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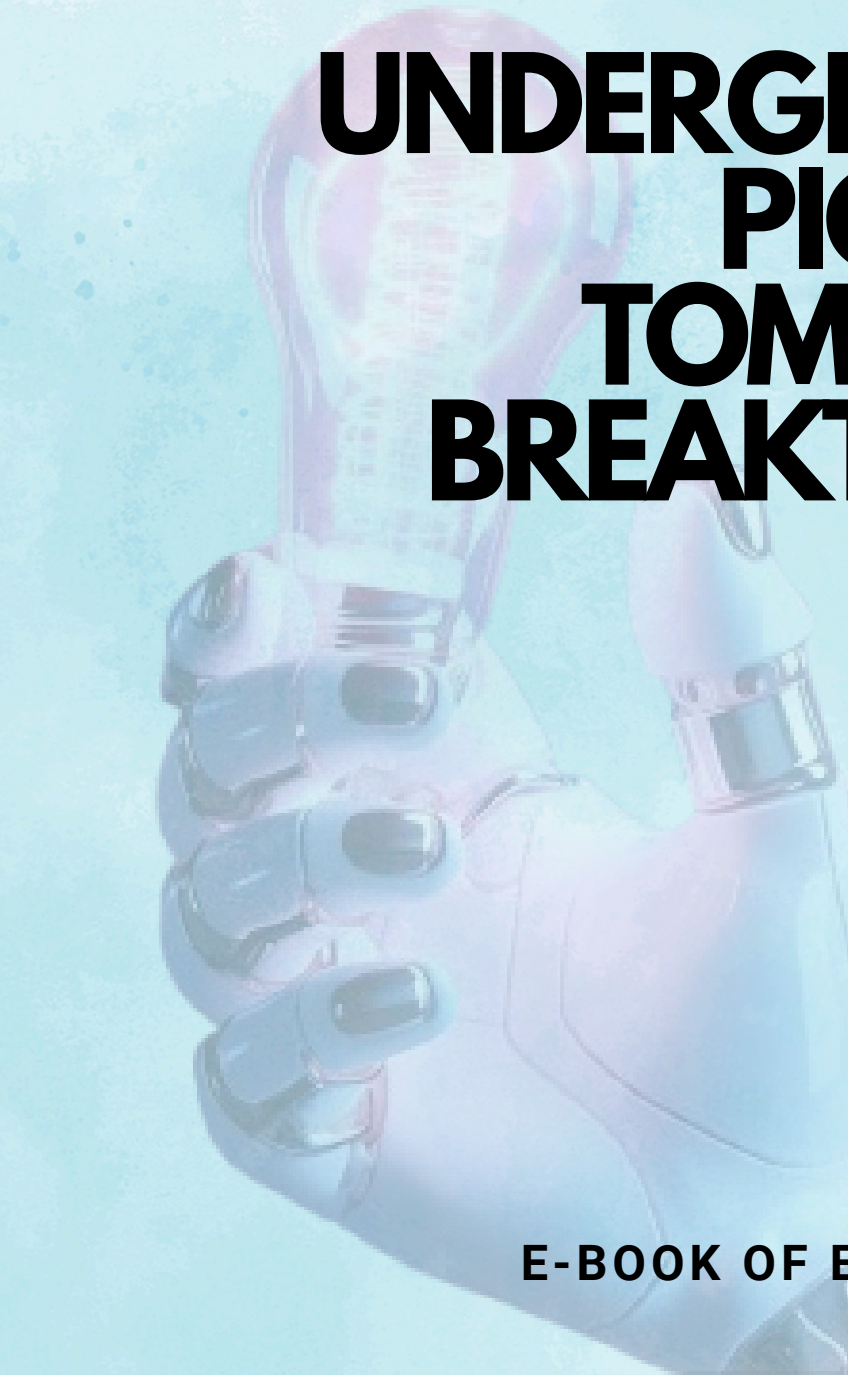

E-BOOK OF EXTENDED ABSTRACTS

PERFORMANCE EVALUATION OF BANKS IN MALAYSIA USING INTEGRATED ENTROPY-FUZZY VIKOR MODEL

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ABSTRACT

Evaluating bank performance is crucial for identifying institutional strengths and weaknesses, and for safeguarding the stability of the national economy, given the banking sector's central role in monetary affairs. While various multi-criteria decision-making (MCDM) methods have been employed for this purpose, no prior research has utilised the integrated Entropy and Fuzzy VIKOR methods to assess bank performance. This study addresses this significant methodological gap by proposing and applying this novel combination to evaluate selected Malaysian banks. To overcome challenges related to the diverse nature of financial indicators and inherent data uncertainties, a comprehensive set of liquidity and profitability ratios were first selected through a meta-analysis of past research. Subsequently, the integrated MCDM approach was applied in which the entropy method objectively determined criteria weights, assigning higher importance to indicators with lower entropy, while the Fuzzy VIKOR method addressed data imprecision and ranked banks based on their performance scores. A case study was conducted on nine major Malaysian banks over a five-year period, with financial data collected via the Eikon Refinitiv DataStream application. The findings reveal notable differences in bank performance, with some consistently demonstrating higher profitability and lower liquidity compared to others. Specifically, the highest-ranked banks exhibited the lowest VIKOR indices (Q_i), while the lowest-ranked banks had the highest Q_i values. This pioneering study provides insightful information for stakeholders, including investors, regulators, and bank management, facilitating more informed strategic decision-making and fostering continuous development within the Malaysian banking industry.

Keywords: Bank Performance, Entropy Method, Fuzzy VIKOR, Multi-Criteria Decision-Making, Malaysian Banks

INTRODUCTION

The banking sector has undergone significant transformations due to globalisation and technology that allowing institutions to provide good quality services without opening new physical entities (Uwuigbe & Fakile, 2012). Increasing competitive, evaluating bank performance have become essential for ensuring efficiency, productivity and profitability while minimising risks to stakeholders (Aduba, 2022). This evaluation is often conducted using profitability, liquidity and leverage such as Return on Equity (ROE), Return on Assets (ROA), Current Ratio (CR), Debt-to-Equity ratio (DER), and Debt-to-Asset ratio (DAR) (Abdel-Basset et al., 2020). Managing liquidity is essential critical, as its deficiency can negatively impact profitability and overall financial health of a bank (Hasmiana et al., 2022).

To enhance decision-making process, various Multi-Criteria Decision-Making (MCDM) methods, including BWM-TOPSIS and the Fuzzy AHP, along with integrated fuzzy-based methods have been employed (Aziz et al., 2023; Nguyen, 2021; Taylan et al., 2021). However, a notable gap in existing research is the limited application of Entropy and Fuzzy VIKOR for measuring bank performance. This study addresses this gap by proposing a novel Entropy Fuzzy VIKOR approach to evaluate Malaysian

banks. This integrated method provides a unique and powerful way to assess performance by first determining the objectives weights of financial criteria using Entropy method and then ranking the banks using the fuzzy VIKOR approach.

METHODOLOGY

This study uses a unique Entropy Fuzzy VIKOR approach to evaluate the performance of Malaysian banks. First, a decision matrix $D = [x_{ij}]$ is built with banks as alternatives (i) and financial ratios as criteria (j) (Chen et al., 2022). This matrix is then converted into a fuzzy decision matrix where (L_{ij}, M_{ij}, U_{ij}), represented by Triangular Fuzzy Number (TFN). The TFN has three values where, L_{ij}, M_{ij} and U_{ij} as low, an average and a high value respectively, which helps handle the uncertainty in the data (Shapiro & Koissi, 2017). The decision matrix is as follows:

$$D = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix}$$

The fuzzy decision matrix is normalised using the Min-max normalisation method, $D \rightarrow [0,1]$ which the value is between 0 to 1 (Rodrigues & Agra, 2022). After normalization, the fuzzy numbers are converted back into a single value through defuzzification using method of Mean-max membership as Equation (1), where $x_k = a_{ij} + b_{ij} + c_{ij}$, and n is a number of triangular fuzzy number.

$$\tilde{x}_{ij} = \frac{\sum_n^{k=1} x_k}{n} \tag{1}$$

The proportion value of alternatives under criteria n, p_{ij} as Equation (2), where $i = 1,2,\cdots,m$ and $j = 1,2,\cdots,n$.

$$p_{ij} = \frac{\tilde{x}_{ij}}{\sum_{i=1}^{m} \tilde{x}_{ij}} \tag{2}$$

The entropy value e_j for each criterion n is used to objectively determine the weight of each financial indicators where the constant of k, $k = \frac{1}{lnln\,(m)}$, ensures that the entropy values are between 0 and 1 (Lam et al. 2021) calculated using Equation (3).

$$e_j = -k \sum_{i=1}^{m} p_{ij} \cdot ln(p_{ij}) \tag{3}$$

The weight of the financial indicators, w_j, using the entropy approach as Equation (4) where $d_j = 1 - e_j$.

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

Then, $x_{ij} \times w_j$ and produce the decision matrix criterion with respect to alternatives.

$$F = \begin{bmatrix} f_{11} & \cdots & f_{1n} \\ \vdots & \ddots & \vdots \\ f_{m1} & \cdots & f_{mn} \end{bmatrix}$$

The best f_j^+ and worst f_j^- values for each criterion are determined. Next two key indices are calculated for each bank which are the utility (S_i) using Equation (4),

$$S_i = \sum_{j=1}^{n} \frac{w_j(f_j^+ - f_{ij})}{f_j^+ - f_j^-} \tag{4}$$

and Regret (R_i) using Equation (5),

$$R_i = max\left(\frac{w_j(f_j^+ - f_{ij})}{f_j^+ - f_j^-}\right) \tag{5}$$

which S_i represents the maximum group utility and R_i indicates the individual regret. Finally, the VIKOR index (Q_i) is computed. This index represents a compromise and is used to rank the banks from best to worst, where v denotes the strategy of maximum group utility weight, while $1 - v$ signifies the individual regret weight using $v = 0.5$ following Lam et al., (2021). The Q_i is as Equation (6), where $S^+ = (S_i)$, $S^- = (S_i)$, $R^+ = (R_i)$ and $R^- = (R_i)$.

$$Q_i = v\left(\frac{S_i - S^+}{S^- - S^+}\right) + (1 - v)\left(\frac{R_i - R^+}{R^- - R^+}\right) \tag{6}$$

RESULTS AND DISCUSSION

In this study, a literature was conducted to identify the most suitable financial measures for estimating a bank's performance from the period of 2019 to 2023. This led to the selecting of five key financial indicator which are ROE, ROA, DER, DAR, and CR. To achieve the research objective, the banks's performance was evaluated using an Integrated Entropy Fuzzy VIKOR model. This method reduces bias and eliminates uninformed human judgment, ensuring the final decision is based on solid inputs underlie decision-making. The final weights of each indicator are shown in Figure 1.

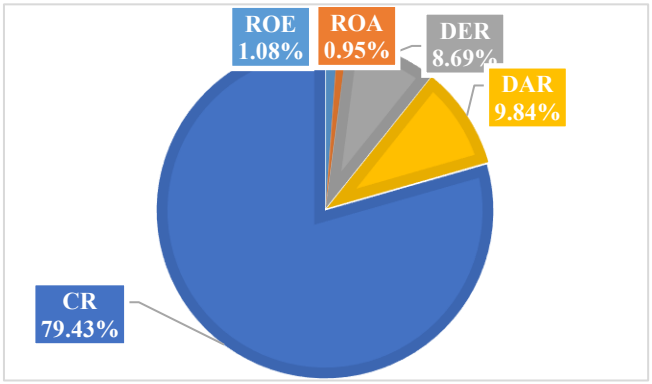

Figure 1: The Weightage of the Importance of Criteria

The analysis shows that CR holds the highest weight at 0.7943, making it the most significant factor in assessing banks' ability to manage its short-term debts and build stakeholder trust. The DAR and DER follow as the next most important criteria, with weights of 0.0984 and 0.0869 respectively. In contrast,

ROA and ROE are found to be the least influential factors, with weights of 0.0095 and 0.0108. The VIKOR index (Q_i), which derived from Utility (S_{ij}) and Regret (R_{ij}) values, is then used to rank the banks. As shown in Table 1, the bank with the smallest Q_i value is considered the closest to the ideal solution, making it the preferred choice.

Based on Table 1, Hong Leong Bank is the most preferred bank with lowest Q_i of 0.0000. Ammb Bank Holding follows with a Q_i of 0.5560, and Malayan Banking is next with 0.6577. Affin Bank Berhad has the lowest rank with a $Q_i$value of 0.9977, which suggests it has the poorest overall performance and is the farthest from the ideal bank.

Table 1 Rank and Q_iValue for Each Alternative

Banks	**Vikor indices Q_i**	**Rank**
Hong Leong Bank	0.0000	1
Bank Islam Malaysia	0.8825	5
Cimb Group Holdings	0.9353	6
Malayan Banking	0.6577	3
Public Bank	0.7319	4
Rhb Bank Bhd	0.9354	7
Affin Bank	0.9977	9
Ammb Holdings	0.5560	2
Alliance Bank Malaysia	0.9508	8

CONCLUSION

This study successfully identified and applied a set of pertinent financial measures used to gauge the performance of banks, with the current ratio (CR), the return on equity (ROE), the return on assets (ROA), debt to equity ratio (DER), and debt to asset ratio (DAR) as a few of the standards to consider. The study achieved its objectives by using the Integrating Entropy-Fuzzy VIKOR model. Objective weights were first determined using the Entropy method to eliminated bias and the fuzzy VIKOR model was then used to rank the banks based on their overall performance. The results clearly showed that Hong Leong Bank was the top-ranked bank, followed by AMMB Holdings, Malayan Banking, Public Bank, and finally Bank Islam Malaysia. The model's effectiveness was confirmed by the lower rankings of the other banks in the comparison. In conclusion, the Integrated Entropy-Fuzzy VIKOR model has proven to be a valid and effective tool for assessing and comparing the performance of Malaysian banks.

REFERENCES

Abdel-Basset, M.; Ding, W.; Mohamed, R.; Metawa, N. An integrated plithogenic MCDM approach for financial performance evaluation of manufacturing industries. Risk Manag. 2020, 22, 192–218

Chen, W., Chen, H., Wu, C., Wang, G., & Zhou, C. (2022). Invulnerability Evaluation of Complex Combat Network Based on Entropy Weight-Analytic Hierarchy Process Method. IEEE Access, 122–126. https://doi.org/10.1109/iccsnt56096.2022.9972995

Hasmiana, M., & Pintor, S. (2022). The effect of financial risk, capital structure, banking liquidity on profitability: Operational efficiency as intervening variables in Persero bank and private commercial banks. *ratio*, *5*(1).

Lam, W. S., Lam, W. H., Jaaman, S. H., & Liew, K. F. (2021). Performance evaluation of construction companies using Integrated Entropy–Fuzzy VIKOR Model. *Entropy*, *23*(3), 320. https://doi.org/10.3390/e23030320

Nguyen, T. A., Nguyen, N. A., Le, T. N., Dang, T. H., Nguyen, A. D. L., Tran, Q. B., & Nguyen, P. N.

(2023). Applying Fuzzy VIKOR algorithm in load ranking for load shedding problem in Microgrid. *IEEE Access*, 271–275. https://doi.org/10.1109/icsse58758.2023.10227249

Uwuigbe, O. R., & Fakile, A. S. (2012). The effects of board size on financial performance of banks: A study of listed banks in Nigeria. *International Journal of Economics and Finance*, 4(2). https://doi.org/10.5539/ijef.v4n2p260