is most commonly used for equity, the total TR or total return index (TRI) can also be determined for bonds by assuming that all coupon payments and the redemptions are reinvested back into the bond.

For example, if a security gives 15% TRs in a year, itmeans that the original value of security increased by 15% due to a price increase and dividend distribution for stock or interest payment for bonds. The Refinitiv Eikon financial database can be used to obtain TRs of firms.

TR may be better than other methods, such as the annual yield for analyzing security's return. This is because it takes into account both the security price appreciation/decline and the annual yield for a period under consideration. This provides a better picture to the investors and stakeholders toward the value of their investment. In this study, fair value-based DEA scores of firms have been compared with the TR of firms.

TRI can be measured for an index also. Standard & Poor's 500 index (S&P 500) and Dow Jones Industrials Return Index (DJIRI) are well-known TRI examples.

3.6 Statistical Methods Employed

Descriptive statistics or descriptive analysis, such as standard deviation, mean, median, minimum and maximum, are used to analyze each variable used (such as available-for-sale securities), its dispersion or spread from the mean and to examine if there are changes in numbers on restatement. Skewness and kurtosis are determined and the KS test is performed for all the variables/financial items, such as total comprehensive income, total expenses, available-for-sale investments - cost (historical cost), available-for-sale investments - fair value, held-to-maturity investments - amortised cost (historical cost), held-to-maturity investments - fair value, general (other) investments (net) - cost (historical cost) and general (other) investments (net) - fair value. Skewness and kurtosis of variables are determined to ascertain the symmetry or lack of it. The KS test is also used for all the variables, such as total comprehensive income, total expenses, available-for-sale investments - historical cost, available-for-sale investments - fair value, held-to-maturity investments - historical cost, held-to-maturity investments - fair value, general (other) investments (net) - historical cost, and general (other) investments (net) - fair value to determine whether the variables follow a normal distribution or not.

Although some of the statistical methods used in the hypothesis testing were mentioned in section 3.4 analytical steps and measures and section 3.5 data analysis, this section explains their use in detail for each hypothesis.

There are four hypotheses to be tested to answer the research questions posed in chapter 1.

H1: There are significant changes in the value of financial items when the financial statements of Thai insurance and banking companies are restated at fair value basis.

At the outset, descriptive analysis has been undertaken to observe changes in the value of financial items when financial statements of Thai insurance and banking companies are restated at fair value basis. The magnitude of the mean differences will be presented and explained. To test whether there has been a significant change on restatement, a paired sample t-test or a Wilcoxon signed-rank test will be performed after determining whether the data meet the assumptions of parametric tests. A paired sample t-test will be used if data are normally distributed (parametric); otherwise, a Wilcoxon signed-rank test will be suitable for the data that are not normally distributed (nonparametric).

H2: There are different conclusions drawn from financial statements analysis using DEA when fair value accounting is applied instead of the historical basis.

H2.1: There are changes in efficiency scores of Thai insurance and banking companies when fair value is applied instead of historical cost.

H2.2: There are changes in ranking based on the efficiency scores obtained of the Thai insurance and banking companies when fair value is applied instead of historical cost.

The nonparametric technique, the DEA, will be used for this purpose. The use and benefits of DEA have been clearly established earlier in 'section 2.4.3 Use of DEA in Financial Statement Analysis.' Specifically, the DEA CCR (Charnes, Cooper and Rhodes) model will be used for measuring total efficiency scores. The comparison between historical cost and fair value efficiency scores will be obtained based on their respective scores from DEA CCR model for testing Hypothesis H2.1. The simple observation method and Wilcoxon signed-rank test will be used for this purpose. To test and analyze Hypothesis H2.2 (H2.2), the insurance companies will be ranked separately based on DEA scores obtained of the two valuation basis, to evaluate whether there were any changes in their ranking. The simple ranking method based on the descending order of firm efficiency scores obtained will be used. Malmquist DEA will also be employed to evaluate the efficiency change and aid in testing Hypothesis H2.2.

H3: There is a positive relationship between Financial Ratio Analysis (FRA) and fair value based DEA efficiency of firms.

The financial ratios mentioned in ‘section 3.4 Analytical steps and measures’ will be used. These ratios will be contrasted and evaluated with fair value-based DEA scores. Statistical methods that will be used are rank normalization method, Spearman’s rank correlation and Wilcoxon rank signed test.

Rank normalization is a nonparametric method that can transform raw data into a ranked scale. It is a way of normalizing data and, in the context of financial ratios, it can generate a cumulative score (rank) by adding the computed rank of each ratio of a firm. Likewise, cumulative scores of other firms can be obtained. This score/rank provides a standardized measure of performance and helps compare the financial performance of firms. This method can use MS Excel. Kane and Meade (1998) have used this method in financial ratio analysis. The authors used this technique to transform financial ratios into scaled rank and evaluate relationship with stock returns. It was suggested that this method was reliable and had more explanatory power than the untransformed ratios. Soloman and Sawilowsky (2009) studied and analyzed the normalization methods, such as Rankit and emphasized the importance of normalizing data using the right method for accuracy of result. The rank normalization method has also been used in management and marketing research.

To evaluate for correlation between the FRA rank and fair value-based DEA rank, Spearman's rank correlation will be computed. It is used for nonparametric data and is suitable for analyzing the relationship between two ranked variables. Its correlation coefficient is denoted by ρ (rho). The of ρ values range from -1 to +1 where -1 indicates a perfect negative correlation, 0 refers to no correlation and +1 shows a perfect positive correlation. A value >0.5 indicates a strong positive correlation, between 0.3.and 0.5 refers to a moderate positive correlation and 0 to 0.3 means a weak negative one. Similarly, <-0.5 represents a strong negative correlation, between -0.5 and -0.3 refers to moderate negative correlation and between -0.3 and 0 as mild negative one. The formula is:

$$\rho = 1 - 6\Sigma d^2 / n(n^2-1)$$

where

d = the difference between the ranks of each pair of data

and, n = the number of data pairs

The Wilcoxon signed rank test will also be used. It is a nonparametric hypothesis test to compare two paired samples. It is a nonparametric equivalent of the parametric paired t-test. It helps determine whether the significance of the difference between the medians of related samples . If the level of significance is preset at , for example, 0.05, and the 2-tailed asymptotic significance (Asymp. Sig (2-tailed)) derived from this test is 0.20, it means there is insufficient evidence to conclude that there is a significant difference between the paired samples. If the z score obtained from this test is negative at -0.42, it means that the first sample rank was lower than the second sample rank, on average. If the z score was positive at +0.45, it means the opposite. However, the z score should be seen in the light of asymptotic significance (2-tailed) to determine whether a difference between the two samples is really significant. Spearman's rank correlation coefficient and Wilcoxon signed rank test can be computed using SPSS software.

H4: There is a positive relationship of DEA score and stock's returns

TR will be used for measuring a stock's returns. To evaluate the relationship between fair value-based DEA score and a stock's total return, quantile regression will be employed at the 25^{th}, 50^{th} (median) and 75^{th} quantiles, with total assets and company age as control variables. It is suitable for small sample size and when dealing with nonparametric data such as the DEA scores.

CHAPTER 4

RESULT AND ANALYSIS

This chapter provides a thorough analysis and presentation of results, connecting empirical findings to the research objectives and conceptual model proposed at the beginning of this study. The use of tables, figures, and contextual explanations enhances the clarity and depth of this research. Sections 4.1 to 4.6 focus on the analysis and results of Thai insurance companies, while sections 4.7 to 4.12 cover the analysis and findings related to Thai banking companies. Although the data from Thai banking companies differ, many of the statistical methods and tools used for Thai insurance companies will also be applied.

4.1 Financial Information of Thai Insurance Companies (PCL)

This section presents financial information pertinent to this research for 15 insurance Public Company Limited (PCLs), also referred to as decision-making units (DMUs), through a series of tables. The data from these companies, which serve as the input and output variables for the data envelopment analysis (DEA) analysis, were collected from their financial statements and annual reports. These documents were sourced from company websites or databases such as Refinitiv Eikon or Bloomberg terminal.

Table 4.1 DMUs and Company Ticker of Insurance Companies

DMU/Insurance PCL	Company Ticker
Allianz Ayudhya Capital	AYUD
Bangkok Insurance	BKI
Bangkok Life Assurance	BLA
Bangkok Union Insurance	BUI
Charan Insurance	CHARAN
Dhipaya insurance	TIPH
Indara Insurance	INSURE
Krungthai-AXA*	Krung-AXA*
KWI	KWI
Muang Thai Insurance	MTI
Nam Seng Insurance	NSI
Syn Mun Kong Insurance	SMK
Thai Setakij Insurance	TSI
Thaivivat Insurance	TVI
The Navakij Insurance	NKI

Table 4.1 lists the company tickers or stock symbols of these DMUs/insurance companies. In this dissertation, the company ticker may occasionally replace the full name of the insurance company. For instance, Krungthai-AXA Life Insurance, marked with an asterisk in the table below, is a PCL but is not yet publicly traded. Consequently, it lacks a company ticker and is represented in this research with the symbol Krung-AXA. The inclusion of Krungthai-AXA Life Insurance PCL in the financial statement analysis aims to provide a comprehensive assessment by incorporating more companies, thereby enhancing the quality of the financial statement analysis.

Table 4.2 Financial Information of Insurance Companies, Fiscal Year 2015 (in Thousands of Thai Baht)

No.	DMU	TCI	EXP	AFS-HC	AFS-FV	HTM-HC	HTM-FV	OT-HC	OT-FV
1	AYUD	877,919	2,083,927	2,889,471	2,745,336	1,877,907	1,878,325	19,490	91,025
2	BKI	7,762,457	10,619,105	9,131,423	39,558,269	7,323,399	7,323,399	550,943	2,286,116
3	BLA	2,554,584	50,640,763	20,763,065	25,988,922	201,411,262	220,444,294	46,662	46,662
4	BUI	15,156	570,163	163,719	210,584	176,573	177,568	699	30,042
5	CHARAN	23,499	193,577	170,697	232,717	406,867	410,961	341	19,351
6	TIPH	1,180,241	7,718,239	8,604,240	8,604,240	7,053,421	7,070,760	715,172	1,197,985
7	INSURE	81,036	574,912	-	-	391,039	390,831	489	14,438
8	Krung-AXA*	7,216,571	53,918,115	150,422,658	159,368,766	4,199,294	4,199,294	617	617
9	KWI	(87,357)	359,511	408	376	-	-	-	-
10	MTI	764,207	6,841,983	6,178,784	5,942,179	3,399,167	3,534,900	42,300	83,500
11	NSI	129,436	1,571,742	565,519	541,822	1,700,561	1,730,250	2,048	2,048
12	SMK	694,955	9,037,597	3,569,987	3,337,779	8,036,988	8,182,300	7,137	272,100
13	TSI	17,579	500,077	90,490	126,463	178,231	178,231	1,550	1,550
14	TVI	10,303	2,627,043	1,722,892	1,847,410	397,681	399,049	3,720	144,984
15	NKI	(15,922)	2,701,122	1,896,711	2,151,766	1,095,100	1,095,256	68,034	219,411

Note: In Tables 4.2 through 4.6, the following abbreviations are used: DMU represents Decision-making unit (insurance PCL), TCI stands for Total comprehensive income, EXP denotes Total expenses, AFS-HC refers to Available-for-sale investments valued at historical cost, AFS-FV signifies Available-for-sale investments valued at fair value, HTM-HC is Held-to-maturity investments at historical cost, HTM-FV is Held-to-maturity investments at fair value, OT-HC is General (other) investments (net) at historical cost, and OT-FV is General (other) investments (net) at fair value.

Table 4.3 Financial Information of Insurance Companies, Fiscal Year 2016 (in Thousands of Thai Baht)

No.	DMU	TCI	EXP	AFS - HC	AFS - FV	HTM - HC	HTM - FV	OT - HC	OT - FV
1	AYUD	512,654	2,201,760	2,730,327	2,620,346	1,954,367	1,954,728	19,490	19,490
2	BKI	(2,270,737)	10,635,881	9,554,845	37,139,029	7,830,656	7,830,656	687,173	2,341,790
3	BLA	7,335,609	52,238,190	57,335,352	65,314,232	185,817,494	201,052,858	29,588	29,588
4	BUI	15,156	807,740	273,752	327,445	167,026	164,997	698	698
5	CHARAN	31,157	178,444	170,164	242,113	396,530	399,997	341	20,700
6	TIPH	1,573,757	7,547,179	9,750,265	9,502,005	5,747,620	5,757,413	715,172	1,207,880
7	INSURE	8,009	405,614	-	-	134,400	134,400	489	22,504
8	Krung-AXA*	4,270,732	56,213,790	178,569,910	186,609,603	6,154,740	6,154,740	472	472
9	KWI	122,594	120,549	5,000,000	433,700	-	-	-	-
10	MTI	762,929	8,145,730	6,916,896	6,848,100	3,509,271	3,610,600	56,100	95,000
11	NSI	110,511	1,813,122	584,133	586,017	1,733,823	1,753,900	2,048	2,048
12	SMK	1,084,264	9,012,529	4,261,481	4,339,170	7,075,229	7,178,000	7,139	272,100
13	TSI	(154,930)	758,491	36,546	79,857	158,190	158,190	1,550	1,550
14	TVI	24,955	2,847,136	1,851,421	1,967,183	475,368	475,368	3,721	228,600
15	NKI	69,108	2,835,368	2,246,253	2,260,006	765,100	765,152	86,881	285,723

Table 4.4 Financial Information of Insurance Companies, Fiscal Year 2017 (in Thousands of Thai Baht)

No.	DMU	TCI	EXP	AFS - HC	AFS - FV	HTM - HC	HTM - FV	OT - HC	OT - FV
1	AYUD	1,089,146	2,028,109	2,634,810	2,586,033	1,956,699	1,956,697	19,490	19,490
2	BKI	979,179	10,798,336	10,245,734	39,058,128	8,051,576	8,051,576	709,921	2,346,704
3	BLA	6,670,054	52,238,190	65,587,680	77,121,935	208,373,406	229,092,982	29,588	29,588
4	BUI	42,893	825,693	276,091	341,897	270,636	269,939	697	697
5	CHARAN	26,142	179,688	170,164	255,217	381,530	387,261	341	22,210
6	TIPH	1,788,761	7,643,698	8,880,355	8,880,355	6,281,845	6,291,922	687,060	855,489
7	INSURE	8,165	510,791	-	-	116,600	116,600	489	24,020
8	Krung-AXA*	9,624,307	67,025,483	207,040,559	221,861,693	8,977,201	8,977,201	2,671,292	2,671,292
9	KWI	101,547	174,261	600,000	510,750	-	-	-	-
10	MTI	655,452	8,338,563	7,291,609	7,290,249	3,370,945	3,478,800	55,000	96,500
11	NSI	141,706	1,832,517	609,698	643,981	1,825,501	1,858,000	2,048	2,048
12	SMK	1,153,979	8,086,513	4,672,258	5,018,572	6,723,491	6,837,100	7,139	272,100
13	TSI	(135,681)	745,409	26,059	49,780	158,504	158,504	1,550	1,550
14	TVI	73,166	2,804,889	2,069,292	2,249,481	503,135	507,600	3,721	237,900
15	NKI	54,205	2,296,136	2,166,544	2,273,640	545,000	544,984	142,106	319,862

Table 4.5 Financial Information of Insurance Companies, Fiscal Year 2018 (in Thousands of Thai Baht)

No.	**DMU**	**TCI**	**EXP**	**AFS - HC**	**AFS - FV**	**HTM - HC**	**HTM - FV**	**OT - HC**	**OT – FV**
1	AYUD	(15,837)	2,113,390	4,775,848	4,516,133	2,203,908	2,204, 389	20,997	19,490
2	BKI	1,220,502	11,057,828	14,035,868	41,359,600	5,904,388	5,904,388	687,321	2,781,109
3	BLA	663,950	48,077,107	68,916,575	75,171,941	217,424,076	233,569,083	30,302	30,302
4	BUI	14,320	942,881	287,427	334,575	279,766	278,373	696	696
5	CHARAN	(13,544)	43,297	170,164	229,836	239,600	253,433	341	22,999
6	TIPH	961,173	7,526,692	12,165,715	11,383,559	3,110,830	3,114,847	687,060	657,681
7	INSURE	(48,189)	574,854	-	-	63,500	63,500	489	24,789
8	Krung-AXA*	(3,904,351)	65,013,370	234,564,710	242,869,772	13,045,353	11,432,006	714	714
9	KWI	72,917	436,627	379,816	385,031	1,278	1,278	562	562
10	MTI	161,458	8,555,736	8,341,047	7,981,036	3,071,697	3,131,900	53,400	97,000
11	NSI	53,751	1,830,024	495,676	476,055	1,917,320	1,934,400	2,148	2,148
12	SMK	517,795	9,096,724	3,622,832	3,679,177	8,239,339	8,287,380	7,139	316,929
13	TSI	(65,481)	632,412	26,059	52,072	129,293	129,293	1,551	1,551
14	TVI	91,108	3,114,392	2,081,013	2,229,543	797,689	798,100	3,721	252,800
15	NKI	(15,761)	2,286,593	2,164,407	2,088,718	590,000	589,961	142,106	271,225

Table 4.6 Financial Information of Insurance Companies, Fiscal Year 2019 (in Thousands of Thai Baht)

No.	DMU	TCI	EXP	AFS - HC	AFS - FV	HTM - HC	HTM - FV	OT - HC	OT – FV
1	AYUD	4,045,754	4,413,972	6,758,157	6,616,030	716,363	716, 875	21,573	20,066
2	BKI	(2,361,688)	13,364,707	11,523,505	33,010,708	11,220,681	11,220,681	727,019	3,440,555
3	BLA	6,946,054	43,596,131	70,729,586	80,104,389	219,980,163	260,293,865	31,338	31,338
4	BUI	(13,355)	1,027,387	292,056	312,247	306,367	312,401	696	696
5	CHARAN	(41,945)	46,227	164,310	210,782	322,600	329,418	341	24,112
6	TIPH	1,554,758	8,307,449	11,520,339	10,352,616	2,791,941	2,802,880	820,038	600,956
7	INSURE	(4,489)	433,634	-	-	71,100	71,100	489	16,908
8	Krung-AXA*	27,468,358	66,703,979	258,725,389	297,329,292	13,045,353	13,045,353	714	714
9	KWI	(392,986)	640,358	375,501	367,177	1,284	1,284	562	562
10	MTI	468,580	8,559,994	8,368,383	8,098,275	3,593,929	3,706,000	40,500	86,200
11	NSI	90,034	2,061,659	802,572	794,962	1,935,709	1,980,600	2,148	95,000
12	SMK	925,272	10,548,005	5,524,344	5,908,722	7,215,853	7,359,995	7,139	355,954
13	TSI	(66,445)	526,906	102,258	101,797	195,837	195,873	1,551	1,551
14	TVI	3,114,392	3,751,398	2,861,758	3,039,533	385,341	391,100	3,721	263,800
15	NKI	10,297	2,542,893	1,848,314	1,797,637	495,000	495,107	142,106	271,905

Table 4.2 (FY 2015) presents data for insurance companies (DMUs) on variables such as TCI, EXP, AFS-HC, AFS-FV, HTM-HC, HTM-FV, OT-HC, and OT-FV. Most companies reported profits, with exceptions being KWI and The Navakij Insurance. Krungthai-AXA had the highest expenses (EXP) at THB 53,918,115, but also a high TCI at THB 7,216,571. Most companies heavily invested in AFS and HTM, except KWI, which had low AFS and no HTM or OT investments. Companies like Bangkok Insurance and Allianz Ayudhya Capital showed large and small differences, respectively, between AFS-HC and AFS-FV values. This pattern was also observed in HTM-HC, HTM-FV, OT-HC, and OT-FV values. For instance, Bangkok Life Assurance had a large difference between historical cost (HC) and fair value (FV) in HTM, while Bangkok Union Insurance had a small difference. Other investments were generally smaller than HTM and AFS investments.

From Table 4.3 (FY 2016), all companies reported profits except Bangkok Insurance. Krungthai-AXA again had the highest EXP at THB 56,213,790 and a high TCI at 4,270,732. Most companies maintained high AFS and HTM investments, with Indara Insurance as an exception with no AFS and low HTM and OT investments. Companies like Bangkok Insurance and Nam Seng Insurance showed large and small differences, respectively, between AFS-HC and AFS-FV values. Similar patterns were observed in HTM-HC, HTM-FV, OT-HC, and OT-FV values. For instance, Bangkok Life Assurance had a large difference between HC and FV in HTM, while Bangkok Union Insurance had a small difference.

From Table 4.4 (FY 2017), all companies reported profits except Thai Setakij Insurance, which had a negative TCI (135,681). Krungthai-AXA maintained the highest EXP at THB 67,025,483 and the highest TCI at 9,624,307. Most companies had high AFS and HTM investments and smaller OT investments. KWI had no HTM and OT investments. Companies like Bangkok Insurance and Allianz Ayudhya Capital showed large and small differences, respectively, between AFS-HC and AFS-FV values. Dhipaya Insurance’s AFS-HC and AFS-FV values were identical. Similar patterns were observed in HTM-HC, HTM-FV, OT-HC, and OT-FV values. For instance, Bangkok Life Assurance had a large difference between HC and FV in HTM, while The Navakij Insurance had a small difference.

From Table 4.5 (FY 2018), some companies reported profits, but Allianz Ayudhya Capital, Charan Insurance, Indara Insurance, Krungthai-AXA, and The Navakij Insurance reported losses. This year saw an increase in the number of companies reporting losses. Krungthai-AXA had the highest EXP at THB 65,013,370. Most companies had high AFS and HTM investments and smaller OT investments. Companies like Bangkok Insurance and KWI showed large and small differences, respectively, between AFS-HC and AFS-FV values. Similar patterns were observed in HTM-HC, HTM-FV, OT-HC, and OT-FV values. For instance, Syn Mun Kong Insurance had a large difference between HC and FV for OT, while Bangkok Union Insurance had no difference.

From Table 4.6 (FY 2019), some companies reported profits, but Bangkok Union Insurance, Bangkok Insurance, Charan Insurance, Indara Insurance, KWI, and Thai Setakij Insurance reported losses. This year saw a continuation of the trend from FY 2018, with several companies reporting losses. Krungthai-AXA had the highest EXP at THB 66,703,979 and the highest TCI at THB 27,468,358. Most companies had high AFS and HTM investments and smaller OT investments. Companies like Bangkok Insurance and Thai Setakij Insurance showed large and small differences, respectively, between AFS-HC and AFS-FV values. Similar patterns were observed in HTM-HC, HTM-FV, OT-HC, and OT-FV values. For instance, Bangkok Life Assurance had a large difference between HC and FV for HTM, while Allianz Ayudhya Capital had a small difference.

4.2 Descriptive Statistics of Insurance Companies

Table 4.7 presents the comprehensive descriptive statistics for the financial variables of Thai insurance companies from 2015 to 2019. These statistics encompass both the FV and HC of specific financial items, including available-for-sale (AFS) investments, held-to-maturity (HTM) investments, and other investments.

Table 4.7 Descriptive Statistics of Thai Insurance Companies for Fiscal Years 2015 to 2019 (in Thousands of Thai Baht)

Descriptive Statistics	Total Comprehensive Income	Expenses	Available-for-Sale Investments - Historical Cost	Available-for-Sale Investments - Fair Value	Held-to-Maturity Investments - Historical Cost	Held-to-Maturity Investments - Fair Value	Other Investments - Historical Cost	Other Investments - Fair Value
Mean	1312398.07	10666670.89	21444284.69	25021116.51	17038203.74	18595603.83	150541.50	354551.86
Median	91108.00	2627043.00	2875614.50	2682841.00	1851704.00	1906362.50	5429.00	30172.00
Std. Deviation	3812267.987	18302493.661	53837120.109	58533828.328	52355035.232	58167419.154	384885.961	745488.686
Skewness	4.815	2.148	3.289	3.227	3.459	3.488	4.463	2.754
Kurtosis	30.197	3.209	10.242	10.317	10.372	10.639	25.762	6.849
Minimum	-3904351	43297	408	376	1278	1278	341	472
Maximum	27468358	67025483	258725389	297329292	219980163	260293865	2671292	3440555
Kolmogorov-Smirnov (Sig.)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Mean and median are measures of central tendency. A significant discrepancy between the mean and median in several variables is evident in Table 4.7. For instance, the median of total comprehensive income was THB 91108.00, while its mean was THB 1312398.07, suggesting potential skewness and outliers in the variables. The standard deviation of all variables was high, indicating a substantial dispersion from the mean. This suggests a high degree of variability in the dataset, potentially indicating non-normality. For instance, the standard deviation of AFS investments-HC was THB 53837120.109.

A broad range between the minimum and maximum values of all variables suggests a significant diversity in the firms' variable values. For instance, the minimum value of HTM investments-HC was THB 1278, while its maximum value was THB 219980163.

Researchers often use Fisher's measure of skewness ($\gamma 1$) and kurtosis or the coefficient of excess ($\gamma 2$) to evaluate the shape of the distribution (Blanca et al., 2013). A $\gamma 1$ value of 0 indicates a symmetrical shape, while a positive value suggests right skewness and a negative value indicates left skewness. The kurtosis coefficient ($\gamma 2$) reflects the relative pointedness or flatness of the data distribution compared to the normal distribution (Ho & Yu, 2015). $\gamma 2=0$ implies that the data has the same pointedness as the normal distribution; otherwise, a positive value implies more peaked, and a negative value implies flatter than the normal. In this study, the skewness and kurtosis of all variables were positive and not close to zero, suggesting a right-skewed distribution with a sharp peak, implying potential outliers. For instance, the skewness of AFS investments-HC was 3.289, and kurtosis was 10.242.

Lall (2015) stated that the one-sample Kolmogorov-Smirnov (K-S) test is used to determine whether the data is drawn from a specific distribution. This non-parametric test does not assume any specific type of distribution, making it potentially more suitable than the student t-test, which assumes a normal distribution. A K-S test value closer to zero may suggest non-normality of data. In this study, the one-sample Kolmogorov-Smirnov test p-value (asymptotic significance) was <0.001 for all variables, indicating a non-normal distribution.

The analysis of all variables' statistics, particularly skewness, kurtosis, and the K-S test, confirms that none of the variables followed a normal distribution. Therefore, it can be inferred that non-parametric methods like DEA and non-parametric statistical tests are suitable for conducting financial statement analysis. Parametric methods or tests may not be appropriate.

4.3 Data Envelopment Analysis of Insurance Companies

Firm efficiency pertains to the optimal utilization of an organization's resources to generate outputs. This study employs DEA, a non-parametric method, given the non-normal distribution of data from the selected companies. DEA, in conjunction with non-parametric tests like the Wilcoxon signed-rank test, measures technical efficiency (TE) scores and rankings, providing a comparative framework for evaluating the performance of Thai insurance and banking companies under different valuation bases (HC and FV). Given the complex nature of these companies, where multiple inputs and outputs must be considered simultaneously, DEA serves as an effective tool for comparative efficiency analysis. This study adopts a framework from multiple-input, multiple-output production functions, enabling a detailed assessment of company performance across two valuation bases, an aspect not thoroughly investigated in existing literature.

The multi-stage constant returns-to-scale (CRS) analysis, as utilized by Charnes et al. (1978), has been conducted for all fiscal years (FYs) to ascertain company efficiency and performance. This DEA model, assuming CRS across multiple production stages and unaffected efficiency by the scale of operations, is preferred for several reasons. Primarily, it facilitates comparison with Financial Ratio Analysis (FRA), which, like the CRS model, disregards scale effects. Moreover, the CRS model applies to competitive industries, such as Thailand's financial sector, where every company, regardless of size, has the opportunity to compete and progress. Consequently, scale effects may not significantly impact firm efficiency.

An output-oriented CRS model was chosen, reflecting the industry's emphasis on maximizing output (total comprehensive income), a crucial performance indicator in the insurance and banking sectors. The CRS model's simplicity and relevance make it an ideal tool for this research, providing a clear framework for evaluating firm efficiency and performance. This application of the CRS model in the Thai insurance and banking sector contributes to existing knowledge by offering insights into efficiency under different operational scales, a relatively unexplored area.

According to Coelli (1997), the multi-stage DEA method is advantageous as it identifies efficient projected points with input and output mixes closely resembling those of inefficient points and is invariant to the units of measurement. The DEA software DEAP 2.1, widely used in academic research, was employed for this analysis. It accommodates multiple inputs and outputs, enabling researchers to compute the relative efficiency of DMUs across various sectors. The software provides a user-friendly platform for executing both input-oriented and output-oriented DEA models, including CRS and Variable Returns to Scale options.

While the DEA is a potent tool for efficiency analysis, it is not without its limitations. Recognizing these limitations is essential for its appropriate application and accurate interpretation of DEA results.

1) The selection of input and output variables can be subjective, varying based on the analysis's scope and objectives. Different combinations of these variables can yield different efficiency scores, making it crucial to select variables that align with the study's purpose.

2) DEA necessitates accurate, reliable, and complete data. Issues with data quality, such as negative or incomplete data, can compromise the validity of the results. Additionally, acquiring data for all DMUs may be challenging or expensive, potentially impacting the results.

3) DEA does not account for external factors that may influence a DMU's performance. These externalities could significantly affect firm performance.

4) DEA results are relative rather than absolute. This means a DMU might be underperforming in absolute terms but still be the most efficient compared to other DMUs in the selected group.

The study uses one output, total comprehensive income, and four inputs: expenses, AFS investments, HTM investments, and other net investments. Initially, the DEA analysis was conducted using HC items as inputs and total comprehensive income as the output, with expenses also included as an input variable. Subsequently, the DEA analysis was performed with FV items and expenses as input variables and total comprehensive income as the output. The former is referred to as HC DEA analysis, and the latter as FV DEA analysis. The DEA results from both analyses were then compared.

The DEA analysis of the aforementioned DMUs or insurance PCLs was also conducted using the Malmquist DEA (M DEA). The Malmquist DEA index provides results based on panel data. The data spans five years, from 2015 to 2019, making M DEA applicable. It offers information about the relative efficiency increase or decrease (efficiency change [EC]) of each DMU compared to its performance in the previous year. The Malmquist index provides insights into the degree of efficiency and productivity growth (Lee et al., 2011). This research focuses on efficiency and EC, not technical changes; therefore, the technical change of DMUs will not be considered.

Before initiating the DEA analysis, the handling of negative values of the output variable was considered. Negative values may occur for some firms given negative total comprehensive income, which represents losses suffered by those firms. Missing values may occur for some companies in input variables, such as missing HTM investments. Some firms may not have certain investments in their portfolio, leading to missing values. Typically, DEA analysis does not consider and cannot work with negative values. A few missing values as an input variable may be considered and will work in this analysis if there are positive values for other inputs of a firm. Therefore, the missing value of input variables of a few firms is not an issue in this analysis, but the negative value of output will need to be normalized. Several approaches for dealing with negative data have been suggested. Bowlin (1998) proposed substituting a very small positive value for a negative value if such a value is an output. The argument was based on the fact that an output variable with a very small value was unlikely to contribute to a high efficiency score of a DMU, which would also be true for a negative value. Therefore, the efficiency score would not normally be affected by this translation. It is likely to be close to the invariant translation. Zhu and Cook (2007) also discussed and endorsed this approach of Bowlin (1998). However, this small value should not be greater than any other value in the output data set (Zhu & Cook, 2007). This research will therefore use the same method to normalize the negative value of output of total comprehensive income, if there are any, in the data sets of different years. Therefore, in cases where total comprehensive income is negative, its value can be taken as 1.

4.3.1 Data Envelopment Analysis Based on Historical Cost

This section discusses the evaluation of the results. Based on the HC DEA analysis, the results of TE of each firm are as follows:

Table 4.8 Technical Efficiency (TE) Scores from Multi-Stage Data Envelopment Analysis of Thai Insurance Companies Valued applying HC

Serial no.	Ticker	Insurance PCL	TE 2015	TE 2016	TE 2017	TE 2018	TE 2019
1	AYUD	Allianz Ayudhya Capital	1.000	1.000	1.000	0.000	1.000
2	BKI	Bangkok Insurance	1.000	0.000	0.230	0.661	0.000
3	BLA	Bangkok Life Assurance	0.345	1.000	0.529	0.169	0.223
4	BUI	Bangkok Union Insurance	0.282	0.431	0.580	0.260	0.000
5	CHARAN	Charan Insurance	0.689	1.000	0.619	0.000	0.000
6	TIPH	Dhipaya insurance	0.209	1.000	0.501	0.765	0.208
7	INSURE	Indara Insurance	1.000	1.000	1.000	0.000	0.000
8	-	Krungthai-AXA Life Insurance	1.000	0.955	0.253	0.000	1.000
9	KWI	KWI	0.000	1.000	1.000	1.000	0.000
10	MTI	Muang Thai Insurance	0.452	0.786	0.280	0.113	0.064
11	NSI	Nam Seng Insurance	0.522	0.691	0.778	0.565	0.103
12	SMK	Syn Mun Kong Insurance	0.542	1.000	1.000	0.744	0.155
13	TSI	Thai Setakij Insurance	0.294	0.000	0.000	0.000	0.000
14	TVI	Thaivivat Insurance	0.046	0.174	0.154	0.228	1.000
15	NKI	The Navakij Insurance	0.000	0.297	0.099	0.000	0.005
	Mean		0.492	0.689	0.535	0.300	0.251

In the DEA context, a TE score of one denotes optimal relative efficiency, whereas a score of zero represents the least relative efficiency among the evaluated companies. Companies with a score of one are the most efficient and serve as benchmarks. Those with scores below one may need to enhance their future efficiency. Zero values in the dataset indicate instances where some companies consistently underperformed compared to the benchmark company.

Allianz Ayudhya Capital demonstrated consistent performance across all years, except in 2018 when its TE was zero given a loss incurred that year. Krungthai-AXA Life Insurance exhibited high relative efficiency in 2015, 2016, and 2019, but low efficiency in 2017 and 2018. Thai Setakij Insurance and The Navakij Insurance consistently showed poor efficiency across all years. Dhipaya Insurance had high efficiency scores in 2016 and 2018, satisfactory in 2017, but poor in 2015 and 2019. Charan Insurance and Indara Insurance underperformed in 2018 and 2019. The average TE scores were higher in 2015, 2016, and 2017 but declined in 2018 and 2019, suggesting a decrease in overall firm efficiency during these years. Figure 4.1 provides a graphical representation of the relative efficiency scores of all firms from 2015 to 2019.

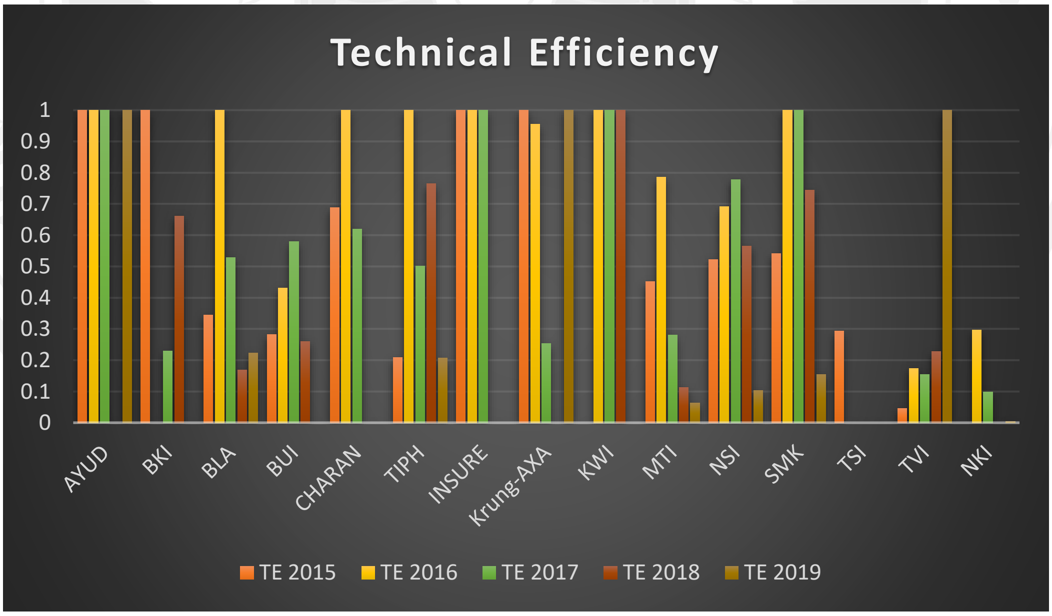

Figure 4.1 Technical Efficiency (TE) Scores of Thai Insurance Companies applying Historical Cost

From Table 4.8 and Figure 4.1, it is evident that in 2015, Allianz Ayudhya Capital, Bangkok Insurance, Indara Insurance, and Krungthai-AXA Life Insurance had the highest relative efficiency (TE scores), while KWI and The Navakij Insurance had the lowest. Thaivivat Insurance also had a low efficiency score. In 2016, several firms, including Allianz Ayudhya Capital, Bangkok Life Assurance, Charan Insurance, Indara Insurance, KWI, Syn Mun Kong Insurance, and Dhipaya Insurance, exhibited high relative efficiency. However, Bangkok Insurance and Thai Setakij Insurance had very low efficiency. Thaivivat Insurance and The Navakij Insurance also had subpar scores.

In 2017, Allianz Ayudhya Capital maintained the highest TE score, similar to 2016. Indara Insurance, KWI, and Syn Mun Kong Insurance also achieved a TE score of one. However, Thaivivat Insurance, The Navakij Insurance, and Thai Setakij Insurance had low efficiency scores. In 2018, only KWI achieved an efficiency score of one. Several firms, including Allianz Ayudhya Capital, Charan Insurance, Indara Insurance, Krungthai-AXA Life Insurance, The Navakij Insurance, and Thai Setakij Insurance, had very low scores. This year marked a period of inefficiency for the insurance industry as several firms' performance was poor.

In FY 2019, while more firms achieved high efficiency, several others had low efficiency. Allianz Ayudhya Capital, Krungthai-AXA Life Insurance, and Thaivivat Insurance had high TE scores, but firms like Thai Setakij Insurance, KWI, Indara Insurance, Charan Insurance, Bangkok Union Insurance, and Bangkok Insurance performed poorly. The Navakij Insurance, Muang Thai Insurance, Nam Seng Insurance, and Syn Mun Kong Insurance also had subpar efficiency scores. In other words, all firms, except Allianz Ayudhya Capital, Krungthai-AXA Life Insurance, and Thaivivat Insurance, underperformed in 2019.

When aggregating TE scores from 2015 to 2019, Allianz Ayudhya Capital achieved the highest technical efficiency, followed by Syn Mun Kong Insurance and Krungthai-AXA Life Insurance. Thai Setakij Insurance had the lowest TE, with The Navakij Insurance slightly above it. Indara Insurance, KWI, Dhipaya Insurance, and Nam Seng Insurance performed satisfactorily in terms of overall relative efficiency.

Based on Malmquist DEA (M DEA) scores obtained from DEAP 2.1, the EC of the firms is as follows. These scores are based on the HC of variables.

Table 4.9 Malmquist Index Mean Efficiency Change of Insurance Companies applying Historical Cost for 2015 to 2019

Serial no.	Ticker	Insurance PCL	Efficiency Change
1	AYUD	Allianz Ayudhya Capital	1.000
2	BKI	Bangkok Insurance	0.000
3	BLA	Bangkok Life Assurance	0.897
4	BUI	Bangkok Union Insurance	0.000
5	CHARAN	Charan Insurance	0.000
6	TIPH	Dhipaya insurance	0.998
7	INSURE	Indara Insurance	0.000
8	-	Krungthai-AXA Life Insurance	1.000
9	KWI	KWI	-
10	MTI	Muang Thai Insurance	0.614
11	NSI	Nam Seng Insurance	0.667
12	SMK	Syn Mun Kong Insurance	0.731
13	TSI	Thai Setakij Insurance	0.000
14	TVI	Thaivivat Insurance	2.161
15	NKI	The Navakij Insurance	-

From the analysis of Table 4.9, Thaivivat Insurance had the highest geometric mean (GM) EC from 2015 to 2019 at 2.161, indicating a 116% growth in technical efficiency over these five years. Firms like Allianz Ayudhya Capital and Krungthai-AXA Life Insurance did not show any overall EC as their EC scores were one. However, several companies, including Bangkok Insurance, Bangkok Union Insurance, Charan Insurance, Indara Insurance, and Thai Setakij Insurance, had GMs of zero, implying a decline in their relative efficiency over the years. Zero should not be interpreted as the absence of efficiency, but rather as a decline in efficiency. DEAP 2.1 Malmquist-DEA could not generate EC scores for a few firms like KWI and The Navakij Insurance. This should not be interpreted as the absence of efficiency. Other firms like Bangkok Life Assurance and Dhipaya Insurance experienced a slight decline in overall efficiency. The former's DEA EC was 0.897 while the latter's was 0.998. If the EC is less than one, it reflects a decline. For instance, 1-0.897=0.103, which reflects a decline in efficiency by 10.3% for Bangkok Life Assurance.

4.3.2 Data Envelopment Analysis Based on Fair Value

This section addresses the evaluation of the results. Based on the FV DEA analysis, the TE results of each firm are as follows:

Table 4.10 Technical Efficiency (TE) Scores from Multi-Stage Data Envelopment Analysis of Thai Insurance Companies applying Fair Value

Serial No.	Ticker	Insurance PCL	TE 2015	TE 2016	TE 2017	TE 2018	TE 2019
1	AYUD	Allianz Ayudhya Capital	1.000	0.686	1.000	0.000	1.000
2	BKI	Bangkok Insurance	1.000	0.000	0.156	0.661	0.000
3	BLA	Bangkok Life Assurance	0.717	0.397	0.412	0.169	0.545
4	BUI	Bangkok Union Insurance	0.204	0.163	0.484	0.226	0.000
5	CHARAN	Charan Insurance	0.306	0.441	0.269	0.000	0.000
6	TIPH	Dhipaya insurance	0.404	0.566	0.495	0.765	0.212
7	INSURE	Indara Insurance	1.000	1.000	1.000	0.000	0.000
8	-	Krungthai-AXA Life Insurance	1.000	0.081	0.246	0.000	1.000
9	KWI	KWI	0.000	1.000	1.000	1.000	0.000
10	MTI	Muang Thai Insurance	0.727	0.387	0.265	0.113	0.089
11	NSI	Nam Seng Insurance	1.000	0.664	0.752	0.596	0.111
12	SMK	Syn Mun Kong Insurance	0.352	0.819	0.529	0.743	0.175

Serial No.	Ticker	Insurance PCL	TE 2015	TE 2016	TE 2017	TE 2018	TE 2019
13	TSI	Thai Setakij Insurance	0.673	0.000	0.000	0.000	0.000
14	TVI	Thaivivat Insurance	0.027	0.043	0.123	0.216	1.000
15	NKI	The Navakij Insurance	0.000	0.101	0.089	0.000	0.006
	Mean		0.561	0.423	0.455	0.299	0.276

Allianz Ayudhya Capital demonstrated consistent performance throughout the years, except for 2018 when its TE was zero given a loss incurred that year. Nam Seng Insurance exhibited high relative efficiency in 2015, 2016, and 2017, but this declined in 2018 and 2019. Dhipaya Insurance maintained satisfactory performance without incurring losses from 2015 to 2019. The Navakij Insurance and Thai Setakij Insurance, however, consistently underperformed, with the latter showing slight improvement only in 2015. Several companies, including Bangkok Insurance, Bangkok Union Insurance, Charan Insurance, Indara Insurance, KWI, Thai Setakij Insurance, and The Navakij Insurance, underperformed in 2019. The mean TE scores were higher in 2015, 2016, and 2017, but declined in 2018 and 2019, suggesting a decrease in overall firm efficiency during these years. Figure 4.2 visually represents the relative efficiency scores of all firms from 2015 to 2019.

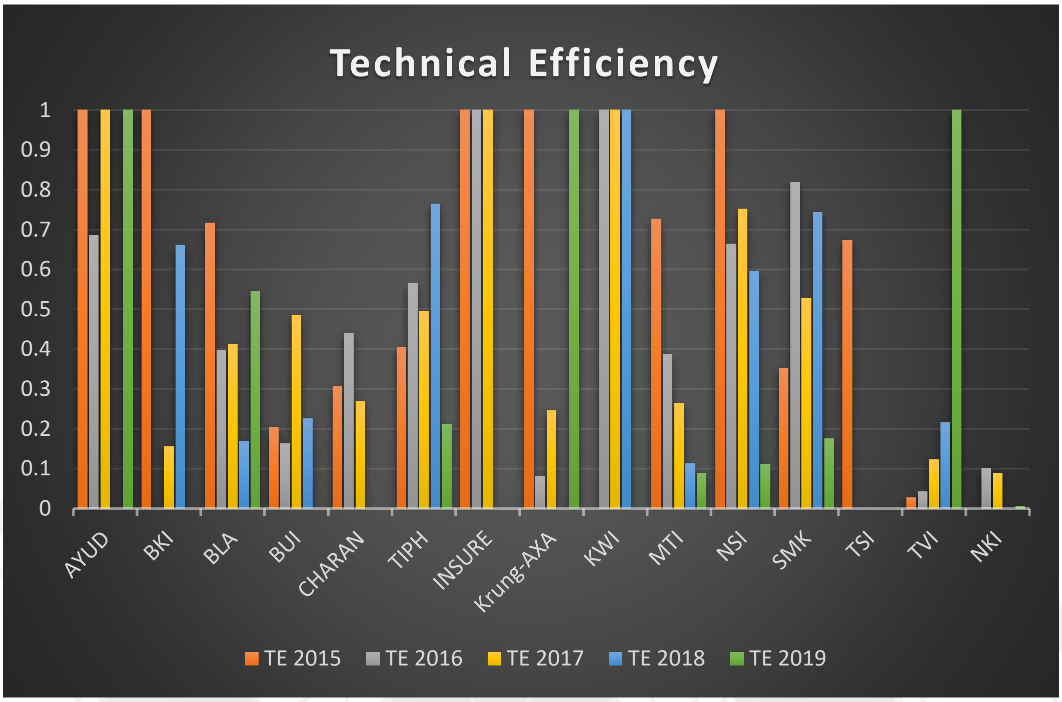

Figure 4.2 Technical Efficiency (TE) Scores of Thai Insurance Companies applying Fair Value

Table 4.10 and Figure 4.2 indicate that in 2015, Allianz Ayudhya Capital, Bangkok Insurance, Indara Insurance, Krungthai-AXA Life Insurance, and Nam Seng Insurance had the highest relative efficiency, while KWI and The Navakij Insurance had the lowest. Thaivivat Insurance also scored poorly. In 2016, Indara Insurance and KWI were among the companies with high relative efficiency, along with Syn Mun Kong Insurance. Conversely, Bangkok Insurance and Thai Setakij Insurance had very low efficiency, with Thaivivat Insurance, The Navakij Insurance, and Bangkok Union Insurance also scoring poorly.

In 2017, Allianz Ayudhya Capital achieved the highest TE score, with Indara Insurance and KWI also scoring 1. Nam Seng Insurance had a relatively high efficiency score of 0.75. However, Bangkok Insurance, Thaivivat Insurance, The Navakij Insurance, and Thai Setakij Insurance had low efficiency scores.

In 2018, only KWI achieved an efficiency score of 1. Dhipaya Insurance and Syn Mun Kong Insurance also had relatively high efficiency scores. However, several companies, including Allianz Ayudhya Capital, Charan Insurance, Indara Insurance, Krungthai-AXA Life Insurance, The Navakij Insurance, and Thai Setakij Insurance, had very low scores. Muang Thai Insurance and Bangkok Life Assurance also underperformed, making 2018 a year of unsatisfactory performance for the insurance industry.

In 2019, while more firms achieved high relative efficiency, there were also more firms with low efficiency. Allianz Ayudhya Capital, Krungthai-AXA Life Insurance, and Thaivivat Insurance had high TE scores, but companies such as Thai Setakij Insurance, KWI, Indara Insurance, Charan Insurance, Bangkok Union Insurance, and Bangkok Insurance performed poorly. The Navakij Insurance, Muang Thai Insurance, Nam Seng Insurance, and Syn Mun Kong Insurance also had poor efficiency scores. In other words, all companies except Allianz Ayudhya Capital, Krungthai-AXA Life Insurance, and Thaivivat Insurance underperformed in 2019.

When aggregating TE scores from 2015 to 2019, Allianz Ayudhya Capital had the highest technical efficiency, followed by Nam Seng Insurance. Indara Insurance and KWI also had relatively high technical efficiency, albeit slightly lower than Nam Seng Insurance. On the lower end, The Navakij Insurance had the lowest TE, with Thai Setakij Insurance just above it. Dhipaya Insurance and Syn Mun Kong Insurance performed satisfactorily.

Based on Malmquist DEA (M DEA) scores obtained from DEAP 2.1, the EC of the firms is as follows. These scores are based on the FV of variables.

Table 4.11 Malmquist Index Mean Efficiency Change of Insurance Companies applying Fair Value for 2015 to 2019

Serial No.	Ticker	Insurance PCL	Efficiency Change
1	AYUD	Allianz Ayudhya Capital	1.000
2	BKI	Bangkok Insurance	0.000
3	BLA	Bangkok Life Assurance	0.934
4	BUI	Bangkok Union Insurance	0.000
5	CHARAN	Charan Insurance	0.000
6	TIPH	Dhipaya insurance	0.850
7	INSURE	Indara Insurance	0.000
8	-	Krungthai-AXA Life Insurance	1.000
9	KWI	KWI	0.000
10	MTI	Muang Thai Insurance	0.592
11	NSI	Nam Seng Insurance	0.577
12	SMK	Syn Mun Kong Insurance	0.840
13	TSI	Thai Setakij Insurance	0.000
14	TVI	Thaivivat Insurance	2.459
15	NKI	The Navakij Insurance	-

From the analysis of Table 4.11, Thaivivat Insurance had the highest GM EC from 2015 to 2019 at 2.459, indicating that its technical efficiency grew by nearly 146% over these five years. Firms like Allianz Ayudhya Capital and Krungthai-AXA Life Insurance did not show any overall EC as their EC scores were 1. However, several firms, including Bangkok Insurance, Bangkok Union Insurance, Charan Insurance, Indara Insurance, Thai Setakij Insurance, and KWI, had GMs of 0, implying a decline in their efficiency over the years. DEAP 2.1 Malmquist-DEA could not generate EC scores for The Navakij Insurance, but this should not be interpreted as an absence of efficiency. EC from one year to another may have changed from 0 to 1 for any two specific years for these firms; such a change cannot be calculated in mathematical terms as it may be undefined. For other firms such as Bangkok Life Assurance, Dhipaya

Insurance, and Syn Mun Kong Insurance, there was a slight decline in overall efficiency. Their DEA EC scores were 0.934, 0.850, and 0.840 respectively. If the EC is less than 1, it reflects a decline. For instance, 1-0.934=0.066, which reflects a decline in efficiency by 6.6% for Bangkok Life Assurance.

4.3.3 Evaluation of Fair Value Data Envelopment Analysis (DEA) Versus Historical Cost DEA Result

The DEA scores based on FV are compared and evaluated against the HC DEA scores for each year. These efficiency scores, discussed in sections 4.3.1 and 4.3.2, are discussed in Table 4.12.

Table 4.12 Comparison of Technical Efficiency Scores for Insurance Companies: Fair Value (FV) versus Historical Cost (HC) Application for Fiscal Year 2015 to 2019

	2015		**2016**		**2017**		**2018**		**2019**	
Ticker	**HC**	**FV**	**HC**	**FV**	**HC**	**FV**	**HC**	**FV**	**HC**	**FV**
AYUD	1.000	1.000	1.000	0.686	1.000	1.000	0.000	0.000	1.000	1.000
BKI	1.000	1.000	0.000	0.000	0.230	0.156	0.661	0.661	0.000	0.000
BLA	0.345	0.717	1.000	0.397	0.529	0.412	0.169	0.169	0.223	0.545
BUI	0.282	0.204	0.431	0.163	0.580	0.484	0.260	0.226	0.000	0.000
CHARAN	0.689	0.306	1.000	0.441	0.619	0.269	0.000	0.000	0.000	0.000
TIPH	0.209	0.404	1.000	0.566	0.501	0.495	0.765	0.765	0.208	0.212
INSURE	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
Krung-AXA*	1.000	1.000	0.955	0.081	0.253	0.246	0.000	0.000	1.000	1.000
KWI	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000
MTI	0.452	0.727	0.786	0.387	0.280	0.265	0.113	0.113	0.064	0.089
NSI	0.522	1.000	0.691	0.664	0.778	0.752	0.565	0.596	0.103	0.111
SMK	0.542	0.352	1.000	0.819	1.000	0.529	0.744	0.743	0.155	0.175
TSI	0.294	0.673	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TVI	0.046	0.027	0.174	0.043	0.154	0.123	0.228	0.216	1.000	1.000
NKI	0.000	0.000	0.297	0.101	0.099	0.089	0.000	0.000	0.005	0.006
Mean	0.492	0.561	0.689	0.423	0.535	0.455	0.300	0.299	0.251	0.276

Table 4.12 reveals that while some companies have identical DEA scores for a specific year under both HC and FV, many do not. For instance, Allianz Ayudhya Capital's scores are identical for FY 2015, 2017, 2018, and 2019. In contrast, Bangkok Life Assurance's scores differ for all years, except 2017.

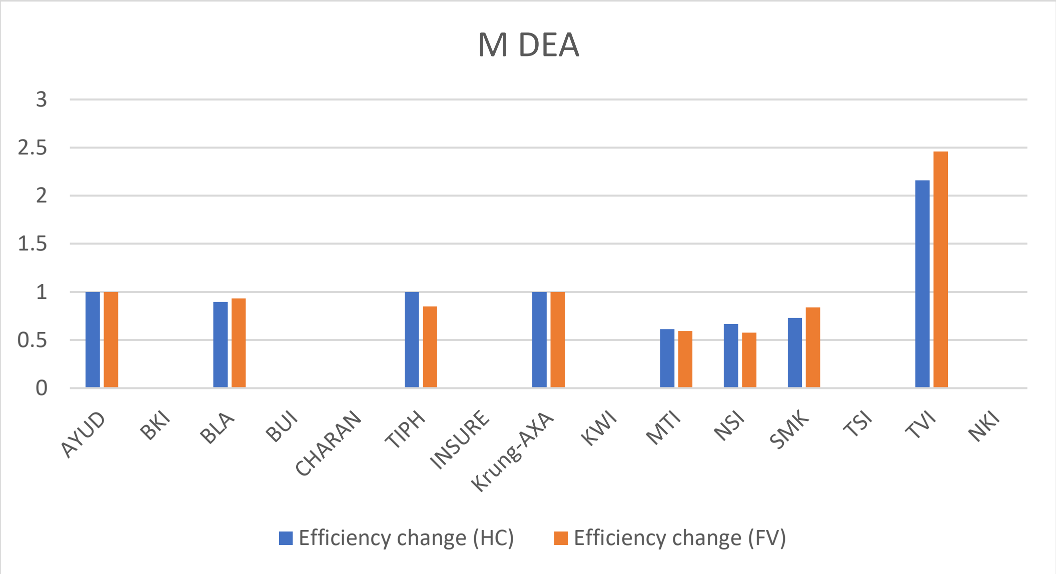

Figure 4.3 Malmquist DEA - Historical Cost versus Fair Value of Insurance Companies

The EC of companies for all years under study, based on Malmquist DEA (M DEA), is presented in sections 4.3.1 and 4.3.2. Figure 4.3 compares this EC using FV and HC. The results indicate minimal differences between the two for most companies. A notable exception is Thaivivat Insurance, with an FV EC of 2.459 and an HC EC of 2.161. Other companies exhibit only minor differences, if any.

4.4 Financial Ratio Analysis—Insurance Companies

This section presents key financial ratios for insurance companies for FY 2015 to 2019. These ratios include profitability metrics (Return on Assets [ROA], Return on Equity [ROE], Loss Ratio), efficiency indicators (Total Asset Turnover [TAT]), leverage or solvency measures (Leverage Ratio, Capital Asset Adequacy), and liquidity ratios (current liquidity). A thorough analysis of the companies' financial performance and efficiency has been conducted using the rank normalization method.

Table 4.13 Financial Ratios of Insurance Companies for Fiscal Year 2015

FY 2015							
Ticker	**Profitability Performance**			**Ratio For Efficiency**	**Ratio For Leverage or Solvency**		**Ratio for Liquidity**
	ROA (%)	**ROE (%)**	**Loss Ratio (%)**	**TAT (Times)**	**Leverage Ratio (Times)**	**CAR (%)**	**Current Liquidity (Times)**
AYUD	6.25%	9.81%	45.50%	0.23	0.52	771.61%	1.49
BKI	4.18%	7.50%	50.60%	0.24	0.74	204.60%	0.63
BLA	1.77%	15.63%	3.95%	0.24	8.25	309%	4.82
BUI	1.45%	3.39%	42.06%	0.45	1.36	207.01%	1.12
CHARAN	4.47%	6.17%	24.30%	0.3	0.36	>140%	3.41
TIPH	2.34%	26.61%	43.78%	0.10	8.6	-	1.32
INSURE	6.30%	48.44%	37.50%	0.49	4.63	>140%	1.00
Krung-AXA*	3.02%	24.28%	29.16%	0.35	7.03	-	1.71
KWI	5.16%	83.79%	-	0.18	27.54	-	1.09
MTI	5.14%	21.31%	51.80%	0.44	3.09	381%	2.81
NSI	4.57%	11.30%	54.28%	0.56	1.55	767.75%	1.74
SMK	6.32%	21.09%	63.18%	0.73	2.27	541.04%	1.32
TSI	0.63%	4.89%	32.70%	0.34	3.98	-	1.17
TVI	0.50%	2.03%	59.94%	0.59	3.19	356%	0.57
NKI	2.05%	5.22%	62.92%	0.53	1.72	552%	1.34

Note: In Tables 4.13 to 4.17, the abbreviations for the financial ratios of insurance companies are defined as follows: ROA represents Return on Assets, ROE signifies Return on Equity, TAT denotes Total Asset Turnover, and CAR stands for Capital Adequacy Ratio. A dash (-) indicates that the information is not available in the annual report or financial database. For Table 4.13, the exact CAR percentages for Charan Insurance and Indara Insurance are not available in their respective annual reports.

Profitability ratios indicate that Indara Insurance, Muang Thai Insurance, Krungthai-AXA Life Insurance, Syn Mun Kong Insurance, and Dhipaya Insurance performed well in FY 2015, as evidenced by their superior ROA and ROE or lower loss ratios. Conversely, KWI underperformed with a negative ROA, and Thaivivat Insurance also struggled with low ROA and ROE and a high loss ratio. Notably, despite a subpar ROA, Bangkok Life Assurance had a low loss ratio, suggesting a higher net premium than claims incurred during the year.

Efficiency ratios (ERs), specifically the TAT ratio, reveal that Syn Mun Kong Insurance and Thaivivat Insurance effectively utilized assets to generate revenues. In contrast, Dhipaya Insurance, KWI, Allianz Ayudhya Capital, Bangkok Insurance, Bangkok Life Assurance, and Charan Insurance were less efficient in revenue generation. Other companies exhibited moderate ERs.

Leverage or solvency ratios show that Allianz Ayudhya Capital, Bangkok Insurance, and Charan Insurance maintained lower leverage ratios, beneficial for solvency. These companies also demonstrated strong financial strength and long-term solvency with robust Capital Adequacy Ratios (CAR). KWI, however, had a high leverage ratio of 27.54, indicating potential solvency issues, compounded by a negative ROA and unavailable CAR in its annual report. Bangkok Life Assurance, Dhipaya Insurance, Krungthai-AXA Life Insurance, and Indara Insurance also had high leverage ratios, suggesting a need for reduction. Most companies met the CAR requirement set by the Office of Insurance Commission, Thailand.

In terms of liquidity, Bangkok Life Assurance and Charan Insurance ranked highest, indicating their ability to meet short-term obligations. However, high liquidity may also suggest an excess of cash and cash equivalents that could be invested for returns. Most other companies had sound liquidity positions with ratios above 1, except for Bangkok Insurance and Thaivivat Insurance, whose liquidity ratios were below 1 in 2015, indicating potential issues in meeting short-term obligations.

Table 4.14 Financial Ratios of Insurance Companies for Fiscal Year 2016

FY 2016							
Ticker	**Profitability Performance**			**Ratio for Efficiency**	**Ratio for Leverage or Solvency**		**Ratio for Liquidity**
	ROA (%)	**ROE (%)**	**Loss Ratio (%)**	**TAT (Times)**	**Leverage Ratio (Times)**	**CAR (%)**	**Current Liquidity (Times)**
AYUD	5.78%	8.74%	48.40%	0.23	0.51	698%	1.54
BKI	4.16%	7.17%	50.30%	0.23	0.72	234.90%	0.68
BLA	1.92%	16.91%	4.52%	0.21	7.47	252%	6.44
BUI	0.71%	1.66%	52.70%	0.53	1.29	229.38%	1.31
CHARAN	3.18%	4.32%	29%	0.26	0.35	>140%	3.48
TIPH	2.82%	25.23%	44.71%	0.11	7.38	-	1.28
INSURE	0.69%	3.53%	40.18%	0.38	3.61	>140%	1.16
Krung-AXA*	2.54%	23.48%	29.00%	0.31	8.25	-	2.03
KWI	6.06%	93.93%	-	0.16	10.71	-	0.99
MTI	3.30%	13.30%	54.60%	0.46	3.03	395%	3.42
NSI	2.69%	7.11%	60.22%	0.57	1.74	419.93%	1.61
SMK	5.90%	17.65%	65.32%	0.71	1.75	514.25%	1.45
TSI	-11.42%	-63.42%	61.62%	0.36	5.29	-	1.15
TVI	0.53%	2.28%	61.34%	0.60	3.39	383%	0.51
NKI	1.21%	3.23%	70.12%	0.52	1.64	428.34%	1.32

Note: Exact CAR of Charan Insurance and Indara Insurance is unavailable from its annual report or could not be found.

Profitability performance ratios indicate that firms such as Allianz Ayudhya Capital, KWI, and Syn Mun Kong Insurance exhibited strong performance in FY 2016. These firms demonstrated superior ROA and ROE, or lower loss ratios compared to their counterparts. Conversely, Thai Setakij Insurance underperformed with negative ROA and ROE. Similarly, Bangkok Union Insurance, Thaivivat Insurance, and The Navakij Insurance showed subpar profitability performance given low ROA and ROE and high loss ratios. Bangkok Life Assurance, however, reported a low loss ratio, indicating a higher net premium than claims incurred during the year.

Solvency ratios suggest that Allianz Ayudhya Capital, Bangkok Insurance, and Charan Insurance maintained lower leverage ratios, beneficial for solvency. These firms also demonstrated robust CAR, indicating financial strength and long-term solvency. KWI, despite a high leverage ratio of 10.71 in FY 2016, showed improvement from its previous leverage ratio of 27.54 in FY 2015. However, this high ratio raises concerns about the company's solvency, especially as its CAR was not reported in the annual report. Firms such as Bangkok Life Assurance, Dhipaya Insurance, Krungthai-AXA Life Insurance, and Thai Setakij Insurance were highly leveraged, suggesting a need to reduce their leverage ratios. Most firms studied met the CAR requirement set by the Office of Insurance Commission, Thailand.

Liquidity analysis reveals that Bangkok Life Assurance and Charan Insurance had the highest liquidity, indicating their ability to meet short-term obligations. However, high liquidity may also suggest an excess of cash and cash equivalents, which could be invested for returns. Most other firms demonstrated satisfactory liquidity positions, with a liquidity ratio greater than 1, except for Bangkok Insurance, KWI, and Thaivivat Insurance, which had a liquidity ratio of less than 1 in 2016. These firms may face challenges in meeting short-term obligations and should explore ways to improve liquidity.

Table 4.15 Financial Ratios of Insurance Companies for Fiscal Year 2017

FY 2017							
Ticker	**Profitability Performance**			**Ratio for Efficiency**	**Ratio for Leverage or Solvency**		**Ratio for Liquidity**
	ROA (%)	**ROE (%)**	**Loss Ratio (%)**	**TAT (Times)**	**Leverage Ratio (Times)**	**CAR (%)**	**Current Liquidity (Times)**
AYUD	4.26%	6.28%	47.60%	0.20	0.44	1023.74%	1.62
BKI	4.09%	7.03%	51.60%	0.23	0.71	219%	0.69
BLA	1.23%	10.06%	4.85%	0.19	6.96	252%	4.53
BUI	1.97%	5.16%	46.81%	0.49	1.93	301.08%	1.24
CHARAN	1.65%	2.22%	30.80%	0.24	0.34	286%	3.59

FY 2017							
Ticker	**Profitability Performance**			**Ratio for Efficiency**	**Ratio for Leverage or Solvency**		**Ratio for Liquidity**
	ROA (%)	**ROE (%)**	**Loss Ratio (%)**	**TAT (Times)**	**Leverage Ratio (Times)**	**CAR (%)**	**Current Liquidity (Times)**
TIPH	3.16%	23.42%	44.46%	0.11	5.55	-	1.34
INSURE	0.69%	3.53%	39.24%	0.51	3.71	624.76%	1.21
Krung-AXA*	1.54%	13.56%	33.53%	0.29	7.81	-	2.20
KWI	1.88%	5.72%	-	0.11	1.2	-	1.71
MTI	3.10%	12.00%	58.60%	0.45	2.74	414%	3.56
NSI	3.33%	9.20%	59.30%	0.58	1.78	449.11%	1.64
SMK	6.32%	16.35%	60.55%	0.64	1.45	547.45%	1.56
TSI	-7.05%	-51.60%	69.55%	0.35	7.64	-	1.12
TVI	0.64%	2.81%	57.10%	0.56	3.41	331.14%	0.50
NKI	2.06%	5.12%	64.73%	0.45	1.38	-	1.39

In FY 2017, Dhipaya Insurance, Syn Mun Kong Insurance, Krungthai-AXA Life Insurance, and Allianz Ayudhya Capital showed better profitability performance ratios. Thai Setakij Insurance underperformed given negative ROA and ROE and a high loss ratio. The Navakij Insurance, Thaivivat Insurance, and KWI also underperformed given low ROA and ROE or high loss ratios. Bangkok Life Assurance, however, reported a low loss ratio, indicating a higher net premium than claims incurred during the year.

ERs, specifically the TAT ratio, show that Syn Mun Kong Insurance, Nam Seng Insurance, and Thaivivat Insurance effectively utilized assets to generate revenues. Conversely, Dhipaya Insurance, KWI, Allianz Ayudhya Capital, Bangkok Insurance, Bangkok Life Assurance, Charan Insurance, and Krungthai-AXA Life Insurance demonstrated less efficient use of assets for revenue generation.

Solvency ratios for FY 2017 indicate that Allianz Ayudhya Capital, Bangkok Insurance, and Charan Insurance maintained lower leverage ratios, beneficial for solvency. These firms also demonstrated robust CAR, indicating financial strength and long-term solvency. However, Krungthai-AXA Life Insurance and Thai Setakij Insurance reported high leverage ratios of 7.81 and 7.84, respectively, raising concerns about their solvency. Their CAR was not reported in the annual report. Firms such as Bangkok Life Assurance, Dhipaya Insurance, Indara Insurance, and Thaivivat Insurance were highly leveraged, suggesting a need to reduce their leverage ratios. Dhipaya insurance CAR was not available in its annual report. Other firms had a leverage ratio of less than 3. Most firms under study met the CAR requirement stipulated by the Office of Insurance Commission, Thailand.

Liquidity analysis for FY 2017 reveals that Bangkok Life Assurance, Muang Thai Insurance, and Charan Insurance had the highest liquidity. However, high liquidity may suggest an excess of cash and cash equivalents, which could be invested for returns. Most other firms demonstrated satisfactory liquidity positions, with a liquidity ratio greater than 1, except for Bangkok Insurance and Thaivivat Insurance, which had a liquidity ratio less than 1. These firms may face challenges in meeting short-term obligations and should explore ways to improve liquidity.

Table 4.16 Financial Ratios of Insurance Companies for Fiscal Year 2018

FY 2018							
Ticker	**Profitability Performance**			**Ratio for Efficiency**	**Ratio for Leverage or Solvency**		**Ratio for Liquidity**
	ROA (%)	**ROE (%)**	**Loss Ratio (%)**	**TAT (Times)**	**Leverage Ratio (Times)**	**CAR (%)**	**Current Liquidity (Times)**
AYUD	6.20%	8.85%	41.30%	0.20	0.42	1064.06%	2.36
BKI	3.99%	6.87%	49.40%	0.23	0.74	239.90%	0.61
BLA	1.57%	12.84%	5.21%	0.17	7.43	252%	8.21
BUI	0.19%	0.54%	53.14%	0.47	1.79	238.12%	0.99
CHARAN	0.77%	1.05%	32.39%	0.24	0.39	273%	3.26
TIPH	3.24%	20.11%	42.73%	0.11	4.86	-	1.36
INSURE	0.90%	4.17%	52.65%	0.52	4.43	505.63%	1.14
Krung-AXA*	0.55%	6.33%	40.10%	0.24	10.55	-	2.63
KWI	1.07%	2.65%	-22.18%	0.02	1.67	>140%	1.66
MTI	2.00%	7.80%	61.30%	0.43	3.16	393%	2.38
NSI	2.67%	7.37%	55.32%	0.53	1.74	559.59%	1.61
SMK	5.04%	12.56%	60.16%	0.67	1.54	696.10%	1.52

FY 2018							
Ticker	**Profitability Performance**			**Ratio for Efficiency**	**Ratio for Leverage or Solvency**		**Ratio for Liquidity**
	ROA (%)	**ROE (%)**	**Loss Ratio (%)**	**TAT (Times)**	**Leverage Ratio (Times)**	**CAR (%)**	**Current Liquidity (Times)**
TSI	-0.06%	-47.61%	71.85%	0.34	6.72	-	1.15
TVI	2.04%	9.09%	52.49%	0.60	3.51	403.03%	0.49
NKI	1.66%	4.04%	58.20%	0.46	1.48	-	1.37

Note: Exact CAR of KWI is unavailable from its annual report or could not be found.

Profitability performance ratios indicate that firms such as Dhipaya Insurance, Syn Mun Kong Insurance, Bangkok Insurance, Thaivivat Insurance, and Allianz Ayudhya Capital outperformed others in FY 2018. These firms demonstrated superior ROA and ROE, or lower loss ratios. Conversely, Thai Setakij Insurance underperformed with negative ROA and ROE, and a high loss ratio. Similarly, Navakij Insurance, Thaivivat Insurance, and KWI exhibited subpar profitability performance given low ROA and ROE or high loss ratios. Bangkok Life Assurance maintained a low loss ratio, similar to FY 2016 and FY 2015, suggesting higher net premium earnings than claims incurred during the year.

ERs, specifically the TAT ratio, reveal that Syn Mun Kong Insurance, Nam Seng Insurance, Indara Insurance, and Thaivivat Insurance effectively utilized assets to generate revenues. In contrast, Dhipaya Insurance, KWI, Allianz Ayudhya Capital, Bangkok Insurance, Bangkok Life Assurance, Charan Insurance, and Krungthai-AXA Life Insurance were less efficient in revenue generation from assets, mirroring their subpar TAT ratios in FY 2017. These firms should consider strategies to enhance efficiency. Other firms demonstrated moderate ERs.

Leverage or solvency ratios show that Allianz Ayudhya Capital, Bangkok Insurance, and Charan Insurance had lower leverage ratios, beneficial for solvency. These firms also maintained robust CAR, indicating financial strength and long-term solvency. However, Krungthai-AXA Life Insurance, Bangkok Life Assurance, and Thai Setakij Insurance had high leverage ratios of 10.55, 7.43, and 6.72 times, respectively, in FY 2018, potentially jeopardizing their solvency. The CAR for Krungthai-AXA Life Insurance and Thai Setakij Insurance was not reported. Firms such as Bangkok Life Assurance, Dhipaya Insurance, Indara Insurance, and Thaivivat Insurance were also highly leveraged. A reduction in their leverage ratios could be beneficial. Dhipaya Insurance did not report its CAR. Most firms studied met the CAR requirement set by the Office of Insurance Commission, Thailand.

Bangkok Life Assurance, Krungthai-AXA Life Insurance, and Charan Insurance exhibited the highest liquidity, indicating their ability to meet short-term obligations. However, high liquidity may also suggest an excess of cash and cash equivalents, which could be invested for returns. The management of these firms should consider this. Most other firms had satisfactory liquidity positions, with a liquidity ratio greater than 1, except for Bangkok Insurance, Thaivivat Insurance, and Bangkok Union Insurance. These firms, with a liquidity ratio of less than 1 in 2018, may face challenges in meeting short-term obligations. As these firms also demonstrated low liquidity in previous FYs, their management should consider strategies to improve liquidity.

Table 4.17 Financial Ratios of Insurance Companies for Fiscal Year 2019

FY 2019							
Ticker	**Profitability Performance**			**Ratio for Efficiency**	**Ratio for Leverage or Solvency**		**Ratio for Liquidity**
	ROA (%)	**ROE (%)**	**Loss Ratio (%)**	**TAT (Times)**	**Leverage Ratio (Times)**	**CAR (%)**	**Current Liquidity (Times)**
AYUD	0.93%	1.40%	56.90%	0.20	0.57	677.38%	1.47
BKI	4.16%	7.44%	54.10%	0.27	0.85	289.70%	0.79
BLA	1.33%	10.59%	6.54%	0.15	6.54	314%	7.62
BUI	0.63%	1.77%	49.29%	0.53	1.85	264.42%	0.95
CHARAN	-3.65%	-5.62%	53.36%	0.40	0.70	262%	8.93
TIPH	4.34%	23.25%	48.44%	0.18	3.89	-	1.39
INSURE	-0.38%	-1.93%	55.45%	0.49	3.63	416.79%	1.2
Krung-AXA*	0.56%	3.67%	59.16%	0.21	5.37	-	2.35

FY 2019							
Ticker	**Profitability Performance**			**Ratio for Efficiency**	**Ratio for Leverage or Solvency**		**Ratio for Liquidity**
	ROA (%)	**ROE (%)**	**Loss Ratio (%)**	**TAT (Times)**	**Leverage Ratio (Times)**	**CAR (%)**	**Current Liquidity (Times)**
KWI	-4.90%	-13.70%	-18.73%	0.01	1.94	>140%	1.04
MTI	1.91%	7.89%	59.50%	0.40	3.17	310%	2.67
NSI	2.20%	6.17%	55.75%	0.57	1.88	678.73%	1.26
SMK	4.34%	10.78%	64.05%	0.73	1.43	546.82%	1.58
TSI	-0.04%	-10.91%	30.02%	0.41	1.66	-	1.6
TVI	1.84%	8.74%	55.49%	0.64	3.97	236.26%	0.49
NKI	0.54%	1.42%	64.94%	0.47	1.76	-	1.35

Note: Exact CAR of KWI is unavailable from its annual report or could not be found.

Profitability performance ratios indicate that firms such as Dhipaya Insurance, Syn Mun Kong Insurance, Bangkok Insurance, and Bangkok Life Assurance exhibited superior performance in FY 2019. These firms demonstrated higher ROA and ROE or lower loss ratios. Conversely, Thai Setakij Insurance underperformed with a negative ROA and ROE, and a high loss ratio. Other firms, including Indara Insurance, The Navakij Insurance, KWI, and Charan Insurance, also underperformed given their low ROA and ROE or high loss ratios. In FY 2019, a decline in profitability ratios was observed for more firms compared to previous years. Notably, Bangkok Life Assurance maintained a consistently low loss ratio.

ERs, specifically the TAT ratio, reveal that Syn Mun Kong Insurance, Nam Seng Insurance, Bangkok Union Insurance, and Thaivivat Insurance effectively utilized assets to generate revenues. However, Dhipaya Insurance, KWI, Allianz Ayudhya Capital, Bangkok Insurance, Bangkok Life Assurance, and Krungthai-AXA Life Insurance were less effective in revenue generation through asset utilization. These firms also had subpar TAT ratios in FY 2018. It is recommended that these firms' management teams investigate this issue to enhance efficiency. Other firms demonstrated moderate ERs.

Solvency or leverage ratios show that Allianz Ayudhya Capital, Bangkok Insurance, and Charan Insurance had comparatively lower leverage ratios, which is favorable for solvency. These firms also had robust CAR, indicating strong financial health and long-term solvency. In contrast, Krungthai-AXA Life Insurance, Bangkok Life Assurance, Thaivivat Insurance, and Dhipaya Insurance had high leverage ratios of 5.37, 6.54, 3.97, and 3.89 times, respectively, in FY 2019. This high ratio is unfavorable for company solvency. The CAR for Krungthai-AXA Life Insurance and Dhipaya Insurance was not reported in the annual report. Indara Insurance and Muang Thai Insurance also had high leverage, albeit not as high as the previously mentioned firms. These firms could potentially benefit from reducing their leverage ratios. Other firms had a leverage ratio of less than 2. Most firms studied met the CAR requirement stipulated by the Office of Insurance Commission, Thailand.

Bangkok Life Assurance, Muang Thai Insurance, and Charan Insurance demonstrated the highest liquidity among the firms, suggesting their ability to meet short-term obligations. However, the liquidity ratios of Charan Insurance and Bangkok Life Assurance, at 8.93 and 7.62 times respectively, appear somewhat high. Excessive liquidity may not be beneficial as these current assets, such as cash, could be deployed elsewhere for better returns. The management of these firms may wish to investigate this. Most other firms had satisfactory liquidity positions, with a liquidity ratio greater than 1. Exceptions include Bangkok Insurance, Bangkok Union Insurance, and Thaivivat Insurance, which had liquidity ratios less than 1 in 2019. These firms may face challenges in meeting short-term obligations as they fall due. As these firms also demonstrated low liquidity in the previous FY, their management may need to explore ways to improve liquidity.

While some companies exhibit strong performance in certain financial ratios, they may underperform in others. Given the multitude of financial ratios, determining a company’s overall and comparative financial performance can be challenging. Therefore, a composite score, derived from the rank normalization method, may provide a more comprehensive view of each company’s overall financial performance. The rank normalization method, which makes no assumptions about the underlying data distribution or its normality, can be applied to normalize both non-parametric and parametric data. This technique facilitates the ranking of firms and aids in comparison, which would otherwise be difficult given the different financial ratios. Company rankings also assist in hypothesis testing. The overall company rankings for the FYs 2015 to 2019, based on this method, are as follows:

Table 4.18 Overall Ranking of Insurance Companies based on Financial Ratios, Fiscal Years 2015–2019

Ticker	2015	2016	2017	2018	2019	Cumulative
AYUD	7	3	3	1	11	2
BKI	11	8	8	7	4	8
BLA	8	7	6	4	4	7
BUI	10	9	9	13	9	12
CHARAN	1	1	4	4	6	3
INSURE	4	13	12	12	14	9
Krung-AXA*	6	6	6	11	13	6
KWI	15	11	12	14	15	14
MTI	3	4	4	8	6	5
NKI	9	12	11	10	12	10
NSI	2	5	2	3	3	4
SMK	4	2	1	2	1	1
TIPH	12	9	9	8	2	11
TSI	13	15	15	15	6	15
TVI	14	14	14	6	8	13

The CAR was not included in the overall rankings of firms across different FYs using the rank normalization method in FRA. The Office of Insurance Commission, Thailand, stipulates a CAR of >140%. This dissertation aimed to determine whether most companies meet this minimum requirement. A high CAR does not necessarily indicate excellent solvency; any firm exceeding the requirement is considered solvent. Therefore, CAR was not ranked or included in this study, despite being reviewed. Its exclusion was also due to some firms not reporting their CARs or stating compliance without providing actual figures. In rare instances, such as with KWI, the loss ratio was unavailable in the financial report, thus not included in the overall ranking/score. This exclusion may introduce bias in the overall ranking. To mitigate this, a sensitivity analysis was conducted using arbitrary numbers close to the mean ratio of all firms for the missing ratio. The analysis revealed no significant impact on the ranking, although an exact ratio would have provided a more accurate comparative analysis. This method was consistently applied in other FYs.

From Table 4.18 shows that in FY 2015, Charan Insurance ranked highest primarily given its low leverage and loss ratios, indicating effective claims management and minimal debt. Nam Seng Insurance closely followed, with its ranking attributed to efficient asset utilization for returns and revenues generation, and high liquidity. Conversely, KWI performed poorly, ranking 15th given negative ROA and ROE, indicating losses in FY 2015, and subpar TAT. In FY 2016, Charan Insurance maintained the top ranking given its low leverage and loss ratios, and high liquidity, indicating effective claims management, minimal debt, and ability to meet short-term obligations. Syn Mun Kong Insurance closely followed, with its ranking attributed to efficient asset utilization for returns and revenues generation, and high ROE. Thai Setakij Insurance performed poorly, ranking 15th given negative ROA and ROE, indicating losses in FY 2016, and a high loss ratio.

In FY 2017, Syn Mun Kong Insurance ranked highest given its high TAT and profitability, indicating effective resource utilization for revenue and profit generation. Nam Seng Insurance ranked 2nd given its superior profitability (except loss ratio), efficiency, liquidity, and relatively lower leverage ratio, suggesting a sound financial position. Thai Setakij Insurance continued to perform poorly, ranking 15th given negative ROA and ROE, indicating losses in FY 2017, a high loss ratio, and high leverage. Based on the research, Thai Setakij Insurance has demonstrated signs of financial stress over the past three FYs.

In FY 2018, Allianz Ayudhya Capital ranked highest given its impressive profitability performance and low leverage ratio, indicating effective resource utilization for profit generation with minimal debt. Syn Mun Kong Insurance ranked 2nd given its superior profitability (except loss ratio) and efficiency, and relatively lower leverage ratio, suggesting a sound financial position. Thai Setakij Insurance continued to perform poorly, ranking 15th given negative ROA and ROE, indicating losses in FY 2018 (its ROE was -47.61%), a high loss ratio, and high leverage. The company's management should address this as high leverage and low profitability may risk financial instability if revenues decline further or if it faces difficulty in repaying its debts on time.

In FY 2019, Syn Mun Kong Insurance ranked highest, as in FY 2017, given its superior profitability (except loss ratio) and efficiency performance, and relatively low leverage ratio, indicating effective resource utilization for profit and revenue generation with minimal debt. Dhipaya Insurance ranked 2nd given its impressive profitability. Despite its high rank, it could improve its TAT ratio, which was only 0.18 times. KWI and Indara Insurance performed poorly, ranking 15th and 14th respectively given negative ROA and ROE, indicating losses in FY 2019. KWI's loss ratio was high at 80%, and its TAT ratio was a mere 0.01 times. The company's management should address these issues to improve its profitability and efficiency performance.

Cumulative rankings from 2015 to 2019 show Syn Mun Kong Insurance as the top-ranked firm, followed by Allianz Ayudhya Capital and Charan Insurance. Thai Setakij Insurance performed poorly, ranking 15th, and KWI also had a low ranking of 14th.

4.5 Total Return of Insurance Companies

Table 4.19 presents the total return (TR) of insurance companies.

Table 4.19 Total Return (TR) of Insurance Companies

	30 December 2014 to 30 December 2019	
Ticker	**TR (Holding period %)**	**TR (Annualized %)**
AYUD	54.07%	9.34%
BKI	-2.44%	-0.51%
BLA	-50.55%	-13.54%
BUI	-0.75%	-0.15%
CHARAN	-14.84%	-3.26%
TIPH	79.03%	12.78%
INSURE	31.36%	5.80%

30 December 2014 to 30 December 2019		
Ticker	**TR (Holding period %)**	**TR (Annualized %)**
KWI	-29.46%	-6.95%
MTI	-30.22%	-7.16%
NSI	-31.62%	-7.32%
SMK	-23.23%	-5.31%
TSI	44.60%	7.92%
TVI	-13.66%	-2.99%
NKI	-9.40%	-2.02%

TR encompasses both changes in stock price and any distributed dividends. The TR (holding period %) represents the percentage TR of the stock during the holding period from December 30, 2014, to December 30, 2019. The TR (annualized %) refers to the annualized percentage TR of the stock during the same holding period, essentially the compounded annual return an investor would have earned if the stock was held throughout the entire period. Krungthai-AXA Life Insurance was excluded from this TR study given its stock not being publicly traded, rendering its TR unavailable.

Based on the provided table, Dhipaya Insurance achieved the highest TR (annualized %) at 12.78%, followed by Allianz Ayudhya Capital at 9.34%, Thai Setakij Insurance at 7.92%, and Indara Insurance at 5.80%. All other firms under study reported negative TR. Bangkok Life Assurance had the lowest TR (annualized %) at -13.54%. These results indicate that the insurance industry, overall, underperformed during the five years from 2015 to 2019.

4.6 Hypothesis Testing for Insurance Companies

This section analyzes and tests the hypotheses on Thai insurance companies.

4.6.1 Hypothesis Testing H1

Regarding H1, section 4.1 reveals that the FV of financial items, as reported in the annual reports of insurance companies, differs from the HC. This variation is observed for several, but not all, financial items under study, across most insurance companies and years. The magnitude of these changes varies significantly among insurance companies, years, and asset types.

For instance, Bangkok Insurance's AFS investments in FY 2019 had an HC of THB 11,523,505, while their FV was THB 33,010,708. Other investments for the same year were valued at THB 727,019 on an HC basis and THB 3,440,555 on an FV basis. However, the company's HTM investments for the same year had identical values under both valuation methods. In contrast, Charan Insurance's AFS investments in FY 2015 had an HC of THB 170,697 and an FV of THB 232,717. Its HTM investments were valued at THB 406,867 (HC) and THB 410,961 (FV). Other investments were valued at THB 341 (HC) and THB 19,351 (FV). All figures are in THB Thousand.

The analysis supports H1 for the majority of financial items, as evidenced by the observed differences between their HCs and FVs. However, this support is not universal. For example, Bangkok Insurance's HTM investments in FY 2019 and Bangkok Life Assurance's other investments in FY 2015 showed no difference between the two valuation methods. These instances suggest that H1 is not universally applicable. Therefore, while H1 is substantiated in several cases, it is only partially supported overall, indicating a nuanced impact of FV accounting on financial reporting within the Thai insurance sector.

Table 4.20 Mean Difference of Variables of Insurance Companies for Fiscal Years 2015-2019 (in Thousands of Thai Baht)

	Mean Difference		
FY	**Available-for-sale investments - Fair value vs. Available-for-sale investments - Historical Cost**	**Held-to-maturity investments - Fair value vs. Held-to-maturity investments - Historical cost**	**Other Investments - Fair value vs. Other investments - Cost**
2015	3,177,611.79	1,383,423.43	210,759.08
2016	2,784,818.64	1,105,084.64	208,377.22
2017	3,971,588.08	1,498,732.78	183,500.57
2018	3,024,594.27	961,773.47	189,429.86
2019	4,872,447.87	2,792,322.20	227,358.80
Overall	3,576,831.82	1,557,400.09	204,010.36

Table 4.20 shows substantial variations in the mean differences over the years in AFS investments, HTM investments, and other investments when comparing FV vs. HC/Cost. The overall mean differences across the five years for each type of investment also indicate notable changes in their valuation when restated at FV. This suggests that the shift to FV accounting impacts the reported values of these financial items in the financial statements of Thai insurance companies. To test whether there are significant changes upon restatement, a Wilcoxon signed-rank test was performed. The results for FY 2015 are as follows:

Table 4.21 Ranks of Variables of Insurance Companies, Wilcoxon Signed-Rank Test for Fiscal Year 2015

Ranks

		N	**Mean Rank**	**Sum of Ranks**
Available-for-sale investments - Fair value vs. Available-for-sale investments - Historical Cost	Negative Ranks	5[a]	5.40	27.00
	Positive Ranks	8[b]	8.00	64.00
	Ties	1[c]	-	-
	Total	14	-	-
Held-to-maturity investments - fair value vs. Held-to-maturity investments - Historical cost	Negative Ranks	1[d]	2.00	2.00
	Positive Ranks	10[e]	6.40	64.00
	Ties	3[f]	-	-
	Total	14	-	-
Other Investments vs. Fair value - Other investments - Cost	Negative Ranks	0[g]	.00	.00
	Positive Ranks	10[h]	5.50	55.00
	Ties	4[i]	-	-
	Total	14	-	

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Historical Cost in 5 instances (or for 5 firms), b. Available-for-sale investments - Fair value > Available-for-sale investments - Historical Cost in 8 instances, c. Available-for-sale investments - Fair value = Available-for-sale investments - Historical Cost in 1 instance, d. Held-to-maturity investments - fair value < Held-to-maturity investments - Historical cost in 1 instance, e. Held-to-maturity investments - fair value > Held-to-maturity investments - Historical cost in 10 instances, f. Held-to-maturity investments - fair value = Held-to-maturity investments - Historical cost in 3 instances, g. Other

Investments - Fair value < Other investments – Cost in 0 instance, h. Other Investments - Fair value > Other investments – Cost in 10 instances, i. Other Investments - Fair value = Other investments - Cost in 4 instances.

This confirms the changes in values on restatement in most instances.

Table 4.22 Test Statistics of Variables of Insurance Companies - Wilcoxon Signed-Rank Test for Fiscal Year 2015

Test Statistics[a]			
	Available-for-sale investments - Fair value vs. Available-for-sale investments - Historical Cost	**Held-to-maturity investments - fair value vs. Held-to-maturity investments - Historical cost**	**Other Investments - Fair value vs. Other investments - Cost**
Z	-1.293[b]	-2.756[b]	-2.803[b]
Asymp. Sig. (2-tailed)	.196	.006	.005

Note: a. Wilcoxon Signed Ranks Test, b. Based on negative ranks.

Table 4.22 presents the financial data for FY 2015. The Z-value for the comparison between the FV and HC of AFS investments is -1.293, with a corresponding p-value (Asymp. Sig. [2-tailed]) of .196. As the p-value exceeds .05, it indicates no statistically significant difference at the 0.05 level.

The Z-value for the difference between the FV and the HC of HTM investments is -2.756, with a corresponding p-value of 0.006. Given that the p-value is less than 0.05, we can infer that the difference between the FV and the HC of HTM investments is statistically significant at the 0.05 level. Similarly, the Z-value for the difference between the FV and the cost of other investments is -2.803, with a corresponding p-value of 0.005. Given that the p-value is less than 0.05, we can infer that the difference between the FV and the cost of other investments is statistically significant at the 0.05

level. This suggests that the method of valuation— FV versus cost—has a meaningful impact on the reported value of these investments.

The Z-values for both HTM investments and other investments are further from zero, indicating that the observed differences are not likely due to random chance and are therefore meaningful. In contrast, the Z-value for AFS investments is closer to zero than the other two variables, suggesting a lower level of certainty that the observed difference is not due to random chance. Test statistics are based on negative ranks. The results for FYs 2016, 2017, 2018, and 2019, obtained from SPSS software, are provided in Appendix A. The Z-values and p-values for each year are as follows:

Regarding FY 2016, for AFS investments, the Z-value for the difference between FV and HC is -1.161, with a p-value of 0.245. For HTM investments, the Z-value for the difference between FV and HC is -2.310, with a p-value of 0.021. For other investments, the Z-value for the difference between FV and cost is -2.521, with a p-value of 0.012.

Regarding FY 2017, for AFS investments, the Z-value for the difference between FV and HC is -2.271, with a p-value of 0.023. For HTM investments, the Z-value for the difference between FV and HC is -2.191, with a p-value of 0.028. For other investments, the Z-value for the difference between FV and cost is -2.521, with a p-value of 0.012.

Regarding FY 2018, for AFS investments, the Z-value for the difference between FV and HC is -1.193, with a p-value of 0.233. For HTM investments, the Z-value for the difference between FV and HC is -0.889, with a p-value of 0.374. For other investments, the Z-value for the difference between FV and cost is -2.073, with a p-value of 0.038.

Regarding FY 2019, for AFS investments, the Z-value for the difference between FV and HC is -1.193, with a p-value of 0.233. For HTM investments, the Z-value for the difference between FV and HC is -2.934, with a p-value of 0.003. For other investments, the Z-value for the difference between FV and cost is -1.988, with a p-value of 0.047.

The discussion pertaining to Thai insurance companies suggests that H1 is partially supported. This inference is drawn from the observation that in all FYs, a statistically significant difference exists between the FV and HC of most variables, with a few exceptions. For instance, the p-value for the difference between the FV and cost of 'Other Investments' is less than 0.05 in all FYs, indicating a statistically significant difference. Similarly, the p-value for the difference between the FV and HC of HTM Investments is also less than 0.05 in all FYs, suggesting a statistically significant difference, except in FY 2018. However, for AFS Securities, the p-value is greater than 0.05 in all FYs, indicating that the difference is not statistically significant, except in FY 2017. This partial support for the hypothesis suggests that while the restatement to FV significantly impacts certain financial items, others are less affected. This underscores the need for a critical assessment of FV accounting, as it may alter the financial statement analysis and position of a company. The findings provide empirical evidence that partially supports the hypothesis that FV restatements lead to significant changes in the valuation of key financial items, highlighting the impact of accounting methods on financial reporting. This has important implications for stakeholders' decision-making processes and their understanding of the financial health of insurance companies.

4.6.2 Hypothesis Testing H2

H2 focuses on Thai insurance companies. Section 4.3.3 reveals that the efficiency scores of several Thai insurance companies vary when they switch the valuation basis from HC to FV. However, not all companies exhibit changes in efficiency scores upon restatement across all study years.

For instance, Bangkok Life Assurance's TE scores fluctuated across the FYs 2015 to 2019 when it switched the valuation basis from HC to FV, except in FY 2018. In FY 2018, the TE scores remained consistent at 0.169 for both valuation bases. Another case is Nam Seng Insurance, whose TE scores altered upon restatement across all years. However, the changes were not substantial in the FYs 2016, 2017, 2018, and 2019. For example, in FY 2016, Nam Seng Insurance's TE score was 0.691 based on HC and 0.664 based on FV. In FY 2019, Allianz Ayudhya Capital's TE scores were identical based on both FV and HC.

These observations partially support H2.1, suggesting changes in efficiency scores upon restatement. It is also worth noting that insurance companies, which exhibit no change in their TE score upon restatement from HC to FV basis in a specific FY, have a TE score that is either at the maximum (1) or the minimum (0).

Although this study does not primarily investigate 'significant' changes in efficiency scores upon restatement, a Wilcoxon signed-rank test was conducted to ascertain if there were significant changes in companies' efficiency scores upon restatement from HC to FV. This additional analysis provides further insights to the reader.

Table 4.23 Wilcoxon Test Ranks for Technical Efficiency (TE) Scores, Fair Value (FV) versus Historical Cost (HC), Insurance Companies, 2015–2019

Ranks

		N	**Mean Rank**	**Sum of Ranks**
TE FV 2015 vs. TE HC 2015	Negative Ranks	4[a]	3.50	14.00
	Positive Ranks	5[b]	6.20	31.00
	Ties	6[c]	-	-
	Total	15	-	-
TE FV 2016 vs. TE HC 2016	Negative Ranks	11[d]	6.00	66.00
	Positive Ranks	0[e]	.00	.00
	Ties	4[f]	-	-
	Total	15	-	-
TE FV 2017 vs. TE HC 2017	Negative Ranks	11[g]	6.00	66.00
	Positive Ranks	0[h]	.00	.00
	Ties	4[i]	-	-
	Total	15	-	-
TE FV 2018 vs. TE HC 2018	Negative Ranks	3[j]	2.33	7.00
	Positive Ranks	1[k]	3.00	3.00
	Ties	11[l]	-	-
	Total	15	-	-
TE FV 2019 vs. TE HC 2019	Negative Ranks	0[m]	.00	.00
	Positive Ranks	6[n]	3.50	21.00
	Ties	9[o]	-	-
	Total	15	-	-

Note: In Tables 4.23 and 4.24, "TE FV" represents the technical efficiency score based on fair value, and "TE HC" denotes the technical efficiency score based on historical cost. Both are followed by their respective fiscal years (e.g., "TE FV 2015" and "TE HC 2015").

a. TE FV 2015 < TE HC 2015, b. TE FV 2015 > TE HC 2015, c. TE FV 2015 = TE HC 2015, d. TE FV 2016 < TE HC 2016, e. TE FV 2016 > TE HC 2016, f. TE FV 2016 = TE HC 2016, g. TE FV 2017 < TE HC 2017, h. TE FV 2017 > TE HC 2017, i. TE FV 2017 = TE HC 2017, j. TE FV 2018 < TE HC 2018, k. TE FV 2018 > TE HC 2018, l. TE FV 2018 = TE HC 2018, m. TE FV 2019 < TE HC 2019, n. TE FV 2019 > TE HC 2019, o. TE FV 2019 = TE HC 2019

The table clearly shows differences between TE under FV and HC methods, as evidenced by the presence of both negative and positive ranks for each FY. However, ties observed in each FY, particularly in FY 2018 and FY 2019, suggest that TE FV and TE HC are identical for some companies.

Table 4.24 Wilcoxon Test Statistics for Technical Efficiency (TE) Score Differences, Fair Value (FV) Versus Historical Cost (HC) in Insurance Companies, 2015–2019

Test Statistics[a]					
	TE FV 2015 vs. TE HC 2015	**TE FV 2016 vs. TE HC 2016**	**TE FV 2017 vs. TE HC 2017**	**TE FV 2018 vs. TE HC 2018**	**TE FV 2019 vs. TE HC 2019**
Z	-1.007[b]	-2.934[c]	-2.934[c]	-.730[c]	-2.201[b]
Asymp. Sig. (2-tailed)	.314	.003	.003	.465	.028

Note: a. Wilcoxon Signed Ranks Test, b. Based on negative ranks, c. Based on positive ranks.

For TE FV 2015 and TE HC 2015, the p-value or asymptotic significance (Asymp. Sig.) (2-tailed) exceeds .05, indicating insufficient evidence to assert a significant difference between TE FV and TE HC in FY 2015. A similar lack of significant difference is observed in FY 2018. Conversely, for TE FV 2016 and TE HC 2016, the p-value or Asymp. Sig. (2-tailed) is less than .05, providing sufficient evidence of a significant difference between TE FV and TE HC in FY 2016. This significant difference is also observed in FY 2017 and FY 2019.

This analysis, focusing on Thai insurance companies, partially supports H2.1. This is because in FYs 2016, 2017, and 2019, there is sufficient evidence to conclude that FV and HC TE scores differ significantly. However, for FYs 2015 and 2018, the data does not provide enough evidence to make the same conclusion. These findings suggest that the impact of FV accounting on TE scores within the insurance sector is nuanced. While the application of FV accounting can lead to changes in efficiency scores, this is not uniformly observed across all companies. This implies that efficiency scores of companies are influenced by the nature of financial items and specific company characteristics. Hypothesis testing for banking companies will be conducted in Section 4.12.2. To test H2.2, the rankings of insurance companies based on their HC TE scores and FV TE scores are determined and compared for each year and cumulatively across all FYs.

Table 4.25 Comparative Rankings of Insurance Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency Scores, 2015

Rank - HC TE 2015			**Rank - FV TE 2015**		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	AYUD	1	1	AYUD	1
1	BKI	1	1	BKI	1
1	INSURE	1	1	INSURE	1
1	Krung-AXA*	1	1	Krung-AXA*	1
5	CHARAN	0.689	1	NSI	1
6	SMK	0.542	6	MTI	0.727
7	NSI	0.522	7	BLA	0.717
8	MTI	0.452	8	TSI	0.673
9	BLA	0.345	9	TIPH	0.404
10	TSI	0.294	10	SMK	0.352
11	BUI	0.282	11	CHARAN	0.306
12	TIPH	0.209	12	BUI	0.204
13	TVI	0.046	13	TVI	0.027
14	KWI	0	14	KWI	0
14	NKI	0	14	NKI	0

In FY 2015, insurance companies were ranked individually based on their TE scores, under both valuation bases. It is evident that the rankings of Thai insurance companies fluctuate when the valuation basis shifts from HC to FV. While Allianz Ayudhya Capital, Bangkok Insurance, Indara Insurance, and Krungthai-AXA Life maintain consistent TE scores and ranks under both valuation bases, the overall ranking varies when all companies are considered.

For instance, in FY 2015, Nam Seng Insurance, initially at the 7th position with a TE score of 0.522 under the HC basis, ascended to the 1st position with a perfect TE score of 1 under the FV basis. Similarly, Muang Thai Insurance improved its rank from 8th to 6th, with its TE score increasing from 0.452 to 0.727 when restated to the FV basis. However, KWI and The Navakij Insurance remained at the lowest ranks under both valuation bases.

Table 4.26 Comparative Rankings of Insurance Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency (TE) Scores, 2016

Rank - HC TE 2016			**Rank - FV TE 2016**		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	AYUD	1	1	INSURE	1
1	BLA	1	1	KWI	1
1	CHARAN	1	3	SMK	0.819
1	TIPH	1	4	AYUD	0.686
1	INSURE	1	5	NSI	0.664
1	KWI	1	6	TIPH	0.566
1	SMK	1	7	CHARAN	0.441
8	Krung-AXA*	0.955	8	BLA	0.397
9	MTI	0.786	9	MTI	0.387
10	NSI	0.691	10	BUI	0.163
11	BUI	0.431	11	NKI	0.101
12	NKI	0.297	12	Krung-AXA*	0.081
13	TVI	0.174	13	TVI	0.043
14	BKI	0	14	BKI	0
14	TSI	0	14	TSI	0

In FY 2016, the rankings based on TE scores also varied when Thai insurance companies switched the valuation basis from HC to FV. For example, Allianz Ayudhya Capital, ranked 1st based on the HC TE, dropped to the 4th position based on the FV TE. Bangkok Life Assurance, initially ranked 1st based on the HC TE, fell to the 8th position based on its FV TE. Nevertheless, firms such as Indara Insurance and KWI retained their top rank upon restatement.

Table 4.27 Comparative Rankings of Insurance Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency (TE) Scores, 2017

Rank - HC TE 2017			Rank - FV TE 2017		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	AYUD	1	1	AYUD	1
1	INSURE	1	1	INSURE	1
1	KWI	1	1	KWI	1
1	SMK	1	4	NSI	0.752
5	NSI	0.778	5	SMK	0.529
6	CHARAN	0.619	6	TIPH	0.495
7	BUI	0.58	7	BUI	0.484
8	BLA	0.529	8	BLA	0.412
9	TIPH	0.501	9	CHARAN	0.269
10	MTI	0.28	10	MTI	0.265
11	Krung-AXA*	0.253	11	Krung-AXA*	0.246
12	BKI	0.23	12	BKI	0.156
13	TVI	0.154	13	TVI	0.123
14	NKI	0.099	14	NKI	0.089
15	TSI	0	15	TSI	0

In FY 2017, the ranking of Thai insurance companies changed when the valuation basis shifted from HC to FV. For instance, Syn Mun Kong Insurance, initially ranked 1st based on HC TE, dropped to 5th place based on FV TE. Dhipaya Insurance moved from 9th to 6th place. However, Allianz Ayudhya Capital, Indara Insurance, and KWI maintained their top positions after restatement.

Table 4.28 Comparative Rankings of Insurance Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency Scores, 2018

Rank - HC TE 2018			Rank - FV TE 2018		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	KWI	1	1	KWI	1
2	TIPH	0.765	2	TIPH	0.765
3	SMK	0.744	3	SMK	0.743
4	BKI	0.661	4	BKI	0.661
5	NSI	0.565	5	NSI	0.596
6	BUI	0.26	6	BUI	0.226
7	TVI	0.228	7	TVI	0.216
8	BLA	0.169	8	BLA	0.169
9	MTI	0.113	9	MTI	0.113
10	AYUD	0	10	AYUD	0
10	CHARAN	0	10	CHARAN	0
10	INSURE	0	10	INSURE	0
10	Krung-AXA*	0	10	Krung-AXA*	0
10	TSI	0	10	TSI	0
10	NKI	0	10	NKI	0

Interestingly, in FY 2018, the rankings remained unchanged when restated from an HC basis to an FV basis. Despite slight changes in the TE scores of some firms, the rankings remained consistent. Notably, 2018 was the only year with a single company, KWI, achieving a perfect relative efficiency score of 1 on both valuation bases. In this year, the HC TE and FV TE scores of all firms were closely aligned. For instance, Thaivivat Insurance had an HC TE of 0.228 and an FV TE of 0.216.

Table 4.29 Comparative Rankings of Insurance Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency Scores, 2019

Rank - HC TE 2019			Rank - FV TE 2019		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	AYUD	1	1	AYUD	1
1	Krung-AXA*	1	1	Krung-AXA*	1
1	TVI	1	1	TVI	1
4	BLA	0.223	4	BLA	0.545
5	TIPH	0.208	5	TIPH	0.212
6	SMK	0.155	6	SMK	0.175
7	NSI	0.103	7	NSI	0.111
8	MTI	0.064	8	MTI	0.089
9	NKI	0.005	9	NKI	0.006
10	BKI	0	10	BKI	0
10	BUI	0	10	BUI	0
10	CHARAN	0	10	CHARAN	0
10	INSURE	0	10	INSURE	0
10	KWI	0	10	KWI	0
10	TSI	0	10	TSI	0

Similarly, in FY 2019, the rankings remained stable upon restatement from an HC basis to an FV basis. Although the TE scores of some firms varied, the rankings were consistent. All firms' HC TE and FV TE scores were closely aligned, except for Bangkok Life Assurance. For instance, The Navakij Insurance had an HC TE of 0.005 and an FV TE of 0.006.

The results for FYs 2015, 2016, and 2017, focusing on Thai insurance companies, support H2.2. However, the results for FYs 2018 and 2019 do not support this hypothesis. This discrepancy is attributed to the underperformance of the insurance industry during these years, with many companies reporting losses and a TE of 0 for both valuation bases. Consequently, firm rankings remained unchanged upon restatement. Additionally, bearish financial markets caused these investments to slide closer to their HC values than in other years.

Table 4.30 illustrates the cumulative ranking based on the mean HC TE of each company for all FYs from 2015 to 2019. Similarly, Table 4.31 shows the cumulative ranking based on the mean FV TE for all FYs of each company. The analysis follows these tables, comparing the data they present.

Table 4.30 Cumulative Ranking of Insurance Companies Based on Mean Technical Efficiency Scores, Historical Cost for Fiscal Years 2015 to 2019

Cumulative Ranking	Ticker	TE 2015	TE 2016	TE 2017	TE 2018	TE 2019	Mean of TEs (HC)
1	AYUD	1	1	1	0	1	0.8
2	SMK	0.542	1	1	0.744	0.155	0.6882
3	Krung-AXA*	1	0.955	0.253	0	1	0.6416
4	INSURE	1	1	1	0	0	0.6
4	KWI	0	1	1	1	0	0.6
6	TIPH	0.209	1	0.501	0.765	0.208	0.5366
7	NSI	0.522	0.691	0.778	0.565	0.103	0.5318
8	CHARAN	0.689	1	0.619	0	0	0.4616
9	BLA	0.345	1	0.529	0.169	0.223	0.4532
10	BKI	1	0	0.23	0.661	0	0.3782
11	MTI	0.452	0.786	0.28	0.113	0.064	0.339
12	TVI	0.046	0.174	0.154	0.228	1	0.3204
13	BUI	0.282	0.431	0.58	0.26	0	0.3106
14	NKI	0	0.297	0.099	0	0.005	0.0802
15	TSI	0.294	0	0	0	0	0.0588

Table 4.31 Cumulative Ranking of Insurance Companies Based on Mean Technical Efficiency (TE) Scores, Fair Value (FV) for Fiscal Years 2015 to 2019

Cumulative Ranking	Ticker	TE 2015	TE 2016	TE 2017	TE 2018	TE 2019	Mean of TEs (FV)
1	AYUD	1	0.686	1	0	1	0.7372
2	NSI	1	0.664	0.752	0.596	0.111	0.6246
3	INSURE	1	1	1	0	0	0.6000
3	KWI	0	1	1	1	0	0.6000

Cumulative Ranking	**Ticker**	**TE 2015**	**TE 2016**	**TE 2017**	**TE 2018**	**TE 2019**	**Mean of TEs (FV)**
5	SMK	0.352	0.819	0.529	0.743	0.175	0.5236
6	TIPH	0.404	0.566	0.495	0.765	0.212	0.4884
7	Krung-AXA*	1	0.081	0.246	0	1	0.4654
8	BLA	0.717	0.397	0.412	0.169	0.545	0.4480
9	BKI	1	0	0.156	0.661	0	0.3634
10	MTI	0.727	0.387	0.265	0.113	0.089	0.3162
11	TVI	0.027	0.043	0.123	0.216	1	0.2818
12	BUI	0.204	0.163	0.484	0.226	0	0.2154
13	CHARAN	0.306	0.441	0.269	0	0	0.2032
14	TSI	0.673	0	0	0	0	0.1346
15	NKI	0	0.101	0.089	0	0.006	0.0392

The restatement of insurance companies from an HC to an FV basis has led to changes in their overall rankings based on mean efficiency scores. For instance, Nam Seng Insurance, originally ranked 7th on an HC basis, rose to 2nd on an FV basis. Conversely, Charan Insurance fell from 8th to 13th. Notably, Allianz Ayudhya Capital maintained the top position under both valuation bases. These shifts in rankings support H2.2, suggesting that the application of FV accounting can alter the efficiency rankings of insurance companies. This validates H2.

To further substantiate this hypothesis, a Malmquist DEA (M DEA) was conducted. Based on M DEA analysis, Table 4.32 presents the overall ranking of the EC in companies.

Table 4.32 Comparison of Geometric Mean (GM) Efficiency Changes (EC) Under Historical Cost (HC) versus Fair Value (FV) for Insurance Companies, 2015 to 2019

GM EC - HC			**GM EC - FV**		
Overall Ranking	**Ticker**	**GM Efficiency change (HC)**	**Overall Ranking**	**Ticker**	**GM Efficiency change (FV)**
1	TVI	2.161	1	TVI	2.459
2	AYUD	1	2	AYUD	1
2	Krung-AXA*	1	2	Krung-AXA*	1
4	TIPH	0.998	4	BLA	0.934
5	BLA	0.897	5	TIPH	0.85
6	SMK	0.731	6	SMK	0.84
7	NSI	0.667	7	MTI	0.592
8	MTI	0.614	8	NSI	0.577
9	BKI	0	9	BKI	0
9	BUI	0	9	BUI	0
9	CHARAN	0	9	CHARAN	0
9	INSURE	0	9	INSURE	0
9	TSI	0	9	KWI	0
	KWI	-	9	TSI	0
	NKI	-		NKI	-

Table 4.32 reveals minor shifts in rankings based on GM EC. For instance, Dhipaya Insurance, ranked 4th based on HC, moved to the 5th position when FV was considered. Similarly, Muang Thai Insurance, initially 8th on the EC HC list, improved to the 7th position on the EC FV list. The mean EC, calculated as the GM of ECs year over year, is computed by comparing the TE of a given year with that of the preceding year. This process is repeated for each year (e.g., comparing 2016 TE with 2015 TE, 2017 TE with 2016 TE, and so forth), and the GM is then calculated for all

four ECs obtained. This analysis reinforces that ECs derived from M DEA differ when companies are restated on an FV basis, leading to alterations in efficiency scores and overall rankings for some companies. Consequently, H2 is also validated by this method. The findings highlight that stakeholders, including investors, analysts, managers, and accounting setters, will perceive changes in companies' operational efficiency, performance, and financial health upon restatement to an FV basis.

4.6.3 Hypothesis Testing (H3)

To test H3 for insurance companies, we can compare the rank normalization method-based FRA ranking of firms with the FV-based DEA rank of companies for each FY. We can also compare the cumulative FRA rank (based on total score) for all FYs from 2015 to 2019 with the cumulative DEA rank (based on total or mean DEA score) of each firm for the same period. This comparison will provide a robust basis for either supporting or rejecting the hypothesis. In this research, the ranking order for ratios such as leverage and loss will be the inverse of that for ROA, ROE, TAT, and current liquidity ratio. This is because lower leverage and loss ratios, along with higher ROA, ROE, TAT, and liquidity ratios, are indicative of superior financial performance.

Spearman's rank correlation can be used to analyze the relationship between two ranked variables (DEA rank and FRA rank of companies). This method is preferred for non-parametric data. Although the test of significance is mentioned (along with Spearman's rho), it will not be considered in this hypothesis testing given the small sample size of 15, which could lead to biased results or misinterpretation. Moreover, since the sample size equals the population size, there is less need to consider the test of significance. Therefore, the focus is on interpreting the correlation coefficient rather than its statistical significance. The Wilcoxon signed-rank test, a non-parametric test, has been performed to determine if there is a statistically significant difference between the two data sets being compared. Its asymptotic significance (Asymp. Sig. [2-tailed]) is reliable as it performs well with small sample sizes and has been considered in this research.

Table 4.33 Comparison of Financial Ratio Analysis (FRA) Rankings and Fair Value-Based Data Envelopment Analysis (DEA) Rankings for Insurance Companies, 2015 to 2019

	2015		**2016**		**2017**		**2018**		**2019**		**Cumulative**	
Ticker	**FRA**	**DEA**	**FRA**	**DEA**	**FRA**	**DEA**	**FRA**	**DEA**	**FRA**	**DEA**	**FRA**	**DEA**
AYUD	7	1	3	4	3	1	1	10	11	1	2	1
BKI	11	1	8	14	8	12	7	4	4	10	8	9
BLA	8	7	7	8	6	8	4	8	4	4	7	8
BUI	10	12	9	10	9	7	13	6	9	10	12	12
CHARAN	1	11	1	7	4	9	4	10	6	10	3	13
INSURE	4	1	12	1	12	1	12	10	14	10	9	3
Krung-AXA*	6	1	6	12	6	11	11	10	13	1	6	7
KWI	15	14	10	1	12	1	14	1	15	10	14	3
MTI	3	6	4	9	4	10	8	9	6	8	5	10
NKI	9	14	11	11	11	14	10	10	12	9	10	15
NSI	2	1	5	5	2	4	3	5	3	7	4	2
SMK	5	10	2	3	1	5	2	3	1	6	1	5
TIPH	12	9	9	6	9	6	8	2	2	5	11	6
TSI	13	8	14	14	15	15	15	10	8	10	15	14
TVI	14	13	13	13	14	13	6	7	10	1	13	11

Note: Font size is smaller since there are large datasets that require more space.

Table 4.33 compares the FRA Rank Normalization method with the FV based DEA rank for the FYs 2015 to 2019. The rankings differ in all years, and the cumulative rankings based on all years also vary between the two variables. For instance, in FY 2015, Charan Insurance is ranked 1st on FRA rank but 11th based on FV DEA rank. Allianz Ayudhya Capital's FRA rank is 7th while its FV DEA rank is 1st. In FY 2016, Charan Insurance is ranked 1st on FRA rank but 7th based on FV DEA rank. Krungthai-AXA's FRA rank is 6th while its FV DEA rank is 12th. Dhipaya Insurance's FRA rank is 9th while its FV DEA rank is 6th. The cumulative FRA rankings versus DEA rankings of these companies also differ.

Table 4.34 Correlation Between Financial Ratio Analysis and Fair Value-Based Data Envelopment Analysis Rankings of Insurance Companies, 2015–2019

Spearman's rho						
	2015	**2016**	**2017**	**2018**	**2019**	**Cumulative**
Correlation Coefficient	.462	.321	.354	.079	.132	.384
Sig. (1-tailed)	.041	.122	.098	.390	.320	.079

Table 4.35 Wilcoxon Signed-Rank Test Comparing Fair Value-Based Data Envelopment Analysis and Financial Ratio Analysis Rankings of Insurance Companies, 2015–2019

Wilcoxon Test Statistics						
	2015	**2016**	**2017**	**2018**	**2019**	**Cumulative**
Z	-.714[a]	-.627[b]	-.693[b]	-.504[a]	-.472[a]	-.158[a]
Asymp. Sig. (2-tailed)	.476	.531	.488	.614	.637	.875

Note: a. Based on positive ranks, b. Based on negative ranks

Tables 4.34 and 4.35 present the Spearman's rho and Wilcoxon signed-rank test statistics. In FY 2015, the Spearman's rho, calculated using SPSS software, is 0.462, suggesting a moderate positive correlation between the FRA and DEA ranks of companies. The asymptotic significance (2-tailed) of 0.476 from the Wilcoxon signed-rank test suggests no statistically significant difference between the DEA fair-value and FRA ranks. The Z-value of -0.714 implies that the DEA rank is, on average, lower than the FRA rank.

In FY 2016, the Spearman's rho is 0.321, indicating a weak positive correlation between the FRA and DEA ranks. The asymptotic significance (2-tailed) of 0.531 from the Wilcoxon signed-rank test, similar to FY 2015, suggests no statistically significant difference between the DEA fair-value and FRA ranks. The Z-value of -0.627 again indicates a lower average DEA rank than the FRA rank.

The analysis for FY 2017 mirrors that of FY 2015 and 2016. The Spearman's rho is 0.354, indicating a weak positive correlation between the FRA and DEA ranks. The asymptotic significance (2-tailed) of 0.488 from the Wilcoxon signed-rank test suggests no statistically significant difference between the DEA fair-value and FRA ranks. The Z-value of -0.693 indicates a lower average DEA rank than the FRA rank. In FY 2018, the Spearman's rho is 0.079, indicating a very weak positive correlation between the FRA and DEA ranks. The asymptotic significance (2-tailed) of 0.614 from the Wilcoxon signed-rank test, consistent with previous years, suggests no statistically significant difference between the DEA fair-value and FRA ranks. The Z-value of -0.504 indicates a lower average DEA rank than the FRA rank.

In FY 2019, the Spearman's rho is 0.132, indicating a very weak positive correlation between the FRA and DEA ranks. The asymptotic significance (2-tailed) of 0.637 from the Wilcoxon signed-rank test, consistent with previous years, suggests no statistically significant difference between the DEA fair-value and FRA ranks. The Z-value of -0.472 indicates a lower average DEA rank than the FRA rank. The cumulative rank, based on all FYs from 2015 to 2019, has also been computed, tested, and analyzed. The results show a moderate-to-weak positive correlation between the two variables under study, with a Spearman's rho of 0.384. The asymptotic significance (2-tailed) of 0.875 from the Wilcoxon signed-rank test suggests no statistically significant difference between the DEA fair-value and FRA ranks over the cumulative period. The Z score of -0.158 indicates that the DEA rank is slightly lower on average than the FRA rank over the same period.

The relationship between the two variables based on cumulative rankings is illustrated in Figure 4.4.

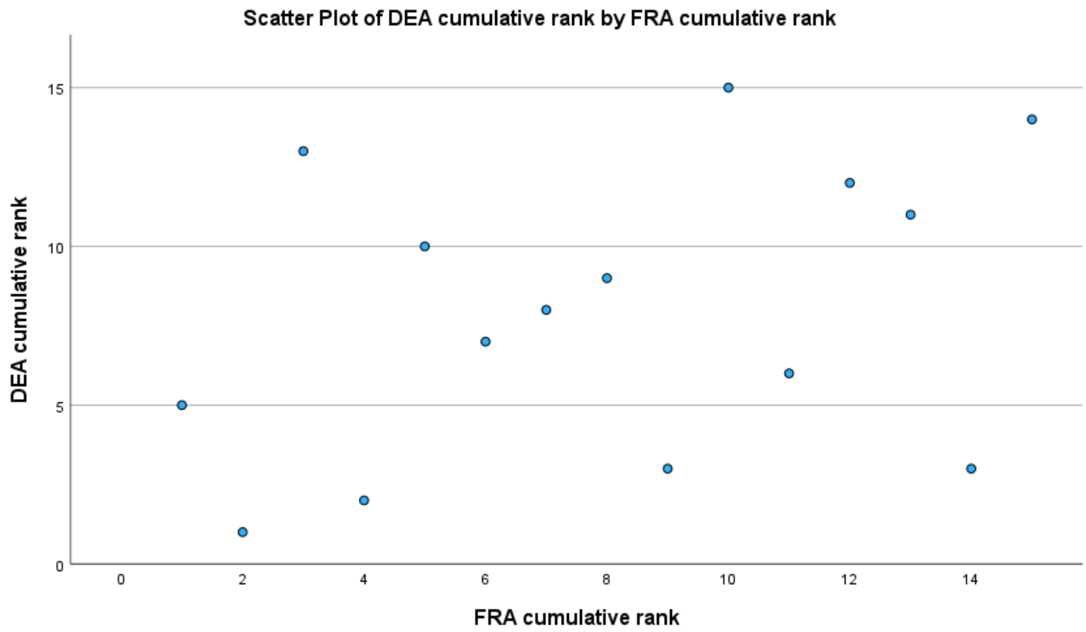

Figure 4.4 Cumulative Data Envelopment Analysis (DEA) Rank versus Financial Ratio Analysis (FRA) Rank of Insurance Companies

The scatterplot indicates a tendency for the DEA rank to increase as the FRA rank increases, albeit with some variation. This observation supports H3. However, this relationship is moderate to weak. A key finding is the similarity in rankings derived from FRA and DEA analyses of companies, with no significant statistical difference according to the Wilcoxon signed-rank test. This implies that, across all years, both FRA and DEA agree on the relative efficiency or performance of companies based on their respective metrics. For stakeholders such as investors, analysts, and managers, these findings suggest that despite their methodological differences, FRA and DEA can provide complementary insights into company performance. The relationship between each component of FRA—including profitability performance, ER, leverage ratio, and liquidity ratio—and the FV-based DEA rank of insurance companies will be analyzed in subsequent sections, lending further support to this research and hypothesis testing.

Table 4.36 Profitability Performance Rank versus Fair Value (FV) based Cumulative Data Envelopment Analysis (DEA) Rank of Insurance Companies

Ticker	Profitability Performance Rank Normalization Method	FV based Cumulative DEA Rank
AYUD	4	1
BKI	5	9
BLA	2	8
BUI	11	12
CHARAN	9	13
INSURE	10	3
Krung-AXA*	6	7
KWI	13	3
MTI	7	10
NKI	14	15
NSI	8	2
SMK	3	5
TIPH	1	6
TSI	15	14
TVI	12	11

Table 4.36 presents the ranking of firms based on their profitability performance (ROA, ROE and loss ratio) and FV based cumulative DEA rank for FYs 2015 to 2019.

Table 4.37 Ratio for Efficiency Rank versus Fair Value (FV) based Cumulative Data Envelopment Analysis (DEA) Rank of Insurance Companies

Ticker	Ratio for Efficiency Rank Normalization Method	FV based Cumulative DEA Rank
AYUD	12	1
BKI	11	9
BLA	13	8
BUI	4	12
CHARAN	10	13
INSURE	5	3
Krung-AXA*	9	7
KWI	15	3
MTI	7	10
NKI	6	15
NSI	3	2
SMK	1	5
TIPH	14	6
TSI	8	14
TVI	2	11

Table 4.37 presents the ranking of firms based on their ratio for efficiency (TAT) and FV based cumulative DEA for FYs 2015 to 2019.

Table 4.38 Ratio for Leverage Rank versus Fair Value (FV) based Cumulative Data Envelopment Analysis (DEA) Rank of Insurance Companies

Ticker	**Ratio for Leverage Rank Normalization Method**	**FV based Cumulative DEA Rank**
AYUD	2	1
BKI	3	9
BLA	14	8
BUI	6	12
CHARAN	1	13
INSURE	12	3
Krung-AXA*	15	7
KWI	9	3
MTI	8	10
NKI	4	15
NSI	7	2
SMK	5	5
TIPH	13	6
TSI	11	14
TVI	10	11

Table 4.38 presents the ranking of firms based on their ratio for leverage (leverage ratio) and FV based cumulative DEA for FYs 2015 to 2019.

Table 4.39 Ratio for Liquidity Rank versus Fair Value (FV) based Cumulative Data Envelopment Analysis (DEA) Rank of Insurance Companies

Ticker	Ratio for Liquidity Rank Normalization Method	FV based Cumulative DEA Rank
AYUD	5	1
BKI	14	9
BLA	1	8
BUI	12	12
CHARAN	2	13
INSURE	13	3
Krung-AXA*	4	7
KWI	10	3
MTI	3	10
NKI	8	15
NSI	6	2
SMK	7	5
TIPH	9	6
TSI	11	14
TVI	15	11

The table 4.39 shows the ranking of firms based on their ratio for liquidity (current liquidity) and FV based cumulative DEA for FYs 2015 to 2019.

Table 4.40 Correlation Between Financial Ratio Analysis Components and Fair Value-Based Cumulative Data Envelopment Analysis (DEA) Rankings of Insurance Companies

Spearman's rho				
	Profitability vs. DEA	**Efficiency vs. DEA**	**Leverage vs. DEA**	**Liquidity vs. DEA**
Correlation Coefficient	.484	-.161	-.123	.098
Sig. (1-tailed)	.034	.283	.331	.364

Table 4.41 Wilcoxon Test Comparison of Cumulative Data Envelopment Analysis (DEA) Rankings and Financial Ratio Analysis Components for Insurance Companies

Wilcoxon Test Statistics				
	DEA vs. Profitability	**DEA vs. Efficiency**	**DEA vs. Leverage**	**DEA vs. Liquidity**
Z	-.285[a]	-.142[a]	-.126[b]	-.063[b]
Asymp. Sig. (2-tailed)	.775	.887	.900	.950

Note: a. Based on negative ranks. b. Based on positive ranks.

Table 4.40 suggests a moderate positive correlation between companies' profitability performance and their FV-based DEA efficiency, as indicated by a Spearman's rho of .484. Conversely, there is a weak negative correlation between the ER and FV-based DEA efficiency, with a Spearman's rho of -.161. The table also shows a weak negative correlation between the leverage ratio and FV-based DEA efficiency (Spearman's rho of -.123), and a very weak positive correlation between the liquidity ratio and FV-based DEA efficiency (Spearman's rho of .098).

Table 4.41's analysis reveals that the DEA rankings and profitability performance of the companies align closely, with no significant statistical difference according to the Wilcoxon signed-rank test (Asymp. Sig. (2-tailed) is .775). This alignment also extends to the DEA rankings and the efficiency, leverage, and liquidity ratios, as the Asymp. Sig. (2-tailed) is greater than .05 in all cases.

In conclusion, an analysis of each category of ratios indicates a positive correlation between certain ratio categories and the overall FV-based DEA score. Specifically, there is a moderate positive correlation between profitability performance and DEA ranking, and a very weak positive correlation between the liquidity ratio and DEA ranking. However, the efficiency and leverage ratios show a weak negative correlation with the DEA ranking. The similarity in ranking between the two methods suggests a good alignment. Therefore, considering the components of FRA, H3 is partially supported.

.

4.6.4 Hypothesis Testing H4

To test H4, we can compare and assess the mean DEA score of FV based on FYs from 2015 to 2019 with the TR (annualized %) for the corresponding FYs of each insurance company. We will use the total assets and the company's age at the end of FY 2019 as control variables. This comparison will form a robust basis for either accepting or rejecting the hypothesis.

Table 4.42 Fair Value (FV) Mean Data Envelopment Analysis (DEA) Score versus Total Return of Insurance Companies (with control variables)

Ticker	FV Mean DEA Score	TR (annualized %)	Total assets (THB millions)	Age (years)
AYUD	0.7372	9.34%	27,816.00	69
BKI	0.3634	-0.51%	57,327.00	72
BLA	0.4480	-13.54%	333,680.00	68
BUI	0.2154	-0.15%	1,969.50	90
CHARAN	0.2032	-3.26%	900.40	70
TIPH	0.4884	12.78%	40,900.00	68
INSURE	0.6000	5.80%	790.00	70
KWI	0.6000	-6.95%	7,847.00	30
MTI	0.3162	-7.16%	23,207.00	21
NSI	0.6246	-7.32%	3,904.01	71
SMK	0.5236	-5.31%	15,933.00	68
TSI	0.1346	7.92%	1,310.80	77
TVI	0.2818	-2.99%	6,530.72	68
NKI	0.0392	-2.02%	5,703.00	86

Table 4.42 presents the FV Mean DEA Score and TR (annualized %) for FYs 2015 to 2019.

Table 4.43 Quantile Regression Analysis of Insurance Companies

Quantile	Pseudo R-Squared	Intercept Coefficient	Intercept Sig.	DEA Score Coefficient	DEA Score Sig.
0.25	.367	-.063	.065	-.042	.217
0.50	.257	-.107	.426	-.075	.591
0.75	.295	-.161	.217	.218	.119

Table 4.44 Quantile Regression Analysis of Insurance Companies (Control Variables)

Quantile	Total Assets Coefficient	Total Assets Sig.	Age Coefficient	Age Sig.
0.25	-2.691E-7	.004	.001	.161
0.50	-3.896E-7	.236	.001	.518
0.75	-5.366E-7	.096	.002	.293

Note: -2.691E-7 corresponds to -0.0000002691, -3.896E-7 corresponds to -0.0000003896 and -5.366E-7 corresponds to -0.0000005366

Tables 4.43 and 4.44 employ quantile regression analysis to investigate the influence of the FV mean DEA score (independent variable) on the TR (dependent variable) among Thai insurance companies, using total assets and age as control variables. The results differ across quantiles. At the 25th percentile, the analysis reveals a statistically significant negative coefficient for total assets (-2.69E-7, p=.004), implying that larger companies correlate with lower TRs. However, the DEA score exhibits a negative, albeit insignificant, relationship (-.042, p=.217) with TR. For median stock returns, neither the DEA score (-.075, p=0.591), total assets (-3.896E-7, p=.236), nor age (.001, p=.518) significantly predict the returns. At the 75th percentile, the DEA score displays a non-significant positive trend (.218, p=.119), suggesting a potential increase in TR with higher DEA scores for better-performing companies, albeit without statistical validation. Total assets exhibit a negative coefficient (-5.366E-7) nearing significance (p=.096), while age (.002, p=.293) remains non-significant. These findings imply that while company size may negatively impact lower quantiles of stock returns, the efficiency score and company age do not consistently or significantly affect the return distribution for the studied companies. The intercepts across different quantiles are not statistically significant, indicating that when the DEA score, total assets, and age are all zero, the stock returns do not significantly deviate from zero at the 25th, 50th, and 75th percentiles. The Pseudo R-squared values, indicative of the model fit, are moderately high (ranging from 0.257 to 0.367), suggesting that the model accounts for a reasonable amount of variance in stock returns across the considered quantiles.

Based on this analysis, we cannot confirm H4 for insurance companies, with total assets and age as control variables. There is insufficient statistical evidence to support this hypothesis. This result is crucial for investors, analysts, and managers, as it suggests that operational efficiency, as indicated by the DEA score, may not be a reliable predictor of insurance companies' stock returns. The total asset role, especially at lower return levels, may encourage managers to optimize asset management.

4.6.5 Summary of all Hypotheses Testing with Result of Insurance Companies

Table 4.45 summarizes the hypotheses testing results regarding the insurance companies.

Table 4.45 Summary of Hypotheses Tests Result Regarding Insurance Companies

Hypothesis	Testing Result
H1: There are significant changes in the value of financial items when the financial statements of Thai insurance and banking companies are restated at fair value basis. It is focused on Thai banking companies.	Partially supported, based on Wilcoxon signed-rank's test of significance.
H2: There are different conclusions drawn from financial statements analysis using DEA when fair value accounting is applied instead of the historical basis.	Overall supported, applying the DEA CRS model and Malmquist DEA index.
H2.1: There are changes in efficiency scores of Thai insurance and banking companies when fair value is applied instead of historical cost.	Partially supported, based on the DEA CRS model, observation method, and Wilcoxon signed-rank's test of significance.
H2.2: There are changes in ranking based on the efficiency scores obtained of the Thai insurance and banking companies when fair value is applied instead of historical cost.	Supported via the observation method and applying Malmquist DEA index.
H3: There is a positive relationship between Financial Ratio Analysis (FRA) and fair-value-based DEA efficiency of firms.	Supported, applying Spearman's rank correlation and Wilcoxon signed-rank's test of significance; Partially supported when each category of FRA is considered, applying Spearman's rank correlation and Wilcoxon signed-rank's test of significance.
H4: There is a positive relationship of DEA score and stock's returns.	The evidence fails to support the hypothesis, applying Quantile Regression Analysis and test of significance.

Therefore, the evidence supports few hypotheses, partially supports a few others, and fails to support H4.

4.7 Financial Information of Thai Banking Companies (PCL)

Sections 4.1 to 4.6 of this dissertation focused on the analysis and results pertaining to Thai insurance companies. Sections 4.7 (this section) to 4.12 will focus on the analysis and findings related to Thai banking companies.

Table 4.46 Decision-Making Units (DMUs) and Company Ticker of Banking Companies

No.	DMU/Banking PCL	Company Ticker
1	Bank of Ayudhya	BAY
2	Bangkok Bank	BBL
3	CIMB Thai Bank	CIMBT
4	Kasikorn Bank	KBANK
5	Kiatnakin Phatra Bank	KKP
6	Krung Thai Bank	KTB
7	LH Financial Group	LHFG
8	The Siam Commercial Bank	SCB
9	Thanachart Capital	TCAP
10	Tisco Financial Group	TISCO
11	TMBThanachart Bank (Earlier known as TMB bank)	TTB

The company ticker or stock symbol of these DMUs, which in this context are the banking companies, are listed in Table 4.46. In this dissertation, the company ticker may occasionally serve as a substitute for the full name of the banking company.

Table 4.47 Financial Information of Banking Companies, Fiscal Year 2015 (in Thousands of Thai Baht)

No.	DMU	TCI	EXP	AFS - HC	AFS - FV	HTM - HC	HTM - FV	OT – HC	OT – FV
1	BAY	18,629,801	70,832,529	106,566,000	107,756,000	1,006,000	1,006,000	190,000	190,000
2	BBL	50,749,000	99,360,270	408,709,269	441,497,000	16,213,000	16,213,000	30,130,000	54,223,000
3	CIMBT	885,567	13,995,024	26,226,263	26,518,000	22,399,000	22,795,000	105,000	105,000
4	KBANK	41,776,356	177,960,242	210,131,123	215,365,000	248,272,000	269,093,000	1,840,000	1,840,000
5	KKP	3,228,307	13,661,857	12,883,807	12,939,863	1,004,840	1,077,271	32,635	206,826
6	KTB	27,570,433	105,457,550	93,660,000	93,740,000	124,295,000	124,977,000	767,000	767,000
7	LHFG	1,713,340	6,633,313	2,374,343	2,352,957	44,824,206	46,508,254	13,544	13,544
8	SCB	45,189,774	94,054,967	378,632,000	382,200,000	133,064,000	147,180,000	276,000	276,000
9	TCAP	9,788,257	43,938,899	158,759,000	160,527,000	9,837,000	11,055,000	4,022,000	4,022,000
10	TISCO	3,972,078	12,879,952	8,052,363	7,886,071	191	191	446,157	1,588,000
11	TTB	9,389,000	31,586,054	43,500,000	43,604,000	38,669,000	39,557,000	565,000	832,000

Note: The abbreviations used in Tables 4.47 through 4.51 are as follows: DMU represents the Decision-Making Unit (Insurance PCL), TCI denotes Total Comprehensive Income, EXP signifies Total Expenses, AFS-HC refers to Available-for-Sale Investments Valued at Historical Cost, AFS-FV indicates Available-for-Sale Investments Valued at Fair Value, HTM-HC stands for Held-to-Maturity Investments at Historical Cost, HTM-FV is Held-to-Maturity Investments at Fair Value, OT-HC is General (Other) Investments (Net) at Historical Cost, and OT-FV is General (Other) Investments (Net) at Fair Value.

Table 4.48 Financial Information of Banking Companies, Fiscal Year 2016 (in Thousands of Thai Baht)

No.	DMU	TCI	EXP	AFS - HC	AFS - FV	HTM - HC	HTM - FV	OT – HC	OT – FV
1	BAY	23,986,836	72,997,470	113,549,000	114,497,000	16,700,000	16,700,000	160,000	210,000
2	BBL	29,453,186	98,388,573	430,573,865	462,742,000	18,121,000	18,121,000	32,603,000	62,330,000
3	CIMBT	(256,150)	13,350,338	30,785,419	30,433,000	17,511,000	17,678,000	73,000	73,000
4	KBANK	52,035,961	184,013,679	329,468,000	336,234,000	298,065,000	320,185,000	1,788,000	1,788,000
5	KKP	5,811,241	12,331,077	12,516,426	12,914,406	1,093,949	1,159,231	24,259	228,787
6	KTB	39,899,954	96,787,394	99,432,000	106,241,000	102,756,000	103,369,000	855,000	855,000
7	LHFG	2,814,855	6,698,833	6,734,203	6,858,683	45,803,471	46,347,255	13,544	13,544
8	SCB	45,361,408	91,602,417	437,566,000	438,473,000	122,166,000	133,768,000	1,072,000	1,072,000
9	TCAP	13,297,310	40,680,631	165,337,000	165,736,000	1,905,000	2,713,000	3,788,000	3,788,000
10	TISCO	5,066,797	12,174,614	6,871,142	6,752,760	16	16	436,069	1,881,000
11	TTB	9,841,000	29,647,970	27,450,000	27,380,000	24,956,000	25,309,000	435,000	705,000

Table 4.49 Financial Information of Banking Companies, Fiscal Year 2017 (in Thousands of Thai Baht)

No.	DMU	TCI	EXP	AFS - HC	AFS - FV	HTM - HC	HTM - FV	OT – HC	OT – FV
1	BAY	23,569,079	81,384,552	65,686,000	66,797,000	16,438,000	16,438,000	344,000	388,000
2	BBL	35,072,119	99,687,390	494,477,854	533,651,000	11,233,000	11,233,000	31,723,000	61,207,000
3	CIMBT	840,932	13,901,653	20,696,320	20,811,000	13,600,000	13,772,000	48,000	48,000
4	KBANK	44,397,008	196,696,068	162,745,000	171,397,000	338,003,000	374,559,000	2,415,000	2,415,000
5	KKP	6,141,050	13,424,093	15,654,401	16,737,401	1,217,919	1,288,933	24,105	232,183
6	KTB	27,360,626	90,358,796	150,307,000	158,497,000	41,837,000	41,838,000	697,000	697,000
7	LHFG	2,799,684	6,523,085	12,075,427	12,463,089	47,145,908	48,594,517	13,544	13,544
8	SCB	48,160,990	96,984,592	424,496,000	432,064,000	120,671,000	134,404,000	1,443,000	1,443,000
9	TCAP	15,247,631	39,554,279	153,725,000	155,454,000	1,000,000	1,793,000	3,672,000	3,672,000
10	TISCO	6,208,876	12,829,643	7,029,873	7,126,781	0	0	420,362	1,841,000
11	TTB	8,892,000	30,743,366	36,831,000	36,865,000	23,511,000	23,851,000	309,000	592,000

Table 4.50 Financial Information of Banking Companies, Fiscal Year 2018 (in Thousands of Thai Baht)

No.	**DMU**	**TCI**	**EXP**	**AFS - HC**	**AFS - FV**	**HTM - HC**	**HTM - FV**	**OT – HC**	**OT – FV**
1	BAY	24,160,811	91,321,510	117,210,000	117,098,000	16,297,000	16,297,000	423,000	419,000
2	BBL	23,543,314	107,207,307	468,982,425	497,838,000	19,849,000	19,849,000	31,585,000	110,498,000
3	CIMBT	(81,593)	14,189,807	49,033,569	48,874,000	20,105,000	20,188,000	30,000	30,000
4	KBANK	40,537,906	195,229,621	260,784,892	266,798,000	371,025,000	392,999,000	4,556,000	4,556,000
5	KKP	5,124,503	16,887,353	18,745,098	18,715,136	1,226,988	1,274,440	25,170	245,322
6	KTB	29,142,527	95,179,051	188,392,000	196,800,000	2,392,000	3,368,727	777,000	1,094,272
7	LHFG	2,531,068	6,612,514	24,391,956	24,080,393	43,240,861	43,929,825	13,801	13,801
8	SCB	35,267,660	105,956,328	430,342,000	432,663,000	120,645,000	131,527,000	2,131,000	2,131,000
9	TCAP	14,552,597	4,797,493	147,408,000	147,676,000	1,298,000	2,010,000	3,652,000	3,652,000
10	TISCO	7,123,256	14,081,742	8,881,371	8,792,839	0	0	219,506	999.000
11	TTB	11,554,000	31,556,408	40,876,000	40,830,000	31,119,000	31,143,000	235,000	518,000

Table 4.51 Financial Information of Banking Companies, Fiscal Year 2019 (in Thousands of Thai Baht)

No.	DMU	TCI	EXP	AFS - HC	AFS - FV	HTM - HC	HTM - FV	OT – HC	OT – FV
1	BAY	34,784,951	94,159,950	102,827,000	102,724,000	12,837,000	12,837,000	577,000	600,000
2	BBL	27,430,526	108,582,223	546,584,928	574,720,000	23,257,000	23,257,000	36,107,000	39,88,9000
3	CIMBT	1,598,833	18,042,496	34,133,070	34,446,000	19,555,000	20,545,000	29,000	29,000
4	KBANK	46,538,357	195,687,321	330,802,951	336,707,000	416,369,000	516,641,000	5,054,000	5,054,000
5	KKP	5,624,603	17,459,893	21,121,142	20,701,105	1,220,624	1,266,411	176,400	385,273
6	KTB	45,277,862	103,530,938	334,204,000	344,198,000	1,737,000	2,566,107	1,041,000	1,537,892
7	LHFG	3,148,389	7,373,618	2,034,413	1,647,803	42,074,794	43,844,511	16,360	16,360
8	SCB	60,278,037	115,594,647	269,416,000	270,740,000	7,830,000	8,717,000	3,681,000	3,681,000
9	TCAP	20,344,991	5,007,738	31,874,000	33,197,000	2,426,000	2,846,000	142,000	142,000
10	TISCO	7,102,939	14,749,548	9,160,026	9,145,766	0	0	217,266	773,000
11	TTB	8,509,000	36,913,533	158,018,000	158,394,000	682,000	740,000	613,000	949,000

Table 4.47 presents the financial data for Thai banking companies in FY 2015. All companies reported profits (TCI). Kasikorn Bank recorded the highest expenses (EXP) at THB 177,960,242, while Bangkok Bank reported the highest TCI at THB 50,749,000. Most companies had substantial investments in AFS and HTM securities. However, Tisco Financial Group was an outlier with its low investment in HTM securities. The disparity between HC and FV of AFS securities varied across companies. For instance, Bangkok Bank showed a significant difference, while CIMB Thai Bank exhibited a smaller gap. A similar pattern was observed in the differences between HC and FV for HTM and Other (OT) securities. Kasikorn Bank, for example, had a large difference in the HC and FV of its HTM securities. In contrast, Bank of Ayudhya, Bangkok Bank, and Tisco Financial Group showed no difference. In comparison to AFS and HTM investments, most companies made smaller investments in other general categories.

Table 4.48 presents the financial data for Thai banking companies in FY 2016. All companies reported profits (TCI), except for CIMB Thai Bank, which incurred losses of THB 256,150. Kasikorn Bank had the highest expenses (EXP) at THB 184,013,679, but also reported the highest TCI at THB 52,035,961. Most companies maintained substantial investments in AFS and HTM securities, with Tisco Financial Group being an exception given its low HTM investments. The disparity between HC and FV of AFS securities varied across companies. For instance, Bangkok Bank showed a significant difference, while CIMB Thai Bank exhibited a smaller gap. A similar pattern was observed in the differences between HC and FV for HTM and Other (OT) securities. Kasikorn Bank, for example, had a large difference in the HC and FV of its HTM securities. In contrast, Bank of Ayudhya, Bangkok Bank, and Tisco Financial Group showed no difference. Compared to AFS and HTM investments, most companies made smaller investments in other general categories, except for Bangkok Bank.

Table 4.49 presents the financial data for Thai banking companies in FY 2017. All companies reported profits (TCI). Kasikorn Bank had the highest expenses (EXP) at THB 196,696,068, while The Siam Commercial Bank reported the highest TCI at THB 48,160,990. Most companies maintained substantial investments in AFS and HTM securities, with Tisco Financial Group being an exception given its low HTM investments. The disparity between HC and FV of AFS securities varied across companies. For instance, Bangkok Bank showed a significant difference, while Tisco Financial Group exhibited a smaller gap. A similar pattern was observed in the differences between HC and FV for HTM and Other (OT) securities. Kasikorn Bank, for example, had a large difference in the HC and FV of its HTM securities. In contrast, Tisco Financial Group had no investment in HTM securities. Compared to AFS and HTM investments, most firms made smaller investments in other general categories, except for Bangkok Bank.

Table 4.50 provides the financial data for Thai banking companies in FY 2018. All companies, except CIMB Thai Bank, reported profits (TCI). CIMB Thai Bank incurred losses of THB 81,593. Kasikorn Bank had the highest expenses (EXP) at THB 195,229,621, and also reported the highest TCI at THB 40,537,906. Most companies held substantial investments in AFS and HTM securities. Tisco Financial Group was an outlier with its low HTM investments. The disparity between HC and FV of AFS securities varied across companies. For instance, Bangkok Bank showed a significant difference, while Kiatnakin Phatra Bank exhibited a smaller gap. A similar pattern was observed in the differences between HC and FV for HTM and Other (OT) securities. Kasikorn Bank, for example, had a large difference in the HC and FV of its HTM securities. In contrast, Bank of Ayudhya and Bangkok Bank had identical HC and FV for their HTM securities. Compared to AFS and HTM investments, most companies made smaller investments in other general categories, with Bangkok Bank being an exception given its large investment.

Table 4.51 provides the financial data for Thai banking companies in the FY 2019. All companies, except CIMB Thai Bank, reported profits (TCI). Kasikorn Bank had the highest expenses (EXP) at THB 195,687,321, and The Siam Commercial Bank reported the highest TCI at THB 60,278,037. Most companies held substantial investments in AFS and HTM securities. Tisco Financial Group was an outlier with its low HTM investments. The disparity between HC and FV of AFS securities varied across companies. For instance, Bangkok Bank showed a significant difference, while Tisco Financial Group exhibited a smaller gap. A similar pattern was observed in the differences between HC and FV for HTM and Other (OT) securities. Kasikorn Bank, for example, had a large difference in the HC and FV of its HTM securities. In contrast, Bank of Ayudhya and Bangkok Bank had identical HC and FV for their HTM securities. Compared to AFS and HTM investments, most companies made smaller investments in other general categories, with Bangkok Bank being an exception given its large investment.

4.8 Descriptive Statistics of Banking Companies

Table 4.52 presents the comprehensive descriptive statistics for the financial variables of Thai banking companies from 2015 to 2019. These statistics encompass both the FV and HC of specific financial items, including AFS investments, HTM investments, and other types of investments.

Table 4.52 Descriptive Statistics of Thai Banking Companies for Fiscal Years 2015 to 2019 (in Thousands of Thai Baht)

	Total Comprehensive Income	**Expenses**	**Available-for-Sale Investments - Historical Cost**	**Available-for-Sale Investments - Fair Value**	**Held-to-Maturity Investments - Historical Cost**	**Held-to-Maturity Investments - Fair Value**	**Other Investments - Historical Cost**	**Other Investments - Fair Value**
Mean	20422699.05	62022585.62	149933598.09	154569037.33	55609177.58	60516885.25	3855376.76	7014024.49
Median	14552597.00	39554279.00	99432000.00	102724000.00	17511000.00	17678000.00	436069.00	767000.00
Std. Deviation	17619895.652	56004727.730	160298739.640	167325586.808	97504343.264	110314206.61	9233943.465	20103131.385
Skewness	.602	.936	1.016	1.059	2.487	2.664	2.847	3.704
Kurtosis	-.974	.104	-.274	-.136	5.607	6.905	6.624	14.424
Minimum	-256150	4797493	2034413	1647803	0	0	13544	999
Maximum	60278037	196696068	546584928	574720000	416369000	516641000	36107000	110498000
Kolmogorov-Smirnov (Sig.)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001

Table 4.52 reveals a significant disparity between the mean and median for several variables, indicating potential skewness. For instance, total expenses had a mean of THB 62022585.62 and a median of THB 39554279.00, suggesting an uneven distribution and the presence of outliers.

The standard deviation of variables such as total comprehensive income, total expenses, and various types of investments (AFS, HTM, and general) in both HC and FV was found to be high. This high standard deviation suggests a wide distribution and less predictability in the data. The extreme values of these variables also exhibit a large range, which could potentially indicate non-normality in the data set, although this is not a definitive conclusion. For instance, the standard deviation of the FV of HTM investments was 110,314,206.61. Further tests may be necessary to determine whether the data follows a normal distribution. The financial items examined showed a substantial range between their minimum and maximum values. To illustrate, the HC of AFS securities ranged from a minimum of THB 2,034,413 to a maximum of THB 546,584,928.

The skewness and kurtosis of the data set are not near zero, suggesting that the data may not follow a normal distribution. The one-sample Kolmogorov-Smirnov (K-S) test, a non-parametric test, was employed in this study. The p-value (asymptotic significance) for all variables in the one-sample K-S test was less than 0.001. The chosen significance level (alpha) is 0.05. In essence, all the values were near zero, indicating that the data did not follow a normal distribution. Based on the analysis of all the variables' statistics, particularly skewness, kurtosis, and the K-S test, it can be affirmed that none of the variables adhered to a normal distribution. Consequently, it can be inferred that non-parametric methods such as DEA and non-parametric statistical tests are suitable for conducting financial statement analysis. Moreover, a non-parametric method like DEA is more appropriate for smaller sample sizes.

4.9 Data Envelopment Analysis of Banking Companies

For insurance companies, a multi-stage CRS DEA was conducted on the financial data of banks listed in Tables 4.47 to 4.51 for the years 2015 to 2019. The CRS model, which does not account for scale effects, was chosen for its output orientation, following the same rationale used for banking companies discussed in Section 4.3. The competitive nature of the Thai banking industry, similar to its insurance sector, and the minimal restrictions on firm entry suggest that scale effects are unlikely to significantly impact firm efficiency. The CRS model yields identical results for both input and output orientations, hence the arbitrary selection of the output-oriented model. The DEA software DEAP 2.1 was utilized for this analysis.

The analysis considered one output variable, total comprehensive income, and four input variables: total expenses, AFS investments, HTM investments, and other investments, the latter also referred to as general investments, which encompass investments in non-marketable securities. Initially, the DEA analysis was performed using HC items as inputs and total comprehensive income as the output, with total expenses included as an input variable. Subsequently, the analysis was conducted with FV items and expenses as input variables and total comprehensive income as the output. The former is referred to as HC DEA analysis and the latter as FV DEA analysis. The results of the two analyses were then compared.

In parallel with the approach used for insurance companies, the financial data from banking PCLs or DMUs was also analyzed using the Malmquist DEA (M DEA), which provides results based on panel data. The focus of this study is to evaluate efficiency and EC derived from the total productivity change obtained from M DEA, rather than technical change.

Any negative value of the output variable, total comprehensive income, will be normalized using the same procedure applied to insurers. In the DEA analysis, missing values of an input variable are acceptable, provided there are positive values for other input variables under study.

4.9.1 Data Envelopment Analysis Based on Historical Cost

This section discusses the evaluation of the results. Based on the HC DEA analysis, the results of technical efficiency of each firm are as follows:

Table 4.53 Technical Efficiency (TE) Scores from Multi-Stage Data Envelopment Analysis of Thai Banking Companies Valued applying Historical Cost

Serial No.	Ticker	Bank PCL	TE 2015	TE 2016	TE 2017	TE 2018	TE 2019
1	BAY	Bank of Ayudhya	1.000	0.696	0.597	0.472	0.989
2	BBL	Bangkok Bank	1.000	0.633	0.725	0.268	0.415
3	CIMBT	CIMB Thai Bank	0.187	0.000	0.124	0.000	0.049
4	KBANK	Kasikorn Bank	0.997	0.594	0.466	0.367	0.609
5	KKP	Kiatnakin Phatra Bank	1.000	1.000	0.943	0.556	0.258
6	KTB	Krung Thai Bank	1.000	0.875	0.621	0.495	0.816
7	LHFG	LH Financial Group	1.000	0.900	0.879	0.504	0.287
8	SCB	The Siam Commercial Bank	1.000	1.000	1.000	0.419	1.000
9	TCAP	Thanachart Capital	0.591	0.734	0.796	1.000	1.000
10	TISCO	Tisco Financial Group	1.000	1.000	1.000	1.000	0.644
11	TTB	TMBThanachart Bank (Earlier known as TMB bank)	0.908	0.721	0.595	0.652	1.000
	Mean		0.880	0.741	0.704	0.521	0.642

Tisco Financial Group demonstrated consistent performance throughout the years, except for 2019 when its TE dropped to 0.664. Similarly, The Siam Commercial Bank maintained a steady performance, barring 2018 when its TE dipped to 0.419. Krung Thai Bank exhibited high relative efficiency in 2015, 2016, and 2019, but saw a decline in 2017 and 2018. Kiatnakin Phatra Bank had high scores in 2015, 2016, and 2017, but experienced a downturn in 2018 and 2019. The mean TE scores were elevated in 2015, 2016, and 2017, but decreased in 2018 and 2019, suggesting a potential decline in overall firm efficiency during the FY s 2018 and 2019. Figure 4.5 offers a clear visual representation of the relative efficiency scores of all firms from 2015 to 2019.

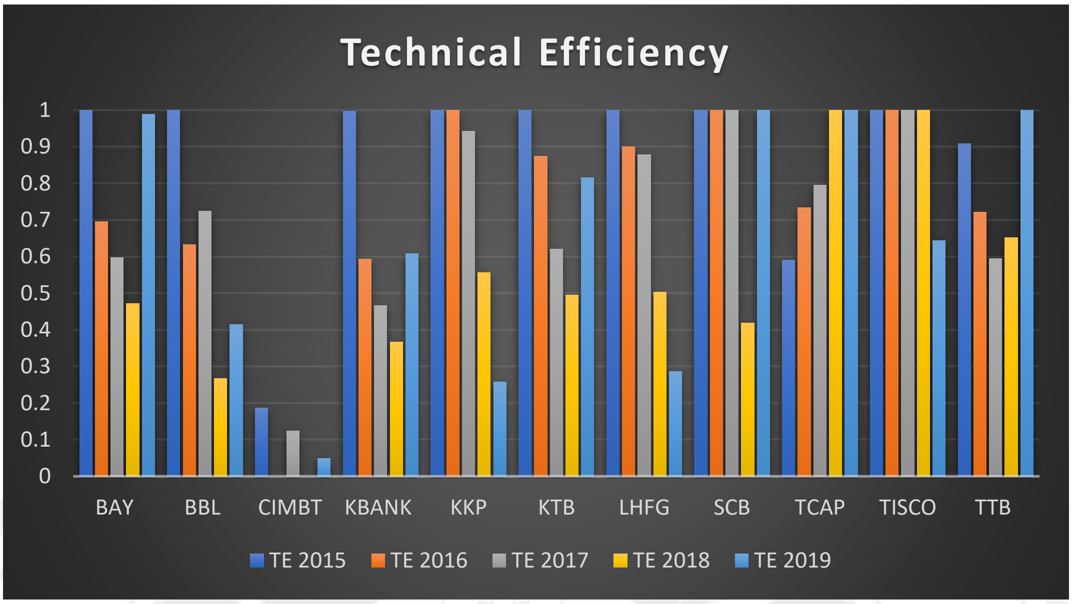

Figure 4.5 Technical Efficiency (TE) Scores of Thai Banking Companies applying Historical Cost

From Table 4.53 and Figure 4.5, Tisco Financial Group, The Siam Commercial Bank, LH Financial Group, Krung Thai Bank, Kiatnakin Phatra Bank, Bangkok Bank, and Bank of Ayudhya achieved the highest relative efficiency with TE scores of 1. Conversely, CIMB Thai Bank exhibited the lowest relative efficiency. Thanachart Capital demonstrated less efficiency, while Kasikorn Bank's TE score neared 1.

In FY2016, fewer firms achieved the highest TE scores of 1. Kiatnakin Phatra Bank, The Siam Commercial Bank, and Tisco Financial Group maintained their high performance from the previous FY, achieving TE scores of 1. CIMB Thai Bank, mirroring its performance from the previous year, recorded the lowest efficiency score given incurred losses. LH Financial Group also performed commendably with a TE score of 0.990, while other banks recorded moderate TE scores.

In FY2017, Tisco Financial Group and The Siam Commercial Bank achieved the highest efficiency. Kiatnakin Phatra Bank and LH Financial Group also recorded high TE scores, while CIMB Bank's efficiency was low at 0.124.

In FY2018, Thanachart Capital and Tisco Financial Group recorded high TE scores. They were closely followed by TMBThanachart Bank and Kiatnakin Phatra Bank. CIMB Bank's efficiency was the lowest given the company's losses. Other companies, including Kasikorn Bank and Bangkok Bank, also recorded low TE scores.

In FY2019, TMBThanachart Bank, Thanachart Capital, and The Siam Commercial Bank performed exceptionally well, achieving perfect TE scores. Bank of Ayudhya also recorded a high score of 0.989, and Krung Thai Bank achieved a commendable efficiency score of 0.816. Kiatnakin Phatra Bank and LH Financial Group's efficiency scores were below average, while CIMB Bank continued its trend of recording the lowest efficiency score.

When aggregating the TE scores from 2015 to 2019, Tisco Financial Group's technical efficiency was the highest, followed by Siam Commercial Bank and Thanachart Capital. At the lower end, CIMB Thai Bank exhibited the lowest TE, with Bangkok Bank and Kasikorn Bank (both with a cumulative score of 3) above it. In comparison, Bank of Ayudhya, Kiatnakin Phatra Bank, Krung Thai Bank, and TMBThanachart Bank demonstrated satisfactory overall relative efficiency.

By employing the Malmquist DEA to obtain M DEA scores, the EC of the banks is as follows. These scores are based on the HC of variables.

Table 4.54 Malmquist Index Mean Efficiency Change of Banking Companies applying Historical Cost for 2015 to 2019

Serial No.	Ticker	Bank PCL	Efficiency Change
1	BAY	Bank of Ayudhya	0.850
2	BBL	Bangkok Bank	0.591
3	CIMBT	CIMB Thai Bank	1.172
4	KBANK	Kasikorn Bank	0.660
5	KKP	Kiatnakin Phatra Bank	1.000
6	KTB	Krung Thai Bank	1.000
7	LHFG	LH Financial Group	1.000
8	SCB	The Siam Commercial Bank	0.854
9	TCAP	Thanachart Capital	1.141
10	TISCO	Tisco Financial Group	1.000
11	TTB	TMBThanachart Bank (earlier known as TMB bank)	0.801

From 2015 to 2019, Thanachart Capital's GM EC was notably higher at 1.141, indicating a 14% (1.141-1= .141 or 14%) growth in technical efficiency over these five years. Despite CIMB Bank's subpar performance across all FYs from 2015 to 2019, it recorded the highest EC score at 1.172. Banks such as Krung Thai Bank, Kiatnakin Phatra Bank, LH Financial Group, and Tisco Financial Group had an EC of 1 each, signifying no overall EC from FY 2015 to 2019. Conversely, companies like Bank of Ayudhya, Bangkok Bank, Kasikorn Bank, The Siam Commercial Bank, and TMBThanachart Bank experienced a decline in overall efficiency. An EC less than 1 indicates a decline. For example, Bangkok Bank's overall efficiency declined by 40.9% (1-0.591=0.409 or 40.9%).

4.9.2 Data Envelopment Analysis Based on Fair Value

This section discusses the evaluation of the results. Based on the FV DEA analysis, the results of technical efficiency of each firm are as follows.

Table 4.55 Technical Efficiency (TE) Scores from Multi-Stage Data Envelopment Analysis of Thai Banking Companies Valued applying Fair Value

Serial No.	Ticker	Bank PCL	TE 2015	TE 2016	TE 2017	TE 2018	TE 2019
1	BAY	Bank of Ayudhya	1.000	1.000	1.000	0.508	0.548
2	BBL	Bangkok Bank	1.000	0.633	0.725	0.261	1.000
3	CIMBT	CIMB Thai Bank	0.188	0.000	0.247	0.000	0.272
4	KBANK	Kasikorn Bank	1.000	0.647	0.701	0.366	0.196
5	KKP	Kiatnakin Phatra Bank	1.000	1.000	1.000	0.555	0.464
6	KTB	Krung Thai Bank	1.000	1.000	0.877	0.563	1.000
7	LHFG	LH Financial Group	1.000	1.000	1.000	0.747	1.000
8	SCB	The Siam Commercial Bank	1.000	1.000	1.000	0.582	0.613
9	TCAP	Thanachart Capital	0.668	0.718	0.814	1.000	1.000
10	TISCO	Tisco Financial Group	1.000	1.000	1.000	1.000	1.000
11	TTB	TMBThanachart Bank (earlier known as TMB bank)	0.956	0.783	0.649	0.654	0.495
	Mean		0.892	0.798	0.820	0.567	0.690

Table 4.55 reveals that Tisco Financial Group consistently excelled in all FYs. LH Financial Group also demonstrated efficiency throughout, except for 2018, where it scored 0.747. CIMB Thai Bank, however, underperformed in all FYs. Firms such as Bank of Ayudhya, Kiatnakin Phatra Bank, The Siam Commercial Bank, and Thanachart Capital achieved high efficiency scores in at least three FYs. Kasikorn Bank showed satisfactory performance in FY 2015, 2016, and 2017, but its efficiency scores declined in FY 2018 and 2019.

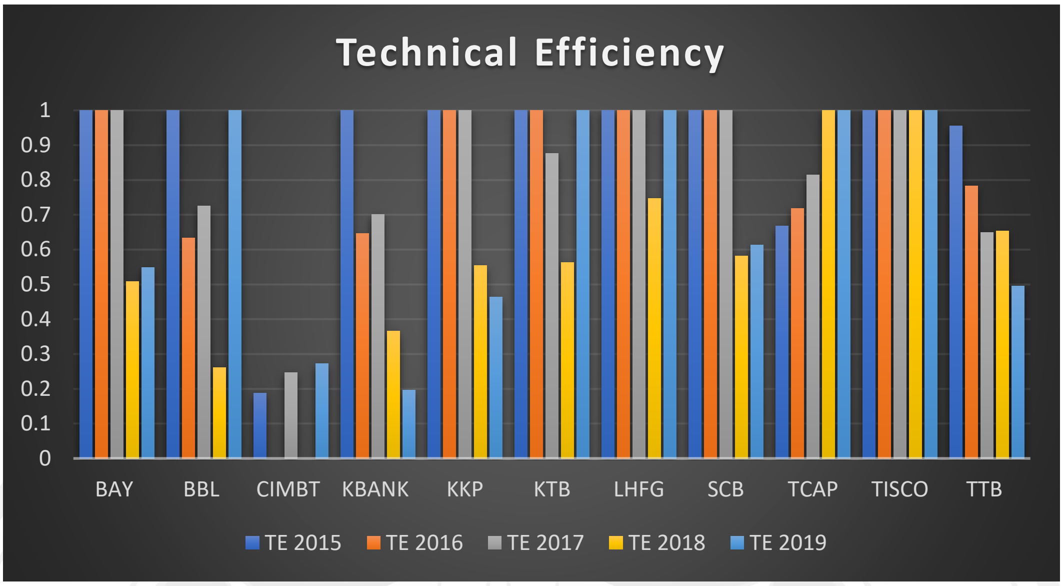

Figure 4.6 Technical Efficiency (TE) Scores of Thai Banking Companies applying Fair Value

An analysis of Table 4.55 and Figure 4.6 shows that in 2015, several banks, including Tisco Financial Group, The Siam Commercial Bank, LH Financial Group, Krung Thai Bank, Kiatnakin Phatra Bank, Bangkok Bank, Kasikorn Bank, and Bank of Ayudhya, achieved the highest relative efficiency. In contrast, CIMB Thai Bank had the lowest relative efficiency. Thanachart Capital's efficiency was relatively lower, but TMBThanachart Bank's TE score was near 1.

In FY 2016, Krung Thai Bank, Kiatnakin Phatra Bank, LH Financial Group, The Siam Commercial Bank, Bank of Ayudhya, and Tisco Financial Group maintained their high performance from the previous FY, achieving the highest TE scores of 1. CIMB Thai Bank, however, continued to have the lowest efficiency score given its losses. Other banks achieved moderate TE scores.

In FY 2017, Tisco Financial Group, The Siam Commercial Bank, LH Financial Group, Kiatnakin Phatra Bank, and Bank of Ayudhya achieved the highest efficiency scores. Other banks had moderate efficiency, while CIMB Thai Bank's efficiency was low at 0.247.

In FY 2018, Thanachart Capital and Tisco Financial Group achieved high TE scores, followed by LH Financial Group and TMBThanachart Bank. CIMB Thai Bank's efficiency was the lowest given its losses. Other firms, including Kasikorn Bank and Bangkok Bank, also had low TE scores. This FY saw lower efficiency scores than previous FYs.

In FY 2019, as per the analysis of Table 4.55 and Figure 4.6, Tisco Financial Group, Thanachart Capital, LH Financial Group, Krung Thai Bank, and Bangkok Bank performed well, achieving perfect TE scores of 1. Kasikorn Bank, CIMB Thai Bank, and Kiatnakin Phatra Bank had low efficiency scores.

When aggregating TE scores from 2015 to 2019, Tisco Financial Group exhibited the highest technical efficiency, followed by LH Financial Group and Krung Thai Bank. CIMB Thai Bank had the lowest TE, with Kasikorn Bank and TMBThanachart Bank slightly above it. Bank of Ayudhya, Kiatnakin Phatra Bank, The Siam Commercial Bank, and Thanachart Capital demonstrated satisfactory efficiency.

The Malmquist DEA was employed to obtain M DEA scores, which reflect the banks' ECs. These scores are based on the FV of variables.

Table 4.56 Malmquist Index Mean Efficiency Change of Banking Companies applying Fair Value for 2015 to 2019

Serial No.	Ticker	Bank PCL	Efficiency Change
1	BAY	Bank of Ayudhya	0.860
2	BBL	Bangkok Bank	1.000
3	CIMBT	CIMB Thai Bank	1.097
4	KBANK	Kasikorn Bank	0.665
5	KKP	Kiatnakin Phatra Bank	0.826
6	KTB	Krung Thai Bank	1.000
7	LHFG	LH Financial Group	1.000
8	SCB	The Siam Commercial Bank	0.885
9	TCAP	Thanachart Capital	1.106
10	TISCO	Tisco Financial Group	1.000
11	TTB	TMBThanachart Bank (Earlier known as TMB bank)	0.848

From 2015 to 2019, Thanachart Capital exhibited the highest GM EC at 1.106, indicating a technical efficiency growth of 10.6% (1.106 - 1 = 0.106 or 10.6%) over these five years. Despite underperforming in all FYs from 2015 to 2019, CIMB Bank's EC score was 1.097. Banks such as Krung Thai Bank, Bangkok Bank, LH Financial Group, and Tisco Financial Group had an EC of 1 each, signifying no overall EC from FY 2015 to 2019. Conversely, other banks like Bank of Ayudhya, Kasikorn Bank, The Siam Commercial Bank, Kiatnakin Phatra Bank, and TMBThanachart Bank experienced a decline in overall efficiency. An EC less than 1 indicates a decline. For example, Bank of Ayudhya's overall efficiency declined by 14% (1 - 0.860 = 0.14 or 14%).

4.9.3 Evaluation of Fair Value Data Envelopment Analysis (DEA) Versus Historical Cost DEA Result

The DEA scores of banks, based on FV, are evaluated and compared with those based on HC for each year. These efficiency scores, previously discussed in sections 4.9.1 and 4.9.2, are represented in the Table 4.57.

Table 4.57 Comparison of Technical Efficiency Scores for Banking Companies: Fair Value (FV) versus Historical Cost (HC) Application

Ticker	2015		2016		2017		2018		2019	
	HC	FV	HC	FV	HC	FV	HC	FV	HC	FV
BAY	1.000	1.000	0.696	1.000	0.597	1.000	0.472	0.508	0.989	0.548
BBL	1.000	1.000	0.633	0.633	0.725	0.725	0.268	0.261	0.415	1.000
CIMBT	0.187	0.188	0.000	0.000	0.124	0.247	0.000	0.000	0.049	0.272
KBANK	0.997	1.000	0.594	0.647	0.466	0.701	0.367	0.366	0.609	0.196
KKP	1.000	1.000	1.000	1.000	0.943	1.000	0.556	0.555	0.258	0.464
KTB	1.000	1.000	0.875	1.000	0.621	0.877	0.495	0.563	0.816	1.000
LHFG	1.000	1.000	0.900	1.000	0.879	1.000	0.504	0.747	0.287	1.000
SCB	1.000	1.000	1.000	1.000	1.000	1.000	0.419	0.582	1.000	0.613
TCAP	0.591	0.668	0.734	0.718	0.796	0.814	1.000	1.000	1.000	1.000
TISCO	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.644	1.000
TTB	0.908	0.956	0.721	0.783	0.595	0.649	0.652	0.654	1.000	0.495
Mean	0.880	0.892	0.741	0.798	0.704	0.820	0.521	0.567	0.642	0.690

Table 4.57 reveals that the DEA scores, based on HC and FV, are identical for some companies in a given year, while they differ for many others. For instance, the scores for Tisco Financial Group are identical for FY 2015, 2016, 2017, and 2018, but they diverge in 2019. Conversely, the scores for TMBThanachart Bank differ for all years, except for 2018.

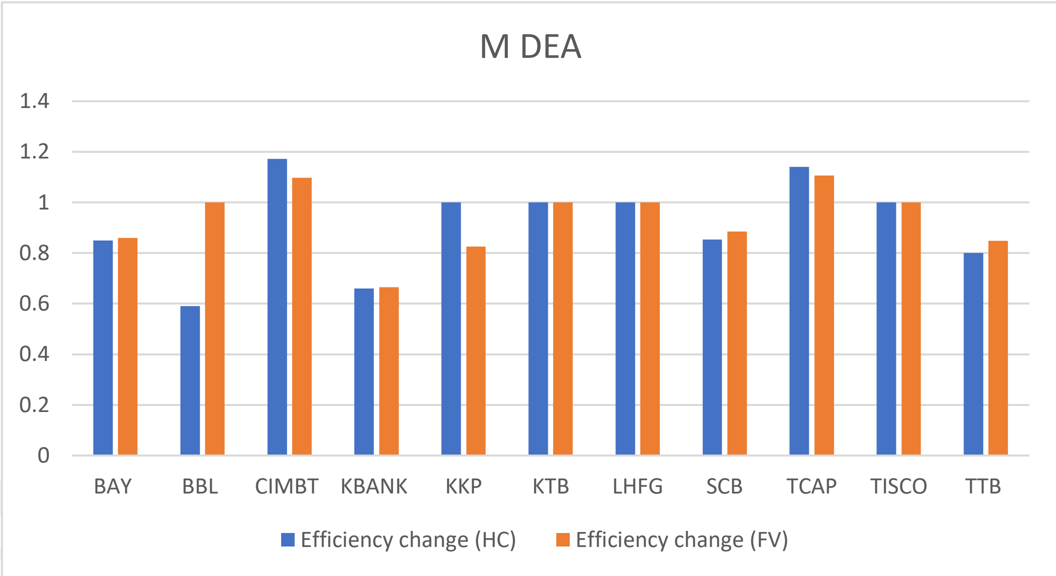

Figure 4.7 Malmquist DEA - Historical Cost versus Fair Value of Banking Companies

The EC of banking companies for all years under study, based on Malmquist DEA (M DEA), is presented in sections 4.9.1 and 4.9.2. Figure 4.7 compares this EC using FV and HC as bases. The comparison reveals minimal differences between the two for most companies. However, a significant difference is observed in the case of Bangkok Bank, where the FV EC is 1, and the HC EC is 0.591. Similarly, Kiatnakin Phatra Bank's FV EC is 0.826, while its HC EC is 1. Other companies exhibit only minor differences, if any.

4.10 Financial Ratio Analysis—Banking Companies

This section presents key financial ratios for the banking companies under study for the FYs 2015 to 2019. These ratios include profitability performance (ROA, ROE, Net Interest Margin [NIM]), efficiency (ER), leverage or solvency (Leverage Ratio, Tier 1 Risk-Adjusted Capital [RAC] Ratio), and risk (Nonperforming Loans [NPLs] as a percentage of Total Loans). A comprehensive analysis of the companies' financial performance and efficiency has been conducted using the rank normalization method.

Table 4.58 Financial Ratios of Banking Companies for Fiscal Year 2015

Ticker	FY 2015						
	Profitability Performance			Ratio for Efficiency	Ratio for Leverage or Solvency		Ratio for Risk
	NIM (%)	ROA (%)	ROE (%)	ER (%)	Leverage (times)	Tier 1 RAC (%)	NPL (%)
BAY	4.15%	1.29%	11.59%	52.6%	7.96	12.33%	2.47%
BBL	2.16%	1.23%	9.98%	47.9%	6.84	15.78%	3.01%
CIMBT	3.27%	0.36%	4.24%	60.6%	11.24	10.99%	3.21%
KBANK	3.40%	1.78%	14.54%	64.8%	7.94	14.53%	3.07%
KKP	4.30%	1.44%	8.89%	53.5%	5.23	14.71%	5.85%
KTB	2.79%	1.05%	11.92%	45.0%	10.45	11.17%	3.77%
LHFG	2.30%	0.91%	9.65%	44.4%	10.12	10.61%	2.11%
SCB	3.20%	1.70%	15.90%	35.6%	10.10	14.1%	2.89%
TCAP	3.16%	1.09%	5.85%	46.71%	15.95	10.29%	4.85%
TISCO	3.40%	1.42%	15.79%	36.7%	8.98	12.71%	3.23%
TTB	3.02%	1.13%	12.77%	52.0%	9.97	11.34%	3.53%

Note: In Tables 4.58 to 4.62, the financial ratios of banking companies are abbreviated as follows: NIM for Net Interest Margin, ROA for Return on Assets, ROE for Return on Equity, ER for Efficiency Ratio, Tier 1 RAC for Tier 1 Risk-Adjusted Capital Ratio, and NPL for Nonperforming Loans (% of Total Loans).

The profitability performance ratios indicate superior performance by The Siam Commercial Bank, Tisco Financial Group, Kasikorn Bank, and Bank of Ayudhya in FY 2015, as evidenced by their higher ROA, ROE, or NIM than other companies. Conversely, CIMB Thai Bank and LH Financial Group exhibited lower ROA, suggesting weaker performance.

The ER reveals that The Siam Commercial Bank and Tisco Financial Group demonstrated strong performance with a low ER, while CIMB Thai Bank and Kasikorn Bank had high ERs, indicating less efficient performance.

In terms of leverage or solvency, Bangkok Bank and Kiatnakin Phatra Bank had relatively lower leverage ratios, suggesting better solvency. These companies also maintained robust Tier 1 RACs, indicating strong financial strength and long-term solvency. In contrast, Thanachart Capital and CIMB Thai Bank had high leverage ratios of 15.95 and 11.24 times, respectively, which could raise concerns about their solvency. However, all companies exceeded the benchmark Tier 1 RAC set by the Bank of Thailand (BOT), suggesting overall financial strength.

The NPL ratio, which reflects the risk associated with NPLs or assets, was higher for Kiatnakin Phatra Bank and Thanachart Capital than other firms. This suggests a higher credit risk for these companies, which could potentially impact their financial stability and profitability.

Table 4.59 Financial Ratios of Banking Companies for Fiscal Year 2016

Ticker	FY 2016						Ratio for Risk
	Profitability Performance			Ratio for Efficiency	Ratio for Leverage or Solvency		
	NIM (%)	ROA (%)	ROE (%)	ER (%)	Leverage (times)	Tier 1 RAC (%)	NPL (%)
BAY	3.74	1.21%	10.74	52.9%	8.05	12.24%	2.40%
BBL	2.34	1.11%	8.59%	52.0%	6.77	16.40%	3.55%
CIMBT	3.77	(0.21%)	(2.34	60.8%	11.14	10.73%	6.19%
KBANK	3.30	1.68%	13.23	63.8%	7.84	15.16%	3.83%
KKP	4.90	2.39%	14.18	47.3%	4.80	15.61%	5.65%
KTB	2.88	1.22%	12.42	42.4%	7.81	12.81%	4.79%
LHFG	2.24	1.31%	14.09	38.5%	9.44	10.58%	1.96%
SCB	3.30	1.70%	14.80	38.7%	10.50	14.8%	2.67%
TCAP	3.32	1.28%	10.98	53.06%	14.13	11.30%	2.41%
TISCO	4.00	1.82%	16.88	40.9%	7.69	14.73%	2.09%
TTB	3.17	1.01%	10.27	50.2%	8.52	12.80%	3.68%

The profitability performance ratios from Table 4.59 for FY 2016 indicate superior performance from Tisco Financial Group, Siam Commercial Bank, and Kiatnakin Phatra Bank. These firms demonstrated higher ROA, ROE, or NIM than their counterparts. Conversely, CIMB Thai Bank underperformed, evidenced by its negative ROA and ROE. The ER reveals that The Siam Commercial Bank and LH Financial Group performed well, as indicated by their low ratios. In contrast, CIMB Thai Bank and Kasikorn Bank exhibited high ERs, suggesting elevated non-interest expenses. Regarding leverage or solvency ratios, Bangkok Bank and Kiatnakin Phatra Bank had relatively lower leverage ratios, indicative of good solvency. These firms also demonstrated robust Tier 1 RAC, suggesting strong financial health and long-term solvency. However, Thanachart Capital and CIMB Thai Bank had high leverage ratios of 14.13 and 11.14 times, respectively, which raises concerns about their solvency. Notably, all firms surpassed the benchmark Tier 1 RAC set by the BOT.

Kiatnakin Phatra Bank and CIMB Thai Bank reported higher NPL ratios than other firms, indicating increased credit risk, which could impact their financial stability and profitability.

Table 4.60 Financial Ratios of Banking Companies for Fiscal Year 2017

Ticker	FY 2017						
	Profitability Performance			Ratio for Efficiency	Ratio for Leverage or Solvency		Ratio for Risk
	NIM (%)	**ROA (%)**	**ROE (%)**	**ER (%)**	**Leverage (times)**	**Tier 1 RAC (%)**	**NPL (%)**
BAY	3.74%	1.19%	10.71%	53.8%	8.28	12.64%	2.43%
BBL	2.32%	1.11%	8.46%	48.9%	6.66	16.63%	4.36%
CIMBT	3.89%	0.13%	1.29%	63.3%	9.09	12.94%	5.07%
KBANK	3.40%	1.38%	10.24%	65.5%	6.32	15.66%	3.86%
KKP	4.70%	2.34%	14.06%	54.4%	5.27	14.61%	5.02%
KTB	2.83%	0.87%	7.99%	42.4%	7.92	13.44%	5.32%
LHFG	2.21%	1.17%	8.84%	43.1%	5.05	19.30%	2.12%
SCB	3.20%	1.50%	12.4%	42.3%	11.00	15.6%	2.83%
TCAP	3.35%	5.71%	83.38%	28.35%	13.71	12.62%	2.58%
TISCO	4.00%	2.14%	18.63%	42.8%	7.77	14.96%	1.95%
TTB	3.13%	1.06%	10.01%	51.4%	8.39	13.27%	4.73%

Turning to Table 4.60, the profitability performance ratios for FY 2017 show that Thanachart Capital, Tisco Financial Group, Siam Commercial Bank, and Kiatnakin Phatra Bank outperformed others. Their ROA, ROE, or NIM were higher than those of other firms. In contrast, CIMB Thai Bank’s ROA and ROE were subpar.

The ER suggests that Thanachart Capital performed well, as indicated by its low ratio. Conversely, CIMB Thai Bank and Kasikorn Bank had high ERs, suggesting elevated non-interest expenses. These two firms have consistently reported high ERs in previous years, indicating a need for improvement.

In terms of leverage or solvency ratios, LH Financial Group and Kiatnakin Phatra Bank had relatively lower leverage ratios, indicative of good solvency. These firms also demonstrated robust Tier 1 RAC, suggesting strong financial health and long-term solvency. However, Thanachart Capital and The Siam Commercial Bank had high leverage ratios of 13.71 and 11 times, respectively, which raises concerns about their solvency. Notably, all firms surpassed the benchmark Tier 1 RAC set by the BOT.

Kiatnakin Phatra Bank and CIMB Thai Bank reported higher NPL ratios than other firms, a trend that was also observed in the previous FY. Additionally, Krung Thai Bank's NPL ratio was high at 5.32%. These firms face increased credit risk, which could impact their financial stability and profitability.

Table 4.61 Financial Ratios of Banking Companies for Fiscal Year 2018

Ticker	FY 2018						
	Profitability Performance			Ratio for Efficiency	Ratio for Leverage or Solvency		Ratio for Risk
	NIM (%)	ROA (%)	ROE (%)	ER (%)	Leverage (times)	Tier 1 RAC (%)	NPL (%)
BAY	3.81%	1.18%	10.61%	53.4%	7.96	12.52%	2.20%
BBL	2.40%	1.15%	8.67%	50.6%	6.55	16.43%	3.85%
CIMBT	3.71%	0.00%	0.02%	65.0%	9.64	14.09%	4.38%
KBANK	3.30%	1.46%	10.61%	66.1%	7.38	15.90%	3.89%
KKP	4.20%	2.14%	14.47%	57.9%	6.26	13.56%	4.13%
KTB	2.79%	1.11%	9.60%	48.0%	7.96	14.47%	5.25%
LHFG	2.03%	1.30%	7.94%	40.5%	5.19	17.50%	2.21%
SCB	3.20%	1.30%	10.8%	46.8%	10.90	15.1%	2.85%
TCAP	3.40%%	0.37%	2.77%	28.08%	13.37	15.42%	2.29%
TISCO	4.20%	2.28%	19.05%	44.4%	7.03	16.75%	2.62%
TTB	2.94%	1.34%	12.30%	40.6%	8.03	13.53%	6.13%

The profitability performance ratios for FY 2018 indicate that Tisco Financial Group and Kiatnakin Phatra Bank outperformed other firms. These companies demonstrated superior ROA, ROE, and NIM. Conversely, CIMB Thai Bank's performance was subpar, as evidenced by its poor ROA and ROE. The ER reveals that Thanachart Capital performed well, as indicated by its low ratio. In contrast, CIMB Thai Bank and Kasikorn Bank exhibited high ERs, suggesting elevated non-interest expenses. These two firms have consistently reported high ERs in previous years, indicating a need for improvement.

Regarding leverage or solvency ratios, LH Financial Group and Kiatnakin Phatra Bank had relatively lower leverage ratios, indicative of good solvency. These firms also demonstrated robust Tier 1 RAC, suggesting strong financial health and long-term solvency. However, Thanachart Capital and The Siam Commercial Bank had high leverage ratios of 13.37 and 10.90 times, respectively, which raises concerns about their solvency. Notably, all firms surpassed the benchmark Tier 1 RAC set by the BOT.

TMBThanachart Bank and Krung Thai Bank reported higher NPL ratios of 6.13% and 5.25%, respectively. This trend, coupled with Krung Thai Bank's high NPL ratio of 5.32% in the previous year, indicates increased credit risk, which could impact their financial stability and profitability.

Table 4.62 Financial Ratios of Banking Companies for Fiscal Year 2019

Ticker	FY 2019						
	Profitability Performance			Ratio for Efficiency	Ratio for Leverage or Solvency		Ratio for Risk
	NIM (%)	ROA (%)	ROE (%)	ER (%)	Leverage (times)	Tier 1 RAC (%)	NPL (%)
BAY	3.60%	1.46%	12.76%	48.9%	7.71	13.26%	2.16%
BBL	2.35%	1.14%	8.52%	46.0%	6.52	17.01%	3.84%
CIMBT	3.50%	0.53%	5.24%	69.9%	9.95	13.1%	4.60%
KBANK	3.30%	1.35%	9.90%	65.7%	7.11	16.19%	4.20%
KKP	4.20%	1.94%	13.91%	56.7%	6.10	13.61%	4.03%
KTB	3.22%	1.12%	9.09%	52.2%	7.91	15.24%	4.91%
LHFG	1.86%	1.32%	7.95%	39.6%	4.85	15.14%	1.78%
SCB	3.30%	1.30%	10.40%	42.5%	12.50	17.0%	3.41%
TCAP	2.01%	0.56%	2.63%	27.03%	0.92	17.66%	2.29%
TISCO	4.20%	2.42%	18.91%	48.7%	6.61	17.37%	2.40%
TTB	2.81%	0.53%	4.92%	55.6%	8.54	14.62%	3.41%

Table 4.62 reveals that in FY 2019, Tisco Financial Group and Kiatnakin Phatra Bank outperformed other firms, mirroring their success from FY 2018. Their ROA and ROE were superior, and their NIM exceeded that of their competitors. Conversely, CIMB Thai Bank's ROA and ROE were subpar.

The ER indicates that Thanachart Capital was efficient given its low ratio. In contrast, CIMB Thai Bank and Kasikorn Bank, with their high ERs, incurred higher non-interest expenses. These firms, which have consistently recorded high ERs in previous years, may need to strategize for improvement.

Leverage or solvency ratios suggest that LH Financial Group, Kiatnakin Phatra Bank, Bangkok Bank, and Tisco Financial Group had relatively lower leverage ratios, indicative of good solvency. These firms also maintained robust Tier 1 RAC, signaling financial strength and long-term solvency. Interestingly, Thanachart Capital's leverage sharply declined to 0.92, potentially indicating improved solvency. However, The Siam Commercial Bank and CIMB Thai Bank, with leverage ratios of 17 and 9.95 respectively, may face solvency challenges. Notably, all firms surpassed the benchmark Tier 1 RAC set by the BOT. In the past five FYs, it is noteworthy that all banks recorded an NPL ratio of less than 5%, often considered a healthy threshold. LH Financial Group reported the lowest NPL ratio, suggesting superior asset quality.

While some firms performed well in certain financial ratios but not in others, it is challenging to draw conclusions about overall and comparative financial performance based solely on individual ratios. Therefore, a composite score, derived using the rank normalization method, may provide a more comprehensive view of each firm's overall financial performance. This approach facilitates the generation of an overall company ranking, enabling a more effective comparison. The overall company rankings for FY 2015 to 2019, based on this method, are as follows:

Table 4.63 Overall Ranking of Banking Companies based on Financial Ratios, Fiscal Years 2015–2019

Ticker	2015	2016	2017	2018	2019	Cumulative
BAY	4	6	7	4	2	2
BBL	6	6	8	7	7	7
CIMBT	10	11	11	11	11	11
KBANK	3	5	6	4	8	8
KKP	5	2	2	3	2	2
KTB	9	6	10	10	9	9
LHFG	8	4	3	2	4	4
SCB	1	3	5	6	6	6
TCAP	10	9	3	7	4	4
TISCO	2	1	1	1	1	1
TTB	7	10	9	9	10	10

Table 4.63 reveals that in FY 2015, The Siam Commercial Bank ranked highest given its superior profitability and efficiency performance. Its low NPL ratio indicated stable financial health. Tisco Financial Group also performed well, demonstrating similar strengths. Conversely, CIMB Thai Bank and Thanachart Capital underperformed given poor profitability, leverage, and efficiency. Improving Thanachart Capital's NPL ratio could enhance its financial stability.

In FY 2016, Tisco Financial Group achieved the highest rank, excelling in profitability, efficiency, leverage, and risk ratio. Kiatnakin Phatra Bank also performed well, although its NPL ratio was high. Both CIMB Thai Bank and TMBThanachart Bank showed poor performance, with the former ranking low in all ratios and the latter demonstrating poor profitability ratios.

FY 2017 saw Tisco Financial Group maintain the highest rank, with excellent profitability, efficiency, and risk ratio, despite comparatively high leverage. Kiatnakin

Phatra Bank performed well, but there is room for improvement in its efficiency and risk ratio. Thanachart Capital and LH Financial Group also performed well, but the former could improve its leverage ratio, and the latter its profitability. Both CIMB Thai Bank and Krung Thai Bank underperformed, with the former ranking low in all ratios except NIM, and the latter showing poor profitability and NPL ratios.

In FY 2018, Tisco Financial Group continued to rank highest, excelling in profitability, efficiency, risk ratio, and leverage. LH Financial Group performed well, but its profitability was unsatisfactory. Kiatnakin Phatra Bank also performed well, but could improve its efficiency. Both CIMB Thai Bank and Krung Thai Bank underperformed, with the former ranking low in almost all ratios except NIM, and the latter showing poor profitability and NPL ratios. Other firms demonstrated satisfactory financial performance.

In FY 2019, Tisco Financial Group maintained the highest rank, excelling in profitability, risk ratio, and leverage. Kiatnakin Phatra Bank performed well, ranking second, but could improve its efficiency. Bank of Ayudhya, also ranking second, has been improving its financial performance over the last couple of years, but could improve its leverage. Both CIMB Thai Bank and TMBThanachart Bank underperformed, with the former ranking low in almost all ratios except NIM, and the latter showing poor profitability and ERs. Krung Thai Bank could improve its risk, solvency, and ROA ratios. Other companies demonstrated satisfactory financial performance.

Cumulative rankings from 2015 to 2019 show Tisco Financial Group with the best ranking, followed by Kiatnakin Phatra Bank and Bank of Ayudhya, both ranked second. LH Financial Group and Thanachart Capital ranked 4th. CIMB Thai Bank and TMBThanachart Bank performed poorly, ranking 11th and 10th, respectively.

4.11 Total Return of Banking Companies

TR of banks is mentioned below:

Table 4.64 Total Return (TR) of Banking Companies

30 December 2014 to 30 December 2019		
Ticker	**TR (Holding period %)**	**TR (Annualized %)**
BAY	-24.96%	-5.76%
BBL	-1.61%	-0.34%
CIMBT	-68.65%	-21.31%
KBANK	-26.90%	-6.27%
KKP	142.90%	20.12%
KTB	-11.85%	-2.57%
LHFG	-15.63%	-3.45%
SCB	Information unavailable	Information unavailable
TCAP	129.98%	18.77%
TISCO	209.15%	26.25%
TTB	-27.01%	-6.31%

TR encompasses both the changes in stock price and any distributed dividends. The term “TR (holding period %)” denotes the percentage TR of the stock during the holding period from December 30, 2014, to December 30, 2019. “TR (annualized %)” signifies the annualized percentage TR of the stock within the same timeframe. Essentially, it represents the compounded annual return an investor would have accrued if the stock was held throughout the entire holding period. Data on the TR for Siam Commercial Bank from 2015 to 2019 was unavailable from Refinitiv Eikon and annual reports, hence it will be excluded from further analysis.

According to Table 4.64, Tisco Financial Group demonstrated an impressive annualized TR at 26.25%, followed by Kiatnakin Phatra Bank at 20.12% and

Thanachart Capital at 18.77%. The remaining firms under study exhibited negative TR, with CIMB Thai Bank recording the lowest annualized TR at -21.31%. In summary, based on the TR, the banking industry did not fully meet investor expectations over the five FYs from 2015 to 2019.

4.12 Hypothesis Testing for Banking Companies

4.12.1 Hypothesis Testing H1

Section 4.7 reveals that the FVs of financial items, as reported in the annual statements of these companies, differ from their HCs. This discrepancy is observed for many, but not all, financial items across most banking companies and FYs, with significant variations in the extent of change among different companies, years, and asset types.

The figures are presented in thousands of Thai Baht. For instance, in FY 2019, Kiatnakin Phatra Bank reported an HC of THB 21,121,142 for AFS investments, while their FV was THB 20,701,105. The bank's HTM investments had an HC of THB 1,220,624 and an FV of THB 1,266,411. Other investments for the same year had an HC of THB 176,400 and a significantly higher FV of THB 385,273. In contrast, in FY 2015, Kasikorn Bank's AFS investments had an HC of THB 210,131,123 and an FV of THB 215,365,000. Its HTM investments had an HC of THB 248,272,000 and an FV of THB 269,093,000. However, the HC and FV of its other investments were identical at THB 1,840,000.

The analysis supports H1 for most financial items, as demonstrated by the observed differences between their HCs and FVs. However, this support is not universal. For example, in FY 2015, Kasikorn Bank's other investments showed no difference between HC and FV. Similarly, Bank of Ayudhya's HTM investments in FY 2018 showed no difference between the two valuation methods. Thus, while H1 is supported in several instances, it is only partially supported overall, suggesting a nuanced impact of FV accounting on financial reporting within the Thai banking sector.

Table 4.65 Mean Difference of Variables of Banking Companies for Fiscal Years 2015-2019 (in Thousands of Thai Baht)

	Mean Difference		
FY	**Available-for-sale investments - Fair value vs. Available-for-sale investments - Historical Cost**	**Held-to-maturity investments - fair value vs. Held-to-maturity investments - Historical cost**	**Other Investments - Fair value vs. Other investments - Cost**
2015	4,081,065.73	3,625,225.36	2,334,184.91
2016	4,361,708.55	3,297,460.54	2,881,496.27
2017	6,194,490.55	4,828,602.09	2,858,156.00
2018	4,101,641.54	3,217,103.91	7,228,265.19
2019	4,438,289.81	9,570,146.46	491,136.27
Overall	4,635,439.24	4,907,707.67	3,158,647.73

Table 4.65 shows that the mean differences in AFS investments, HTM investments, and other investments (when comparing FV vs. HC/Cost) vary significantly over the years. The overall mean differences across five years for each investment type also indicate notable changes in their valuation when restated at FV. This implies that the transition to FV accounting impacts the reported values of these financial items in the financial statements of Thai banking companies.

Furthermore, to test whether these restatements result in significant changes, a Wilcoxon signed-rank test was conducted. The outcomes of the test for FY 2015 are presented below.

Table 4.66 Ranks of Variables of Banking Companies, Wilcoxon Signed-Rank Test for Fiscal Year 2015

Ranks				
		N	**Mean Rank**	**Sum of Ranks**
Available-for-sale investments - Fair value vs. Available-for-sale investments - Historical Cost	Negative Ranks	2[a]	3.00	6.00
	Positive Ranks	9[b]	6.67	60.00
	Ties	0[c]	-	-
	Total	11	-	-
Held-to-maturity investments - fair value vs. Held-to-maturity investments - Historical cost	Negative Ranks	0[d]	.00	.00
	Positive Ranks	8[e]	4.50	36.00
	Ties	3[f]	-	-
	Total	11	-	-
Other Investments - Fair value vs. Other investments - Cost	Negative Ranks	0[g]	.00	.00
	Positive Ranks	4[h]	2.50	10.00
	Ties	7[i]	-	-
	Total	11	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Historical Cost in 2 instances (or for 2 firms), b. Available-for-sale investments - Fair value > Available-for-sale investments - Historical Cost in 9 instances, c. Available-for-sale investments - Fair value = Available-for-sale investments - Historical Cost in 0 instance, d. Held-to-maturity investments -

fair value < Held-to-maturity investments - Historical cost in 0 instance, e. Held-to-maturity investments - fair value > Held-to-maturity investments - Historical cost in 8 instances, f. Held-to-maturity investments - fair value = Held-to-maturity investments - Historical cost in 3 instances, g. Other Investments - Fair value < Other investments - Cost in 0 instance, h. Other Investments - Fair value > Other investments - Cost in 4 instances, i. Other Investments - Fair value = Other investments - Cost in 7 instances.

This confirms the changes in values on restatement in several instances.

Table 4.67 Test Statistics of Variables of Banking Companies - Wilcoxon Signed-Rank Test for Fiscal Year 2015

Test Statistics[a]			
	Available-for-sale investments - Fair value vs. Available-for-sale investments - Historical Cost	**Held-to-maturity investments - fair value vs. Held-to-maturity investments - Historical cost**	**Other Investments - Fair value vs. Other investments - Cost**
Z	-2.401[b]	-2.521[b]	-1.826[b]
Asymp. Sig. (2-tailed)	.016	.012	.068

Note: a. Wilcoxon Signed Ranks Test, b. Based on negative ranks.

In Table 4.67, the Z-value for the comparison between the FV and HC of AFS investments is -2.401, with a corresponding p-value of .016. This p-value, being less than .05, indicates a statistically significant difference at the 0.05 level.

Similarly, the Z-value for the comparison between the FV and HC of HTM investments is -2.521, with a p-value of .012. As this p-value is also less than .05, it suggests a statistically significant difference at the 0.05 level. In contrast, the Z-value for the comparison between the FV and cost of other investments is -1.826, with a p-value of .068. Given that this p-value is greater than .05, it suggests that the difference is not statistically significant at the 0.05 level. However, the p-value is close to the .05 threshold. The Z-values for AFS and HTM investments, being far from 0, suggest a meaningful difference. The Z-value for other investments, being closer to 0, indicates that the observed difference may be given random chance. The test statistics are based on negative ranks. The results for FYs 2016, 2017, 2018, and 2019, obtained using SPSS software, are provided in Appendix B.

In FY 2016, the Z-value for the comparison between the FV and HC of AFS investments is -2.312, with a p-value of .021. The Z-value for the comparison between the FV and HC of HTM investments is -2.521, with a p-value of .012. The Z-value for the comparison between the FV and cost of other investments is -2.023, with a p-value of .043. These p-values indicate statistically significant differences in all cases.

In FY 2017, the Z-value for the comparison between the FV and HC of AFS investments is -2.934, with a p-value of .003. The Z-value for the comparison between the FV and HC of HTM investments is -2.521, with a p-value of .012. The Z-value for the comparison between the FV and cost of other investments is -2.023, with a p-value of .043. These p-values indicate statistically significant differences in all cases.

In FY 2018, the Z-value for the comparison between the FV and HC of AFS investments is -.978, with a p-value of .328. The Z-value for the comparison between the FV and HC of HTM investments is -2.521, with a p-value of .012. The Z-value for the comparison between the FV and cost of other investments is -1.572, with a p-value of .116. The p-value for HTM investments indicates a statistically significant difference, but this is not the case for the other two categories of variables.

In FY 2019, the Z-value for the comparison between the FV and HC of AFS investments is -2.223, with a p-value of .026. The Z-value for the comparison between the FV and HC of HTM investments is -2.521, with a p-value of .012. The Z-value for the comparison between the FV and cost of other investments is -2.201, with a p-value of .028. These p-values indicate statistically significant differences in all categories of variables.

From the discussion pertaining to Thai banking companies, it can be inferred that H1 is only partially supported. This is because, while a statistically significant difference between the FV and HC of most variables is observed across all FYs, there are notable exceptions. For instance, the Z-values and p-values for other investments in FY 2015, and for AFS securities and other investments in FY 2018, suggest that the observed differences in their FV and HC could potentially be attributed to random chance. This partial support implies that while FV impacts certain financial items, others are less affected. The findings underscore the need for a critical assessment of FV accounting, as it may alter the analysis and interpretation of a company's financial statements. This could have significant implications for stakeholders' decision-making processes and their understanding of the financial health of banking companies.

4.12.2 Hypothesis Testing H2

This section 4.12.2 examines Thai banking companies. As per section 4.9.3, the efficiency scores of numerous Thai banking companies vary when the valuation basis shifts from HC to FV. However, not every bank's efficiency scores alter upon restatement across all studied years.

For instance, the TE scores of TMBThanachart Bank underwent changes in all FYs from 2015 to 2019 upon restatement from HC to FV. The TE scores of Kasikorn Bank fluctuated with the change in the valuation basis, though the differences in 2015 and 2018 were relatively insignificant. In FY 2015, the TE score of Kasikorn Bank based on HC was 0.997, while its TE score based on FV was 1.000. Similarly, in FY 2018, its HC-based TE score was 0.367, and the FV-based score was 0.366. The TE scores of Thanachart Capital varied across different FYs, except in FY 2018 and FY 2019, where they remained the same. In 2015, the Bank of Ayudhya recorded the same TE of 1 for both valuation bases. This discussion partially supports H2.1. It is noteworthy that for most banks, if the TE score remains the same (and does not change upon restatement) for both valuation bases in a specific FY, such banks are likely to have a TE score of 1 or 0.

While this study does not primarily investigate 'significant' changes in efficiency scores upon restatement, a Wilcoxon signed-rank test was conducted to ascertain if there were significant changes in the efficiency scores of banking companies upon restatement from HC to FV. This additional information is provided for the reader's benefit.

Table 4.68 Wilcoxon Test Ranks for Technical Efficiency (TE) Scores, Fair Value (FV) vs. Historical Cost (HC), Banking Companies, 2015–2019

Ranks				
		N	**Mean Rank**	**Sum of Ranks**
TE HC 2015 - TE FV 2015	Negative Ranks	4[a]	2.50	10.00
	Positive Ranks	0[b]	.00	.00
	Ties	7[c]	-	-
	Total	11	-	-
TE HC 2016 - TE FV 2016	Negative Ranks	5[d]	4.00	20.00
	Positive Ranks	1[e]	1.00	1.00
	Ties	5[f]	-	-
	Total	11	-	-

Ranks				
		N	**Mean Rank**	**Sum of Ranks**
TE HC 2017 - TE FV 2017	Negative Ranks	8[g]	4.50	36.00
	Positive Ranks	0[h]	.00	.00
	Ties	3[i]	-	-
	Total	11	-	-
TE HC 2018 - TE FV 2018	Negative Ranks	5[j]	5.80	29.00
	Positive Ranks	3[k]	2.33	7.00
	Ties	3[l]	-	-
	Total	11	-	-
TE HC 2019 - TE FV 2019	Negative Ranks	6[m]	4.83	29.00
	Positive Ranks	4[n]	6.50	26.00
	Ties	1[o]	-	-
	Total	11	-	-

Note: In Tables 4.68 and 4.69, “TE FV” represents the technical efficiency score based on fair value, and “TE HC” denotes the technical efficiency score based on historical cost. Both are followed by their respective fiscal years, e.g., “TE FV 2015” and “TE HC 2015.”

a. TE HC 2015 < TE FV 2015, b. TE HC 2015 > TE FV 2015, c. TE HC 2015 = TE FV 2015, d. TE HC 2016 < TE FV 2016, e. TE HC 2016 > TE FV 2016, f. TE HC 2016 = TE FV 2016, g. TE HC 2017 < TE FV 2017, h. TE HC 2017 > TE FV 2017, i. TE HC 2017 = TE FV 2017, j. TE HC 2018 < TE FV 2018,

k. TE HC 2018 > TE FV 2018, l. TE HC 2018 = TE FV 2018, m. TE HC 2019 < TE FV 2019, n. TE HC 2019 > TE FV 2019, o. TE HC 2019 = TE FV 2019

Table 4.68 clearly indicates that TE scores based on FV differ from those based on HC, as evidenced by several negative and positive ranks mentioned for each FY. However, more ties were observed in FY 2015 and FY 2016, suggesting that the TE scores based on FV and HC were identical for some firms in these years.

Table 4.69 Wilcoxon Test Statistics for Technical Efficiency (TE) Score Differences, Fair Value Versus Historical Cost in Banking Companies, 2015–2019

	Test Statistics[a]				
	TE HC 2015 vs. TE FV 2015	**TE HC 2016 vs. TE FV 2016**	**TE HC 2017 vs. TE FV 2017**	**TE HC 2018 vs. TE FV 2018**	**TE HC 2019 vs. TE FV 2019**
Z	-1.826[b]	-1.992[b]	-2.521[b]	-1.542[b]	-.153[b]
Asymp. Sig. (2-tailed)	.068	.046	.012	.123	.878

Note: a. Wilcoxon Signed Ranks Test, b. Based on positive ranks.

In the case of TE FV 2015 and TE HC 2015, the p-value or asymptotic significance (2-tailed) is marginally above .05. This indicates that the evidence is insufficient to assert a significant difference between TE FV and TE HC for FY 2015. A similar lack of significant difference is observed between these two variables for FY 2018 and FY 2019.

Conversely, for TE FV 2016 and TE HC 2016, the p-value or asymptotic significance (2-tailed) is less than .05. This provides adequate evidence to affirm a significant difference between TE FV and TE HC. A similar significant difference is observed between these two variables for FY 2017.

Therefore, results partially support the hypothesis that efficiency scores of Thai insurance and banking companies change when FV is applied instead of HC. This is evident in FYs 2016 and 2017, where significant differences between FV and HC TE scores were observed. However, for FYs 2015, 2018, and 2019, the data did not provide sufficient evidence to conclude a significant difference. These findings suggest that the application of FV accounting can lead to changes in efficiency scores, but this is not uniformly observed across all banks. It implies that efficiency scores of banks are influenced by the nature of financial items and specific company characteristics.

To test H2.2, the rankings of companies based on their TE for each FY, as well as overall rankings based on TE for all FYs, are evaluated below:

Table 4.70 Comparative Rankings of Banking Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency Scores, 2015

Rank - HC 2015			**Rank - FV 2015**		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	BAY	1	1	BAY	1
1	BBL	1	1	BBL	1
1	KKP	1	1	KBANK	1
1	KTB	1	1	KKP	1
1	LHFG	1	1	KTB	1
1	SCB	1	1	LHFG	1
1	TISCO	1	1	SCB	1
8	KBANK	0.997	1	TISCO	1
9	TTB	0.908	9	TTB	0.956
10	TCAP	0.591	10	TCAP	0.668

Rank - HC 2015			Rank - FV 2015		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
11	CIMBT	0.187	11	CIMBT	0.188

In FY 2015, banks were ranked based on their TE scores. A change in the ranking of firms was observed when restating from HC basis to FV basis. This change was solely due to Kasikorn Bank, which moved from rank 8 to 1. Banks such as Bank of Ayudhya, Bangkok Bank, Kiatnakin Phatra Bank, Krung Thai Bank, LH Financial Group, The Siam Commercial Bank, and Tisco Financial Group maintained an efficiency score of 1 in both HC and FV valuations. CIMB Thai Bank had the lowest efficiency in both valuations.

Table 4.71 Comparative Rankings of Banking Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency Scores, 2016

Rank - HC 2016			Rank - FV 2016		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	KKP	1	1	BAY	1
1	SCB	1	1	KKP	1
1	TISCO	1	1	KTB	1
4	LHFG	0.9	1	LHFG	1
5	KTB	0.875	1	SCB	1
6	TCAP	0.734	1	TISCO	1
7	TTB	0.721	7	TTB	0.783
8	BAY	0.696	8	TCAP	0.718
9	BBL	0.633	9	KBANK	0.647
10	KBANK	0.594	10	BBL	0.633
11	CIMBT	0	11	CIMBT	0

As shown in Table 4.71, FY 2016 saw more changes in ranking based on the efficiency scores of Thai banks when changing the valuation basis from HC to FV. For instance, Krung Thai Bank moved from rank 5 in HC to rank 1 in FV. Other firms also experienced changes in their ranking upon restatement. Kiatnakin Phatra Bank maintained the top rank based on both HC and FV.

Table 4.72 Comparative Rankings of Banking Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency Scores, 2017

Rank - HC 2017			**Rank - FV 2017**		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	SCB	1	1	BAY	1
1	TISCO	1	1	KKP	1
3	KKP	0.943	1	LHFG	1
4	LHFG	0.879	1	SCB	1
5	TCAP	0.796	1	TISCO	1
6	BBL	0.725	6	KTB	0.877
7	KTB	0.621	7	TCAP	0.814
8	BAY	0.597	8	BBL	0.725
9	TTB	0.595	9	KBANK	0.701
10	KBANK	0.466	10	TTB	0.649
11	CIMBT	0.124	11	CIMBT	0.247

Table 4.72 shows that in FY 2017, changes in ranking were observed based on the efficiency scores of Thai banks when changing the valuation basis from HC to FV. For example, Bangkok Bank moved from rank 6 based on HC to rank 8 on FV basis. Krung Thai Bank improved its rank from 7 in HC to 6 in FV. Other firms also experienced changes in their ranking upon restatement.

Table 4.73 Comparative Rankings of Banking Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency Scores, 2018

Rank - HC 2018			Rank - FV 2018		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	TCAP	1	1	TCAP	1
1	TISCO	1	1	TISCO	1
3	TTB	0.652	3	LHFG	0.747
4	KKP	0.556	4	TTB	0.654
5	LHFG	0.504	5	SCB	0.582
6	KTB	0.495	6	KTB	0.563
7	BAY	0.472	7	KKP	0.555
8	SCB	0.419	8	BAY	0.508
9	KBANK	0.367	9	KBANK	0.366
10	BBL	0.268	10	BBL	0.261
11	CIMBT	0	11	CIMBT	0

In FY 2018, changes in ranking were observed based on the efficiency scores of Thai banks upon restatement. For instance, LH Financial Group improved its rank from 5 based on HC TE to 3 based on FV TE. The Siam Commercial Bank moved from 8th rank on HC TE to 5th rank on FV TE basis.

Table 4.74 Comparative Rankings of Banking Companies Based on Historical Cost (HC) and Fair Value (FV) Technical Efficiency (TE) Scores, 2019

Rank - HC 2019			**Rank - FV 2019**		
Rank	**Ticker**	**TE**	**Rank**	**Ticker**	**TE**
1	SCB	1	1	BBL	1
1	TCAP	1	1	KTB	1
1	TTB	1	1	LHFG	1
4	BAY	0.989	1	TCAP	1
5	KTB	0.816	1	TISCO	1
6	TISCO	0.644	6	SCB	0.613
7	KBANK	0.609	7	BAY	0.548
8	BBL	0.415	8	TTB	0.495
9	LHFG	0.287	9	KKP	0.464
10	KKP	0.258	10	CIMBT	0.272
11	CIMBT	0.049	11	KBANK	0.196

In FY 2019, as in previous years, the rankings of Thai banks changed based on the efficiency scores obtained after restatement. For instance, The Siam Commercial Bank, ranked 1st based on HC TE, fell to 6th place based on FV TE. Similarly, Kasikorn Bank dropped from 7th place on HC TE to 11th on FV TE. The results from FYs 2015 through 2019 support H2.2 for banks. Cumulative rankings, based on the mean TE score of companies from 2015 to 2019, were considered for both valuation bases.

Table 4.75 Cumulative Ranking of Banking Companies Based on Mean Technical Efficiency (TE) Scores, Historical Cost (HC) Versus Fair Value (FV) for 2015 to 2019

Overall Ranking HC			**Overall Ranking FV**		
Ticker	**Mean of TEs**	**Overall Ranking**	**Ticker**	**Mean of TEs**	**Overall Ranking**
TISCO	0.9288	1	TISCO	1	1
SCB	0.8838	2	LHFG	0.9494	2
TCAP	0.8242	3	KTB	0.888	3
TTB	0.7752	4	TCAP	0.84	4
KTB	0.7614	5	SCB	0.839	5
KKP	0.7514	6	BAY	0.8112	6
BAY	0.7508	7	KKP	0.8038	7
LHFG	0.714	8	BBL	0.7238	8
BBL	0.6082	9	TTB	0.7074	9
KBANK	0.6066	10	KBANK	0.582	10
CIMBT	0.072	11	CIMBT	0.1414	11

Tisco Financial Group consistently held the top overall rank on both HC and FV bases. However, cumulative rankings changed upon restatement for several other companies. For example, Siam Commercial Bank fell from 2nd place based on HC to 5th place based on FV. Krung Thai Bank rose from 5th place based on HC to 3rd place on FV. Kasikorn Bank and CIMB Thai Bank maintained their positions at 10th and 11th, respectively, on both valuation bases. Thus, these cumulative analyses support H2.2, as rankings change upon restatement from HC to FV .

Overall, H2 has been validated for banks. The analysis suggests that the application of FV accounting can alter the efficiency ranking of banking companies. To further substantiate H2, a Malmquist DEA (M DEA) was performed. The overall ranking of EC in companies, based on M DEA analysis, is illustrated and analyzed below.

Table 4.76 Comparison of Geometric Mean Efficiency Changes (GM EC) Under Historical Cost (HC) versus Fair Value (FV) for Banking Companies

GM EC - HC			GM EC - FV		
Overall Ranking	**Ticker**	**GM Efficiency Change (HC)**	**Overall Ranking**	**Ticker**	**GM Efficiency Change (FV)**
1	CIMBT	1.172	1	TCAP	1.106
2	TCAP	1.141	2	CIMBT	1.097
3	KKP	1	3	BBL	1
3	KTB	1	3	KTB	1
3	LHFG	1	3	LHFG	1
3	TISCO	1	3	TISCO	1
7	SCB	0.854	7	SCB	0.885
8	BAY	0.85	8	BAY	0.86
9	TTB	0.801	9	TTB	0.848
10	KBANK	0.66	10	KKP	0.826
11	BBL	0.591	11	KBANK	0.665

Table 4.76 shows a few changes in the ranking based on GM EC. For instance, CIMB Thai Bank, ranked 1st based on HC, fell to 2nd place based on FV. Kiatnakin Phatra Bank dropped from 3rd place on the EC HC list to 10th on the EC FV list. It is understood that the mean EC is the GM of EC from one year to another. That is, EC is computed by comparing the TE of a year with the previous year (e.g., 2016 TE with 2015 TE, 2017 TE with 2016 TE, and so on), and then the GM is calculated for all four ECs obtained. This analysis reinforces that ECs obtained from M DEA are distinct when firms are restated at FV basis, leading to changes in efficiency scores of at least

some firms and overall rankings based on efficiency scores. Therefore, H2 is validated by this method as well for banking companies. The findings underscore that stakeholders, such as investors, analysts, managers, and accounting setters, will gain different insights into the banks' operational efficiency, performance, and financial health upon restatement to FV basis.

4.12.3 Hypothesis Testing H3

To test H3, we can compare the rank normalization method-based FRA ranking of banks, akin to insurance companies, with the FV-based DEA rank of banks for each FY. We can also evaluate the cumulative FRA rank (based on total score) of banks for all FYs against their DEA cumulative rank (based on total score). This comparison will help determine whether the data analysis supports the hypothesis.

Spearman's rank correlation is a suitable method for analyzing the relationship between two ranked or scored variables (DEA rank and FRA rank of firms). The test of significance (Sig. [1-tailed]), which is mentioned alongside Spearman's rho, will not be considered in hypothesis testing given the small sample size of 11, which could lead to biased interpretation of results. Moreover, as the sample size represents the population, there is less need to consider the test of significance. Instead, the Wilcoxon ranked sign test will be used to ascertain the statistical difference, or lack thereof, between the two data sets. Its asymptotic significance (Asymp. Sig. [2-tailed]) provides reliable results even for a small sample size and will be considered in hypothesis testing.

Table 4.77 Comparison of Financial Ratio Analysis (FRA) Rankings and Fair Value-Based DEA Rankings for Banking Companies, 2015 to 2019

	2015		2016		2017		2018		2019		Cumulative	
Ticker	**FRA**	**DEA**	**FRA**	**DEA**	**FRA**	**DEA**	**FRA**	**DEA**	**FRA**	**DEA**	**FRA**	**DEA**
BAY	4	1	6	1	7	1	4	8	2	7	2	6
BBL	6	1	6	10	8	8	7	10	7	1	7	8
CIMBT	10	11	11	11	11	11	11	11	11	10	11	11
KBANK	3	1	5	9	6	9	4	9	8	11	8	10
KKP	5	1	2	1	2	1	3	7	2	9	2	7
KTB	9	1	6	1	10	6	10	6	9	1	9	3
LHFG	8	1	4	1	3	1	2	3	4	1	4	2
SCB	1	1	3	1	5	1	6	5	6	6	6	5
TCAP	10	10	9	8	3	7	7	1	4	1	4	4
TISCO	2	1	1	1	1	1	1	1	1	1	1	1
TTB	7	9	10	7	9	10	9	4	10	8	10	9

Note: Font size is smaller since there are large datasets that require more space.

Table 4.77 compares the FRA Rank Normalization method with the FV based DEA rank for the FYs 2015 to 2019. The rankings differ each year, and the cumulative rankings based on all years also vary between the two variables. For instance, in FY 2015, Bank of Ayudhya is ranked 4th according to FRA rank, but it is ranked 1st based on FV DEA rank. Kasikorn Bank's FRA rank is 3, while its FV DEA rank is 1. In FY 2016, Bank of Ayudhya is ranked 6th on FRA rank, but it is ranked 1st based on FV DEA rank. Thanachart Capital's FRA rank is 9, while its FV DEA rank is 8.

Table 4.78 Correlation Between Financial Ratio Analysis and Fair Value-Based DEA Rankings of Banking Companies, 2015–2019

Spearman's rho						
	2015	**2016**	**2017**	**2018**	**2019**	**Cumulative**
Correlation Coefficient	.678	.660	.698	.387	.345	.626
Sig. (1-tailed)	.011	.014	.009	.120	.150	.020

Table 4.79 Wilcoxon Signed-Rank Test Comparing Fair Value-Based DEA and Financial Ratio Analysis Rankings of Banking Companies, 2015–2019

Wilcoxon Test Statistics						
	2015	**2016**	**2017**	**2018**	**2019**	**Cumulative**
Z	-2.077[a]	-1.129[a]	-.916[a]	-.060[a]	-.535[a]	-.211[b]
Asymp. Sig. (2-tailed)	.038	.259	.360	.953	.593	.833

Note: a. based on positive ranks, b. based on negative ranks

Tables 4.78 and 4.79 present the Spearman's rho and Wilcoxon signed-rank test statistics. In FY 2015, the Spearman's rho of 0.678 implies a moderate positive correlation between the FRA and DEA ranks of banks. The Asymp. Sig. (2-tailed) value of 0.038 from the Wilcoxon signed-rank test signifies a significant difference between the DEA fair-value and FRA ranks, with a Z-value of -2.077 suggesting a lower average DEA rank than FRA rank.

In FY 2016, the Spearman's rho of 0.660 indicates a similar moderate positive correlation between the FRA and DEA ranks. However, the Asymp. Sig. (2-tailed) value of 0.259 from the Wilcoxon signed-rank test shows no statistically significant difference between the DEA fair-value and FRA ranks. The Z-value of -1.129 suggests a lower average DEA rank than FRA rank.

For FY 2017, the Spearman's rho of .698 suggests a moderately positive correlation between the FRA and DEA ranks. The Asymp. Sig. (2-tailed) value of .360 from the Wilcoxon signed-rank test indicates no significant difference between the DEA fair-value and FRA ranks. The Z-value of -.916 suggests a lower average DEA rank than FRA rank.

In FY 2018, the Spearman's rho suggests a weak to moderate positive correlation between the FRA and DEA ranks. The Asymp. Sig. (2-tailed) value of .953 from the Wilcoxon signed-rank test indicates no significant difference between the DEA fair-value and FRA ranks. The Z-value of -.060, being closer to 0, suggests that the DEA and FRA ranks are almost identical.

For FY 2019, the Spearman's rho of .345 indicates a weak positive correlation between the FRA and DEA ranks. The Asymp. Sig. (2-tailed) value of .593 from the Wilcoxon signed-rank test shows no significant difference between the DEA fair-value and FRA ranks. The Z-value of -.535 suggests a lower average DEA rank than FRA rank.

The cumulative result for FYs 2015 through 2019 shows a moderate positive correlation between the two variables, with a Spearman's rho of .626. The Asymp. Sig. (2-tailed) value of 0.833 from the Wilcoxon signed-rank test indicates no significant difference between the overall DEA fair-value and FRA ranks. The Z-value of -.211 suggests a slightly lower average DEA overall rank than the FRA overall rank.

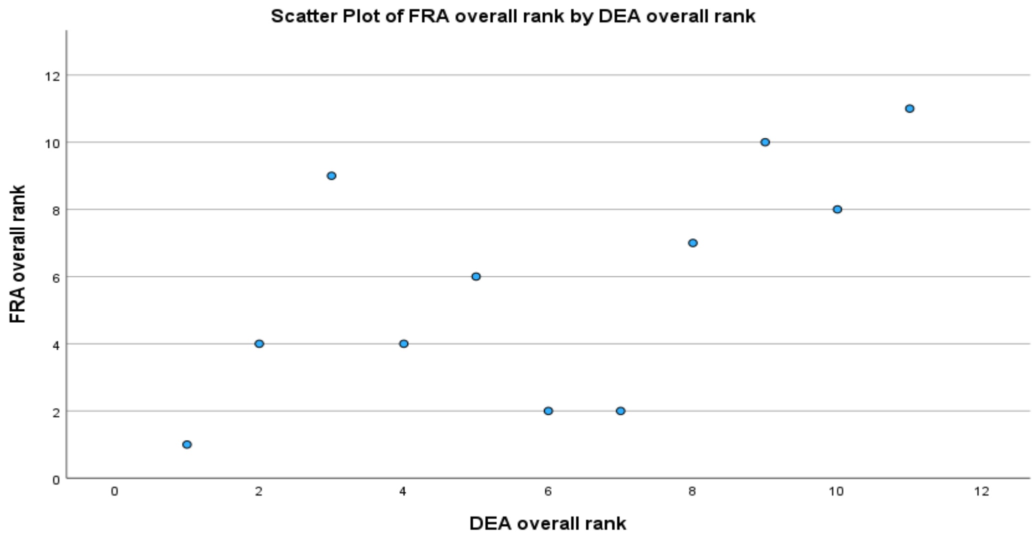

Figure 4.8 Cumulative DEA Rank versus FRA Rank of Banking Companies

The scatterplot indicates a positive correlation between DEA and FRA ranks, suggesting that as DEA rank increases, so does the FRA rank. From the analysis, it can be inferred that banks may accept H3, given the moderate positive relationship between FRA and FV-based DEA efficiency. A key observation is the similarity in rankings from FRA and DEA analyses of firms. There is no significant statistical difference in the DEA and FRA ranks, as evidenced by the Wilcoxon signed-rank test, exception for FY 2015.

In summary, the correlation analysis for banking companies generally reveals a moderate positive relationship between FRA and DEA rankings, albeit less pronounced in the last two years. The Wilcoxon test indicates similar rankings across most years, suggesting alignment between FRA and DEA rankings in this sector. This alignment could imply that factors influencing DEA efficiency and FRA results tend to converge over most years. For stakeholders, such as investors, analysts, and managers, these findings suggest that despite FRA and DEA employing different methodologies for performance evaluation, they can provide complementary insights.

The forthcoming paragraphs will analyze the relationship between each component of FRA, such as profitability performance, ER, leverage ratio, and risk ratio, and the FV-based DEA rank of banking companies. This analysis will lend further credibility to this research and hypothesis testing.

Table 4.80 Profitability Performance Rank versus Fair Value (FV) based Data Envelopment Analysis (DEA) Rank of Banking Companies

Ticker	**Profitability Performance Rank Normalization Method**	**FV based Cumulative DEA Rank**
BAY	5	6
BBL	11	8
CIMBT	10	11
KBANK	3	10
KKP	2	7
KTB	8	3
LHFG	9	2
SCB	3	5
TCAP	6	4
TISCO	1	1
TTB	6	9

Table 4.80 presents the ranking of companies based on their profitability performance (NIM, ROA and ROE ratios) and FV based cumulative rank for FYs 2015 to 2019.

Table 4.81 Efficiency Ratio Rank versus Fair Value (FV) based Data Envelopment Analysis (DEA) Cumulative Rank of Banking Companies

Ticker	Efficiency Ratio Rank Normalization Method	FV based Cumulative DEA Rank
BAY	8	6
BBL	6	8
CIMBT	10	11
KBANK	11	10
KKP	9	7
KTB	5	3
LHFG	1	2
SCB	1	5
TCAP	3	4
TISCO	4	1
TTB	7	9

Table 4.81 presents the ranking of companies based on their ratio for efficiency (ER) and FV based cumulative rank for FYs 2015 to 2019.

Table 4.82 Leverage Ratio Rank versus Fair Value (FV) based Data Envelopment Analysis (DEA) Cumulative Rank of Banking Companies

Ticker	Leverage Ratio Rank Normalization Method	FV based DEA Cumulative Rank
BAY	8	6
BBL	1	8
CIMBT	11	11
KBANK	3	10
KKP	2	7
KTB	6	3

LHFG	5	2
SCB	7	5
TCAP	10	4
TISCO	4	1
TTB	9	9

Table 4.82 presents the company rankings based on their ratio for leverage (Leverage and Tier 1 RAC) and FV based cumulative rank for FYs 2015 to 2019.

Table 4.83 Risk Ratio Rank versus Fair Value (FV) based Data Envelopment Analysis (DEA) Cumulative Rank of Banking Companies

Ticker	**Risk ratio (NPL) Rank Normalization Method**	**FV based DEA Cumulative Rank**
BAY	2	6
BBL	6	8
CIMBT	9	11
KBANK	7	10
KKP	9	7
KTB	11	3
LHFG	1	2
SCB	4	5
TCAP	5	4
TISCO	3	1
TTB	8	9

Table 4.83 presents the ranking of companies based on their ratio for risk (NPL %) and FV based cumulative rank for FYs 2015 to 2019.

Table 4.84 Correlation Between Financial Ratio Analysis Components and Fair Value-Based Cumulative Data Envelopment Analysis (DEA) Rankings of Banking Companies

Spearman's rho				
	Profitability vs. DEA	**Efficiency vs. DEA**	**Leverage vs. DEA**	**Risk vs. DEA**
Correlation Coefficient	.260	.797	.118	.501
Sig. (1-tailed)	.220	.002	.365	.058

Table 4.85 Wilcoxon Test Comparison of Cumulative Data Envelopment Analysis (DEA) Rankings and Financial Ratio Analysis Components for Banking Companies

Wilcoxon Test Statistics				
	DEA vs. Profitability	**DEA vs. Efficiency**	**DEA vs. Leverage**	**DEA vs. Risk**
Z	-.051[a]	-.045[b]	-.060[a]	-.584[a]
Asymp. Sig. (2-tailed)	.959	.964	.953	.559

Note: a. Based on negative ranks. b. Based on positive ranks.

The results from Table 4.84 suggest a weak positive correlation between profitability performance and FV-based DEA efficiency of companies, as indicated by a Spearman’s rho of .260. A strong positive correlation is observed between the ER and FV-based DEA efficiency, with a Spearman’s rho of .797. The leverage ratio and FV-based DEA efficiency show a very weak positive correlation, with a Spearman’s rho of .118. Lastly, a moderate positive correlation exists between the risk ratio (NPL%) and DEA efficiency, as the Spearman's rho is .501.

Table 4.85, which presents results based on the Wilcoxon signed-rank test, shows no significant statistical difference in the rankings of DEA and profitability performance of the companies, as indicated by an Asymp. Sig. (2-tailed) value of .959. Similarly, no significant statistical difference is found between the rankings of DEA and the ER of the firms, with an Asymp. Sig. (2-tailed) value of .964. The same holds true for the rankings of DEA and the leverage ratio, as well as DEA and the risk ratio, as their Asymp. Sig. (2-tailed) values are greater than .05.

In conclusion, an analysis of each category of ratios reveals a positive correlation with the FV-based cumulative DEA score. This correlation is strong between the ER and DEA efficiency ranking, moderately positive between the risk ratio and DEA efficiency ranking, and very weak between profitability performance and leverage with DEA ranking. The similarity in ranking between the two methods indicates a better alignment. Therefore, when considering the components of FRA, it can be concluded that H3 is supported.

4.12.4 Hypothesis Testing H4

Out of the 10 banks under review, seven reported negative TRs from 2015 to 2019. Despite this, it is still possible to evaluate and apply statistical methods to ascertain if a positive relationship exists. Data on TRs for The Siam Commercial Bank was unavailable from sources such as Refinitiv Eikon, and thus, it will be excluded from this H4 test.

For hypothesis testing, the mean DEA score of the FV, calculated from all FYs between 2015 and 2019, can be compared and assessed against the annualized TRs (%) for the corresponding FYs of each bank. The total assets and company age at the end of FY 2019 will serve as control variables. This comparison will form the basis for either accepting or rejecting the hypothesis.

Table 4.86 Fair Value (FV) Mean Data Envelopment Analysis (DEA) Score versus Total Return (TR) of Banking Companies

Ticker	FV Mean DEA Score	TR (Annualized %)	Total assets (THB millions)	Age (years)
BAY	0.8112	-5.76%	2,359,592	74
BBL	0.7238	-0.34%	3,216,743	75
CIMBT	0.1414	-21.31%	399,157	70
KBANK	0.582	-6.27%	3,293,889	74
KKP	0.8038	20.12%	311,690	49
KTB	0.888	-2.57%	3,012,216	53
LHFG	0.9494	-3.45%	240,731	10
TCAP	0.84	18.77%	160,927	39
TISCO	1	26.25%	298,143	50
TTB	0.7074	-6.31%	1,858,190	62

Table 4.86 presents the FV Mean DEA Score and TR (annualized %) for FYs 2015 to 2019.

Table 4.87 Quantile Regression Analysis of Banking Companies

Quantile	Pseudo R-Squared	Intercept Coefficient	Intercept Sig.	DEA Score Coefficient	DEA Score Sig.
0.25	.383	-.731	.063	.695	.031
0.50	.532	-.745	.106	.699	.059
0.75	.649	-.251	<.001	.332	<.001

Note: Data Envelopment Analysis (DEA)

Table 4.88 Quantile Regression Analysis of Banking Companies (Control Variables)

Quantile	Total Assets Coefficient	Total Assets Sig.	Age Coefficient	Age Sig.
0.25	-1.301E-7	.035	.007	.129
0.50	-8.470E-8	.199	.007	.203
0.75	-1.009E-7	<.001	.004	<.001

Note: -1.301E-7corresponds to -0.0000001301, -8.470E-8 corresponds to -0.0000008470 and -1.009E-7 corresponds to -0.0000001009

The quantile regression analysis, presented in Tables 4.87 and 4.88, explores the relationship between the independent variable, FV mean DEA score, and the dependent variable, TR (annualized percentage), with total assets and age serving as control variables. This analysis is conducted at three distinct quantiles (0.25, 0.50, and 0.75), each representing a different segment of the TR distribution.

At the 25th percentile, a higher DEA score correlates positively and significantly with stock returns (Coefficient: .695, p=.031), indicating that superior returns are associated with higher DEA scores at the lower end of stock returns. Conversely, total assets exhibit a significant negative correlation with returns (Coefficient: -1.301E-7, p=.035), implying that larger firms tend to yield lower returns at this level. Age, while positive, does not significantly affect returns (Coefficient: .007, p=.129). At the median (50th percentile), the DEA score continues to demonstrate a positive and significant influence on stock returns (Coefficient: .699, p=.059), underscoring the positive contribution of operational efficiency to stock returns. Total assets, while negative, do not significantly impact returns (Coefficient: -8.470E-8, p=.199). Age also shows a non-significant positive effect (Coefficient: .007, p=.203).

At the 75th percentile, the positive correlation between the DEA score and stock returns becomes more pronounced and remains significant (Coefficient: .332, $p<.001$). Total assets significantly negatively affect returns (Coefficient: -1.009E-7, $p<.001$), while age exhibits a positive and significant effect (Coefficient: 0.004, $p<0.001$). The intercepts at the 25th and 50th percentiles are not statistically significant, suggesting that when the DEA score, total assets, and age are all zero, the stock returns do not significantly deviate from zero at these levels. However, at the 75th percentile, the intercept is statistically significant, indicating that when the DEA score, total assets, and age are all zero, the expected stock returns are significantly below zero.

The Pseudo R-squared values increase across the quantiles (0.383, 0.532, and 0.649 at the 25th, 50th, and 75th percentiles, respectively), indicating an upward trend in the model's explanatory power for higher stock returns. Based on this analysis, it can be inferred that H4, with total assets and age as control variables, is supported by sufficient statistical evidence. This finding is crucial for investors, analysts, and managers, as it suggests that operational efficiency, as indicated by the DEA score, may be a reliable predictor of stock returns. Firm size, as represented by total assets, tends to negatively influence returns, particularly at the lower and higher quantiles. Moreover, the age of the bank becomes more significant at the higher quantile (0.75), correlating positively with stock returns.

4.12.5 Summary of all Hypotheses Testing Results Regarding Banking Companies

Table 4.89 summarizes the hypotheses testing results regarding banking companies.

Table 4.89 Summary of Hypotheses Testing Results Regarding Banking Companies

Hypothesis	Testing Result
H1: There are significant changes in the value of financial items when the financial statements of Thai insurance and banking companies are restated at fair value basis. It is focused on Thai banking companies.	Partially supported, based on Wilcoxon signed-rank's test of significance.
H2: There are different conclusions drawn from financial statements analysis using DEA when fair value accounting is applied instead of the historical basis.	Overall supported, applying the DEA CRS model and Malmquist DEA index.
H2.1: There are changes in efficiency scores of Thai insurance and banking companies when fair value is applied instead of historical cost.	Partially supported, based on the DEA CRS model, observation method and Wilcoxon signed-rank's test of significance.
H2.2: There are changes in ranking based on the efficiency scores obtained of the Thai insurance and banking companies when fair value is applied instead of historical cost.	Supported, by the observation method and applying Malmquist DEA index.
H3: There is a positive relationship between Financial Ratio Analysis (FRA) and fair-value-based DEA efficiency of firms.	Supported, applying Spearman's rank correlation and Wilcoxon signed-rank's test of significance; Also supported when each category of FRA is considered, applying Spearman's rank correlation and Wilcoxon signed-rank's test of significance.
H4: There is a positive relationship of DEA score and stock's returns.	Supported, applying Quantile Regression Analysis and the test of significance.

Therefore, the evidence supports few hypotheses and partially supports a few others, as in Table 4.89.

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Overall Findings

This study examines the impact of restating financial statements from an HC to an FV basis on several Thai insurance and banking companies. It reveals that while the values of some financial statement items change across all FYs upon restatement, not all items are affected. Significant changes are observed in the variables under study across different FYs, although a few variables exhibit no significant change. Efficiency scores (TE) and rankings based on these scores also vary upon restatement for some, but not all, companies. Consequently, stakeholders, including shareholders, prospective investors, and analysts, should consider the effects of FVs on a company's efficiency and ranking when analyzing financial statements.

The research further uncovers a positive correlation between the FV-based DEA and FRA. These methods can be used concurrently to identify areas of improvement in both efficiency and financial performance. However, neither method can be deemed superior. A positive correlation is found between profitability performance and DEA scores for insurance companies, and between efficiency and risk ratios and DEA scores for banking companies. These findings may be useful to stakeholders when analyzing companies in the financial sector.

The performance of the Thai insurance and banking industry, in terms of TRs, was subpar. Only a handful of companies reported positive TR over the five-year period from 2015 to 2019. Among banks, DEA scores, with total assets and age as control variables, are more predictive of stock returns. However, a positive correlation between DEA scores and stock returns could not be established for insurance companies.

5.2 Discussions

5.2.1 Discussion on Changes in Financial Items on Restatement

The analyses in sections 4.6.1 and 4.12.1, which test H2 for insurance and banking companies respectively, revealed significant changes in financial statement items for numerous Thai insurance and banking companies when restated from HC to FV basis. However, not all financial items' values changed upon restatement. This result aligns partially with prior research. Rodríguez-Pérez et al. (2011) noted changes in financial items' values upon restatement from HC to FVs, with the extent of change varying across asset classes and companies. This finding is corroborated by Ghafeer and Abdul-Rahman (2014), who observed changes in income statement figures upon restatement, though the degree of change may vary between valuation bases.

The research also partially supports Elsiefy and ElGammal's (2017) findings, which suggested that restatement led to significant changes in income statement financial items but minor changes in statement of financial position items. Similarly, Hellman (2011) reported that the adoption of International Financial Reporting Standard (IFRS) in Sweden resulted in less conservative asset valuations and increased asset and owners' equity values.

Missonier-Piera (2007) examined the economic motives for revaluing fixed assets in Swiss listed companies during 1994, 1997, 2000, and 2004. The author posited that restating fixed assets to FV basis enhanced international stakeholders' perception of a firm and facilitated debt financing. This suggests an increase or change in a firm's fixed assets' value upon restatement. The findings of this dissertation's H1 are partially validated, as several firms' financial item values increased or changed upon restatement to FV. However, these findings do not fully align with Sharma and Senan's (2020) study on Saudi insurance listed companies, which did not identify any significant difference in these firms' equity upon restatement. It is worth noting that the change in financial items upon restatement and the degree of this change depend on the variables or financial items selected by researchers, based on their research questions and study objectives.

5.2.2 Discussion on Financial Statements Analysis Using Data Envelopment Analysis When Fair Value Accounting Is Applied

The analysis and results in sections 4.6.2 and 4.12.2, which test H2 for insurance and banking companies respectively, reveal that restatement alters the efficiency scores of some, but not all, companies. This partially supports H2.1. The change in rankings based on TE scores confirms H2.2. Consequently, investors and other stakeholders must consider the impact of FV on company efficiency and rankings when analyzing financial statements.

Previous studies that draw conclusions from financial statement analysis using DEA to compare HC with FV basis and analyze efficiency scores are limited. This study's findings partially align with Rodríguez-Pérez et al.'s (2011) research on Spanish insurance companies. They suggested that a shift from FV to HC basis might alter the efficiency of some, but not most, companies. Moreover, the overall profitability and efficiency ranking of the majority of these companies remained unchanged upon restatement, except for a few. The partial alignment of this research with Rodríguez-Pérez et al.'s (2011) findings could be due to differences in sample size, the number of years included in the panel data, selected variables, and the economic conditions of the

Spanish and Thai financial markets. Rodríguez-Pérez et al. (2011) focused solely on the year 2003, analyzing a sample of 85 Spanish insurance companies.

Ari and Yilmaz (2015) examined the advantages and disadvantages of HC accounting and FV accounting. They proposed that companies should use both valuation bases to provide reliable and relevant financial information. Although their research did not compute firms' efficiency scores, it evaluated both valuation bases in terms of their usefulness to stakeholders. Ari and Yilmaz (2015) indirectly relates to this research's hypothesis, but it does not directly support or refute it.

5.2.3 Discussion on Financial Ratio Analysis and Efficiency of Firms

Based on the findings in sections 4.6.3 and 4.12.3, which test H3 for insurance and banking companies respectively, a positive relationship exists between FRA and company efficiency, as measured by FV. However, this relationship is moderate to weak for Thai insurance companies and moderate for banking companies. The strength of this relationship may be influenced by the fact that FRA variables reflect financial performance, while DEA scores indicate resource utilization efficiency. The Wilcoxon rank signed test further reveals a non-significant difference between the ranks of FRA and DEA across all FYs.

Few studies have compared FRA and FV-based DEA scores. Halkos and Salamouris (2004) found similar results from DEA and FRA, suggesting DEA could supplement or replace ratio analysis in performance evaluation. This study supports their findings, showing similar cumulative rankings but only a moderate (to weak) positive correlation.

Chen and Ali (2002) argued that FRA fails to recognize all dominating DMUs as DEA does, but the best-ranked performance by FRA is a DEA frontier. This research concurs with their first assertion but finds their second claim to be inconsistent. There were instances where the top-ranked FRA firm also achieved a perfect DEA score, particularly among banking companies.

Feroz et al. (2003) applied DEA to the US oil and gas industry and concluded that DEA effectively complements ratio analysis by providing additional information. DEA converts financial performance indicators into technical efficiency equivalents, which can clarify conflicting signals from multiple financial ratios and enhance analysis. This research aligns with Feroz et al. (2003), suggesting that FRA can supplement DEA and provide additional insights, such as benchmark comparisons. However, this study does not confirm Feroz et al.'s (2003) claim that DEA might be superior to FRA. The aim of this research is not to determine the superior method, but to compare and analyze their results.

5.2.4 Discussion on Data Envelopment Analysis and Stock Returns

Based on the analysis in Section 4.6.4, H4 is not confirmed for insurance companies. However, Section 4.12.4, indicates a positive relationship between the DEA score and stock returns, with the age of the company and total assets as control variables. Thus, this hypothesis is validated for banks.

Kirkwood and Nahm (2006) examined the correlation between firm efficiency and stock returns of Australian banks, concluding that efficiency is reflected in the stock returns. The findings of this study contradict those related to insurance but align with those for banks. This discrepancy could be attributed to the different sub-sectors analyzed: this dissertation investigates both the insurance and banking sectors, while Kirkwood and Nahm (2006) focused solely on banking companies. Additionally, the financial sector and investors in Thailand may exhibit different behaviors compared to their Australian counterparts.

Chen (2008) assessed Taiwanese listed companies across eight major industries and found that DEA portfolios based on high-efficiency companies yielded higher returns. Similarly, Fadzlan and Muhd-Zulkhibri (2007) studied Singapore commercial banks and identified a positive relationship between efficiency and stock returns. However, they used DEA cost efficiency, not technical efficiency, for comparison with stock returns. The findings of this research corroborate previous studies on banking companies but do not validate those on insurance companies.

5.3 Conclusions and Recommendations

In the insurance industry, Allianz Ayudhya Capital, Nam Seng Insurance, Indara Insurance, and KWI outperformed their competitors from 2015 to 2019, according to overall DEA FV scores. Conversely, Navakij Insurance, Thai Setakij Insurance, Charan Insurance, and Bangkok Union Insurance underperformed when evaluated on an FV basis. Allianz Ayudhya Capital, Syn Mun Kong Insurance, Krungthai-AXA, Indara Insurance, and KWI demonstrated superior efficiency based on overall DEA HC scores. However, Thai Setakij Insurance and The Navakij Insurance were less efficient when evaluated on an HC basis. The analysis suggests that several insurance companies could improve their efficiency, particularly in FY 2018 and FY 2019. Stakeholders such as investors, analysts, managers, and regulatory bodies may find this information useful for decision-making.

This study aimed to assess whether the values of financial items change upon restatement and whether the efficiency and ranking of insurance companies vary across different years. The findings confirm that the value of financial items does change for many insurance companies upon restatement. While the efficiency scores of several companies change upon restatement, not all companies experience this change. The overall firm rankings also shift from HC basis to FV upon restatement. Notably, changes in rankings were observed from FY 2015 to 2017, but not in FY 2018 and 2019.

In the banking sector, Tisco Financial Group consistently performed well in all FYs, according to both FV and HC DEA scores. Conversely, CIMB Thai bank's efficiency was subpar on both valuation bases. Other banks, including LH Financial Group, Krung Thai Bank, Thanachart Capital, and The Siam Commercial Bank, demonstrated high efficiency based on their FV. However, Kasikorn Bank and TMBThanachart Bank's FV-based efficiency was less satisfactory. The Siam Commercial Bank and Thanachart Capital outperformed other banks in terms of their HC-based DEA ranking. Conversely, Kasikorn Bank and Bangkok Bank underperformed when evaluated on an HC basis. Although not the primary objective of this research, it was observed that banks generally outperformed insurance companies in terms of their TE scores in each FY. Stakeholders may find this information useful for decision-making.

When considering both banking and insurance companies, it can be inferred that FVs impact company efficiency measurements, and this effect may differ from the HC basis. Therefore, stakeholders might benefit from evaluating the FVs and their impact on financial items and company efficiency. The study can help determine the additional efficiency required for inefficient companies to reach the efficiency frontier. This information could assist corporate managers in strategizing how to reduce input variables or increase output to move toward the efficiency frontier. For example, if a company's efficiency score (TE) is 0.595 in a particular FY, it needs to enhance its efficiency by 0.405 (or 1-0.595) to reach the frontier. This information could enable the manager to improve the company's efficiency in the subsequent year.

This study also aimed to ascertain whether a positive correlation exists between the FV-based DEA score and the FRA. The findings indicate a moderate-to-weak positive correlation between the two, suggesting that stakeholders such as investors, analysts, regulatory agencies, and managers can infer a relationship between firm efficiency derived from FVs and financial performance (FRA) in Thai companies, encompassing both insurance and banking sectors. For instance, Tisco Financial Group exhibited the highest DEA and FRA scores among all firms, while CIMB Thai bank demonstrated poor performance in both DEA efficiency and FRA.

The study also evaluated each category of ratio with the FV-based DEA score. The results suggest a moderate positive correlation between profitability performance and FV-based DEA ranking in insurance companies. In banks, a strong positive correlation exists between the ER and DEA efficiency ranking, and a moderate positive correlation between the risk ratio and DEA efficiency ranking. These findings provide stakeholders with insights, enabling them to focus on the profitability performance of insurance companies and the efficiency and risk ratios of banking companies to assess firm efficiency and performance.

This research does not aim to assert the superiority of one method over another. Instead, it posits that both FRA and DEA scores can be utilized by stakeholders to complement each other, providing a holistic yet distinctive view of a company's financial performance. This approach offers a fresh perspective, encouraging stakeholders to analyze companies using not only traditional methods like FRA but also relatively modern techniques like DEA.

Another objective of this study was to determine whether a positive correlation exists between the FV-based DEA score and stock returns, with total assets and company age as control variables. This correlation was confirmed in the banking sector but not in the insurance sector. Analysts and investors are advised to consider this evaluation, inferring that a highly efficient bank may also yield better stock returns. For instance, Tisco Financial Group had a high TE score and higher stock returns. However, in the case of insurance companies, this hypothesis was not confirmed. For example, Dhipaya Insurance had the highest annualized TR of 12.78%, but its DEA-based rank/score was modest, indicating no definitive correlation between the two. This suggests that sector-specific factors and other elements such as market sentiment, economic events, and regulatory changes may influence stock prices and TRs.

The strength of this research lies in its provision of practical insights to stakeholders, including accounting standard setters, managers, and investors, about the relevance of FV and financial statement analysis. It adopts a holistic perspective, considering not just DEA, but also FRA and stock returns to formulate comprehensive evaluations and conclusions. The study analyzes financial information for each FY as well as cumulative financial information for all FYs to test different hypotheses and derive robust findings and conclusions. By considering two sectors of the financial industry, namely insurance and banking, the research gains additional credibility and scope.

One recommendation from this research is that financial analysts and decision-makers should be equipped with techniques and software that can navigate the complexities of FV accounting. Rather than relying solely on either DEA scores or FRA, stakeholders should use both techniques to analyze firm performance and efficiency. Managers should be provided with data derived from DEA scores to help them strategize, optimize input and output variables, and enhance their efficiency.

In summary, financial statement analysts and preparers of financial information, such as the accounting department, will gain a better understanding of the value of financial items and the relevance of FVs. Internal decision-makers, including accountants and management, should make improved performance assessments and financial strategies, aiding in the optimization of company efficiency. This research will also assist investors and financial analysts in evaluating firms' stock returns in relation to the firms' efficiency based on FV, aiding them in stock selection.

5.4 Contribution of Study

This research contributes to organizations, accounting standard setters, and the economy by proposing an improved method of financial statement analysis and the application of FV accounting. It assists managers, analysts, and investors in making informed decisions, thereby enhancing company efficiency and contributing to societal living standards. A unique aspect of this research is its comprehensive approach to firm ranking. Not only does it determine the overall ranking of firms from FRA and compare it with the FV DEA ranking, but it also ranks firms based on each category of FRA, such as profitability performance and efficiency, and compares these with the FV DEA ranking. This approach results in a robust financial statement analysis. Another notable feature of this study is the use of sector-specific ratios for banks and insurance companies, leading to well-founded conclusions.

5.4.1 Practical Contribution

Investors, both individual and institutional, as well as company management, prioritize safety and high returns on investments. They compare financial statements of companies both regionally and internationally. Institutional investors, such as mutual fund companies, pension funds, and finance companies, have significant funds that require purposeful investment. This research aims to facilitate informed financial decisions by these investors through financial statement analysis.

The study contributes to policy-making in accounting and finance. It assists global organizations like the International Accounting Standards Board (IASB) and the International Federation of Accountants, as well as national accounting bodies like the Thai Federation of Accounting Professions (TFAC), in formulating future standards. The focus is on insurance and banking companies, highlighting the impact on efficiency scores when financial statement items are restated at FV. For example, the IASB may require HTM investments to be recorded at FV with an additional disclosure about their amortized HC in the notes to the financial statements. This is because it is possible to determine the FV of such investments, which are currently recorded at amortized HC.

The research investigates the causes of differences or similarities in efficiency scores between the two valuation bases. It aids managers and analysts in identifying high-performing companies and provides strategies for others to improve their performance. This is beneficial for benchmarking, enabling companies to compare their performance against industry leaders.

The study also examines whether a higher DEA efficiency leads to better company performance in terms of total stock returns. It evaluates the link between a company's performance and its efficiency, assisting users in selecting companies for investment. The study reveals that DEA efficiency can predict stock performance for Thai banking companies, but not for Thai insurance companies. This distinction is vital for stakeholders engaged in sector-specific investment and analysis.

FV accounting, favored by the IFRSs for measuring certain assets and liabilities, marks a significant departure from the HC basis. This change offers a fresh perspective on financial reporting and analysis. However, the preference for FV or HC is debatable, as scholars and industry practitioners have differing views. This study indicates that a change in valuation basis affects not only financial numbers but also the efficiency and rankings of companies.

The relevance and benefits of FV accounting versus HC basis have been controversial for decades. This research offers practical insights into the relevance of FV accounting and financial statement analysis for company management, investors, accounting departments, regulators, and analysts. It suggests that FV-based financial statement analysis may yield different results. However, it does not conclude whether FV accounting is superior to the HC basis.

Considering both valuation bases (HC and FV) and using DEA in financial statement analysis will assist analysts, preparers, and investors in making informed financial decisions and understanding the relevance of FV accounting. This research suggests that the DEA technique can complement or replace the traditional financial ratio, as it effectively transforms any number of input and output variables into one overall score, relative to the best-in-class observations. This technique can aid investors in making better investment decisions and managers in making sound managerial decisions.

5.4.2 Academic Contribution

This study examines the impact of two valuation methods, HC and FV accounting, on firm efficiency and performance. The analysis employs DEA and FRA, an interdisciplinary approach that enriches the existing literature by providing insights into the effects of these accounting methods on financial reporting and analysis.

The research delves into the insurance and banking sectors of Thailand's financial industry, assessing the influence of accounting valuation methods on their efficiency and financial performance. It presents empirical evidence on how these methods can modify the efficiency and ranking of companies within these sectors. Rodríguez-Pérez et al. (2011) observed changes in DEA scores for a limited number of Spanish insurance companies when FV replaced HC. This suggests that a shift from HC to FV may affect the efficiency and profitability of a select few companies, leaving the majority unaffected. However, this study validates that the efficiency scores of numerous Thai companies, in both insurance and banking sectors, alter upon restatement, with a few exceptions. This research thus demonstrates that financial markets across different countries display unique behavioral patterns.

The study supports Fahnestock and Bostwick's (2011) claim that stakeholders need a comprehensive understanding of FV accounting to accurately interpret financial statements. It emphasizes the ongoing debate between FV and HC, proposing that FV could supplement HC. This is evident from the first two hypotheses and the results obtained, which show changes in the value of several financial items, DEA scores, and company rankings upon restatement. Thus, conducting an FV analysis is advisable.

Additionally, this study attempts to correlate fair-value-based DEA scores with FRA and stock returns, contributing to the academic discourse by exploring potential links between them. Feroz et al. (2003) successfully applied DEA to the US oil and gas industry, concluding that DEA could effectively supplement ratio analysis by providing additional information. This research corroborates Feroz et al.'s (2003) assertion, suggesting that DEA could be used alongside FRA to provide supplementary information, such as company comparisons with benchmarks.

Kirkwood and Nahm (2006) proposed that the efficiency of Australian banks, as indicated by DEA scores, was reflected in their stock prices. Rodríguez-Pérez et al. (2011) argued that FV analysis offers more value-relevant information than HC, as it strongly correlates with stock market indicators. This research affirms a positive relationship between fair-value-based DEA scores and total stock returns for the Thai banking sector but does not establish this relationship for the Thai insurance sector. This nuanced academic contribution to the Thai financial sector suggests that fair-value-based DEA efficiency can predict stock returns in the banking sector but not in the insurance sector, which could aid stakeholders, such as analysts and investors, in decision-making.

Lastly, this research contributes to the field of FV accounting, which the IASB has emphasized over the past two decades. The IFRS 13 FV Measurement, issued in 2011, underscores the importance of FV in financial accounting and financial statement analysis. This research enhances the effectiveness of IFRS standards by restating financial statement items, such as AFS securities, HTM investments, and general investments, to their FV. It evaluates the impact of this restatement on financial statement analysis and how users can benefit from it, thereby enriching the existing body of knowledge.

5.5 Limitations of the Study and Future Research

This research has certain limitations. One such limitation is that the DEA based on HC was not evaluated and compared with FRA. Future studies could explore whether there is a positive relationship between DEA scores based on HC and FRA, and the strength of this relationship. However, the focus of this study was to evaluate the correlation between FV scores and FRA, hence the comparison between HC DEA and FRA was not conducted. In subsequent research, the consideration of other input variables in DEA analysis could be beneficial. For instance, reinsurance assets could be an input variable for insurance companies, and premises & equipment could replace another input variable for banks. These assets, substantial in their value or amount, were not considered in this study as the inclusion of additional input variables could have compromised the effectiveness of the DEA analysis, especially when the sample size is 15 or less. Future research could compare the DEA results obtained from different variables (input or output) within the same industry with the present study to assess their similarity. It could also investigate why there is no significant relationship between FV DEA scores and stock returns in insurance companies, and whether factors such as economic events and market sentiment should be considered in predicting stock returns. Future studies could also apply FV-based DEA to other industries such as real estate and oil & gas.

BIBLIOGRAPHY

Ablanedo-Rosas, J. H., Gao, H., Zheng, X., Alidaee, B., & Wang, H. (2010). A study of the relative efficiency of Chinese ports: a financial ratio-based data envelopment analysis approach. *Expert Systems, 27*(5), 349-362.

Agasthya, S. (2015, June 23). Financial ratio analysis: Introduction. Retrieved from https://mudranka.wordpress.com/2015/06/23/financial-ratio-analysis-introduction/

Ak, B. K., Dechow, P. M., Sun, Y., & Wang, A. Y. (2013). The use of financial ratio models to help investors predict and interpret significant corporate events. *Australian Journal of Management*, *38*(3), 553-598.

Al Qaisi, F., Tahtamouni, A., & Al-Qudah, M. (2016). Factors affecting the market stock price-The case of the insurance companies listed in Amman Stock Exchange. *International Journal of Business and Social Science*, *7*(10), 81-90.

Amir, E. (1993). The market valuation of accounting information: The case of postretirement benefits other than pensions. *Accounting Review*, 703-724.

Anadol, B. (2000). *Valuing private companies: A DEA approach.* (Master's thesis) University of Toronto, Ontario, Canada.

Ari, M., & Yilmaz, R. (2015). Comparative examination of fair value accounting and historical cost accounting in perspective of advantages and disadvantages. *Journal of Accounting & Finance*, (65), 147-160.

Armen, S. (2013). Performance assessment of major US airlines via cash flow ratios. *Annals of the University of Oradea, Economic Science Series*, *1*(2), 398-408.

Arumugam, T. T. (2007). An analysis of discounted cash flow (DCF) approach to business valuation in Sri Lanka. (Doctoral dissertation) St. Clements University, Liberia.

Avkiran, N. K. (2009). Opening the black box of efficiency analysis: An illustration with UAE banks. *Omega*, *37*(4), 930-941.

Avkiran, N. K. (2015). An illustration of dynamic network DEA in commercial banking including robustness tests. *Omega*, *55*, 141-150.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, *30*(9), 1078-1092. https://www.jstor.org/stable/2631725

Barlev, B., & Haddad, J. R. (2003). Fair value accounting and the management of the firm. *Critical Perspectives on Accounting*, *14*(4), 383-415.

Barnes, P. (1987). The analysis and use of financial ratios. *Journal of Business Finance and Accounting*, *14*(4), 449-461.

Barth, M. E. (1994). Fair value accounting: Evidence from investment securities and the market valuation of banks. *Accounting Review*, *69*, 1-25.

Barth, M. E., & Clinch, G. (1998). Revalued financial, tangible, and intangible assets: Associations with share prices and non-market-based value estimates. *Journal of Accounting Research*, *36*, 199-233.

Barth, M. E., Beaver, W. H., & Landsman, W. R. (2001). The relevance of the value relevance literature for financial accounting standard setting: another view. *Journal of Accounting and Economics*, *31*(1-3), 77-104. https://doi.org/10.1016/S0165-4101(01)00019-2

Basso, A., & Funari, S. (2001). A data envelopment analysis approach to measure the mutual fund performance. *European Journal of Operational Research*, *135*(3), 477-492.

Battese, G. E., & Coelli, T. J. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics*, *20*(2), 325-332.

Benson, B. W., & Davidson, W. N. (2010). The relation between stakeholder management, firm value, and CEO compensation: A test of enlightened value maximization. *Financial Management*, *39*(3), 929-964.

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research*, *98*(2), 175-212.

Berhe, TA, & Kaur, J. (2017). Determinants of insurance companies' profitability Analysis of insurance sector in Ethiopia. *International Journal of Research in Finance and Marketing (IJRFM)*, *7*(4), 124-137.

Bessong, P. K., & Charles, E. (2012). Comparative analysis of fair value and historical cost accounting on reported profit: A study of selected manufacturing companies in Nigeria. *Research Journal of Finance and Accounting*, *3*(8), 132-149.

Bilych, A. V. (2013). Theoretical and practical aspects of business valuation based on DCF-method (discounted cash flow). *Економіка АПК*, (8), 78-84.

Blanca, M. J., Arnau, J., López-Montiel, D., Bono, R., & Bendayan, R. (2013). Skewness and kurtosis in real data samples. *Methodology*, *9*(2), 78-84.

Bowlin, W. F. (1998). Measuring performance: An introduction to data envelopment analysis (DEA). *The Journal of Cost Analysis*, *15*(2), 3-27.

Boyer, R. (2007). Assessing the impact of fair value upon financial crises. *Socio-Economic Review*, *5*(4), 779-807.

Bratton, W. W. (2001). Enron and the dark side of shareholder value. *Tulane Law Review*, *76*, 1275.

Buachoom, W. W. (2022). Effect of fair value accounting and corporate governance on stock prices: Evidence of information efficiency in Thailand. In C. F. Lee & M. T. Yu (eds.), *Advances in pacific basin business, economics and finance* (pp. 209–228). Emerald Publishing Limited

Buffett, M., & Clark, D. (2008). *Buffett, and the interpretation of financial statements a warren: A search for the company, the competitive in the advantage with a durable motherboard*. New York, NY: Simon and Schuster.

Care Ratings. (2016, December 28). *Financial ratios – Insurance sector - Credit rating*. Retrieved from https://www.careratings.com/pdf/resources/Financial%20Ratios%20-%20Insurance%20Sector.pdf

Carroll, T. J., Linsmeier, T. J., & Petroni, K. R. (2003). The reliability of fair value versus historical cost information: Evidence from closed-end mutual funds. *Journal of Accounting, Auditing & Finance*, *18*(1), 1-24.

CFI. (2022). *Bank-specific ratios*. Corporate Finance Institute. Retrieved from https://corporatefinanceinstitute.com/resources/knowledge/finance/bank-specific-ratios/

Chao, C. M., Yu, M. M., Hsiung, N. H., & Chen, L. H. (2018). Profitability efficiency, marketability efficiency and technology gaps in Taiwan are banking industry: Meta-frontier network data envelopment analysis. *Applied Economics*, *50*(3), 233-250.

Charnes, A., Cooper, WW, & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research*, *2*(6), 429-444. https://doi.org/10.1016/0377-2217(78)90138-8

Chea, A. C. (2011). Fair value accounting: Its impacts on financial reporting and how it can be enhanced to provide more clarity and reliability of information for users of financial statements. *International Journal of Business and Social Science*, *2*(20), 12-19. https://doi:10.2139/ssrn.2365712

Chen, H. (2008). Stock selection using data envelopment analysis. *Industrial Management & Data Systems*, *108* (9), 1255-1268.

Chen, W. C., & McGinnis, L. F. (2007). Reconciling ratio analysis and DEA as performance assessment tools. *European Journal of Operational Research*, *178*(1), 277-291.

Chen, Y., & Ali, A. I. (2002). Output–input ratio analysis and DEA frontier. *European Journal of Operational Research*, *142*(3), 476-479.

Chhikara, K. S., & Rani, S. (2012). Efficiency measurement of life insurers of India through the eyes of data envelopment analysis (DEA). *ZENITH International Journal of Business Economics & Management Research*, *2*(11), 97-112.

Christensen, H., & Nikolaev, V. (2009). Who uses fair value accounting for non-financial assets after IFRS adoption? Retrieved from https://www.scribd.com/document/46266372/Who-Uses-Fair-Value-Accounting-for-Non-Financial-Assets-After-Ifrs-Adoption#

Chu, S. F., & Lim, G. H. (1998). Share performance and profit efficiency of banks in an oligopolistic market: evidence from Singapore. *Journal of Multinational Financial Management*, *8*(2-3), 155-168.

Coelli, T. J. (1997). A multi-stage methodology for the solution of orientation DEA models. *Operations Research Letters, 23,* 143-149.

Comparative Income Statement (Examples, Analysis, Format). (2020). Retrieved from https://www.wallstreetmojo.com/comparative-income-statement/

Corporate Finance Institute (CFI). (2022). *Bank-specific ratios*. Corporate Finance Institute. Retrieved from https://corporatefinanceinstitute.com/resources/knowledge/finance/bank-specific-ratios/

Cummins, J. D., & Rubio-Misas, M. (2006). Deregulation, consolidation, and efficiency: Evidence from the Spanish insurance industry. *Journal of Money, Credit and Banking*, *38*(2), 323-355. http://dx.doi.org/10.1353/mcb.2006.0029

Cummins, J. D., Weiss, M. A., & Zi, H. (2004). Economies of scope in financial Services: DEA bootstrap analysis of the US insurance industry. *Data Envelopment Analysis and Performance Management*, 127.

da Costa Jr., N., Lima, M., & Lanzer, E., & Lopes, A. (2008). DEA investment strategy in the Brazilian stock market. E*conomics Bulletin, AccessEcon, 13*(2), 1-10.

Dalnial, H., Kamaluddin, A., Sanusi, Z. M., & Khairuddin, K. S. (2014). Accountability in financial reporting: Detecting fraudulent firms. *Procedia-Social and Behavioral Sciences*, *145*, 61-69.

Danbolt, J., & Rees, W. (2008). An experiment in fair value accounting: UK investment vehicles. *European Accounting Review*, *17*(2), 271-303.

de Lancer Julnes, P. (2000). Decision-making tools for public productivity improvement: A comparison of DEA to cost-benefit and regression analyses. *Journal of Public Budgeting, Accounting & Financial Management*, *12*(4), 625.

Deng, H., Yeh, C. H., & Willis, R. J. (2000). Inter-company comparison using modified TOPSIS with objective weights. *Computers & Operations Research*, *27*(10), 963-973.

Dietrich, J. R., Harris, M. S., & Muller III, K. A. (2000). The reliability of investment property fair value estimates. *Journal of Accounting and Economics*, *30*(2), 125-158.

Donthu, N., Hershberger, E. K., & Osmonbekov, T. (2005). Benchmarking marketing productivity using data envelopment analysis. *Journal of Business Research*, *58*(11), 1474-1482.

Doyle, J., & Green, R. (1994). Efficiency and cross-efficiency in DEA: Derivations, meanings and uses. *Journal of the Operational Research Society*, *45*(5), 567-578.

Eckstein, C. (2004). The measurement and recognition of intangible assets: Then and now. *Accounting Forum, 28*(2), 139-158.

Edirisinghe, N. C. P., & Zhang, X. (2008). Portfolio selection under DEA-based relative financial strength indicators: Case of US industries. *Journal of the Operational Research Society*, *59*(6), 842-856.

Ellul, A., Jotikasthira, C., Lundblad, C. T., & Wang, Y. (2015). Is historical cost accounting a panacea? Market stress, incentive distortions, and gains trading. *The Journal of Finance*, *70*(6), 2489-2538.

Elsiefy, E., & ElGammal, W. (2017). The effect of using fair value accounting on fundamental analysis: Some evidence from the emerging economies. *The Journal of Developing Areas*, *51*(3), 103-121.

Fadzlan, S., & Muhd-Zulkhibri, A. M. (2007). Singapore banking efficiency and its relation to stock returns: A DEA window analysis approach. *International Journal of Business Studies: A Publication of the Faculty of Business Administration, Edith Cowan University*, *15*(1), 83.

Fahnestock, R. T., & Bostwick, E. D. (2011). An analysis of the fair value controversy. *Journal of Finance and Accountancy, 8*(1), 1-12.

Färe, R., & Grosskopf, S. (1996). Static production structure. In *Intertemporal Production Frontiers: With Dynamic DEA* (pp. 9-45). Dordrecht: Springer.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society: Series A (General)*, *120*(3), 253-281. https://doi.org/10.2307/2343100

Fernandez-Castro, A., & Smith, P. (1994). Towards a general non-parametric model of corporate performance. *Omega*, *22*(3), 237-249.

Feroz, EH, Kim, S., & Raab, RL (2003). Financial statement analysis: A data envelopment analysis approach. *Journal of the Operational Research Society*, *54*(1), 48-58. https://doi.org/10.1057/palgrave.jors.2601475

Freeman, R. E. (1984). *Strategic management: A stakeholder approach.* Boston: Pitman.

Fridson, M. S., & Alvarez, F. (2011). *Financial statement analysis: A practitioner's guide* (Vol. 597). Hoboken, NJ: John Wiley & Sons.

Frijns, B., Margaritis, D., & Psillaki, M. (2012). Firm efficiency and stock returns. *Journal of Productivity Analysis*, *37*(3), 295-306.

Gaganis, C., Hasan, I., & Pasiouras, F. (2013). Efficiency and stock returns: Evidence from the insurance industry. *Journal of Productivity Analysis*, *40*(3), 429-442.

Garrison, R. H., Noreen, E. W., & Brewer, P. C. (2018). *Managerial accounting*. New York, NY: McGraw-Hill.

Ghafeer, N. M., & Abdul-Rahman, A. A. (2014). The impact of fair value measurements on income statement: IFRS 13" an application study in insurance companies. *Research Journal of Finance and Administration, 5 (16), 120-127*.

Gümüş, Y., & Çelikkol, H. (2011). Data envelopment analysis: An augmented method for the analysis of firm performance. *International Research Journal of Finance and Economics*, *79*, 137-142.

Halkos, G. E., & Salamouris, D. S. (2004). Efficiency measurement of the Greek commercial banks with the use of financial ratios: A data envelopment analysis approach. *Management Accounting Research*, *15*(2), 201-224.

Harrington, C. (2005). The effect of competitive structure on the relationship between leverage and profitability. *Journal of Regulatory Economics*, *19*(30), 44-64.

Harris, T. S., & Ohlson, J. A. (1987). Accounting disclosures and the market's valuation of oil and gas properties. *Accounting Review*, 65(4), 651-764.

Harrison, J. S., & Wicks, A. C. (2013). Stakeholder theory, value, and firm performance. *Business Ethics Quarterly*, *23*(1), 97-124.

Hays, F. H., De Lurgio, S. A., & Gilbert, A. H. (2009). Efficiency ratios and community bank performance. *Journal of Finance and Accountancy*, *1*(1), 1-15.

Hellman, N. (2011). Soft adoption and reporting incentives: A study of the impact of IFRS on financial statements in Sweden. *Journal of International Accounting Research*, *10*(1), 61-83.

Henderson, S., & Goodwin, J. (1992). The case against asset revaluations. *Abacus*, *28*(1), 75-87.

Hill, H., & Kalirajan, K. P. (1993). Small enterprise and firm-level technical efficiency in the Indonesian garment industry. *Applied Economics*, *25*(9), 1137-1144.

Hitz, J. M. (2007). The decision usefulness of fair value accounting–A theoretical perspective. *European Accounting Review*, *16*(2), 323-362.

Ho, A. D., & Yu, C. C. (2015). Descriptive statistics for modern test score distributions: Skewness, kurtosis, discreteness, and ceiling effects. *Educational and Psychological Measurement, 75*(3), 365-388.

Ho, C. T. B. (2007). Performance measurement using data envelopment analysis and financial statement analysis. *International Journal of Operational Research*, *2*(1), 26-38.

Hoogervorst, H. (2015, June 29). *Historical cost versus fair value measurement: Les extrémes se rejoignent.* Paper presented at the IFRS conference, Paris, France. Retrieved from https://shorturl.asia/g61w9

Horrigan, J. O. (1968). A short history of financial ratio analysis. *The Accounting Review*, *43*(2), 284-294.

Howard M. Schilit, (1993). *Financial shenanigans: How to detect accounting gimmicks and fraud in financial reports.* New York, NY: McGraw Hill.

Hwang, SN, Chuang, WC, & Chen, YC (2010). Formulate stock trading strategies using DEA: A Taiwanese case. *INFOR: Information Systems and Operational Research*, *48*(2), 75-81.

Inselbag, I., & Kaufold, H. (1997). Two DCF approaches for valuing companies under alternative financing strategies (and how to choose between them). *Journal of Applied Corporate Finance*, *10*(1), 114-122.

International Accounting Standards Board (IASB). (2012). IASB. Retrieved from https://www.iasplus.com/en/resources/ifrsf/iasb-ifrs-ic/iasb

International Accounting Standards Board (IASB). (2013). International Financial Reporting Standard 13, Fair Value Measurements. Retrieved from https://www.ifrs.org/content/dam/ifrs/publications/pdf-standards/english/2022/issued/part-a/ifrs-13-fair-value-measurement.pdf?bypass=on

International Accounting Standards Board. (2018). *Conceptual Framework for Financial Reporting*. Retrieved from https://www.ifrs.org/content/dam/ifrs/publications/pdf-standards/english/2021/issued/part-a/conceptual-framework-for-financial-reporting.pdf

Jarolim, N., & Öppinger, C. (2012). Fair value accounting in times of financial crisis. *ACRN Journal of Finance and Risk Perspectives*, *1*(1), 67-90.

Jayasekara, S.G.S.D., Perera K.L.W., & Ajward, R. (2018). Fair value accounting practices and efficiency of banks: A theoretical perspective. *Accounting and Finance Research, 7*(4), 66-77.

Jensen, M. (2001). Value maximisation, stakeholder theory, and the corporate objective function. *European Financial Management*, *7*(3), 297-317.

Jiao, Y. (2010). Stakeholder welfare and firm value. *Journal of Banking & Finance*, *34*(10), 2549-2561.

Johnson, L. T. (2005). Relevance and reliability. *The FASB Report*, 1-4. Retrieved from https://shorturl.asia/nY8mJ

Kaffash, S., & Marra, M. (2017). Data envelopment analysis in financial services: A citations network analysis of banks, insurance companies and money market funds. *Annals of Operations Research*, *253*(1), 307-344.

Kanagaretnam, K., Mathieu, R., & Shehata, M. (2009). Usefulness of comprehensive income reporting in Canada. *Journal of Accounting and Public Policy*, *28*(4), 349-365.

Kane, G., & Meade, N. (1998). Ratio analysis using rank transformation. *Review of Quantitative Finance and Accounting*, *10*, 59-74.

Kao, C., & Liu, S. T. (2014). Multi-period efficiency measurement in data envelopment analysis: The case of Taiwanese commercial banks. *Omega*, *47*, 90-98. https://doi:10.1016/j.omega.2013.09.001

Kaplan, R., S., & Norton, D., P. (1996). *The balanced scorecard: Translating strategy into action.* Boston: Harvard Business School Press.

Kenton, W. (2020). *Activity ratios definition*. Retrieved from https://www. investopedia.com/terms/a/activityratio.asp

Kenton, W. (2021). Cash Ratio. Retrieved from https://www.investopedia.com /terms/c/cash-ratio.asp

Kirkwood, J., & Nahm, D. (2006). Australian banking efficiency and its relation to stock returns. *Economic Record*, *82*(258), 253-267.

Kothari, S. P., & Ball, R. (1994). *Financial statement analysis*. New York, NY: McGraw-Hill Companies.

Kulchev, K. (2017). The interpretation of financial statements in terms of contemporary financial analysis. *Journal of Business Management,* 74-84. Retrieved from https://shorturl.asia/VpWMj

Kumbirai, M., & Webb, R. (2010). A financial ratio analysis of commercial bank performance in South Africa. *African Review of Economics and Finance*, *2*(1), 30-53.

Kuo, C. (2011). Cost efficiency estimations and the equity returns for the US public solar energy firms in 1990–2008. *IMA Journal of Management Mathematics*, *22*(4), 307-321.

Lall, A. (2015, October). Data streaming algorithms for the Kolmogorov-Smirnov test. In *2015 IEEE International Conference on Big Data (Big Data)* (pp. 95-104). IEEE.

Landsman, W. (1986). An empirical investigation of pension fund property rights. *Accounting Review*, *61*(4), 662-691.

Landsman, W. R. (2007). Is fair value accounting information relevant and reliable? Evidence from capital market research. *Accounting and business research, 37*(sup1), 19-30. https://doi.org/10.1080/00014788.2007.9730081

Laux, C., & Leuz, C. (2010). Did fair-value accounting contribute to the financial crisis? *Journal of Economic Perspectives*, *24*(1), 93-118.

Lee, K. R., Leem, B., Lee, C. W., & Lee, C. (2011). Malmquist productivity index using DEA frontier in stata. *Stata Journal*, *2*(2), 1-9.

Lejin, W. (2006). Application of Fair Value in China's New Accounting Standards: The Significance and the Characteristics. *Accounting Research*, 221-224. Retrieved from https://www.atlantis-press.com/article/7697.pdf

Lessambo, F. I. (2018). *Financial statements: Analysis and Reporting.* New York, NY: Springer.

Lhaopadchan, S. (2010). Fair value accounting and intangible assets: Goodwill impairment and managerial choice. *Journal of Financial Regulation and Compliance*, *18*(2), 120-130.

Lim, S., Oh, K. W., & Zhu, J. (2014). Use of DEA cross-efficiency evaluation in portfolio selection: An application to Korean stock market. *European Journal of Operational Research*, *236*(1), 361-368.

Lopes, A. L. M., Lanzer, E., Lima, M. V. A., & Costa Junior, N. d. (2008). Dea investment strategy in the brazilian stock market. *Economics Bulletin, 13*(2), 1-10.

Lu, Y., Zhang, J., & Liu, G. (2007). On fair value measurements and disclosures based on uncertainties. *Accounting Research*, *232*(2), 18-23.

Manea, M. D. (2013). Fair value, an alternative to historical cost in accounting. *Valahian Journal of Economic Studies*, *4*(1), 57.

Mautz Jr, R. D., & Angell, R. J. (2006). Understanding the basics of financial statement analysis. *Commercial Lending Review, 21*(5), 27-34.

Menicucci, E., & Paolucci, G. (2017). Fair value accounting within a financial crisis: An Examination of Implications and Perspectives. *International Journal of Business and Social Science*, *8*(2), 41-56.

Mielcarz, P., & Wnuczak, P. (2011). DCF fair value valuation, excessive assets and hidden inefficiencies. *Contemporary Economics, 5*(4), 44-57.

Missonier-Piera, F. (2007). Motives for fixed-asset revaluation: An empirical analysis with Swiss data. *The International Journal of Accounting*, *42*(2), 186-205.

Moll, D. K. (2004). Shareholder oppression and "fair value": Of discounts, dates, and dastardly deeds in the close corporation. *Duke Law Journal*, *54*, 293-383.

Muller III, K. A., Riedl, E. J., & Sellhorn, T. (2011). Mandatory fair value accounting and information asymmetry: Evidence from the European real estate industry. *Management Science, 57*(6), 1138-1153.

Murthi, B. P. S., Choi, Y. K., & Desai, P. (1997). Efficiency of mutual funds and portfolio performance measurement: A non-parametric approach. *European Journal of Operational Research*, *98*(2), 408-418.

Muslih, M., & Marbun, S. O. (2020). The Effect of Risk Management, Firm Age, and Firm Size on the Performance of Banking Companies Registered in Indonesia Stock Exchange Moderated By Corporate Governance and Budget as Control Variable. *International Journal of Science and Society*, *2*(4), 274-290. https://doi.org/10.54783/ijsoc.v2i4.211

Nguyen, G. X., & Swanson, P. E. (2009). Firm characteristics, relative efficiency, and equity returns. *Journal of Financial and Quantitative Analysis, 44*(1), 213-236.

Nissim, D., & Penman, S. H. (2001). Ratio analysis and equity valuation: From research to practice. *Review of Accounting Studies*, *6*(1), 109-154.

Novickytė, L., & Droždz, J. (2018). Measuring the efficiency in the Lithuanian banking sector: The DEA application. *International Journal of Financial Studies*, *6*(2), 37. https://doi.org/10.3390/ijfs6020037

Palea, V. (2014). Fair value accounting and its usefulness to financial statement users. *Journal of Financial Reporting and Accounting, 12*(2), 102-116. https://doi.org/10.1108/JFRA-04-2013-0021

Penman, S. H. (2007). Financial reporting quality: Is fair value a plus or a minus? *Accounting and Business Research*, *37*(sup1), 33-44.

Piesse, J., & Thirtle, C. (2000). A stochastic frontier approach to firm level efficiency, technological change, and productivity during the early transition in Hungary. *Journal of Comparative Economics*, *28*(3), 473-501.

Pille, P., & Paradi, J. C. (2002). Financial performance analysis of Ontario (Canada) credit unions: An application of DEA in the regulatory environment. *European Journal of Operational Research*, *139*(2), 339-350.

ProThinker. (2018, July 09). Cash flow analysis archives - ProThinker - Professional analytics on demand. Retrieved from https://prothinker.com/category/cash-flow-analysis/

Qamruzzaman, M. (2014). Analysis of performance and financial soundness of financial institution (Banks): A comparative study. *Research Journal of Finance and Accounting*, *5*(7), 169-186.

Quanjun, L., & Zhengwei, Z. (2006). Reflections on the newly issued accounting standards. *Accounting Research*, 3.

Rahmawati, E. (2006). Support and against historical cost accounting: Is it value relevance for decision making? *Journal of Accounting and Investment*, *7*(1), 113-125.

Richard, J. (2004). The secret past of fair value: Lessons from history applied to the French case. *Accounting in Europe*, *1*(1), 95-107.

Robinson, T. R. (2020). *International financial statement analysis*. Hoboken, NJ: John Wiley & Sons.

Rodríguez-Pérez, G., Slof, J., Solà, M., Torrent, M., & Vilardell, I. (2011). Assessing the impact of fair-value accounting on financial statement analysis: A data envelopment analysis approach. *Abacus*, *47*(1), 61-84. https://doi.org/10.1111/j.1467-6281.2011.00331.x

Saha, A., & Ravisankar, T. S. (2000). Rating of Indian commercial banks: A DEA approach. *European Journal of Operational Research*, *124*(1), 187-203.

Sahu, P. A., & Charan, P. (2013). Ratio analysis is an instrument–For decision making-A study. *Asia Pacific Journal of Research*, *1*(8), 1-6.

Samad, A. (2004). Bahrain commercial bank's performance during 1994-2001. *Credit and Financial Management Review*, *10*(1), 33-40.

Sathye, M. (2001). X-efficiency in Australian banking: An empirical investigation. *Journal of Banking & Finance*, *25*(3), 613-630.

Sexton, T. R., Silkman, R. H., & Hogan, A. J. (1986). Data envelopment analysis: Critique and extensions. *New Directions for Program Evaluation*, (32), 73-105.

Shanklin, S. B., Hunter, D. R., & Ehlen, C. R. (2011). A retrospective view of the IFRS conceptual path and treatment of fair value measurements in financial reporting.

Journal of Business & Economics Research (JBER), *9*(3), 23-28. https://doi.org/10.19030/jber.v9i3.4126

Sharif, O., Hasan, M., Kurniasari, F., Hermawan, A., & Gunardi, A. (2019). Productivity and efficiency analysis using DEA: Evidence from financial companies listed in bursa Malaysia. *Management Science Letters*, *9*(2), 301-312. https//doi:10.5267/j.msl.2018.11.010

Sharma, K. (2018). Fair-Value accounting and financial statement analysis in Thai insurance companies. *AJMI-ASEAN Journal of Management and Innovation*, *5*(2), 176-188.

Sharma, R. B., & Senan, N. A. M. (2020). Fair value measurement in Saudi Arabia and its expected impact: A special focus on the insurance sector. *International Journal of Advanced Science and Technology, 29*(6), 1693-1699.

Sherman, H. D., & Zhu, J. (2013). Analyzing performance in service organizations. *MIT Sloan Management Review*, *54*(4), 36-42.

Škrinjarić, T. (2014). Investment strategy on the Zagreb stock exchange based on dynamic DEA. *Croatian Economic Survey*, *16*(1), 129-160.

Soloman, S. R., & Sawilowsky, S. S. (2009). Impact of rank-based normalizing transformations on the accuracy of test scores. *Journal of Modern Applied Statistical Methods*, *8*(2), 9.

Srivastaw, A. K. (2020). Comparative Income Statement (Examples, Analysis, Format). Retrieved from https://www.wallstreetmojo.com/comparative-income-statement/

Strouhal, J. (2015). Historical costs or fair value in accounting: Impact on selected financial ratios. *Journal of Economics, Business and Management*, *3*(5), 560-564.

Sturm, J. E., & Williams, B. (2004). Foreign bank entry, deregulation and bank efficiency: Lessons from the Australian experience. *Journal of Banking & Finance*, *28*(7), 1775-1799. https://doi.org/10.1016/j.jbankfin.2003.06.005

Subramanyam, K. R. (2013). *Financial statement analysis.* (10th ed.). Erwin, NY: McGraw-Hill.

Sureka, S. (2021). List of financial ratios: Advantages & Disadvantage: Types of ratios. EDUCBA. Retrieved from https://www.educba.com/list-of-financial-ratios/.

The Stock Exchange of Thailand (SET). (2022). Manual guides. Retrieved from https://media.settrade.com/common/settrade/document/manual/SET_Formula_Glossary.pdf

Thaire Life Assurance Public Company Limited. (2020). *Capital adequacy ratio: Car* Retrieved from https://www.thairelife.co.th/upload/irdisclosure/filee_201222155918.PDF

Thanassoulis, E., Boussofiane, A., & Dyson, R. G. (1996). A comparison of data envelopment analysis and ratio analysis as tools for performance assessment. *Omega*, *24*(3), 229-244.

Tone, K., & Tsutsui, M. (2010). Dynamic DEA: A slacks-based measure approach. *Omega*, *38*(3-4), 145-156.

Tsolas, I. E. (2011). Modelling profitability and effectiveness of Greek-listed construction firms: An integrated DEA and ratio analysis. *Construction Management and Economics*, *29*(8), 795-807.

Tugas, F. C. (2012). A comparative analysis of the financial ratios of listed firms belonging to the education subsector in the Philippines for the Years 2009-2011. *International Journal of Business and Social Science*, *3*(21), 173-190.

Tuovila, A. (2019, September 19). Common size income statement definition. Retrieved from https://www.investopedia.com/terms/c/commonsizeincomestatement.asp

Vlaović-Begović, S., Momčilović, M., & Jovin, S. (2013). Advantages and limitations of the discounted cash flow to firm valuation. *Škola Biznisa*, (1), 38-47. Retrieved from http://scindeks-clanci.ceon.rs/data/pdf/1451-6551/2013/1451-65511301038v.pdf

Wanke, P., & Barros, C. P. (2016). Efficiency drivers in Brazilian insurance: A two-stage DEA Meta frontier-data mining approach. *Economic Modelling, 53*, 8-22.

Weiss, E., & Majkuthová, S. (2006). Discounted Cash Flow (DCF) Assessment method and its use in assessment of a producer company. *Metalurgija*, *45*(1), 67-70.

Weygandt, J., Kimmel, P., & Kieso, D. (2013). *Financial accounting: IFRS* (3rd ed.). America, US: John Wiley & Sons.

Wier, H. A. (2009). Fair value or conservatism: The case of the gold industry. *Contemporary Accounting Research*, *26*(4), 1207-1233.

Wild, J. J. & Shaw, K.W. (2019). *Fundamental accounting principles.* New York, NY: McGraw-Hill.

Wild, J. J., Kwok, W., Venkatesh, S., Shaw, K.W. & Chiappetta, B. (2016). *Fundamental accounting principles*. New York, NY: McGraw-Hill.

Williams, J. R., Haka, S. F., Bettner, M. S., & Carcello, J. V. (2018). *Financial & Managerial accounting: The basis for business decisions*. New York, NY: McGraw-Hill.

Xuyue, G. J. (2006). Research on measurement attributes of accounting: Market price, historical cost, current cost and fair value. *Accounting Research*, 9.

Yang, X., & Morita, H. (2013). Efficiency improvement from multiple perspectives: An application to Japanese banking industry. *Omega*, *41*(3), 501-509.

Yeh, Q. J. (1996). The application of data envelopment analysis in conjunction with financial ratios for bank performance evaluation. *Journal of the Operational Research Society*, *47*(8), 980-988.

Yu, Y. S., Barros, A., Tsai, C. H., & Liao, K. H. (2014). A comparison of ratios and data envelopment analysis: efficiency assessment of Taiwan public listed companies. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, *4*(1), 212-219.

Yue, P. (1992). Data envelopment analysis and commercial bank performance: A primer with applications to Missouri banks. *Federal Reserve Bank of St. Louis Review, 74*(1), 31-45. Retrieved from https://repositories.lib.utexas.edu/bitstream/handle/2152/46390/yue-1992-dea-missouri-banks.pdf?sequence=2

Zamel, A. M., Behery A. H., & Hefny, D. A. (2020). Limitations of historical cost accounting information under inflationary conditions: A theoretical study. *Journal of Commercial Research, 42*(4), 3-22.

Zhang, Y., Andrew, J., & Rudkin, K. (2012). Accounting as an instrument of neoliberalisation? Exploring the adoption of fair value accounting in China. *Accounting, Auditing & Accountability Journal*, *25*(8), 1266-1289.

Zhu, J. (2014). *Quantitative models for performance evaluation and benchmarking: Data envelopment analysis with spreadsheets* (Vol. 213). New York, NY: Springer.

Zhu, J., & Cook, W. D. (2007). *Modeling data irregularities and structural complexities in data envelopment analysis*. Berlin/Heidelberg, Germany: Springer Science & Business Media.

Zhu, N., Shah, W. U. H., Kamal, M. A., & Yasmeen, R. (2020). Efficiency and productivity analysis of Pakistan's banking industry: A DEA approach. *International Journal of Finance & Economics, 26*(4), 6362-6374. https://doi.org/10.1002/ijfe.2123

Zyla, M. L. (2009). *Fair value measurements: Practical guidance and implementation*. New York, NY: John Wiley & Sons.

APPENDICES

Appendix A

Hypothesis Testing H1 for Insurance Companies

NPar Tests (Non-parametric tests) - Insurance companies

Ranks of Variables of Insurance Companies, Wilcoxon Signed-Rank Test for FY 2016

Ranks

		N	**Mean Rank**	**Sum of Ranks**
Available-for-sale investments - Fair value - Available-for-sale investments - Amortized cost	Negative Ranks	4[a]	8.50	34.00
	Positive Ranks	10[b]	7.10	71.00
	Ties	0[c]	-	-
	Total	14	-	-
Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized cost	Negative Ranks	1[d]	3.00	3.00
	Positive Ranks	8[e]	5.25	42.00
	Ties	5[f]	-	-
	Total	14	-	-
Other Investments - Fair value - Other investments - Cost	Negative Ranks	0[g]	.00	.00
	Positive Ranks	8[h]	4.50	36.00
	Ties	6[i]	-	-
	Total	14	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Amortized cost

b. Available-for-sale investments - Fair value > Available-for-sale investments - Amortized cost

c. Available-for-sale investments - Fair value = Available-for-sale investments - Amortized cost

d. Held-to-maturity investments - fair value < Held-to-maturity investments - Amortized cost

e. Held-to-maturity investments - fair value > Held-to-maturity investments - Amortized cost

f. Held-to-maturity investments - fair value = Held-to-maturity investments - Amortized cost

g. Other Investments - Fair value < Other investments - Cost

h. Other Investments - Fair value > Other investments - Cost

i. Other Investments - Fair value = Other investments - Cost

Test Statistics of Variables of Insurance Companies - Wilcoxon Signed-Rank Test for FY 2016

Test Statistics[a]			
	Available-for-sale investments - Fair value - Available-for-sale investments - Amortized Cost	**Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized Cost**	**Other Investments - Fair value - Other investments - Cost**
Z	-1.161[b]	-2.310[b]	-2.521[b]
Asymp. Sig. (2-tailed)	.245	.021	.012

Note: a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Ranks of Variables of Insurance Companies, Wilcoxon Signed-Rank Test for FY 2017

Ranks

		N	Mean Rank	Sum of Ranks
Available-for-sale investments - Fair value - Available-for-sale investments - Amortized cost	Negative Ranks	3[a]	4.33	13.00
	Positive Ranks	10[b]	7.80	78.00
	Ties	1[c]	-	-
	Total	14	-	-
Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized cost	Negative Ranks	3[d]	2.00	6.00
	Positive Ranks	7[e]	7.00	49.00
	Ties	4[f]	-	-
	Total	14	-	-
Other Investments - Fair value - Other investments - Cost	Negative Ranks	0[g]	.00	.00
	Positive Ranks	8[h]	4.50	36.00
	Ties	6[i]	-	-
	Total	14	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Amortized cost

b. Available-for-sale investments - Fair value > Available-for-sale investments - Amortized cost

c. Available-for-sale investments - Fair value = Available-for-sale investments - Amortized cost

d. Held-to-maturity investments - fair value < Held-to-maturity investments - Amortized cost

e. Held-to-maturity investments - fair value > Held-to-maturity investments - Amortized cost

f. Held-to-maturity investments - fair value = Held-to-maturity investments - Amortized cost

g. Other Investments - Fair value < Other investments - Cost

h. Other Investments - Fair value > Other investments - Cost

i. Other Investments - Fair value = Other investments - Cost

Test Statistics of Variables of Insurance Companies - Wilcoxon Signed-Rank Test for FY 2017

Test Statistics[a]

	Available-for-sale investments - Fair value - Available-for-sale investments - Amortized Cost	**Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized Cost**	**Other Investments - Fair value - Other investments - Cost**
Z	-2.271[b]	-2.191[b]	-2.521[b]
Asymp. Sig. (2-tailed)	.023	.028	.012

Note: a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Ranks of Variables of Insurance Companies, Wilcoxon Signed-Rank Test for FY 2018

Ranks

		N	**Mean Rank**	**Sum of Ranks**
Available-for-sale investments - Fair value - Available-for-sale investments - Amortized cost	Negative Ranks	5[a]	7.80	39.00
	Positive Ranks	10[b]	8.10	81.00
	Ties	0[c]	-	-
	Total	15	-	-
Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized cost	Negative Ranks	4[d]	5.75	23.00
	Positive Ranks	7[e]	6.14	43.00
	Ties	4[f]	-	-
	Total	15	-	-
Other Investments - Fair value - Other investments - Cost	Negative Ranks	2[g]	2.50	5.00
	Positive Ranks	7[h]	5.71	40.00
	Ties	6[i]	-	-
	Total	15	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Amortized cost

b. Available-for-sale investments - Fair value > Available-for-sale investments - Amortized cost

c. Available-for-sale investments - Fair value = Available-for-sale investments - Amortized cost

d. Held-to-maturity investments - fair value < Held-to-maturity investments - Amortized cost

e. Held-to-maturity investments - fair value > Held-to-maturity investments - Amortized cost

f. Held-to-maturity investments - fair value = Held-to-maturity investments - Amortized cost

g. Other Investments - Fair value < Other investments - Cost

h. Other Investments - Fair value > Other investments - Cost

i. Other Investments - Fair value = Other investments - Cost

Test Statistics of Variables of Insurance Companies - Wilcoxon Signed-Rank Test for FY 2018

Test Statistics[a]

	Available-for-sale investments - Fair value - Available-for-sale investments - Amortized Cost	**Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized Cost**	**Other Investments - Fair value - Other investments - Cost**
Z	-1.193[b]	-.889[b]	-2.073[b]
Asymp. Sig. (2-tailed)	.233	.374	.038

Note: a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Ranks of Variables of Insurance Companies, Wilcoxon Signed-Rank Test for FY 2019

Ranks

		N	Mean Rank	Sum of Ranks
Available-for-sale investments - Fair value - Available-for-sale investments - Amortized cost	Negative Ranks	7[a]	5.57	39.00
	Positive Ranks	8[b]	10.13	81.00
	Ties	0[c]	-	-
	Total	15	-	-
Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized cost	Negative Ranks	0[d]	.00	.00
	Positive Ranks	11[e]	6.00	66.00
	Ties	4[f]	-	-
	Total	15	-	-
Other Investments - Fair value - Other investments - Cost	Negative Ranks	2[g]	4.00	8.00
	Positive Ranks	8[h]	5.88	47.00
	Ties	5[i]	-	-
	Total	15	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Amortized cost

b. Available-for-sale investments - Fair value > Available-for-sale investments - Amortized cost

c. Available-for-sale investments - Fair value = Available-for-sale investments - Amortized cost

d. Held-to-maturity investments - fair value < Held-to-maturity investments - Amortized cost

e. Held-to-maturity investments - fair value > Held-to-maturity investments - Amortized cost

f. Held-to-maturity investments - fair value = Held-to-maturity investments - Amortized cost

g. Other Investments - Fair value < Other investments - Cost

h. Other Investments - Fair value > Other investments - Cost

i. Other Investments - Fair value = Other investments - Cost

Test Statistics of Variables of Insurance Companies - Wilcoxon Signed-Rank Test for FY 2019

Test Statistics[a]			
	Available-for-sale investments - Fair value - Available-for-sale investments - Amortized Cost	**Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized Cost**	**Other Investments - Fair value - Other investments - Cost**
Z	-1.193[b]	-2.934[b]	-1.988[b]
Asymp. Sig. (2-tailed)	.233	.003	.047

Note: a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Appendix B

Hypothesis Testing H1 for Banking Companies

NPar Tests (Non-parametric tests) - Banking Companies

Ranks of Variables of Banking Companies, Wilcoxon Signed-Rank Test for FY 2016

Ranks

		N	Mean Rank	Sum of Ranks
Available-for-sale investments - Fair value - Available-for-sale investments - Amortized cost	Negative Ranks	3[a]	2.33	7.00
	Positive Ranks	8[b]	7.38	59.00
	Ties	0[c]	-	-
	Total	11	-	-
Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized cost	Negative Ranks	0[d]	.00	.00
	Positive Ranks	8[e]	4.50	36.00
	Ties	3[f]	-	-
	Total	11	-	-
Other Investments - Fair value - Other investments - Cost	Negative Ranks	0[g]	.00	.00
	Positive Ranks	5[h]	3.00	15.00
	Ties	6[i]	-	-
	Total	11	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Amortized cost

b. Available-for-sale investments - Fair value > Available-for-sale investments - Amortized cost

c. Available-for-sale investments - Fair value = Available-for-sale investments - Amortized cost

d. Held-to-maturity investments - fair value < Held-to-maturity investments - Amortized cost

e. Held-to-maturity investments - fair value > Held-to-maturity investments - Amortized cost

f. Held-to-maturity investments - fair value = Held-to-maturity investments - Amortized cost

g. Other Investments - Fair value < Other investments - Cost

h. Other Investments - Fair value > Other investments - Cost

i. Other Investments - Fair value = Other investments – Cost

Test Statistics of Variables of Banking Companies - Wilcoxon Signed-Rank Test for FY 2016

Test Statistics[a]			
	Available-for-sale investments - Fair value - Available-for-sale investments - Amortized Cost	**Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized Cost**	**Other Investments - Fair value - Other investments - Cost**
Z	-2.312[b]	-2.521[b]	-2.023[b]
Asymp. Sig. (2-tailed)	.021	.012	.043

Note: a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Ranks of Variables of Banking Companies, Wilcoxon Signed-Rank Test for FY 2017

Ranks				
		N	**Mean Rank**	**Sum of Ranks**
Available-for-sale investments - Fair value - Available-for-sale investments - Amortized cost	Negative Ranks	0[a]	.00	.00
	Positive Ranks	11[b]	6.00	66.00
	Ties	0[c]	-	-
	Total	11	-	-
Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized cost	Negative Ranks	0[d]	.00	.00
	Positive Ranks	8[e]	4.50	36.00
	Ties	3[f]	-	-
	Total	11	-	-
Other Investments - Fair value - Other investments - Cost	Negative Ranks	0[g]	.00	.00
	Positive Ranks	5[h]	3.00	15.00
	Ties	6[i]	-	-
	Total	11	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Amortized cost

b. Available-for-sale investments - Fair value > Available-for-sale investments - Amortized cost

c. Available-for-sale investments - Fair value = Available-for-sale investments - Amortized cost

d. Held-to-maturity investments - fair value < Held-to-maturity investments - Amortized cost

e. Held-to-maturity investments - fair value > Held-to-maturity investments - Amortized cost

f. Held-to-maturity investments - fair value = Held-to-maturity investments - Amortized cost

g. Other Investments - Fair value < Other investments - Cost

h. Other Investments - Fair value > Other investments - Cost

i. Other Investments - Fair value = Other investments - Cost

Test Statistics of Variables of Banking Companies - Wilcoxon Signed-Rank Test for FY 2017

Test Statistics[a]

	Available-for-sale investments - Fair value - Available-for-sale investments - Amortized Cost	**Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized Cost**	**Other Investments - Fair value - Other investments - Cost**
Z	-2.934[b]	-2.521[b]	-2.023[b]
Asymp. Sig. (2-tailed)	.003	.012	.043

Note: a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Ranks of Variables of Banking Companies, Wilcoxon Signed-Rank Test for FY 2018

Ranks

		N	**Mean Rank**	**Sum of Ranks**
Available-for-sale investments - Fair value - Available-for-sale investments - Amortized cost	Negative Ranks	6[a]	3.67	22.00
	Positive Ranks	5[b]	8.80	44.00
	Ties	0[c]	-	-
	Total	11	-	-
Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized cost	Negative Ranks	0[d]	.00	.00
	Positive Ranks	8[e]	4.50	36.00
	Ties	3[f]	-	-
	Total	11	-	-
Other Investments - Fair value - Other investments - Cost	Negative Ranks	2[g]	1.50	3.00
	Positive Ranks	4[h]	4.50	18.00
	Ties	5[i]	-	-
	Total	11	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Amortized cost

b. Available-for-sale investments - Fair value > Available-for-sale investments - Amortized cost

c. Available-for-sale investments - Fair value = Available-for-sale investments - Amortized cost

d. Held-to-maturity investments - fair value < Held-to-maturity investments - Amortized cost

e. Held-to-maturity investments - fair value > Held-to-maturity investments - Amortized cost

f. Held-to-maturity investments - fair value = Held-to-maturity investments - Amortized cost

g. Other Investments - Fair value < Other investments - Cost

h. Other Investments - Fair value > Other investments - Cost

i. Other Investments - Fair value = Other investments – Cost

Test Statistics of Variables of Banking Companies - Wilcoxon Signed-Rank Test for FY 2018

Test Statistics[a]

	Available-for-sale investments - Fair value - Available-for-sale investments - Amortized Cost	**Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized Cost**	**Other Investments - Fair value - Other investments - Cost**
Z	-.978[b]	-2.521[b]	-1.572[b]
Asymp. Sig. (2-tailed)	.328	.012	.116

Note: a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Ranks of Variables of Banking Companies, Wilcoxon Signed-Rank Test for FY 2019

Ranks				
		N	Mean Rank	Sum of Ranks
Available-for-sale investments - Fair value - Available-for-sale investments - Amortized cost	Negative Ranks	3[a]	2.67	8.00
	Positive Ranks	8[b]	7.25	58.00
	Ties	0[c]	-	-
	Total	11	-	-
Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized cost	Negative Ranks	0[d]	.00	.00
	Positive Ranks	8[e]	4.50	36.00
	Ties	3[f]	-	-
	Total	11	-	-
Other Investments - Fair value - Other investments - Cost	Negative Ranks	0[g]	.00	.00
	Positive Ranks	6[h]	3.50	21.00
	Ties	5[i]	-	-
	Total	11	-	-

Note: a. Available-for-sale investments - Fair value < Available-for-sale investments - Amortized cost

b. Available-for-sale investments - Fair value > Available-for-sale investments - Amortized cost

c. Available-for-sale investments - Fair value = Available-for-sale investments - Amortized cost

d. Held-to-maturity investments - fair value < Held-to-maturity investments - Amortized cost

e. Held-to-maturity investments - fair value > Held-to-maturity investments - Amortized cost

f. Held-to-maturity investments - fair value = Held-to-maturity investments - Amortized cost

g. Other Investments - Fair value < Other investments - Cost

h. Other Investments - Fair value > Other investments - Cost

i. Other Investments - Fair value = Other investments - Cost

Test Statistics of Variables of Banking Companies - Wilcoxon Signed-Rank Test for FY 2019

Test Statistics[a]

	Available-for-sale investments - Fair value - Available-for-sale investments - Amortized Cost	**Held-to-maturity investments - fair value - Held-to-maturity investments - Amortized Cost**	**Other Investments - Fair value - Other investments - Cost**
Z	-2.223[b]	-2.521[b]	-2.201[b]
Asymp. Sig. (2-tailed)	.026	.012	.028

Note: a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

BIOGRAPHY

Name-Surname	Mr. Keertiman Sharma
Academic Background	Chartered Global Management Accountant (ACMA, CGMA) CIMA, UK and AICPA, US MBA Finance Dr. Ram Manohar Lohia Avadh University, India
Experience	Head of Accounting Program (2018-2020) Lecturer, Course lead - Managerial Accounting, Internal Audit and Control Department of Accounting and Finance Stamford International University, Bangkok, Thailand