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Using Z Score Model to Quantify Saudi Banks' Systematic Risk

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Abstract. The study aimed to quantify the systematic risk for Saudi banks using Z score for the period 2013-2022. The sample of the study comprised of all 10 Saudi banks registered on the Saudi capital market known as TASI. The current study used Z score model as a proxy for the systematic risk that is the inverse of the probability of insolvency as this model relies on published accounting information. Z score model used equity to total assets as a proxy for the financial solvency, return on assets as a proxy for banks' performance and the standard deviation of returns on assets as a proxy for volatility. The results of the study indicated that Z score for all Saudi banks for the study period recorded 25.1736332, which is better than Z scores recorded by banks in several developed countries such as Austria, Germany, Spain, France, Russian Federation, and Ukraine. In addition, the results of Z score on a yearly basis showed that the best Z score was in 2015 and the lowest Z score was in 2020. The results of the study has made an incremental contribution to the current literature as it provided empirical evidence on the validity of Z score as a proxy for the systematic risk in capturing the impact of extreme exogenous events on the degree of stability of Saudi banks. The results have policy implications for several stakeholders including but not limited to the regulator, bank managers and investors as the results showed the best and worst performers in terms of systematic risk and provided empirical evidence on the ability of Z score model in predicting the systematic risk either in the years of prosperity or the years of depression.

Keywords: Probability of Insolvency, Return on Assets, Equity/Total Assets, Value at Risk, Standard Deviation.

Introduction

Banks are linked to each other through direct channels - similar business- and indirect channels –similar assets- that leads to the spread of multiple risks. Therefore, estimating the systemic risks has become of great importance Zou & Gong (2022). Banks are the backbone of the financial system and the real economy, therefore, the solvency of the banking system enhances the solvency of the financial system and the stability of the real economy. The global financial crisis in 2008, which resulted in the mortgage crisis in America, greatly affected the soundness of the financial system and the stability of the economy. Acharya et al. (2017; Billio et al. (2012) explained that the supervisory authorities focus on estimating the risks of the individual banks rather than estimating and monitoring the financial systemic risks, which expose banks to macroeconomic shocks. Wang et al. (2023) explained that the Systemic risks threaten the integrity of the financial system and thus have negative impacts on the economic and social development. Therefore, systemic risks have become the focus of countries' attention around the world. Lee et al. (2022; Ye et al. (2022); Wang et al. (2023) stated that despite the wealth of research on the definition of the systematic risk, there is no consensus on the definition of it, as the systematic risk is not just a collection of individual types of risks, Instead, the systemic risk is the opposite of liquidity risk, credit risk, and operational risk as banks can identify and estimate these risks directly as the systematic risk can be captured indirectly. Kaufman & Scott

(2003) defined the systemic risk as the probability of insolvency of the system as a whole rather than the insolvency of part of it because of the strong connection among the parts or the components of the system. Bisias et al. (2012; Oosterloo and de Haan (2003) attributed the systematic risk to imbalances, breakdown of trust, risk correlation, information asymmetry, asset bubbles, contagion, and unexpected external events. Dow (2000) attributed the systematic risks to engaging in high-risk activities, adopting aggressive organizational culture by focusing on short-term profits, failure of management in the banking system, which leads to banks' inability to respond to the macroeconomic shocks as well as the moral hazard. Allen & Carletti (2011) identified (6) types of systemic risks namely: asset bubble, especially the real estate bubble, liquidity and mispricing of assets, panic, contagion, sovereign default , and currency asymmetry in the banking system. Nier (2009) attributed to the Systemic risks to the exposure of the banking system to macroeconomic- based risk for example, external factors and procyclicality or because of the microeconomics- based risk when one of the banks fails, and the impact of this is transmitted to the banking system as a whole. BIS (2010) stated that the systemic risks have a cross section dimension, as Systemic risks arise due to the instability of banks, concentration, size, correlation between banks, in addition, the Systemic risks have a time series dimension as systemic risks arise over time rather than due to the activities of one bank. Cerruti, et al. (2012) stated that the Systemic risks exist due to the collective behavior of banks such as excessive debt, high financial leverage, misunderstanding risks during periods of boom and overestimating risks during recessions as Systemic risks are exacerbated during periods of recession and financial crises because of the strong correlation among banks. Huang et al. (2019); Verma et al. (2019); Zedda & Cannas (2020) stated that the global financial crises, the problem of sovereign debt, and Covid- 19 pandemic have revealed the importance of transferring risks from the banking systems to the financial markets and the real economy. Previous studies revealed the existence of a high degree of dependence and contagion between banks within the single country or among countries during periods of crises. Andria's et al. (2020); Bats & Houben (2020; Meuleman & Vent (2020) explained that systemic risks are affected by a number of determinants such as liquidity, interbank transactions, market factors, and macro- wise prudential policies approaches.

The Literature on bank risk is a very wide-ranging as most previous studies such as Lokeshnath & Sandhya (2023; Mujadidah & Jaya, (2023; Ratchvelishvili, et al. (2023); Rajhi & Hassai (2013; Alshadadi & Deshmukh (2023; Kumar& Chodisetty (2024) used either the original or the modified version of z scores developed by Altman (1968) to measure the systemic risk based on some financial ratios such as retained earnings/assets, working capital/assets, market value of owners' equity/book value of liabilities, sales / assets, profits before interest and taxes/ assets. However, the researchers belief that this model does not fit the nature of banks' business as it classifies banks based on predetermined scores. In addition, the Altman Z score's financial ratios are not valid as a proxy for the systematic risk or the probability of insolvency as banks never classify balance sheet as current and non-current assets, therefore, the researchers could not calculate the working capital for banks. Therefore, some studies such as Alshadadi& Deshmukh (2023) used macroeconomic variables such as oil prices, interest rates, inflation, as independent variable and banks' assets and deposits as dependent variables to estimate the systematic risk of banks. However, the researchers beliefs that total assets and total deposits are inappropriate systematic risk indicators. In addition, Rajhi

& Hassai (2013) used bank size index, loans/assets, loan provisions/net interest income ratio to reflect credit risk, capital/assets, liquid assets/deposits ratio as a proxy for liquidity risk to construct Z score as the dependent variable. While Song (2023) stated that that Basel iii based -systemic risk indicators did not contribute to reducing the systemic risks of equity, rather, increased these risks.

The current study used the Z-risk index developed by Boyd& Graham (1986); Hannan& Hanwick (1988) to quantify the systematic risk of Saudi banks. According to Baker& Metzemakers (2005) Z-risk index as an insolvency risk is able to captures the extreme events of the systematic and irregular sources. As the bank is insolvent when losses have exhausted its equity capital. Z-risk index is mathematically simple and uses published accounting data, and does not require any assumptions unlike probabilistic methods. Lepetit & Strobel (2013) stated that Z score model can measure the risks of each individual bank and the risks of the banking system as a whole. In addition, it can measure the risks of non-listed banks because it relies on accounting information from the financial statements. Ratchvelishvili, et al. (2023) used the current version of Z score that considers return on assets, equity to assets ratio as a proxy for the financial solvency and the standard deviation of return on assets to reflect the volatility. In addition, Single & Singh (2021) used Z score as a proxy for probability of insolvency.

Study's Problem

The current study is different from the previous studies on quantifying the systematic risk as the study covered 10 years compared to three years in most previous studies to determine the effectiveness of Z score in capturing the systemic risks under fluctuated economic cycles, extreme regional and global events, such as sharp fluctuation in oil prices, Covid-19 and Yemen War. Moreover, the current study is the first that used a real indicator for the systematic risk in Saudi Arabia as previous studies such as the study by Alshadadi & Deshmukh (2023) used total assets and total deposits as proxies for the systematic risk. The current study is multi-faceted as the current study calculated the systemic risks as follows:

1. Systematic risks for all banks as a whole for study period as the benchmark index to determine the systematically important banks.
2. Systematic risks for all banks as a whole year by year over the study period to investigate the effectiveness of Z Sore to capture the extreme exogenous variables.
3. Systematic risks for each bank for the study period to support the results of the aggregated Z scores for all banks.

To the best of the researcher's knowledge, this study is the first in Saudi Arabia that used Z scores as a proxy for the systematic risk developed by Roy (1952); Boyd & Graham (1986); Hannan & Hanwick (1988). Moreover, none of the previous study covered the current study's period. In addition, the study gains its importance because it provides empirical evidence on the Kingdom of Saudi Arabia as an emerging country on the validity of Z score as a proxy for the systematic risks, therefore, the current study filled this gap in the current literature.

Study's Objectives

The current study aimed to quantify the systematic risk for Saudi banks and compare the degree of the stability of Saudi banks to the degree of stability of other banks in some advanced

countries. In addition, the study tested the validity of the Z score index in capturing the systematic risk for Saudi banks under extreme exogenous events.

Literature Review and Hypotheses Development

The study divided the literature review section into two subsections as the first subsection addressed the theoretical framework on approaches to estimating the systematic risks without addressing mathematical formulations except for Z score and the second subsection addressed the study's hypotheses.

Literature Review and the Theoretical Framework

Zou & Gong (2022) stated that there are several methods to estimate the systematic risk such as CoVaR model, spillover index model using value at Risk (VAR) concept. However, there are some limitations to these models as they relied on the reduced-form statistical structure. In addition, these models treated the whole market as a portfolio of all banks and determined banks' contribution to risks by using financial market data.

Sharpe (1964) developed capital asses pricing model (CAPM). As Venanzi (2020) used CAPM model to estimate the systematic risk. However, the model has several assumptions, such as, market perfection without transaction costs, loans and borrowing at the risk-free and limitless rate, market efficiency and investor aversion to risk. Therefore, these assumptions resulted in limitations for the use of CAPM.As a result some modification made to the model to overcome these limitations Mabrouk (2020). However, CAMP model used only with market data. Altman (1968); Altman (1977) was the first author who used the accounting information to predict the financial insolvency of companies. In 1868, Edward Altman developed Z-Score model as a tool to predict the probability of financial Bankruptcy as part of the multivariate discriminant analysis. Edward Altman conducted a study comprised (66) companies divided into two groups of (33) companies each in the United States of America. The first group comprised companies submitted the bankruptcy form according to The American law, while the second group comprised solvent companies. The model used five financial ratios namely: retained earnings/assets, working capital/assets, market value of owners' equity/book value of liabilities, sales / assets, profits before interest and taxes/ assets. However, the model faced criticism as it was used only for studying industrial companies registered on the stock exchange. Altman modified Z score model to address the criticisms of the first version of the model. As Altman added two modifications to the model by placing the book value of equity in place of the market value to apply the model on non- listed companies and excluding the ratio of sales to assets from the model because this ratio is influenced by Industry- specific factors as the asset turnover rate in service activities is high because service activities are capital-intensive and therefore the model may reduce the risk of Bankruptcy in service activities compared to non-service activities. Traditional Z score model developed by Altman did not succeed in predicting the probability of insolvency of banks as it recorded inaccuracy of 70% Erari et al. (2013).

According to the previous studies, there are two approaches to measuring the systemic risks. The first is from top to bottom approach, which relies on historical data of time series for variables that seem intuitively and economically related to the systemic risk. The second approach is from bottom to top by estimating the risks of each bank individually using accounting or market data to define the systemic risk. Most methods for measuring the systematic risk depend on analyzing tail characteristics of banks' asset returns using market data. There are two types of research in this regard. The first focuses on risk diversification

which refers to the impact of bank's risks on banks as a whole Chen et al. (2022). The second focuses on risk transfer which indicates the necessity of calculating the total risks for all banks and then allocating them among banks in certain proportions. According to the risk distribution approach, this approach depends on frequent stock prices data and probabilities of default used by market participants when pricing financial instruments. While the distribution method uses indicators such as value-at-risk models and conditional value-at-risk conditional on banks being under pressure Tiwari et al. (2021). According to the risk diversification approach, the systematic risk is estimated using the change in the conditional value at risk which reflects the sensitivity of market returns to the change in the returns of each individual bank Adrian et al. (2016). According to the risk transfer approach, Acharya, et al. (2017) proposed an optimal transfer system from the risk perspective. According to Abdul Karim, et al. (2019) the banking stability indicators can be divide into two groups: principles- based indicators and theoretical -based indicators. According to Karim, et al. (2016) the supervisory authorities in the United States of America used the financial ratios of CAMEL system as indicators of the financial safety. Then, the supervisory authorities around the world used the CAMEL system to evaluate the financial and banking safety. Karim, et al. (2018) stated that the International Monetary Fund used CAMEL system comprising the following five components: Capital adequacy, Asset quality, Management quality, Earnings ability and Liquidity. However, the Monetary Fund added an additional component to reflect the bank's response to changes in the market which comprised interest rates, the exchange rates, and inflation rates to estimate the systemic risk.

According to Kashya & Jeremy (2004) the supervisory rules issued by Basel Committee on Banking Supervision are principles-based indicators for assessing the financial soundness of banks. The Basel Committee on Banking aimed to issue unified supervisory rules applied by member states as these rules considered recommendations to the central banks of member states as these rules were crystallized through what are known as Basel i, Basel ii and Basel iii which aim to increase the ability of banks to contain and limit the contagion of the financial crises Basel Committee on Banking Supervision, Basel III(2018) According to the Basel Committee approach, banks estimate the systemic risk of each bank separately then converted into systemic risks score and then the contribution of each individual bank to the systemic risk is calculated by comparing the systemic risk score for each bank separately with the average. Basel Committee on Banking Supervision proposed the Indicator -base measurement approach to estimating the systemic risk of banks Bank for International Settlements (2018).

Most of the existing indicators of the systemic risk depend on confidential and unpublished accounting information that is difficult to obtain, and, therefore, certain assumptions should be made or using only information from the stock market. Therefore, Z score is one of the most common models for estimating the systemic risks, since it relies on published accounting information to measure the systemic risks at the level of each individual bank, at the level of a group of banks, or at the level of the banking system as a whole. In addition, unlike probabilistic methods, Z score does not require prior assumptions about the level of Acceptable risk.

Buriak & Lyeonov (2015) stated that, In terms of the type of data, the systematic risk indicators depend on macroeconomic indicators, network indicators, forward-looking risk indicators, stress-testing indicators, liquidity and default indicators Bisias, et al. (2012).

The roots of Z score goes back to Roy (1952) although it is often attributed to Boyd & Graham (1986); Hannan & Hanweck (1988); Boyd et al. (1993). Z score is widely used in assessing the financial and banking stability due to its relative ease and the reliance on accounting information only. Z-score used to estimate the insolvency risk at the aggregate level rather than individual bank levels using different methods. Demirguc-Kunt & Detragiache (2010) used the aggregated individual bank balance sheets before estimating the aggregate Z-scores, while Beck et al. (2010) used the median of the individually calculated Z-scores. On the other hand, Houston et al. (2010) used the weighted average of individually calculated Z-score indicators as the aggregate insolvency risk index. As Bank insolvency is defined as the situation in which the ratio of capital to assets plus the return on assets, is less than or equal to zero. Strobel (2010) noted that constructing Z score as the weighted mean based -aggregate bank insolvency risk indicator is inherently biased.

Study's Hypotheses

Based on the literature review and the study's objectives, the researchers developed the following hypothesis: Z score model can capture the systematic risk under the external extreme events.

Methodology and Analysis of Results

Sample and Data

The current empirical study applied to Saudi banks registered on the Saudi capital market known as TASI for the period 2013-2022. The study collected the data of all variables necessary to estimate Z score from the annual financial reports of Saudi banks.

Study's Method

This study used the case study approach to get in depth understanding of the systematic risks for Saudi banks to determine top performs and bad performs in terms of the systematic risk, and then test the validity of Z score model.

Z Score's Model Specification

Z score has an inverse relationship with the probability of insolvency as the higher the Z score index, the more stable the bank is and thus the longer the distance to insolvency. The study used Z score to estimate Insolvency risk for Saudi banks that is the inverse of Z score of all Saudi banks. Strobel (2010) pointed out that estimating Z -score for each bank separately and then calculating an average for all banks' z scores as an indicator of the safety and stability of the banking system is bias and error. The study used Z-score to determine how many standard deviations a bank is under its predicted return on assets. Kyshakevych & Klymkovych (2018) used the natural logarithm of the Z-score because of the Z-significant score's skewness Laeven & Levine (2009). The study used the following formula to construct Z score

$$Z \text{ score} = ROA + E / TA) / \sigma \text{ ROA of 10 years}$$

Where: ROA = stands for the return on assets. E= stands for equity. A = stands for total assets. σ ROA = stands for the standard deviation of return on assets for 10 years.

Analysis of Results

The study estimated the aggregated Z score for all banks as a whole to use the calculated aggregated Z score of 25.1736332 as a benchmark to identify the systemically important banks. The study used the leave-one-out approach developed by Li, Tripe & Malone, (2017). The following formula used to calculate the systemically important banks= Z-score- Z score -1. Where Z score stands for the degree of stability of all banks while Z score -1 stands for the degree of the stability of all banks after leaving out one bank. The general rule, the bank is positively systematically important if Z score is greater than Z score -1. That is, the bank positively contributed to the degree of the stability of the banking system. However, if Z score is less than Z score -1, the bank negatively contributed to the degree of the stability of the banking system.

According to Table 1 all Saudi listed banks except Al Rajhi Bank positively contributed to the stability of Saudi banking system. The results of Table 1 indicated that Riyadh Bank is the best performer in terms of systematic risk as the z score of all banks without Riyadh bank declined to 4.899449058 against 25.1736332 when Riyadh Bank included with all banks. However, AL RAJHI BANKING was the worst performer in terms of the systematic risk as the z score of all banks without Al Rajhi Bank recorded 26.55616681 versus 25.1736332 when AL RAJHI BANKING is included. Therefore, the regulator should monitor AL RAJHI BANKING by demanding it more capital buffer or liquidity buffer or both. As for z scores -1 of Arab National Bank, BANK ALBILAD, ALINMA BANK, Saudi National Bank were close to s scores of all banks, that is, they are average performers. While z scores -1 of Bank AlJazira, SAUDI INVESTMENT Bank, Banque Saudi Fransi, Saudi British Bank after excluding them were less than Z score for all banks, that is, they were good performer in terms of the systematic risk.

The current study recorded aggregated Z-score for all banks of 25.1736332, which is greater than z scores recorded by previous studies. as studies conducted by Zhang, et al. (2012) recorded Z- score of 14, while studies by Ratchvelishvili, et al. (2023) recoded Z- score of 19.54. In addition, Z score of Saudi banks is greater than Z score of Austria, Germany, Spain, France, Russian Federation, Ukraine, Turkey as they recorded z scores less than of Saudi banks (see Table 2)

Table 1. Saudi Banks' Overall Systematic Risk and Systematically Important Banks.

Bank Name	Z score	Z score -1	Difference
Riyadh Bank	25.173	4.89944	20.27418
Bank AlJazira	25.173	5.48855	19.68508
SAUDI INVESTMENT bank	25.173	5.40032	19.77331
Banque Saudi Fransi	25.173	5.34048	19.83315
Saudi British Bank	25.173	5.42853	19.74509
Arab National Bank	25.173	24.1232	1.050413
AL RAJHI BANKING	25.1736	26.55616	-1.38253
BANK ALBILAD	25.1736	24.33926	0.834373
ALINMA BANK	25.1736	23.59158	1.582051
Saudi National Bank	25.1736	24.92996	0.243666

Source: Outputs of Z score Model

Table 2. Z Scores for Selected Countries In 2015.

Countries	Z scores
China	28,62
United States	27,75
Austria	24,37
Germany	21,61
Spain	19,86
France	18,93
Russian Federation	4,34
Ukraine	2,82

Source: Kyshakevych & Klymkovych (2018)

Table 3 summarized Z scores for each year separately, as the results indicated that the greatest degree of stability for Saudi banks was In 2015 as Z score recorded 58.071134. While the lowest degree of stability for Saudi banks was in 2020 as Z score recorded 13.804260. However, Saudi banks are still more stable than several developed countries (see Table, 2). The results provided empirical evidence of the effectiveness and validity of Z score in capturing the impact of exogenous factors on the stability of banks .In 2015, Saudi Arabia recoded a positive GDP of 0.0411, which was the largest from 2013 to 2021. While in 2020, Saudi Arabia recoded a negative GDP of -0.0414, which was the least GDP over the study period due to Covid -2019 pandemic. In 2021, Saudi banks began to recover from the negative effects of the Corona pandemic recording Z score of 37.0547490, 48.6607188 in 2021 and 2022 respectively. The improvements in z scores was because of the improvement in oil prices and the unprecedented GDP of 0.087 in 2022 because of increasing oil prices after Russian-Ukrainian war broke out in February 2022. Based on z scores of each year, the study accepted the hypothesis that "Z score model can capture the systematic risk under the external extreme events.

Table 3. Saudi Banks' Yearly Systematic Risk.

Years	Equity/Capital	ROA	σ ROA	Z Score
2013	0.13	0.019	0.004	31.3
2014	0.13	0.019	0.0043	30.7
2015	0.18	0.019	0.003	58.0
2016	0.19	0.024	0.003	50.1
2017	0.12	0.014	0.0040	30.7
2018	0.13	0.022	0.0066	29.5
2019	0.16	0.020	0.0070	23.6
2020	0.14	0.012	0.0106	13.8
2021	0.15	0.016	0.0042	37.0
2022	0.15	0.014	0.003	48.6

Source: Outputs of Z score Model

Table 4 summarizes Z score for each individual bank for the study period as Riyadh Bank recorded the highest Z score of 79.445422 supporting that Riyadh Bank is positively and systematically important. ALINMA BANK came in the second rank recording Z score of 57.539347. Then the Saudi National Bank came in third rank recording 56.248659. while The Saudi British Bank recoded the lowest Z score of 13.8320 due to the high volatility of return on assets recording standard deviation of 0.0129395.

Table 4. Systematic Risk for Individual Banks.

BANKS	Equity/Capital	ROA	σ ROA	Z score
Riyadh Bank	0.159	0.017	0.002	79.44
Bank AlJazira	0.1341	0.011	0.005	26.81
SAUDI INVESTMENT bank	0.1430	0.012	0.004	34.60
Banque Saudi Fransi	0.1638	0.014	0.003	44.9
Saudi British Bank	0.1787	0.0142	0.012	13.83
Arab National Bank	0.1473	0.016	0.003	45.07
AL RAJHI BANKING	0.121	0.024	0.002	55.32
BANK ALBILAD	0.1170	0.021	0.003	37.22
ALINMA BANK	0.1808	0.016	0.0031	57.53
Saudi National Bank	0.1463	0.019	0.002	56.24

Source: Outputs of Z score Model

Discussion and Conclusions

The study aimed to estimate the systematic risk for Saudi banks using Z score model and compare the results of the model to the results of the model in advanced countries. The empirical study conducted on all 10 banks registered on the Saudi capital market, known as TASI for the period 2013-2022. In the literature review, the study addressed all approaches to estimating the systematic risks. The study criticized the traditional Altman Z score (1968) as a proxy for the systematic risk as it does not fit the nature of business of banks. Therefore, the study used Z score model developed by Roy (1952); Boyd and Graham (1986); Hannan and Hanwick (1988) as this model considers return on assets as a proxy for banks' performance, equity / total assets as a proxy for the financial solvency and the standard deviation of returns on assets as a proxy for volatility. The results of the study indicated that Z score for all banks under study as a whole recorded 25.1736332 and the study used this score as the benchmark to determine the best and worst performing banks in terms of the systematic risk. The study used the following formula to determine the best and the worst performer= Z score – z core -1 as the bank considered a good performer if z score -1 is less than Z score and vice versa as Riyadh Bank was the best performer as the Z score for all banks including Riyadh Bank recorded 25.1736332 but Z score without Riyadh Bank recoded 4.899449058, that is, the degree of stability of Saudi banks declined by 20.27418 when dropping Riyadh Bank. On the other hand, AL RAJHI BANKING was the poorest performer as Z score for all banks including AL RAJHI BANKING recorded 25.1736332 but Z score without AL RAJHI BANKING recoded 26.55616681, that is, the degree of stability of Saudi banks increased by 1.38253361 when dropping AL RAJHI BANKING. In conclusion, Saudi banks recorded Z score of 25.1736332 while o Z scores of Austria, Germany, Spain, France, Russian Federation and Ukraine recorded 24, 37; 21, 61; 19, 86; 18, 93; 4, 34; 2, 82 respectively.

By Analyzing Z scored on a yearly basis, the best score was in 2015 as Z score recorded 58,071 because of the positive GDP of 0.0411. However, the worst score was in 2020 as Z score recorded 13.8 because of corvid -19 that caused a negative GDP of -0.0414. Then the Z score started recovering to record 37.0547, 48.66071 in 2021 and 2022 respectively due to increasing oil prices after Russian-Ukrainian war that broke out in February 2022. Based on the results we can infer that Z score is a valid approach to estimating the systematic risk for Saudi banks.

References

Abdul Karim, N., Alhabshi, S.M. J., Kassim, S., Haron, R. (2019). A Critical Review of Bank Stability Measures in Selected Countries with Dual Banking System. Revista Publicando, 6, No 19. 2019, 118-131. https://www.researchgate.net/publication/330438857_A_Critical_Review_of_Bank_Stability_Measures_in_Selected_Countries_with_Dual_Banking_System_A_Critical_Review_of_Bank_Stability_Measures_in_Selected_Countries_with_Dual_Banking_System_A_Critical_Revie

Acharya, V., Pedersen, L.H., Philippian, T., Richardson, M., (2017). Measuring Systemic Risk. Rev. Finances. Stud. 30 (1), 2–47. https://doi.org/10.1093/rfs/hhw088.

Adrian, T., Brunnermeier, M.K., (2016). CoVaR. Am. Econ. Rev. 106, 1705–1741. https://doi.org/10.2139/ssrn.1269446.

Allen, F., and Carletti, E. (2011). Systemic Risk and Macroprudential Regulation. University of Pennsylvania and European University Institute, mimeo,, 1-13 DOI:10.4337/9781783470945.00014

Alshadadi, M., Deshmukh, P.V. (2023). Systematic Risk's Effect on the Stability of the Banking Sector: Evidence from Saudi Arabia. Studies in economics and business relation, vol. 4, issue 2: pp 54-72. DOI:10.48185/sebr.v4i2.954

Altman (1968). Financial Ratios. Discriminant Analysis and the Prediction of Corporate Bankruptcy. Journal of Finance, volume 23, issue 4, 589 - 609 https://www.raggeduniversity.co.uk/wp-content/uploads/2016/08/FINANCIAL-RATIOS-DISCRIMINANT-ANALYSIS-AND.pdf

Altman, (1970) .Ratio Analysis and the Prediction of Firm Failure: A Reply. Journal of Finance, volume 25, issue 25, 1169 - 1172. https://ideas.repec.org/a/bla/jfinan/v25y1970i5p1169-72.html

Andrieş, A.M., Niter, S., Sprincean, N. (2020) .The Impact of Central Bank Transparency on Systemic Risk—Evidence From Central and Eastern Europe. Research in International Business and Finance, Volume 51,100921. https://doi.org/10.1016/j.ribaf.2018.06.002

Bank for International Settlements (2018) .Global Systemically Important Banks: Revised Assessment Methodology and the Higher Loss Absorbency Requirement. https://www.bis.org/bcbs/publ/d445.pdf

Basel Committee on Banking Supervision, Basel III: A Global Regulatory Framework for More Resilient Banks and Banking System. https://www.bis.org/publ/bcbs189_dec2010.pdf

Bats, J.V., Houben, A.C.F.J. (2020).Bank-Based Versus Market-Based Financing: Implications for Systemic Risk. Journal of Banking & Finance, Volume 114, May 2020, 105776. https://doi.org/10.1016/j.jbankfin.2020.105776

Beck, T., A. Demirguc-Kunt, and R. Levine (2010).Financial Institutions and Markets across Countries and over Time: The Updated Financial Development and Structure Database. The World Bank Economic Review 24 (1), PP77-92. https://documents1.worldbank.org/curated/en/916561468331178510/pdf/776350JRN020100itutions0and0Markets.pdf

Bikker, J.A. and Metzemakers, P.A.J. (2005).Bank Provisioning Behavior and Procyclicality. Journal of International Financial Markets, Institutions and Money, Vol. 15 No. 2, 141-157. http://www.sciencedirect.com/science/article/pii/S1042-4431(04)00067-8

Billio, M., Getmansky, M., Andrew, W., Pelizzon, L., (2012). Econometric Measures Of Connectedness And Systemic Risk In The Finance And Insurance Sectors. J. Finance. Econ. 104 (3), 535–559. https://doi.org/10.1016/j.jfineco.2011.12.010.

BIS. (2010). Macro Prudential Instruments and Frameworks: A Stocktaking of Issues and Experiences. CGFS Papers No 38, BIS, 17-19. https://www.bis.org/publ/cgfs38.pdf

Bisias, D., Flood, M., Lo, A. W., & Valavanis, S. (2012). A Survey of Systemic Risk Analytics. Annual Review of Financial Economics, 4, 255-296. https://www.financialresearch.gov/working-papers/files/OFRwp0001_BisiasFloodLoValavanis_ASurveyOfSystemicRiskAnalytics.pdf

Boyd, J.H. and Graham, S.L. (1986).Risk, Regulation, And Bank Holding Company Expansion into Nonbanking. Quarterly Review, Vol. 10 No. 2, 2-17. https://ideas.repec.org/a/fip/fedmqr/y1986isprp2-17nv.10no.2.html

Buriak, A., Lyeonov, S., & Vasylieva, T. (2015). Systemically Important Domestic Banks: An Indicator-Based Measurement Approach for the Ukrainian Banking System. Prague Economic Papers, 24(6), 715-728. https://pep.vse.cz/artkey/pep-201506-0006_systematically-important-domestic-banks-an-indicator-based-measurement-approach-for-the-ukrainian-banking-syst.php

Cerruti, E., Claessens, S., McGuire, P. (2012). Systemic Risks in Global Banking: what Can Available Data Tell Us and what More Data Are Needed? Bank of International Settlements. Working Paper 376. https://www.bis.org/publ/work376.pdf

Chen, T.H., Lee, C.C., Shen, C.H., (2022). Liquidity Indicators, Early Warning Signals in Banks, And Financial Crises. North Am. J. Econ. Finan. 62, 101732 https://ideas.repec.org/a/eee/ecofin/v62y2022ics1062940822000821.html

Demirguc-Kunt, A. and E. Detragiache (2010).Basel Core Principles and Bank Soundness: Does Compliance Matter?. Journal of Financial Stability, in press https://www.imf.org/external/pubs/ft/wp/2010/wp1081.pdf

Dow, J. (2000). What Is Systemic Risk? Moral Hazard, Initial Shocks, and Propagation, Monetary and Economic Studies, Bank of Japan, December, 19-21 https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=9d6cca24bb99daae03b172a426b553dd6b534688

Erari, A., Salim, U., Idrus, M. S., & Djumahir. (2013). Financial Performance Analysis of PT. Bank Papua: Application of Cael, Z-Score and Bank meter. IOSR Journal of Business and Management, 7 (5), 08-16 https://www.iosrjournals.org/iosr-jbm/papers/Vol7-issue5/B0750816.pdf

Hannan, T.H. and Hanwick, G.A. (1988).Bank Insolvency Risk and the Market for Large Certificates Of Deposit. Journal of Money, Credit and Banking, Vol. 20 No. 2,. 203-211. http://links.jstor.org/sici?sici=0022-2879%2819880 ... 0.CO%3B2-5&origin=bc

Houston, J. F., C. Lin, P. Lin, and Y. Ma (2010).Creditor Rights, Information Sharing, And Bank Risk Taking. Journal of Financial Economics 96 (3), 485-512 http://www.sciencedirect.com/science/article/pii/S0304-405X(10)00040-1

Huang, Q., Haan, J., Scholtens, B. (2019). Analyzing Systemic Risk in the Chinese Banking System. Pacific economic review, Volume24, Issue2, 348-72. https://doi.org/10.1111/1468-0106.12212

Karim, N. A., Alhabshi, S. M. S. J., Kassim, S., & Haron, R. (2018). Measuring Bank Stability: A Comparative Analysis between Islamic and Conventional Banks in Malaysia. Proceedings of the 2nd Advances in Business Research International Conference (pp.169-177) 169–177. DOI:10.1007/978-981-10-6053-3_16

Karim, N. A. Al-Harsh, S. M., Abduh.M. (2016). Macroeconomics Indicators and Bank Stability: A Case of Banking in Indonesia.Buletin Ekonomi Moneter Dan Peranakans 18, no. 4 , 431–48. : https://doi.org/10.21098/bemp.v18i4.609

Kashyap, Anil K, and Jeremy C Stein (2004). Cyclical Implications of the Basel II Capital Standards. Economic Perspectives 28, no. 1 18–32. https://www.chicagofed.org/publications/economic-perspectives/2004/1qtr2004-part2-kashyap-stein

Kaufman, G.G. and Scott, K.E. (2003) .What Is Systemic Risk, and Do Bank Regulators Retard or Contribute to It. The Independent Review, Vol. 7, No. 3, 371-391 https://www.jstor.org/stable/24562449

Kyshakevych, B. Klymkovych, I. (2018) .Estimation Of Z-Score for Ukrainian Banking System. Periodyk Naukowy Akademii Polonijnej. nr5 , 43-51 http://pnap.ap.edu.pl/index.php/pnap/article/view/292/271

Laeven, L., & Levine, R. (2009). Bank Governance, Regulation and Risk Taking. Journal of Financial Economics, 259-275. https://doi.org/10.1016/j.jfineco.2008.09.003

Lee, C.C., Wang, C.W., Ho, S.J. (2022). Financial Aid and Financial Inclusion: Does Risk Uncertainty Matter. Pac. -Basin Financ. J. 71, 101700 https://doi.org/10.1016/j. pacfin.2021.101700.

Lepetit, L., Strobel, F. (2013). Bank Insolvency Risk and Time-Varying Z-Score Measures. Journal of International Financial Markets, Institutions and Money. https://ideas.repec.org/a/eee/intfin/v25y2013icp73-87.html

Li, X., Tripe, D. W., & Malone, C. B. (2017). Measuring Bank Risk: An Exploration of Z-Score. https://doi.org/10.2139/ssrn.2823946

Lokeshnath, B., Sandhya, M. (2023) .Insolvency And Bankruptcy Code: A Study of Indian Banks With Reference To Altman Z Score. EPRA International Journal of Economic and Business Review-Peer Reviewed Journal Volume - 11, Issue - 8, August 2023 | e-ISSN: 2347 - 9671| p- ISSN: 2349 – 0187. Article DOI: https://doi.org/10.36713/epra14205

Mabrouk, A. (2020) .Wavelet-Based Systematic Risk Estimation: Application on GCC Stock Markets: The Saudi Arabia Case. Quantitative Finance and Economics, Volume 4, Issue 4, 542–595. Doi: 10.3934/QFE.2020026

Meuleman, E., Venne, R.V. (2020) .Macro Prudential Policy and Bank Systemic Risk. Journal of Financial Stability. Volume 47, 100724. http://www.sciencedirect.com/science/article/pii/S1572308920300024

Mukhibad,H. , Jayanto,P.Y. , Budiantoro, R.A. Hapsoro, B.H.A Musyaffi,N.M.(2023).Equity-Based Financing And Risk In Islamic Banks: A Cross-Country Analysis. Cogent Economics & Finance, Volume 11 Issue 2.,, 1-19-https://doi.org/10.1080/23322039.2023.2235117

Nier, E. W. (2009). Financial Stability Frameworks and the Role of Central Banks: Lessons from the Crisis. IMF Working Paper WP/09/70, IMF, 24-25. file:///C:/Users/S.oraby/Downloads/9781616352295-9781616352295%20(6).pdf

Oosterloo, S., and de Haan, J. (2003). A Survey of Institutional Frameworks for Financial Stability. Occasional Studies Vol.1/Nr.4, De Nederlandsche Bank, 11-16. https://www.dnb.nl/media/2itnjniw/200311_04-_a_survey_of_institutional_frameworks_for_financial_stability.pdf

Rajhi, W., Slim A. Hassair, S.A. (2013) .Islamic Banks and Financial Stability: A Comparative Empirical Analysis between Mena and Southeast Asian Countries. Région et Development ,37, 150-177. https://regionetdeveloppement.univ-tln.fr/wp-content/uploads/7Rajhi.pdf

Ratchvelishvili, A., Mercan, M., Dzagania, B. (2023). Determinant Factors of Risk-Taking in Georgian Banking Institutions with Machine Learning. Journal of Business; ISSN: 2233-369X; e-ISSN: 2346-8297; Volume 12, Issue 1, 15-49 file:///C:/Users/S.oraby/Downloads/ban+risk+taking%20(4).pdf

Roy, A. D. (1952). Safety First and the Holding of Assets. Econometrica Vol. 20 No. 3, pp. 431-449. http://dx.doi.org/10.2307/1907413

Singla, R., Singh, G. (2021).Default Risk and Stock Returns: Evidence from Indian Corporate Sector. The Journal of Business Perspective Volume 27, Issue 3. https://doi.org/10.1177/09722629211003358

Sharpe, W.F. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. Journal of finance, Volume19, Issue3, 425-442. https://doi.org/10.1111/j.1540-6261.1964.tb02865.x

Strobel, F. (2010) .Bank Insolvency Risk and Aggregate Z-Score Measures: A Caveat. Economic bulletin, Volume 30, Issue 4, 2576 -2578. https://ideas.repec.org/a/ebl/ecbull/eb-10-00540.html

Kumar, B. U. & Chodisetty, R.S.M. (2024). Using Altman Z-Score Model of Financial Soundness of Banking Industry in India by-A Case Study on Select Public Sector Banks in India-An Empirical Evidence. EPRA International Journal of Environmental Economics, Commerce and Educational Management, Vol. 11 Issue1, 1-19 DOI: https://doi.org/10.36713/epra15484

Venanzi, D. (2020). Systematic Risk of European Banks. Available at SSRN: https://ssrn.com/abstract=3644863 or http://dx.doi.org/10.2139/ssrn.3644863

Verma, R., Ahmad, W., Uddin, G. S., Bekiro, S. (2019). Analyzing the Systemic Risk of Indian Banks. Economics Letters, Volume 176, March 2019, 103-108. https://doi.org/10.1016/j.econlet.2019.01.003.

Ye, M., Shen, J.H., Golson, E., Lee, C.C., Li, Y., (2022). The Impact of Sino-U.S. Trade Friction on the Performance of China's Textile and Apparel Industry. Int. Financ. 25 (2), 151–166. https://doi.org/10.1111/infi.12413.

Zhang, Z. Lu, L.X.X.Z, Zhang. H. (2015) Determinants of Financial Distress in Large Financial Institutions: Evidence from U.S. Bank Holding Companies. Contemporary Economic Policy, Volume34, Issue2, 250-267. https://doi.org/10.1111/coep.12105

Zedda, S., Cannas, G. (2020).Analysis of Banks' Systemic Risk Contribution and Contagion Determinants through the Leave-One-Out Approach. Journal of Banking & Finance, Volume 112, 105-160 DOI:10.1016/j.jbankfin.2017.06.008

Zou, J.; Fu, X.; Yang, J.; Gong, C. (2022). Measuring Bank Systemic Risk in China: A Network Model Analysis. Systems, 10, 14, 1-19. https://doi.org/10.3390/systems10010014

Tiwari, A. K., Mishra, B. R., & Solarin, S. A. (2021). Analyzing The Spillovers between Crude Oil Prices, Stock Prices and Metal Prices: The importance of frequency domain in USA. Energy, 220, 119732. https://doi.org/10.1016/j.energy.2020.119732

استخدام نموذج زد سكور لقياس المخاطر النظامية للبنوك السعودية

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المستخلص. تهدف الدراسة الى القياس الكمي للمخاطر النظامية للبنوك السعودية باستخدام نموذج Z score للفترة ٢٠١٣-٢٠٢٢ حيث شملت عينة الدراسة ١٠ بنوك المسجلة في سوق المال السعودي. هذا وقد استخدمت الدراسة نموذج Z score كمؤشر للمخاطر النظامية باعتباره معكوس احتمال الاعسار المالي، حيث يعتمد النموذج على المعلومات المحاسبية المنشورة والتي تشمل نسبة حقوق الملكية الى إجمالي الأصول كمقياس للملاءة المالية والعائد على الأصول كمقياس لأداء البنك والانحراف المعياري للعائد على الأصول كمؤشر للتقلبات. اشارت نتائج الدراسة الى ان مؤشر Z score لكافة البنوك السعودية محل الدراسة بلغ ٢٥.17 والذي يعد أفضل من مؤشرات زد سكور في العديد من دول العالم المتقدم مثل استراليا – المانيا– اسبانيا– فرنسا الاتحاد السوفيتي– أوكرانيا. كما اشارت نتائج الدراسة على أساس سنوي ان عام ٢٠١٥ كان الأفضل وان عام ٢٠٢٠ كان الأسوأ من منظور المخاطر النظامية. كما اشارت نتائج الدراسة الى انها ساهمت جزئيا في الادب الحالي، حيث انها قدمت دليل عملي عن صلاحية نموذج Z score في تحديد تأثير العوامل الخارجية على المخاطر النظامية واستقرار البنوك. علاوة على ذلك فان نتائج الدراسة المشار اليها سيكون لها تأثير إيجابي كبير على العديد من الأطراف ذوي العلاقة منها على سبيل المثال وليس الحصر الجهات الرقابية المصرفية بالمملكة والمستثمرين ومديري البنوك، حيث كشفت الدراسة عن البنوك ذات الأداء الأفضل والأداء الضعيف من منظور المخاطر النظامية سواء في سنوات الرخاء او الكساد.

الكلمات المفتاحية: احتمال الفشل، العائد على الأصول، حقوق الملكية/الأصول، القيمة المعرضة للمخاطر، الانحراف المعياري.