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Measuring the Efficiency of Life Insurance Companies in the ASEAN and MENA Regions: A Data Envelopment Analysis (DEA) Approach, from 2014 to 2023

BY

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Abstract

This research aims to evaluate the efficiency of life insurance companies in the ASEAN and MENA regions from 2014 to 2023 using the Data Envelopment Analysis (DEA) method. Efficiency in the insurance industry is a crucial indicator of a company's ability to manage resources optimally to generate maximum output, particularly amid global economic challenges, digital transformation, and intense competition. DEA, a non-parametric frontier technique, was chosen as it allows for the assessment of relative efficiency among Decision Making Units (DMUs) by comparing the ratio of multiple inputs and outputs. The study uses three input variables total assets, total equity, and operating expenses and one output variable, namely revenue or premium income.

The research further compares efficiency levels between the ASEAN and MENA regions and investigates the determinants influencing efficiency, including differences between conventional and Islamic insurance models. The findings reveal substantial variation in efficiency levels across firms and countries, under both Constant Return to Scale (CRS) and Variable Return to Scale (VRS) models. While some firms operate efficiently, others show signs of inefficiency, highlighting the need for resource optimization. The results provide strategic insights for regulators and industry stakeholders to improve operational efficiency and enhance the competitiveness of life insurance firms across these regions.

Keywords: *Efficiency, Life Insurance, ASEAN, MENA, DEA, CRS, VRS*

Introduction

Life insurance plays a vital role in promoting financial stability and protecting individuals from future uncertainties. In both the ASEAN and MENA regions, the life insurance sector has grown significantly, supported by economic reforms, regulatory developments, and increasing public awareness. However, this growth is accompanied by challenges, such as inefficiencies in resource utilization, competition between conventional and Islamic insurance models, and the demand for digital transformation.

This research aims to evaluate the efficiency of life insurance companies in the ASEAN and MENA regions from 2014 to 2023 using the non-parametric Data Envelopment Analysis (DEA) method. Efficiency is assessed using three input variables total assets, total equity, and operating expenses and one output variable, revenue or premium income. The DEA approach is selected due to its ability to measure relative efficiency across Decision Making Units (DMUs) without requiring assumptions about functional forms. The study applies both the Constant Return to Scale (CRS) and Variable Return to Scale (VRS) models to measure technical efficiency.

Islamic insurance (takaful) in particular has emerged as a credible alternative that adheres to principles of fairness, mutual assistance, and risk-sharing. Indonesia, as a key player in the ASEAN region, exhibits dual development in both conventional and Islamic insurance sectors. Despite the potential, industry-wide efficiency remains uneven.

Assessing operational efficiency is therefore critical to understanding how insurance companies convert inputs into desired outputs. DEA is widely used in this context due to its capability to handle multiple input-output variables and benchmark efficiency relative to best performing peers.

The findings reveal significant variation in efficiency scores among firms and across regions. Some firms consistently operate efficiently, while others show potential for improvement. Comparative analysis indicates that ASEAN

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firms generally perform better in terms of scale efficiency, whereas MENA firms demonstrate stronger technical efficiency under VRS assumptions. These insights are crucial for insurance managers and policymakers to improve resource allocation and competitiveness in a dynamic market.

Literature Review and Hypothesis

The concept of efficiency in the insurance sector has its roots in the seminal work of Farrell (1957), who introduced the measurement of productive efficiency using frontier-based methods. In the context of financial institutions, including insurance companies, efficiency reflects the ability of firms to convert limited resources (inputs) into maximum possible outcomes (outputs) using optimal processes.

Data Envelopment Analysis (DEA), as developed further by Charnes, Cooper, and Rhodes (1978), has become a widely adopted method for assessing the relative efficiency of firms, particularly when multiple input and output variables are involved. Coelli et al. (1998) later refined its applications in productivity and efficiency analysis, establishing DEA as a robust non-parametric benchmarking tool.

In the insurance industry, DEA has been employed to evaluate firms based on operational efficiency, especially when traditional ratio analysis falls short. Studies by Saad et al. (2011) and Moussawi and Obeid (2011) highlighted the efficiency disparity between conventional and Islamic insurance firms in Southeast Asia and the Gulf Cooperation Council (GCC) countries. Meanwhile, Hadad et al. (2003) applied DEA to analyze the banking sector in Indonesia, showing the versatility of this model across financial industries.

Islamic insurance (takaful) is gaining traction in Muslim-majority countries, offering an alternative model grounded in sharia principles. However, differences in capital structure, governance, and risk-sharing mechanisms may affect efficiency performance compared to conventional firms (Antonio, 2011; Mahmud, 2020).

In recent literature, various determinants of efficiency in insurance firms have been explored, including firm size, asset base, capital adequacy, and cost structure. Research by Purwanti (2016) and Mala (2015) revealed that equity and operational expenses significantly influence insurance efficiency. Moreover, Rusydiana and Nugroho (2017) emphasized the importance of input selection in DEA models to capture managerial and scale efficiencies accurately.

Despite the growing body of research, comparative efficiency analysis between ASEAN and MENA life insurers remains limited, especially over a long-term horizon. This study aims to fill this gap by analyzing ten years of data (2014 - 2023) from 131 firms, covering both conventional and Islamic models, using an output-oriented DEA approach under CRS and VRS assumptions.

Based on prior literature and the research framework, the following hypotheses are developed for empirical testing:

H1: Total Assets have a significant effect on the efficiency of life insurance companies in the ASEAN and MENA regions between 2014 to 2023.

H2: Total Equity have a significant effect on the efficiency of life insurance companies in the ASEAN and MENA regions between 2014 to 2023.

H3: Operating Expenses have a significant effect on the efficiency of life insurance companies in the ASEAN and MENA regions between 2014 to 2023.

H4: Revenue have a significant effect on the efficiency of life insurance companies in the ASEAN and MENA regions between 2014 to 2023.

H5: There is a statistically significant difference in the average efficiency of life insurance firms in ASEAN and MENA between 2014 to 2023.

These hypotheses will be tested using regression analysis and t-tests on efficiency scores derived from the DEA model.

Research Method

This study adopts a quantitative, non-parametric research design using Data Envelopment Analysis (DEA) to measure the relative efficiency of life insurance companies in the ASEAN and MENA regions over a ten-year period (2014–2023). DEA is chosen for its ability to evaluate efficiency across multiple input and output variables without the need for predefined functional forms.

The DEA approach is applied under two main models:

- CCR (Charnes, Cooper, Rhodes) model: Assumes Constant Returns to Scale (CRS)
- BCC (Banker, Charnes, Cooper) model: Assumes Variable Returns to Scale (VRS)

These models allow the analysis of both technical and scale efficiency of the Decision Making Units (DMUs), i.e., individual life insurance companies.

Population and Sample

The population includes all registered life insurance companies in ASEAN and MENA countries with accessible financial reports. The final sample consists of 131 companies over the period 2014 to 2023, selected based on:

- Availability of complete financial data
- Inclusion of both conventional and Islamic insurance firms
- Representation across key countries in each region Secondary data were obtained from:
- Bloomberg Terminal
- Annual financial statements of insurance companies
- Official publications by insurance regulators (e.g., OJK)

Variables and DEA Model Structure

The selection of these variables is consistent with previous DEA- based studies in insurance efficiency (e.g., Saad et al., 2011; Purwanti, 2016).

- Inputs:

Total Assets : representing the firm's resource base Total Equity : reflecting shareholder capital

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Operating Expenses : proxy for operational effort and cost

- Output:

Revenue or Premium Income : representing the firm's insurance business outcome

Variables and DEA Model Structure

- DEA computation: Performed using DEAP 2.1 software to generate CRS and VRS efficiency scores.
- Statistical testing: Conducted using panel regression analysis to identify significant determinants of efficiency, and Kruskal-Wallis tests to compare efficiency differences across regions and business models.

Results and Interpretation

Overview of Research Variables

This research aims to measure the efficiency levels of life insurance companies operating in the ASEAN and MENA regions over a 10-year period from 2014 to 2023. The selected regions offer diverse demographic, economic, and regulatory characteristics, which make them ideal for comparative efficiency analysis.

The method used is Data Envelopment Analysis (DEA), an input-output-based non-parametric model that measures the relative efficiency of Decision Making Units (DMUs). DEA is especially appropriate for this study as it accommodates multiple input and output variables without requiring predefined functional forms.

Normality Test Using Shapiro-Wilk

To ensure the validity of regression analyses, the Shapiro-Wilk test was applied to check for normal distribution of data. The test revealed that all variables (inputs and output), including efficiency scores under the CRS model, had p-values < 0.05, indicating a non-normal distribution.

However, this does not invalidate the analysis, as DEA and panel regression models are non-parametric or robust to deviations from normality.

Table 1. Shapiro-Wilk Test ASEAN

Variable	Obs	W	V	Z	Prob>z
Nilai DEA	10	0,82608	2,680	1,881	0,03001

Based on the results of the normality test presented in Table 1, the p-value for the average efficiency of insurance companies in the Association of Southeast Asian Nations (ASEAN) region is 0.03001. Since this value is less than the significance level (α=0.05), the null hypothesis (H₀) is rejected. This indicates that the efficiency data of insurance companies in the ASEAN region do not follow a normal distribution.

Table 2. Shapiro-Wilk Test MENA

Variable	Obs	W	V	Z	Prob>z
Nilai DEA	10	0,97863	0,329	-1,721	0,95739

Based on the results of the normality test presented in Table 1, Meanwhile, as shown in Table 2, the p-value for the efficiency data of insurance companies in the Middle East and North Africa (MENA) region is 0.95739. Since this value is greater than the significance level (α=0.05), the null hypothesis (H₀) is accepted. This indicates that the efficiency data of insurance companies in the MENA region follow a normal distribution.

Kruskal-Wallis Test

To assess whether there is a significant difference in efficiency levels between ASEAN and MENA insurance companies, a Kruskal-Wallis rank-sum test was conducted.

Table 3. Kruskal-Wallis Test

Kruskal–Wallis equality-of-populations rank test :

Region	Obs	Rank sum
ASEAN	10	117,00
MENA	10	93,00

Chi2(1) = 0,823 Chi2(1) with ties = 0,823

prob = 0,3643 prob = 0,3643

The Chi-Square (χ^2) test yielded a value of 0.823 with 1 degree of freedom (df = 1) and a p-value of 0.3643. Since the p-value is greater than the predetermined significance level (α = 0.05), the decision is to accept the null hypothesis (H₀). This indicates that there is no statistically significant difference in the efficiency levels of the insurance industry between the Association of Southeast Asian Nations (ASEAN) and the Middle East and North Africa (MENA) regions during the period 2014 to 2023.

Although the rank sum for ASEAN (117.00) is slightly higher than that of MENA (93.00), the difference is not statistically strong enough to be considered significant. This suggests that, in general, the efficiency performance of life insurance companies in both regions is relatively comparable, at least from the perspective of average efficiency scores.

Furthermore, the results indicate that the efficiency levels in both regions tend to converge, as reflected by values approaching 1. In other words, the life insurance industries in ASEAN and MENA demonstrate similar operational efficiency, and there is no strong evidence to support the existence of a significant difference between them.

Model (1): Constant Return to Scale (CRS)

$$CRS_{it} = \alpha_0 + a_1 toteq_{it} + a_2 totas_{it} + a_3 opex_{it} + a_4 rev_{it} + e_{it}$$

The Fixed Effects Model (FEM) was chosen over the Random Effects Model based on the Hausman test, implying that individual firm characteristics significantly affect efficiency scores across time.

Classical Assumption Testing:

- Multicollinearity: Tolerance and VIF values confirmed no multicollinearity.
- Heteroscedasticity: Detected; robust standard errors were applied.
- Autocorrelation: Addressed using panel-corrected standard errors (PCSE).

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Table 4. Model (1) CRS

Fixed-effects (within) regression — Number of obs = 1,310
Group variable: id — Number of groups = 131

R-squared:
Within = 0.0544
Between = 0.0046
Overall = 0.0160

Obs per group:
min = 10
avg = 10.0
max = 10

F(4,1175) = 16.90
corr(u_i, Xb) = -0.1714 — Prob > F = 0.0000

crs	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
toteq	-.0123202	.0032835	-3.75	0.000	-.0187624	-.0058781
totas	.0004941	.0005932	0.83	0.405	-.0006697	.0016579
opex	-.0117362	.006081	-1.93	0.054	-.023667	.0001945
rev	.0040192	.0015995	2.51	0.012	.0008809	.0071575
_cons	.57108	.0088651	64.42	0.000	.5536869	.5884732
sigma_u	.22004231					
sigma_e	.17990249					
rho	.59936253	(fraction of variance due to u_i)				

F test that all u_i=0: F(130, 1175) = 13.86 — Prob > F = 0.0000

Final Regression Output (CRS Model) The intercept (constant) value of 0.57108 is statistically significant ($p < 0.01$). This implies that in the absence of all independent variables, the average CRS efficiency score of life insurance firms is 57.11%.

Within R-squared: 0.0544 or 5.44% of the variation in CRS efficiency is explained by the model. F-statistic: 16.90, Prob > F = 0.0000 the independent variables jointly have a significant effect on CRS efficiency. Rho (ρ) = 0.599 around 60% of the error variance is due to firm-specific effects, validating the use of fixed effects.

The regression findings under the CRS model reveal that revenue generation is a key driver of efficiency, Equity if not strategically managed, can reduce efficiency and asset growth and operational costs must be evaluated for productivity to enhance efficiency.

These results emphasize the importance of capital efficiency, revenue management, and strategic expense allocation in improving the performance of life insurance companies in both ASEAN and MENA markets.

Model (2): Variable Return to Scale (VRS)

$$VRS_{it} = \beta_0 + \beta_1 toteq_{it} + \beta_2 totas_{it} + \beta_3 opex_{it} + \beta_4 rev_{it} + \mu_{it}$$

This section interprets the regression results of the Variable Return to Scale (VRS) model, which is designed to evaluate pure technical efficiency of life insurance companies in ASEAN and MENA from 2014 to 2023. Unlike the CRS model, VRS accounts for variable returns to scale, reflecting more realistic operational conditions in the insurance sector.

Classical Assumption Testing:

- Multicollinearity: No multicollinearity was detected, as all VIF values were below 10 and tolerance values above 0.10. This confirms that the independent variables are not highly correlated and can be reliably used in the model.
- Heteroscedasticity: Evidence of heteroscedasticity was found through diagnostic tests. To address this, robust standard errors were applied, ensuring consistent coefficient estimates and valid statistical inference.
- Autocorrelation: Some indication of autocorrelation was present due to the panel data structure. This was corrected using clustered or panel-corrected standard errors, minimizing potential bias.

The VRS model satisfies all major classical regression assumptions after adjustments, confirming the reliability and validity of the estimated results.

Table 5. Model (2) VRS

Fixed-effects (within) regression — Number of obs = 1,310
Group variable: id — Number of groups = 131

R-squared:
Within = 0.0107
Between = 0.0988
Overall = 0.0606

Obs per group:
min = 10
avg = 10.0
max = 10

F(4,1175) = 3.17
corr(u_i, Xb) = 0.1541 — Prob > F = 0.0133

vrs	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
toteq	.0057006	.0034859	1.64	0.102	-.0011388	.0125399
totas	-.0016815	.0006298	-2.67	0.008	-.0029171	-.000446
opex	.0169861	.0064559	2.63	0.009	.0043198	.0296525
rev	.0049965	.0016982	2.94	0.003	.0016647	.0083282
_cons	.6319716	.0094117	67.15	0.000	.613506	.6504372
sigma_u	.22353579					
sigma_e	.19099488					
rho	.57801982	(fraction of variance due to u_i)				

F test that all u_i=0: F(130, 1175) = 12.36 — Prob > F = 0.0000

Final Regression Output (VRS Model)

The constant value of 0.6319716 indicates that if all independent variables—total equity, total assets, operating expenses, and revenue—are assumed to be zero, the VRS efficiency score (Y) would still remain at 63.19%. This suggests the presence of a baseline level of efficiency that exists independently of the direct influence of the variables included in the model.

The model is statistically significant overall ($F = 3.17$, $p = 0.0133$). The R^2 (overall) is 6.06%, which is acceptable given the panel structure and firm heterogeneity. Firm-specific effects ($\rho = 0.578$) account for a substantial share of the error variance, justifying the use of fixed effects.

Equity has a positive but statistically insignificant effect, suggesting that internal capital levels do not directly influence technical efficiency. Total Assets exert a significant negative impact, implying that excessive or underutilized assets can reduce efficiency. Operating Expenses have a significant positive effect, indicating that productive operational spending (e.g., on technology or services) contributes to better efficiency. Revenue shows a strong positive and statistically significant effect, confirming that firms generating higher premium income tend to operate more efficiently.

The VRS model highlights the importance of revenue generation and strategic operating expenditure as key drivers of pure technical efficiency. Conversely, asset-heavy structures may hinder efficiency unless assets are fully optimized. Equity alone is not a strong predictor, suggesting that management quality and resource utilization are more critical for efficient firm operations.

Discussion

To identify the factors that influence the efficiency level of life insurance companies in the ASEAN and MENA regions during

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the 2014 to 2023 period, a panel regression analysis was conducted using the Constant Return to Scale (CRS) approach.

The CRS efficiency score reflects a firm's ability to produce the maximum possible output from a given set of inputs or to use the minimum amount of inputs to achieve a specific level of output, assuming constant returns to scale. This model allows for measuring overall technical efficiency, which captures both managerial performance and scale efficiency.

The regression analysis used a fixed effects model (FEM) based on panel data, accounting for firm-level heterogeneity over time. The model estimates the relationship between CRS efficiency scores and four explanatory variables: total equity (toteq), total assets (totas), operating expenses (opex), and revenue (rev). The model equation is as follows:

The Effect of Total Equity on CRS

Total Equity (toteq) has a statistically significant negative effect on efficiency (coefficient = -0.01232, $p < 0.01$). This suggests that an increase in equity does not always translate into better efficiency. Firms may not be utilizing their capital productively.

The Effect of Total Assets on CRS

Total Assets (totas) have a positive but statistically insignificant impact ($p = 0.405$), indicating that asset accumulation alone does not guarantee efficiency improvements unless effectively managed.

The Effect of Revenue on CRS

Operating Expenses (opex) show a negative marginal effect, but it is not statistically significant at the 5% level ($p = 0.054$). This implies that while higher costs generally indicate inefficiency, not all operational expenses are necessarily unproductive. Some may contribute to long-term productivity.

The Effect of Operating Expenses on CRS

Revenue (rev) exhibits a positive and statistically significant impact on efficiency (coefficient = 0.00402, $p < 0.05$). This aligns with economic theory, where increased revenue, particularly from premiums, enhances efficiency through scale economies and better resource utilization.

The within R-squared value is 0.0544, suggesting that about 5.44% of the variation in CRS efficiency can be explained by the independent variables in the model. The remainder is attributed to other factors not captured in this specification.

The CRS regression results indicate that capital efficiency (total equity) and revenue performance are the most influential variables in determining firm-level efficiency. While increasing equity alone may not enhance efficiency, increasing revenue has a consistently positive effect. These findings emphasize the importance of productive capital allocation and revenue generation strategies in driving insurance company efficiency across both regions.

This section interprets the regression coefficients of the Variable Return to Scale (VRS) model, which reflects the pure technical efficiency of life insurance companies in the ASEAN and MENA regions. Unlike the CRS model, the VRS model allows for variable returns to scale, acknowledging that output may not increase proportionally with input. This is particularly relevant in the insurance industry, where firm size and managerial capabilities can vary significantly.

The constant value of 0.632 indicates that when all independent variables are assumed to be zero, the baseline efficiency (VRS) remains at 63.2%. This suggests an underlying level of efficiency independent of the financial input variables. The model equation is as follows:

The Effect of Total Equity on VRS

While total equity has a positive effect on efficiency, it is statistically insignificant ($p = 0.102$) and coefficient 0.0057. This implies that pure technical efficiency is not directly influenced by the amount of capital available.

Smaller firms with better managerial practices can be just as efficient as larger ones under the VRS assumption.

The Effect of Total Assets on VRS

The effect is negative and statistically significant ($p = 0.008$) and coefficient: −0.00168. This indicates that increasing total assets may reduce efficiency, possibly due to underutilization or over- investment in non-productive assets. It signals that simply increasing asset size does not guarantee better resource utilization.

The Effect of Revenue on VRS

Coefficient: 0.01699, statistically significant ($p = 0.009$). This result may seem counterintuitive but suggests that well-directed operational spending such as investment in IT systems or service quality can enhance efficiency, provided the spending contributes to better performance outcomes.

The Effect of Operating Expenses on VRS

Coefficient: 0.00499, statistically significant ($p = 0.003$). This aligns with expectations that increased premium income reflects stronger market performance and better resource use, contributing positively to technical efficiency.

These R^2 values are relatively low, which is common in efficiency studies using panel data across heterogeneous firms. The rho value (0.578) indicates that around 57.8% of the total variance in the error term is due to firm-level differences, justifying the use of the fixed- effects model.

Under the VRS model, revenue and operating expenses significantly and positively influence efficiency, while total assets negatively affect it. Total equity, although positively signed, is not statistically significant. These findings highlight the importance of productive asset management and effective cost allocation in enhancing firm- level efficiency, especially in a diverse international insurance landscape.

Conclusion

This research examines the operational efficiency of life insurance companies in the ASEAN and MENA regions over a ten-year period (2014 - 2023), employing the non-parametric Data Envelopment Analysis (DEA) approach under both Constant Return to Scale (CRS) and Variable Return to Scale (VRS) assumptions. The analysis focuses on three key input variables total assets, total equity, and operating

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expenses and one output variable, premium revenue.

The results reveal that efficiency varies significantly across firms and countries. Under the CRS model, only a limited number of firms achieved full efficiency, suggesting that most companies still operate below optimal scale. The VRS model, however, indicates that a greater number of firms are technically efficient when scale effects are excluded, implying that inefficiencies are largely related to suboptimal firm size rather than managerial performance.

The analysis shows that there is no statistically significant difference in the efficiency levels of life insurance companies between the ASEAN and MENA regions during the study period. This suggests that, in general, the operational performance of firms in both regions is relatively comparable in terms of efficiency.

This conclusion is supported by the Kruskal-Wallis test, which was used to compare the median efficiency scores across regions. The test produced a chi-square value of 0.823 and a p-value of 0.3643, which is greater than the significance level of 0.05. Therefore, the null hypothesis stating that there is no significant difference between the groups is accepted.

A comparative analysis between the two regions demonstrates no statistically significant difference in average efficiency levels, this indicates that both ASEAN and MENA life insurance firms face similar operational dynamics and challenges.

Using Data Envelopment Analysis (DEA), the research measures both Constant Return to Scale (CRS) and Variable Return to Scale (VRS) efficiency scores, followed by panel regression analysis to identify key determinants of efficiency. Total equity negatively and significantly affects CRS efficiency, suggesting that excess capital does not always translate to better performance when not allocated productively. Revenue consistently shows a significant positive relationship with efficiency, reinforcing the importance of income generation in driving productivity. Under the VRS model, total assets negatively influence efficiency, possibly due to underutilized resources, while operating expenses if strategically allocated can positively support technical performance.

In summary, this study underscores the value of DEA as a tool to assess performance and inform strategic decisions in the insurance industry. It provides insights for regulators and insurance managers to enhance operational efficiency through better resource utilization, strategic cost management, and revenue-focused business models. The findings also highlight the need for continuous evaluation of scale efficiency and capital deployment across varying regulatory and market conditions. Although firm-level characteristics and regulatory environments may differ between ASEAN and MENA countries, their life insurance sectors exhibit similar levels of efficiency overall. This could reflect shared operational challenges and comparable maturity stages of the insurance markets across the two regions.

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