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Data Envelopment Analysis of Fair Value Versus Historical Cost Accounting: An Insight into Thailand's Insurance Sector

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Abstract

In today's dynamic financial environment, several countries have harmonized their accounting standards with the International Accounting Standards Board's International Financial Reporting Standards, leading to increasing use of fair value accounting among firms. However, the practical implications of this transition, especially for the Thai insurance sector, remain under-explored. The aim of the present study was to bridge this gap by evaluating the effect of fair value versus historical cost accounting on the financial statement analysis. Data Envelopment Analysis (DEA) constant-returns-to-scale and Malmquist DEA models were used to examine Thai insurance companies from financial years 2015 to 2019. The objectives included assessing the change in value of financial items on restatement from historical cost to fair value, evaluating the ensuing changes on the efficiency of firms, and benchmarking the firms for comparative performance evaluation. The findings obtained suggest statistically significant differences in many financial items on restatement, along with noticeable changes in firms' efficiency scores and overall rankings. The study underscores the theoretical debate between fair value and historical cost, and suggests that fair value can be used to complement historical cost.

Keywords: *Data envelopment analysis, historical cost, fair value*

Introduction

Historical cost (HC) is most commonly used to prepare financial statements. It is rooted in the conservatism principle that records the actual cost of a financial item. Although, in line with accounting standards, HC requires some adjustment with time such as charging depreciation in each accounting period for long term assets. The basis of Historical Cost Accounting (HCA) requires that most liabilities and assets are measured and reported at their historical prices (Rahmawati, 2006). For the purpose of accounting, fair value is an exit price and not the entry price, and has emerged as a response to dynamic financial environments. Fair Value Accounting (FVA) is based on using current market values to recognize certain assets and liabilities (Chea, 2011). It is the price that would be received on selling an asset or paid to transfer a liability between market participants at the measurement date, or an estimated value when it is difficult to determine the current price (IFRS Foundation, 2023).

The primary difference between HCA and FVA is that while the former relies on the historical price, the latter values assets and liabilities at their current market prices. Another typical difference between historical cost and fair value is that financial statements in the former are updated, but these updates are less frequent than for fair value items. In Thailand, FVA is used for measuring investment assets like available-for-sale investments and trading investments. In line with industry practices, Thai financial companies have adopted global accounting practices and disclose investments, like held-to-maturity investments and general investments, at fair value in the notes to financial statements, although these investments are recognized in financial statements at their amortised/historical cost. This statement is based on the author's analysis of annual reports of firms, and is also mentioned in a study by Swatdikun and Ungphakorn (2018).

The use of FVA is increasing in several countries since the International Financial Reporting Standards (IFRS) issued by the International Accounting Standards Board (IASB) has emphasized it.

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Barth (1994) mentioned that fair value estimates of investment securities provided more explanatory power than historical cost. Explanatory power refers to the extent of positive relationship of valuation basis (either fair value or historical cost) with the market capitalization and profitability of a firm. The Securities Exchange Commission, Thailand (SEC), in co-operation with the Thai Federation of Accounting Professions (TFAC), have gradually revised the Thai Financial Reporting Standards (TFRS) and harmonized them with IFRS issued by IASB (Buachoom, 2022). These organizations have mandated the use of FVA for assets and liabilities in Thai listed firms, and in some cases, disclosure of the fair value of financial items such as held-to-maturity securities in notes to the financial statements.

The IASB officially introduced fair value reporting as an alternative approach to HCA in the 1970s (Shanklin et al., 2011). The practical implications of this transition, especially for the Thai insurance sector, remain underexplored. In this study, the aim was to help determine whether FVA has advantages over HCA for stakeholders in understanding financial statements by evaluating the effect of these two methods on financial statement analysis. This study involved Thai insurance companies and used the Data Envelopment Analysis (DEA) model to analyze financial statements based on the two valuation bases. Since Thai insurance companies have a considerable proportion of financial investments, the analysis potentially could reveal differences between their fair values and historical cost values. Therefore by contrasting these approaches, the present study will potentially provide insights into the firms' performance and efficiency. Using the DEA model, Sharma (2018) investigated whether a change from HC to FV affected financial statement analysis. However, the study was limited in scope, had only a few different financial items, and did not use the Malmquist DEA model.

The study reported here aimed to provide a deeper understanding of the two accounting valuation methods on the efficiency and financial performance of insurance firms. Readers should gain deeper insights into the implications of adopting FVA in the Thai insurance sector. This has the potential to benefit the industry, accounting professionals, investors, and others.

The objectives of this study were as follows:

1. Assess the change, if any, in financial statement items of Thai financial companies when the basis is changed from HC to FVA.

2. Evaluate whether a firm's efficiency improves on account of changing from an HC to a FVA reporting system, what impact this has on users, and whether the firm repositions itself as a result.

3. Examine the potential impact of fair value accounting on the efficiency and financial performance of Thai insurance companies.

4. Benchmark the firms and compare the less efficient firms with the benchmark, which may lead to improvement in their future efficiency.

This research differs in that it analyzes comprehensive financial information of Thai insurance firms for the financial years from 2015 to 2019, has a broader scope as it uses both data envelopment analysis (DEA) and Malmquist data envelopment analysis (M DEA), and uses appropriate input variables and output variable suitable to the objectives of this study.

Literature Review

Fair Value versus Historical Cost Accounting

Historical cost basis means that the accounting information is based on actual cost. Rahmawati (2006) stated that although HCA has weaknesses, its benefits outweigh its limitations, as it still retains explanatory power for investors. Chea (2011) mentioned that in FVA, the values of assets and liabilities are determined and recognized from prices offered in an active market where a large number of transactions take place between independent and unrelated parties.

The relevance of HCA has been a subject of debate particularly in the last two to three decades. Accounting bodies globally have been steadily shifting towards the use and requirement of FVA in preparing financial statements. FVA is more reliable and useful to the users when financial markets are stable (Menicucci & Paolucci, 2017). According to Rodríguez-Pérez et al. (2011), FVA indicates a

strong relationship with stock market indicators and provides value relevant information to users as compared to HCA. The above study involved eighty-five insurance companies, and a few firms reported efficiency changes on restatement from HCA to FVA. DEA scores were used to indicate efficiency of firms.

Palea (2014) suggested that financial statements should be prepared based on both valuation bases to provide comprehensive and useful information to stakeholders. Fahnestock and Bostwick (2011) studied how FVA was interpreted by stakeholders. While some critics placed the blame on FVA for the US financial crisis in 2008, Fahnestock and Bostwick (2011) suggested that it was due to the fact that accountants, auditors, analysts, and investors were under-educated or uneducated in understanding the value and implications of FVA. Investors normally believe FVA is more relevant than HCA (Landsman, 2007; Barth et al., 2001). From the discussion, it can be construed that FVA provides relevant information, is more useful during financial market stability, and is more appropriate for investment properties and available-for-sale securities as it reflects current market conditions. However, it has earnings volatility and requires estimation of financial items when markets are not active. On the other hand, the use of HCA is beneficial when consistency and reliability of financial information is preferred, and for certain assets whose market prices are not readily available. Its limitations include lack of relevant information, along with failure to consider current financial realities and future potential cash flows.

Very few studies, especially within the insurance sector, have been done in Thailand to evaluate the effect of fair value versus historical cost basis on financial statement analysis. Sharma (2018) addressed this issue and concluded that there are changes in the values of financial items on restatement. He suggested that although the efficiency scores of some Thai insurance firms obtained from DEA may change, the efficiency relative to each other (ranking) did not change. Buachoom (2022) suggested that investors in Thai stock market trust the use of publicized efficient information provided by FVA and corporate governance practices to make investment decisions. Buachoom concluded that FVA and corporate governance practices provide relevant and reliable information to investors and stakeholders for determining a firm's value, i.e., its stock price.

Use of Data Envelopment Analysis (DEA) in Financial Statement Analysis

DEA is a relatively recently developed method that can be used in Financial Statement Analysis. It was first introduced by Charnes et al. (1978). DEA was based on the work of Farrell (1957), and Banker et al. (1984) further developed it. It can be used to measure the relative performance of decision-making units (DMUs) or firms. Such DMUs may be different and comparable units, departments within an organization, or they could be different firms in various sectors. This approach measures the relative efficiency of DMUs by generating an overall score based on input and output variables, and compares DMUs with best-in-class observations. It is a non-parametric linear programming method that has been considered a balanced benchmarking method (Sherman & Zhu, 2013), and a reliable method to know the operational efficiency of a firm (Feroz et al., 2003). Feroz and colleagues concluded that DEA can be used to complement financial statement analysis, and may provide additional insights into the efficiency and performance of an enterprise. It can help to identify inefficient firms and the extent to which they may increase their output (like revenues) or decrease their inputs (like expenses) to enhance efficiency and reach the efficient frontier.

The DEA models can be of various types such as the Variable Returns-to-Scale model, Constant Returns-to-Scale (CRS) model, and Malmquist DEA index. Malmquist DEA represents the total factor productivity growth over time by comparing the productivity change of decision making units. It provides insights into the degree of efficiency and productivity growth (Lee et al., 2011). Productivity change can be decomposed into two components, efficiency change and technical change. This model can be used in facilitating the decisions taken by managers and investors.

There are advantages of using DEA in financial statement analysis. DEA can include multiple inputs and outputs to determine an overall score or ranking of DMUs. It enables data sets to be

analyzed and the results to be computed precisely. Moreover, it does not categorically require specifying the mathematical structure of production functions.

The most important issue in DEA is to be able to use the right input and output variables for determining a firm's efficiency in that industry (Yeh, 1996). The selected input variables are total expenses, available-for-sale investments, held-to-maturity investments, and other general investments (net). The selected output variable is total comprehensive income. Expenses are incurred to generate total comprehensive income, and therefore expenses have been chosen as one of the inputs. Available-for-sale investments, held-to-maturity investments, and general investments (net) form a substantial portion of the total assets of an insurance firm, and help to increase its total income. The choice of input variables and output variable is influenced by the literature on DEA applications for financial statement analysis. Beyond the researcher's selection, these variables are also informed by the literature reviews of scholars such as Rodríguez-Pérez et al. (2011), Kaffash and Marra (2017), Novickytė and Droždz (2018), Sharma (2018), and Zhu et al. (2020).

Research Hypotheses

Based on the research objectives and literature review, in this paper changes, if any, will be assessed in financial statement items of Thai insurance companies when they are restated from an HC to a FV basis. Evaluation of the efficiency of changes made by a firm on restatement will be assessed, and whether this leads users to position a firm differently from its competitors.

H_1: There are significant changes in the value of financial items when the financial statements of Thai insurance companies are restated on a fair value basis.

H_2: There are different conclusions drawn from financial statements analysis using DEA when fair value accounting is used instead of the historical basis.

$H_{2.1}$: There are changes in efficiency scores of Thai insurance companies when the valuation basis is changed from historical cost to fair value.

$H_{2.2}$: There are changes in ranking based on the efficiency scores obtained for Thai insurance companies when the valuation basis is changed from historical cost to fair value.

Research Methodology

Sample and Data Collection

Financial information was taken from the financial statements and annual reports of 15 Thai insurance companies. Financial information for five financial years from 2015 to 2019 was obtained. This sector was chosen since it has a high proportion of financial investments. Better evaluation of the two valuation methods, fair value and historical cost, will aid in financial statement analysis. Another reason for selecting this sector was that it contributes substantially to the Thai economy. In 2019, the financial sector contributed approximately THB 1.27 trillion to the GDP of Thailand. Furthermore, adoption of IFRS in Thailand has had a pronounced effect on the Thai insurance sector because of its significant financial investments. However, there has been a notable gap in academic literature exploring the interplay of FVA and HCA within this context.

The efficiency and performance of financial sector organizations has been studied by a number of researchers (Zhu et al., 2020, Sharif et al., 2019, Novickytė & Droždz, 2018, Kao & Liu, 2014, Sturm & Williams, 2004). Their motivation was that this sector was important to the economic development of a nation, and few studies have been done to investigate whether efficiency gains followed from using the DEA method. The present study contributes to research in this field by evaluating the Thai insurance sector.

Research instruments used included the LSEG Refinitive Eikon financial platform, official websites of insurers, settrade.com, and websites of the Securities Exchange of Thailand (SEC) and the Stock Exchange of Thailand (SET). Financial information and access to the annual reports of firms were gained from these sources. Financial statements and notes to the financial statements were accessed to get the fair values or historical cost of financial items.

The acronyms in capital letters of these firms mentioned below refer to their stock symbol or ticker, and these symbols will be frequently used in this study. The list of these companies is as follows: AYUD—Allianz Ayudhya Capital, BKI—Bangkok Insurance, BLA—Bangkok Life Assurance, BUI—Bangkok Union Insurance, CHARAN—Charan Insurance, TIPH—Dhipaya insurance, INSURE—Indara Insurance, Krung-AXA*—Krungthai-AXA*, KWI—KWI, MTI—Muang Thai Insurance, NSI—Nam Seng Insurance, SMK—Syn Mun Kong Insurance, TSI—Thai Setakij Insurance, TVI—Thaivivat Insurance, and NKI—The Navakij Insurance.

Statistical Methods Employed

The statistical methods and analyses used in the study were as follows:

1. Descriptive statistics were used. Skewness and kurtosis were computed, and the Kolmogorov–Smirnov test was performed to determine whether the data sets were normally distributed or not. To study hypothesis H_1, fair values of financial items were determined and compared with the historical cost of these financial items. To test whether there was a significant change on restatement, the Wilcoxon signed-rank test was performed after determining whether the data met the assumptions for parametric tests or not.

2. Efficiency and profitability were focused upon in determining the financial items to be used as input and output variables for the purpose of DEA analysis. Variables such as total comprehensive income, total expenses, and the historical cost and fair value of available-for-sale, and held-to-maturity and other general investments were used. Separate DEA scores were calculated for each valuation basis of these financial items.

To evaluate hypothesis $H_{2.1}$, the two-sets of DEA scores (historical cost and fair value valuation) were compared to measure any changes in the efficiency scores. To examine hypothesis $H_{2.2}$, the insurance companies were ranked separately based on DEA scores obtained for the two valuation bases, to evaluate whether there were any changes in their ranking. The Wilcoxon signed-rank test, a simple ranking method, and Malmquist DEA were employed to test hypothesis H_2.

Data Analysis

The input variables used in this study were total expenses, available-for-sale investments, held-to-maturity investments, and other general investments (net). The output variable was total comprehensive income. The variable “total expenses (EXP)” included gross claim less claim recovered from reinsurers, commissions and brokerage, other underwriting expenses, and operating expenses. Other general investments (net) indicate investments in non-listed equity securities net of allowance for impairment (if any).

Several reasons for the choice of these variables will be mentioned. Total expenses, available-for-sale investments (AFS), held-to-maturity investments (HTM) and other general investments (net) (OT) (as inputs) help to generate income (total comprehensive income as output) for an organization. Another reason is that investments like AFS, HTM, and OT not only form a major portion of an insurance company, but they also have their historical cost and fair values available. The variables also were chosen based on expert opinion mentioned in the literature review (e.g., Zhu et al., 2020, Novickytė & Droždz, 2018, Kaffash & Marra, 2017, Rodríguez-Pérez et al., 2011).

The DEA software (DEAP version 2.1) and IBM SPSS Version 29 were used in data analysis and hypothesis testing. To determine technical efficiency, DEAP version 2.1 was used. Statistical measures were analyzed using the Kolmogorov–Smirnov (KS) test and IBM SPSS Version 29.

An output-oriented approach and constant returns-to-scale (CRS) DEA model has been assumed in this research. The reason for choosing the DEA CRS model was that it can be applied to an industry that is competitive. The financial sector in Thailand is competitive. The CRS approach assumes that efficiency of a DMU is not affected by the scale of operations. An output-oriented, as well as an input-oriented model, of CRS provides the same results, and so an output-oriented model was randomly chosen. The DEA CRS is a simple model for assessing the relative efficiency of firms. It assumes that there is a constant returns-to-scale over multiple stages in a production process.

As discussed below, the data were not normally distributed. Therefore, non-parametric methods such as data envelopment analysis (DEA) and non-parametric tests such as the Wilcoxon signed-rank test were employed. The primary function of DEA in this study was to measure efficiency scores and rankings to provide a comparative framework for assessing Thai insurance firms' performance under different valuation bases. The Wilcoxon signed-rank test, suitable for paired data sets, addressed hypothesis H_1 by identifying significant changes in values of financial items. For hypotheses $H_{2.1}$ and $H_{2.2}$, a simple ranking method and Malmquist DEA were utilized. Since the sample involved Thai insurance firms dealing in all aspects of Thai life and general insurance firms (excluding insurance brokers and reinsurance firms), these statistical methods were appropriate for the study. Consequently, traditional confidence intervals, which express uncertainty due to sampling variability, may not be applicable in this context.

Results and Discussion

Financial information and Descriptive Statistics

Krungthai-AXA Life Insurance and its symbol has been marked with the * symbol in this study. This is so because although it is a Public Company Limited (PCL), it is not a publicly traded company yet. Due to this reason, it does not have a firm ticker yet, and so this firm has been arbitrarily represented with the symbol Krung-AXA* in this study. This firm has been included for financial statement analysis to provide holistic assessment by incorporating more firms.

In the discussion and tables below, total comprehensive income is represented by TCI, total expenses are represented by EXP, available-for-sale investments–historical cost is represented by AFS–HC, available-for-sale investments–fair value as AFS–FV, held-to-maturity investments–historical cost as HTM–HC, held-to-maturity investments–fair value as HTM–FV, other investments–cost as OT–HC, and other investments–fair value as OT–FV. HC refers to historical cost, and FV refers to the fair value of financial items.

Financial information was obtained for all insurance companies from 2015 to 2019. Most of them earned profits (TCI) for financial years 2015 to 2017. However, a few firms in 2018 and 2019 suffered losses. TSI suffered losses in each financial year from 2016 to 2019. It can be seen that most firms like BLA and Krung-AXA* had high investments in AFS and HTM in all years. Some firms like BKI had large differences in the values of AFS–HC and AFS–FV, while a few firms like AYUD showed relatively less differences in the values of AFS–HC and AFS–FV. Similarly, some firms had large differences in HTM–HC and HTM–FV, as well as in OT–HC and OT–FV, while some had less. For example, BLA's HC and FV difference in HTM value was large, while for BUI, this difference was small in all years. OT investments made by most of the firms were comparatively small.

Descriptive statistics pertaining to financial information is given for 2019 in Table 1. Descriptive statistics for all financial years from 2015 to 2019 had the same variables and the analysis produced almost similar results (results not shown), especially with regard to determining the normality or non-normality of data sets.

Table 1 *Descriptive Statistics of Thai Insurer Variables for Financial Year 2019 (Figures in '000 THB)*

Desc. Statistics	TCI	EXP	AFS–HC	AFS–FV	HTM–HC	HTM–FV	OT–HC	OT–FV
Mean	2782839	11101647	25808210	30680659	17485168	20277490	119996	347354
Median	90034	3751398	5524344	5908722	716363.00	1956697.00	3721	31338
Std. Deviation	7180840	18859848	66778654	76627309	56175150	66528990	268380	873322
Skewness	3.294	2.435	3.483	3.451	3.836	3.847	2.344	3.622
Kurtosis	11.640	5.570	12.535	12.385	14.794	14.855	4.235	13.546
Minimum	-2361688	46227	102258	101797	1284	1284	341	562
Maximum	27468358	66703979	258725389	297329292	219980163	260293865	820038	3440555
Kolmogorov-Smirnov (Sig.)	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001

The descriptive statistics for all financial years from 2015 to 2019 were calculated including financial items based on fair value and historical cost. The standard deviation of all the variables was high, which means that there was high variability in all data sets. Maximum and minimum values encompassed a large range for all variables. Skewness and kurtosis for the different variables indicated non-normality of data sets. The Kolmogorov-Smirnov *p*-values (asymptotic significance) < .001 were obtained for all the variables in all the years. Since all the values were close to zero, this suggested that the data was not normally distributed. Thus, non-parametric methods were used for undertaking the financial statement analysis.

DEA Analysis

Firm efficiency refers to how best an organization uses its inputs or resources to produce output(s). The DEA (multi-stage) constant returns-to-scale (CRS) analysis, as used by Charnes et al. (1978), was performed for all financial years to determine the efficiency and performance of firms.

Fair value based DEA scores were compared and evaluated with historical cost DEA scores. In Table 2 below, technical efficiency (TE) scores obtained for all financial years based on historical cost (HC) and fair value (FV) of financial items are shown.

Table 2 *Technical Efficiency Scores Based on Fair Value vs Historical Cost Data Envelopment Analysis*

Ticker	2015			2016			2017			2018			2019		
	HC	FV	Δ	HC	FV	Δ	HC	FV	Δ	HC	FV	Δ	HC	FV	Δ
AYUD	1	1	0	1	.686	.314	1	1	0	0	0	0	1	1	0
BKI	1	1	0	0	0	0	.230	.156	.074	.661	.661	0	0	0	0
BLA	.345	.717	-.372	1	.397	.603	.529	.412	.117	.169	.169	0	.223	.545	-.322
BUI	.282	.204	.078	.431	.163	.268	.580	.484	.096	.260	.226	.034	0	0	0
CHARAN	.689	.306	.383	1	.441	.559	.619	.269	.35	0	0	0	0	0	0
TIPH	.209	.404	-.195	1	.566	.434	.501	.495	.006	.765	.765	0	.208	.212	-.004
INSURE	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0
Krung-AXA*	1	1	0	.955	.081	.874	.253	.246	.007	0	0	0	1	1	0
KWI	0	0	0	1	1	0	1	1	0	1	1	0	0	0	0
MTI	.452	.727	-.275	.786	.387	.399	.280	.265	.015	.113	.113	0	.064	.089	-.025
NSI	.522	1	-.478	.691	.664	.027	.778	.752	.026	.565	.596	-.031	.103	.111	-.008
SMK	.542	.352	.190	1	.819	.181	1	.529	.471	.744	.743	.001	.155	.175	-.02
TSI	.294	.673	-.379	0	0	0	0	0	0	0	0	0	0	0	0
TVI	.046	.027	.019	.174	.043	.131	.154	.123	.031	.228	.216	.012	1	1	0
NKI	0	0	0	.297	.101	.196	.099	.089	.01	0	0	0	.005	.006	-.001
Mean	.492	.561	-.069	.689	.423	.266	.535	.455	.08	.300	.299	.001	.251	.276	-.025

The symbol Δ represents the difference between HC and FV for each respective year. In the context of DEA, a TE score of one indicates the highest relative efficiency, while a score of zero signifies the lowest relative efficiency. The presence of zero values in the dataset reflects instances where certain firms consistently performed as least efficient in comparison to the reference firm (firm(s) with a TE score of one).

It is clear from Table 2 that for some companies, their HC and FV based DEA scores were the same for a particular year, but for many companies, they were different. For example, Allianz Ayudhya Capital's HC and FV based scores were the same for financial years 2015, 2017, 2018, and 2019. Bangkok Life Assurance's HC and FV based scores were different for all years except 2017.

In accordance with the research objectives, the DEA analysis presented in Table 2 reveals the changes in efficiency scores on restatement and the potential impact of FVA on firm efficiency. The firms with a score of one had the highest relative efficiency and served as a benchmark, while the firms with scores of below one may need to improve their future efficiency.

Research hypothesis H_1 stated that: There are significant changes in the value of financial items when the financial statements of Thai insurance companies are restated at fair value basis. From the financial information obtained, it can be seen that the fair values of financial items (variables) are not the same as that of the historical cost. These changes are for many of the financial items under study (if not all), for most of the insurance companies, and in most of the years. In other words, the numbers changed, but the extent of this change varied significantly between the insurance companies, the years, and the type of assets.

For instance in 2015, AYUD's values of financial items based on historical cost were different from that of their fair value. Its AFS–HC was THB 2,889,471 while its AFS–FV was THB 2,745,336. In a similar way, BLA's historical cost values were different from its fair values in 2015. However, its OT–C and OT–FV were the same at THB 46,662. In 2019, there was a significant change in BKI's AFS–HC and AFS–FV values. The former was THB 11,523,505, and the latter was THB 33,010,708. However, its HTM–HC and HTM-FV were the same in that financial year at THB 11,220,681. Furthermore, an analysis of the financial information for 2019 reflected that FV of financial items were generally higher than their respective HC. For instance, the mean and median of all variables, such as AFS, HTM, and OT were higher than their HC. This was also the case with the variables from years 2015 to 2018.

The results indicate that hypothesis H_1 can be accepted for many of the financial items, but not for all of them. From 2015 to 2019, changes were observed in AFS values on restating from HC to FV for most insurance firms: 13 firms in 2015, 14 firms in 2016, 13 firms in 2017, 14 firms in 2018, and 14 firms in 2019. The restatement also affected HTM and OT values, with changes observed in 11 and 10 firms respectively in 2015, 9 and 8 firms in 2016, 10 and 8 firms in 2017, 11 and 9 firms in 2018, and 11 and 10 firms in 2019. Given these observations, hypothesis H_1 can be partially accepted.

Furthermore, in order to test whether there were significant changes on restatement or not, the Wilcoxon signed-rank test was performed. The results for year 2015 are shown in Table 3.

Table 3 *Wilcoxon Signed Ranks Test*

Test Statistics[a]			
	Available-for-sale Investments (Fair Value) and Available-for-sale Investments (Historical Cost)	Held-to-maturity–Investments (Fair Value) and Held-to-maturity Investments (Historical Cost)	Other Investments (Fair Value) and Other Investments (Historical Cost)
Z-value	-1.293[b]	-2.756[b]	-2.803[b]
Asymp. Sig. (2-tailed)	.196	.006	.005
a. Wilcoxon Signed Ranks Test			
b. Based on negative ranks.			

In the above Table, the available-for-sale investments (fair value) to available-for-sale investments (historical cost) Z-value was -1.293, and the *p*-value > .05. This suggests that the difference between fair value and historical cost of these investments cannot be regarded as statistically significant.

The held-to-maturity investments (fair value) to held-to-maturity investments (historical cost) Z-value was -2.756, and the *p*-value was .006. Hence, the difference between fair value and historical cost of held-to-maturity investments was statistically significant. Other Investments (fair value) to other investments (historical cost) Z-value was -2.803, and the *p*-value was .005. The difference between fair value and historical cost of other investments was statistically significant.

Similarly, the Wilcoxon signed-rank test was performed on variables for the 2016 to 2019 financial years. Other investments (fair value) to other investments (historical cost) *p*-values were < .05 in all financial years indicating that there was a statistically significant difference between their

fair value and cost. In all the years, held-to-maturity investments (fair value) to held-to-maturity investments (historical cost) *p*-values were also < .05, suggesting a statistically significant difference between their fair value and historical cost, except in the 2018 financial year. However, in all the years for available-for-sale securities, the *p*-value was > .05, which indicated that the difference was not statistically significant, except in the year 2017. Therefore, hypothesis H_1 was reinforced and can be partially accepted, that is: There are significant changes in the value of financial items when the financial statements of Thai insurance companies are restated at fair value basis.

Rodríguez-Pérez et al. (2011) mentioned that the values of financial items changed on restatement from historical cost to fair values. This represents the results obtained in the present findings. The extent of this change varied among classes of assets and from company to company. The results are also supported by the findings of Ghafeer and Abdul-Rahman (2014), who suggested that financial numbers on the face of income statements change on restatement, but the degree of change may vary between the two valuations. Sharma (2018) also concluded that there are changes in numbers when financial items are restated on the FV basis.

It can be surmised from Table 2 that the efficiency scores of several Thai insurance companies changed when the valuation basis changed from historical cost to fair value. However, not all the insurers' efficiency scores changed on restatement in all the years under study.

For instance, SMK's TE scores changed in all financial years when the valuation basis changed from historical cost to fair value. TIPH scores also changed in all years except 2018, when the TE score was the same (.765) for FV as for HC. Charan's scores were different, except in the 2018 and 2019 financial years, when FV and HC based TE scores were the same at zero.

The results partially supported hypothesis $H_{2.1}$: There are changes in efficiency scores of Thai insurance companies when they change the valuation basis from historical cost to fair value. Also for most insurers, if relative efficiency is the same (and does not change) for both valuation bases in a particular financial year, such insurers will most likely have a TE score of one or zero.

The findings of this study partially validate the prior research done by Rodríguez-Pérez et al. (2011) for Spanish insurance companies, and Sharma (2018) for Thai insurance companies. The authors suggested that when the firms change from the fair value to historical cost basis, the efficiency may change for few companies, but not all.

For testing hypothesis $H_{2.2}$ (i.e., There are changes in ranking based on the efficiency scores obtained for the Thai insurance companies when they change valuation basis from historical cost to fair value), the rankings of firms based on their overall TE scores for all financial years from 2015 to 2019 (mean of TEs HC and TEs FV basis) were considered.

Table 4 *Firm Rankings Based on Historical Cost (HC) TE Versus Fair Value (FV) TE*

Overall ranking	Ticker	Mean of TEs (HC)
1	AYUD	.800
2	SMK	.688
3	Krung-AXA*	.642
4	INSURE	.600
4	KWI	.600
6	TIPH	.537
7	NSI	.532
8	CHARAN	.462
9	BLA	.453
10	BKI	.379
11	MTI	.339
12	TVI	.320
13	BUI	.311
14	NKI	.080
15	TSI	.059

Overall ranking	Ticker	Mean of TEs (FV)
1	AYUD	.737
2	NSI	.625
3	INSURE	.600
3	KWI	.600
5	SMK	.524
6	TIPH	.488
7	Krung-AXA*	.465
8	BLA	.448
9	BKI	.363
10	MTI	.316
11	TVI	.282
12	BUI	.215
13	CHARAN	.203
14	TSI	.135
15	NKI	.039

Based on mean (average) efficiency scores, the overall ranking of the insurance companies changed on restatement from an historical cost to a fair value basis. For example, NSI ranked 7th on the HC basis, but it was ranked 2nd on the FV basis. CHARAN was ranked 8th on the HC basis, but was ranked 13th on the FV basis. However, for both valuation bases, AYUD retained the top slot.

Based on overall ranking, the results support $H_{2.2}$, as the overall ranking changes on restatement from historical cost to fair value basis. Overall, they validated H_2: There are different conclusions drawn from financial statement analysis using DEA when fair value accounting is used instead of the historical basis.

The study partially validated the findings of Rodríguez-Pérez et al. (2011). These authors suggested that the overall ranking of profitability and efficiency for the majority of firms did not change on restatement, except for a few. The reason for this partial validation could be attributed to factors like differences in sample sizes of insurance companies and number of years included in the panel data, variables selected, and the economic situation of Spanish financial markets, which may differ from Thai financial markets.

In addition, to provide support for the second hypothesis ($H_{2.2}$ and $H_{2.1}$), the Malmquist DEA (M DEA) was conducted. The M DEA analysis provides overall ranking of the changes in efficiency among firms. There were minor changes in the ranking based on GM (geometric mean) efficiency change (EC). For example, TIPH was ranked 4th based on HC, but it was ranked 5th based on FV. MTI was ranked 8th on the EC HC list, while it had a ranking of 7th on the EC FV list. It is understood here that mean efficiency change is the geometric mean of efficiency change from one year to another. This means that EC is computed by comparing the TE of one year with that of the previous year (like 2016 TE with 2015 TE, 2017 TE with 2016 TE, and so on), and then the geometric mean is calculated for all the 4 ECs obtained. On the basis of this analysis, the idea is reinforced that since efficiency changes obtained from M DEA are distinct when the firms are restated on a FV basis, there would have been a change in efficiency scores in at least some of the firms, and changes in overall rankings based on efficiency scores. Therefore, there is validation of hypothesis H_2: There are different conclusions drawn from financial statements analysis using DEA when fair value accounting is used instead of the historical basis.

The results showed differences between FV and HC of financial items, highlighting the potential implications of valuation methods on the financial statement analysis of Thai insurance firms. While some studies done globally have explored the valuation bases in different sectors, very few studies have delved into the Thai insurance sector. These findings provide empirical evidence demonstrating how the choice of valuation basis can impact the efficiency and financial performance of Thai insurance firms. The differences in FV and HC values of variables of firms and their efficiency scores on restatement reinforce the significance of the valuation basis chosen. This is particularly important in sectors like insurance, where the firms have a significant proportion of financial instruments. It is therefore pertinent for theorists to carefully consider the choice of valuation methods when modelling the efficiency and financial performance of firms. As countries continue to adopt IFRS, this study underscores the theoretical implications of the use of fair value in financial statement analysis.

Conclusions and Recommendations

Allianz Ayudhya Capital, Nam Seng Insurance, Indara Insurance, and KWI stood out as more efficient than their peers according to DEA fair value scores. The Navakij Insurance, Thai Setakij Insurance, and Charan Insurance under-performed. From the results obtained from DEA historical cost, Allianz Ayudhya Capital, Syn Mun Kong Insurance, and Krungthai-AXA had higher efficiency scores, while Bangkok Union Insurance, The Navakij Insurance, and Thai Setakij Insurance did not perform well. Several insurance companies have the potential to enhance their efficiency. Notably, in financial years 2018 and 2019, several firms did not perform well when compared to the financial years of 2015, 2016, and 2017.

Evidence obtained from this study indicates that the value of several financial items does change for many insurance companies on restatement. The efficiency scores of several firms changed on

restatement, but not for all the firms. The overall ranking of firms also changed on restatement from historical cost basis to the fair value. When evaluated on a yearly basis, there were changes in rankings in 2015 to 2017, but on restatement, the rankings did not change in 2018 and 2019.

It may be construed that fair values lead to positioning firms differently compared with their standing when efficiency is measured on the historical cost basis. Stakeholders may therefore be better off if they also evaluate the fair values and their effects on financial items and efficiency of firms. Based on the results of this study, it is possible to determine how much additional efficiency underperforming firms need in order to reach the efficiency frontier. It may therefore help corporate managers to evaluate how they may increase output or reduce input variables to move towards the efficiency frontier. For instance, if the efficiency score (TE) of a firm is say .60 in a particular financial year, it needs to enhance its efficiency by .40 (or 1.0 minus .6) to reach the frontier. With this information, managers may be in a better position to enhance efficiency in the following year.

The strength of this study lies in that it used two models of DEA, namely DEA constant-returns-to-scale and Malmquist DEA, for the panel data of five years to analyze the efficiency, efficiency change, and rankings of the firms. It took into consideration five financial years, which thus lends more credence and scope to this research. The study provides practical insights to stakeholders like accounting standard setters, managers, investors, and financial analysts about the relevance of fair value and financial statement analysis. Investors are interested in higher returns on investments. They should also analyze the fair values of firms, as fair value based financial statement analysis may provide different results. This study does not suggest whether fair value accounting is superior to historical cost basis or not. However, in the present environment where IFRS standards issued by IASB prefer fair valuation for certain assets and liabilities, this study makes an academic contribution by indicating that the change in valuation basis not only affects the financial numbers, but also the efficiency and rankings of firms to a certain extent. This study also provides insights for accounting standard setters as to the relevance of fair value accounting vis-à-vis the historical cost basis in financial statement analysis. The analysis of financial statements based on fair values can be used to complement historical cost-based analysis, and thereby may contribute to investment and managerial decision making.

Limitations of the Study

In DEA, it is not possible to capture all the variables that affect a firm's efficiency. In future research, other input variable(s) may be considered in DEA analysis. For example, reinsurance assets can be considered as one of the input variables for insurance companies. Such assets may be considerable in terms of their value or amount for a firm. A related study may also be undertaken for other industries in the future such as banks, oil and gas, and real estate.

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