Received: October 2023 Accepted: December 2023 DOI: https://doi.org/10.58262/ks.v12i1.083

# Quantifying Credit Portfolio's Economic Capital for Evaluating Banks' Risk Adjusted Performance Evidence from Saudi Arabia

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### Abstract

The study aims to quantify the economic capital necessary to absorb credit risks and calculate risk adjusted returns on the economic capital using parameters of the probability of default (PD), the loss given defaults (LGD) and the exposure at default (EAD) according to the foundation internal rating- approach under the second pillar of Basel ii and compare the results with the regulatory capita according to the standardized approach under the first pillar of Basel ii. The study used the case study method to estimate the economic capital model for Bank AlJazira for the period 2018-2022. The study used R software programming language and Monte Carlo Simulation to generate the parameters of value at risk (VAR). The study used the estimated parameters of the expected losses and the unexpected losses to develop risk adjusted returns on the economic capital. The results showed that the estimated expected losses were greater than the actual allocations for loan losses calculated by the bank, i.e., the bank was under provisioning. However, the bank's regulatory capital under the Standardized approach was greater than the estimated economic capital, i.e., the bank was over capitalized. In addition, the results of the risk-adjusted return based on the outputs of the economic capital model indicated that the bank achieved negative returns during some years. While the results of the risk-adjusted return on the regulatory capital indicated positive results during the study period. In general, the results indicated that the economic capital model under the foundation internal rating- based approach generated expected losses greater than the allocations for loan losses, while the model generated risk capital less than the regulatory capital under the standardized approach which generated large regulatory capital. Therefore, it can be concluded that the regulatory capital is greater than the economic capital because it focuses on protecting depositors and creditors against the risks of default, while the economic capital focuses on measuring the risk capital from the perspective of shareholders. The results of the study will be useful to academics, practitioners and regulatory authorities.

**Keywords:** Probability of Default – Loss Given Default – Exposure at Default- Expected Losses – Unexpected Losses-Allocations For Loan Losses.

### 1. Introduction

The research in the field of credit risk is relatively recent, as Gordy (2000) suggested important improvements in the field of credit risk modeling at the portfolio level. Giese (2005) stressed on the importance of credit modeling since the credit risk is the largest driver of the economic capital in banks. The development of credit risk measurement models dates back to Merton (1974) model, where the model assumed that the company's assets play an important role in determining the risk of default as the default occurs when the market value of the assets is less

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than liabilities. Based on Merton (1974) model, other models emerged assuming the default may occur before the maturity date of the obligations. Therefore, default occurs when the bank' liabilities are greater than its assets. Accordingly, the recovery rate upon default is an exogenous factor that did not depend on the company's capital. Recently other models emerged assuming that the recovery rates upon default did not depend on the probability of default and the credit risk can be measured on the basis of the stochastic process.

Amelia Ho (2012) pointed out that in light of the global financial crisis of 2008 and its repercussions on the collapse of some major financial institutions with high regulatory capital adequacy ratio drew the attention to the effectiveness of the regulatory capital in preventing the financial crises. Amelia (2012) pointed out that the regulatory capital model suffered from weaknesses in the field of risk-based decision-making. Therefore, Amelia (2012) suggested the economic capital as an alternative to the regulatory to facilitate risk-based decision-making and encourages banks to adopt effective internal controls to manage risks.

The economic capital defined by Sweeting (2011) as the surplus of assets or the surplus of cash flows to deal with the potential shortage in assets or the increase in liabilities over certain period of time with a certain level of confidence. Basel Committee on Banking Supervision (2009) defined the economic capital as the procedures followed by the bank to measure risks resulting from risky activities to absorb the financial impact of these risks. Therefore, the economic capital can be seen as a measure of the overall risk or the risk of business units rather than the capital buffer. The economic capital is also known as capital at risk or risk adjusted capital or internal capital. Matten, Bankowym (2000) defined the economic capital as the measure of future risks, rather than the capital held by banks as the economic capital is estimated by VaR approach to absorb unexpected losses and determine the return on capital. Therefore the economic capital is different from the concept of regulatory capital which accounts for existing capital levels set by Basel as a percentage of risk-weighted assets.

Caruana (2005) stated that Basel ii dealt with the concept of economic capital and the regulatory capital. The second pillar of Basel ii aimed to set minimum capital adequacy requirements sensitive to risks to bring the regulatory capital in the first pillar be very close to the economic capital. The second pillar of Basel ii included the supervisory review to determine the adequacy of capital i.e. the economic capital to absorb the unexpected losses through the internal rating of risks by banks. Therefore, banks must maintain both the regulatory capital and the economic capital is estimated by the bank so that the bank remains financially solvent. The objective of the economic capital is to maximize the shareholders' wealth, while the regulatory capital meets the interests of depositors of the bank and the goal is to minimize potential risks.

The results of quantifying the economic capital are important because they determine whether banks' regulatory capital is less than the economic capital. In the event that the regulatory capital is less than the economic capital. In the event that the regulatory capital is less than the economic capital or decrease the risk weighted assets. Andrle, et al. (2017) indicated that undercapitalized banks can decrease the size of risk-weighted assets or increase equity through issuing new shares, limit cash dividends to shareholders, increase retained earnings by increasing the operational efficiency and increasing lending margins. The outputs of economic capital models are different from the outputs of other capital adequacy models, as the results of economic capital with risks on the basis of probabilistic estimates of the potential losses in the future. Therefore, the economic capital is more forward-looking risk measure

compared to other traditional capital adequacy measures.

Bandyopadhyay (2023) indicated that Basel iii addressed the shortcomings of the regulatory capital, as it made significant reforms on risk-weighted assets and allowed banks to use their internal data instead of relying on external credit rating agencies to measure the parameters of PD, LOD and EAD taking into account some regulatory controls to quantify the economic capital or the internal capital. In addition, Nenada, Srdan (2021) pointed out that Basel Committee on Banking Supervision has published additional reforms on risk-weighted assets to calculate the capital adequacy ratio, as banks can use the standardized approach to assess credit risk based on risk sensitive weighted assets. Kaplan, et al. (2018) pointed out that the economic capital is a measure of risk used by banks to quantify the capital required to hold to absorb the unexpected losses in the credit portfolio. The economic capital model is stochastic, which is the difference between the quantile and the distribution of losses and it is calculated using Monte Carlo simulation. Das (2007) pointed out that Basel ii takes into account two types of losses, the expected losses and the unexpected losses. Therefore, determining the regulatory or the economic capital must adhere to the concept of both types of losses and suggested using the value at risk (VaR) model as an information system to identify the inherent risks with modeling the distribution of losses explicitly and the result of the modeling is the best estimate of the capital adequacy.

Hull (2018) stated that regulatory authorities aim to protect depositors and debt holders against risks of default. Therefore, the regulatory authorities require banks to maintain a minimum amount of capital to absorb losses resulting from lending activities, which is the main source of losses. The amount of capital required to absorb credit losses with a specific level of confidence over a period of time is known as the economic capital. The expected losses must be covered by loan pricing policies by increasing interest rates. As for the unexpected losses, which is the difference between total value at risk and expected losses, banks must absorb those losses by maintaining capital known as the economic capital.

The most widely used measure in evaluating banks' performance is the return on equity as The European Central bank (2010) criticized the use of the return on equity by banks as the return on equity is ineffective in high volatility environments, it does not reflect the bank's long-term strategy, it is insensitive to risks, it is a short term indicator.. Kumarhttps (2023) indicated that Risk-adjusted performance indicators have recently gained tremendous importance in the banking industry, especially in light of opportunities for external expansion, intensification of competition, challenges of non- performing assets. This concern is due to the fact that traditional performance measures such as return on assets or return on equity lack the forward -looking perspective and they are incapable of providing information of value to shareholders. Therefore, there is a need for the risk-adjusted performance based on the economic capital concept. Majeed, Bindman. (2001) pointed out that risk-adjusted performance indicators help improve budgeting decisions, reduce adverse selection risks and effectively allocate resources.

Shareholders are interested in measuring banks 'profitability using the return on equity, costs to income ratio and the return on assets. However, the return on equity is insensitive to risks, as the main source of the increase in the return on equity is attributed to higher financial leverage. The accounting leverage is insensitive to risk because it depends on the accounting capital and non-risk weighted assets. Therefore, the economic capital is the best for calculating the financial leverage because it is directly related to risks. On the other hand, the return on the economic capital is the best measure of banks' performance, as it links risk-adjusted returns to risk capital. Tran & phan (2020) indicated that credit risks had negative impacts on the profits.

# **Research Problem**

To measure the economic capital, it is necessary to distinguish between expected losses and unexpected losses, as the expected losses are considered costs of doing business and are not considered risks because banks expect the occurrence of them. Therefore, the statistical probability of the collapse of banks due to these losses is zero. The expected losses are absorbed by adding margins when pricing of bank's products and therefore, no capital is needed for the expected losses. The regulatory capital corresponds to the expected losses of the recurring nature, while the economic capital corresponds to the unexpected losses that serve as a measure of risks.

The literature review indicated that there are many concepts of capital such as the capital set by the external credit rating agencies, the regulatory capital set by the regulators, the economic capital, and the accounting capital. The regulatory capital is nothing more than the normal financial leverage. i.e. Expressing the capital as a ratio of total assets, or the risk-sensitive financial leverage.i.e. Expressing the capital as a ratio of the risk-weighted assets. As for the concept of capital from the perspective of the external rating agencies, it is appropriate for the debt market, especially since estimating the risk structure of banks is a complex process, and the work of external credit rating agencies focuses on the possibilities of failure to repay debts and not assessing the capital adequacy. As for the accounting capital, it is just a non-risk sensitive financial leverage. However, the economic capital concept focuses on the capital needed to absorb risks assumed by banks.

All of the aforementioned capital concepts except the concept of economic capital do not help in developing risk- based performance indicators and do not help in risk -based decision making. This study focuses on the risk-adjusted performance derived from the economic capital model according to Basel ii. To the best knowledge of the researcher, there is no any study in the Kingdom have dealt with quantifying the economic capital as per Basel's perspective in order to develop risk-based performance indicators. Therefore, the study attempts to fill this gap in the current literature especially Saudi central bank required banks to use both Standardized and IRB Approaches. SAMA Banking Supervision Department June, 2006

The study is motivated to answer the following questions:

- Is the bank under study undercapitalized or overcapitalized?
- Is the bank under study under provisioning or overprovisioning?

# **Study Objective**

The study aims to compare the estimated credit risks using both the standardized approach under the first pillar of Basel ii and the internal rating -based approach under the second pillar of Basel ii. Whereas the standardized approach focuses on estimating the regulatory capital, while the internal rating -based approach focuses on estimating the economic capital. In addition, the study aims to develop risk-adjusted performance measures based on the outcomes of both approaches. Therefore, the study achieves its objectives by

- Estimating the parameter of probability of default.
- Estimating the parameter of loss given default.
- Estimating the parameter of exposure at default.

- Estimating the value at risk
- Estimating the unexpected losses.
- Estimating the expected losses.
- Estimating the risk -adjusted return on the economic capital.
- Estimating the risk -adjusted return on the regulatory capital.

# 2. Literature Review and Hypotheses Development

# 2.1 Literature Review

Nehrebecka (2023) conducted a study to examine the tail risk in non-performing loans under normal and abnormal circumstances, i.e. before and after Covid 19 and study the impact of sectors concentration on the level of the economic capital. Using the multi-factor structural model, each economic sector is affected to a varying degree by market risks and borrowers' assets in the same sector. The results of the study indicated that increased tail risk of the concentration risk increased the economic capital. While, Yao, Song (2021) conducted a study to investigate the impact of bank size on the level of economic capital in China for the period 2011 to 2019. The results of the study indicated that large state-owned commercial banks have advantages in size, capital and experience compared to medium and small banks. The results found negative correlations between the size of the bank and the level of banks' economic capital.

Krebs, Nipple (2021) Conducted a study to compare estimates of the economic capital to absorb credit risks, considering it equals to unexpected losses based on rules of Basel Convention and the economic capital based on net profits. The results indicated that the economic capital calculated based on unexpected losses is greater than the net profit based economic capital. BARBOZA, et al. (2016) conducted a study to quantify the economic capital using data of PD and LGD for different credit rating. The results indicated that banks can improve their rating based on the credit quality of borrowers by lending to borrowers with low rates of PD and LGD. The study used the simulation method to compare the economic capital of banks with different ratings. Elizaldea, Repullo (2007) conducted a study to analyze determinants of the regulatory capital, the economic capital, and the actual capital. The study used the single factor model under Basel ii. The results indicated that the interest margin - the difference between interest income and the interest expense - and the cost of capital contributed to large deviations between the economic capital and the regulatory capital, while the actual capital was close to the regulatory capital. The results also indicated that banks maintain high regulatory capital as a buffer to absorb losses in future. As for the market discipline, the results indicated that the deposit insurance rate led to an increase in both the economic capital and the actual capital.

Bialas, Solek (2010) Indicated that according to Basel ii, the regulatory capital is calculated to absorb credit risks by multiplying on balance sheet assets and off balance sheet liabilities by 8%. The credit risk can be measured using one of the following three approaches: The standard approach that sets risk weights for assets by the external rating agency, and in the absence of these rating, the regulatory authority determines risk weights, while the Internal Rating-Based Approach (IRB) allows banks to use their internal rating system to assess risks of borrowers and determine the probability of default, provided that the supervisory authority determines the loss given default. The advanced Internal Rating-Based Approach (Advanced IRB) allows banks to

estimate both probability of default and loss given default as explained in the following table.

	Standard Approach	Foundation Internal Rating Based Approach	Advanced Internal Rating Based Approach
Rating	External	Internal	Internal
Estimation of Probability of Default	N/A	By Banks	By Banks
Estimation of Loss Given Default	N/A	By Regulators	By Banks
Estimation of Exposure At Default	N/A	By Regulators	By Regulators
Risk Mitigation For Guarantees and Services Characteristics	By Regulators	By Regulators Via PD, LGD, EAD	By Banks Through PD, LGD, EAD

### Basel Approaches to Measure Credit Risk

Kumarhttps (2023) showed that the emergence of risk-adjusted performance indicators dates back to 1970s for the purpose of identifying risks inherent in loan portfolios and determining the capital required to absorb risks depositors and lenders are exposed to in the event of default , as well as determining the capital required to support the operational activities of banks. Le, et al., (2020) used non-performing loans as a measure of the risk when measuring the riskadjusted efficiency of banks, although this indicator does not reflect the size of the risks. On the other hand, Klaassen, Eeghen (2015) proposed a system for evaluating the performance of banks based on the Du Pont system by combining the return on equity, the return on assets, and the risk-adjusted return on capital. Return on equity completely ignores risks because profits can be accompanied by bearing more risks. In addition, Culp (2000) indicated that the importance of risk-adjusted return indicators has increased as a result of the increase in the competition and the decrease in the margin of the financial intermediation in banks.

In 1970s, Trust Bank proposed the risk-adjusted return to allocate capital on the basis of risk. The risk-adjusted return can be ex ante to allocate capital to absorb risks, and it can be ex post to evaluate the actual performance of banks. However, using this indicator to allocate capital on an ex post basis raises many problems. Rossi (2011) pointed out the importance of the risk-adjusted return on capital to compare the returns and risks for each product in the loan portfolio and recommended that banks should abandon the traditional return on equity in favor of the risk-adjusted performance and banks should invest in data and information technology to make reasonable estimates of the economic capital.

Carter, et al. (2004) conducted a study to evaluate commercial loans' risk adjusted returns, which are calculated by subtracting provisions for doubtful loans and risk-free rates from the gross returns for small and large banks for the period 1996-2001. The results indicated that small banks achieved greater risk-adjusted returns than large banks, after taking into account concentration risks, cost of funds, and other factors affecting returns. Stiroh, (2004) conducted a study on the relationship between the diversification and risk-adjusted performance of small community banks. The results indicated that focusing on activities that generate non-interest income was associated with the decrease in risk-adjusted performance. As the diversity may lead to the involvement of managers in activities that do not have sufficient experience or do not have competitive advantages. The results also indicated that the determinants of risk-adjusted performance in small banks differ from those in large banks. Weisman (2002) pointed out that the concern about risk-adjusted performance was attributed to the investors' need for an effective tool for evaluating performance, taking into account

risks borne by managers and determining the best option for capital allocation. The concern was also due to the fact that the regulatory framework of Basel ii required banks to maintain capital to absorb unexpected losses.

Based on the literature review, risk-adjusted returns takes into account expected losses ignoring unexpected loss that are impacted by the economic cycle - rather than provisions for loan losses shown on the income statement as the expected losses are calculated on the basis of average default rates and recovery rates in the long term. Therefore, expected losses reflect loan losses in the long term rather than the actual losses that are affected by the economic cycle. In addition, the risk-adjusted returns links the risk-adjusted return to the capital at risk.

# 2.2 Hypotheses Development

Based on the literature review and study objectives, the study develops the following hypotheses

- 1. There are no differences between the estimated expected losses and actual allocations for loan losses for the bank under study.
- 2. There are no differences between the regulatory capital and the estimated economic capital for the bank under study.

# 3. Methodology and Empirical Results

# 3.1 Sample and Data

The empirical study is being conducted on Bank Al Jazira in the Saudi Arabia to estimate the economic capital model to absorb credit risks for the period 2018-2022. The necessary data to measure variables of the economic capital model was obtained from the bank's financial statements published on the bank's official website.

# 3.2 Research Method

The research problem should be addressed using the appropriate research method, as the study problem is about quantifying the economic capital based on the requirements of Basel ii. The study did not aim to generalize the results of the bank under study on other banks either in or out of Saudi Arabia. The case study is a flexible research method in the social sciences, as the unit of analysis can be an individual, a group, or a phenomenon of interest **Stake (2000)**. The case study method involves the intensive and detailed study of a situation in the real life, whether quantitative, descriptive, retrospective, prospective, deductive, or inductive in building theory Walshe, et al. (2004). The study adopted the quantitative study method to achieve the objectives of the study and answer the study questions in order to gain a deeper understanding of the study problem, which focused on how to estimate the economic capital model according to Basel ii requirements and develop risk adjusted performance indicator .The study has chosen Bank Al Jazira as the unit of the analysis for the empirical study because the bank has made sufficient disclosures of the credit portfolio in terms of products and risk structures.

# 3.3 Overview on Bank AlJazira

Bank AlJazira was established in 1976 as a joint stock company and commenced its business in October 1976. The bank included (82) branches, (2421) employee and total assets of SAR 115.5 billion in 2022. The bank maintains a diverse loan portfolio in terms of products and

risks. The bank applied the international financial reporting standards, accounting standards issued by the professional organizations related to the accounting and auditing profession in the Kingdom, SOCPA, and the accounting standards issued by the Central Bank of Saudi Arabia known as (SAMA).Bank Allazira manages credit risks by monitoring the value at risk and diversifying lending in terms of products diversity, customers diversity in different economic sectors, setting a maximum limit for the value at risk for the single borrower. In addition, the bank required borrowers to provide additional guarantees in the event of deterioration of borrowers' creditworthiness, and re-estimating the guarantees to determine the adequacy of the allocations for loan losses. Moreover, Bank AlJazira compares the probability of default at the time of granting loans with the probability of default at the date of preparing financial statements for the remaining period of the loan's life to determine the adequacy of loan allocations and the capital adequacy ratio. The bank monitors the credit risk of the borrowers by comparing the probability of default at the end of financial periods with the acceptable probability of default for the previous year to determine the changes in the credit risk through internal, external, quantitative and qualitative, historical and forward looking data from different sources such as borrowers' financial statements, external credit rating agencies, and customer records at the bank to determine the behavior of payments, the rate of utilization of credit facilities, and macroeconomic indicators such as economic growth rate, oil prices, unemployment rate, and inflation rate.

Bank AlJazira classifies its loan portfolio into three stages for the purpose of measuring credit risk as required by IFRS (9) as follows: The first stage includes new loans granted by the bank or purchased from other banks and these loans are low-risk with acceptable probability of default, as the bank builds the allocations for loan losses covering (12) month, in addition, this stage includes loans reclassified from the second stage which witnessed improvements in credit risk. The second stage includes loans that have witnessed an increase in the credit risk and need to be followed up, but have not yet credit impaired, as the bank builds expected credit losses covering the remaining life of the loan. The second stage also includes loans reclassified from the third stage that have witnessed an improvement in their credit risk and are no longer credit impaired. The third stage includes impaired loans and the bank builds allocations for loan losses to cover the remaining life of the loan.

The bank estimates the expected credit losses by estimating the parameters of probability of default, loss given default and the exposure at default as follows: Probability of default, the bank derives the probability of default for all three stages referred to using internal statistical models based on internal and external, historical and forward looking data, guided by Probabilities of defaults specified by Moody's. Loss given default is the potential loss rate in the event of default. Due to data limitation the Bank uses the regulatory LGD benchmarks. The bank uses the ratios approved by the Saudi central bank as per the Foundation Internal Rating Based Approach.

Table(1) showed the distribution of the loan portfolio according to the bank's products, where commercial loans accounted for75% of total portfolio, then consumer loans accounted for 41.4%, and the remaining percentages were distributed among credit cards and others. That is, the loan portfolio is well diversified

	Amounts in Millions	Relative Weight %
Credit Cards	829,400	1.1 %
Consumer	30,362,048	41.4%

### Table (1) Loan Portfolio by Products.

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Commercial	41,820,305	57%
Others	305,901	0.005%
Total	73,317,654	100%

**Source:** The Annual Financial Reporting 2022. P 56 <u>https://www.bankaljazira.com/ar-sa/About-Us/Corporate-Governance/Financial-Reports.</u>

Table No (2) showed distribution of the loan portfolio according to the risk structure, where high quality loans included in the first stage accounted for 91.3% of total loans, while loans that need to be followed up included in the second stage accounted for 3.9%, while high-risk loans included in the third stage accounted for 4.8%. That is, the portfolio is well risk diversified.

## Table (2) Loan Portfolio by Risk Categories.

	Amounts in Millions	Relative Weight %
12 month ECL	66,966,856	91.3%
Life time ECL not credit impaired	2,840,214	3.9%
Lifetime ECL credit impaired	3,510,584	4.8%
Total	73,317,654	100
Source: The Annual Financial Reportin	g 2022. P 57 <u>http</u>	s://www.bankaljazira.com/ar-
sa/About-Us/Corporate-Governance/Fin	ancial-Reports	,

Table (3) showed the geographical distribution of the loan portfolio, where loans granted to the Kingdom's economic sectors accounted for 99.1%, while loans to the rest of the world's countries accounted for 0.9, That is, the loan portfolio is geographically concentrated.

Table (	(3)	Loan	Portfolio	by	Risk	Geograph	hical	Concentratio	ons.
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	Amounts in Millions	Relative Weight %
Kingdom of Saudi Arabia	70029847	99.1%
GCC and Middle East	475,169	0.0067
Other Countries	93,993	0.0013
Total *	70599009	100%
	. 2022 D 110 A	

**Source:** The Annual Financial Reporting 2022. P 110. Amounts net of allowances for loan losses <u>https://www.bankaljazira.com/ar-sa/About-Us/Corporate-Governance/Financial-Reports.</u>

Table (4) showed that the bank developed an internal credit rating system that included (10) levels of probabilities of defaults, corresponding to probabilities of defaults developed by Moody's. The internal credit rating system included (6) probabilities of defaults for good loans in the first stage, while two probabilities of defaults for loans in the second stage, and two levels of probabilities of defaults for the third stage.

Table (4)	Internal	Credit Rating	g by Bank Al	jazira.

Risk Categories	Bank AlJazira Internal Grade (PD)	PD Upper Bound	Mapping to Moody's Master Scale	Moody's Master PD
Low – Fair Risk- First Stage	From 1A to 6A	From 0.010% to 2.300%	From A2 to Ba3	From 0.0109% to 2.8100%

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Watch List- Second Stage	From 7A to 7C	From 8.000% to 100.000%	From B2 to Caa1	From 7.1600% to 17.3816%
Default-Third Stage	From 8A to 9B	100.000%	С	100.000%
Sources The Ar	pupel Einspecial P	operating 2022 D	03 https://www.ba	altaliazina com /an

Source: The Annual Financial Reporting 2022. P 93 <u>https://www.bankaljazira.com/ar-</u> sa/About-Us/Corporate-Governance/Financial-Reports.

## 3.3 Model Specification

The study followed Gordy (2003); McNeil et al. (2015) who defined the credit risk as the losses resulting from the counterpart default. Also the study followed Altman (2006) who suggested the basic variables for measuring credit risk, namely PD, LGD and EAD. According to Jorion and Zhang (2009) it is possible to infer the economic capital model using the parameters developed by Altman (2006). The study used the basic model of Basel ii to quantify the economic capital required to cover credit risks depending on the parameters of both expected losses and unexpected losses.

The Probability of default, It is the probability that the borrower will fail to repay loans in full when are due for payment. The Probability of default is calculated as a percentage based on the borrower's data, including, but not limited to, the current credit rating and the history of the borrower's transactions in the past, in addition to the current market conditions in the borrower's economic environment. The study used the probabilities of defaults developed by the Bank AlJazira as explained in table (4)

The Loss given default, It is the loan losses incurred by the bank in the event of default as banks are unable to recover the principal of the loan by liquidation of the guarantees .Loss given default is calculated using the following formula: 1- the recovery rate, as the recovery rate is the percentage of the principal loans that the bank expects to be recovered by liquidating the guarantees provided by the borrower. The study used the Loss given default ratios set by the regulator in the kingdom as the regulator set 65%, 50%, 50% for credit cards, consumer loans and commercial loans respectively. The global LGD rates, according to the study by JPMC, recorded 40% for more than 3,700 default cases over 18 years using a discount rate of 15%. Araten (2004). The exposure at default, it is the outstanding balance of loans on the default date and it represents the maximum loss that the bank will bear at the time of the borrower's default.

Expected loss is calculated by the following equation

EL=PD\*LGD\*EAD (1)

Whereas: EL refers to expected loss; PD refers to probability of default; LGD refers to loss given default; EAD refers to the exposure at default.

The economic capital can be estimated using the following formula:

EC (L) = VaR  $\alpha$  (L) – EL (2) i.e. Economic capital = value at risk - expected losses.

Whereas: EL Refers to the expected loss; EC refers to the economic capital; value at risk (VaR) refers to the maximum loss within a specific period of time with a specific confidence level as VaR determines the risk tail of the loss and is defined as the size of the loss distribution Jorion (2006);  $\alpha$  refers to the level of confidence.

The study used the Monte Carlo simulation procedure to infer the loss distribution and the model generates loan portfolio loss distribution, which is divided into expected losses and unexpected losses. The study used Monte Carlo Simulations to quantify the economic capital. According to Antwi , et al. (2014) Monte Carlo Simulations had some advantages such as it accurately determines the latent confusion in the loan portfolio, it takes into account all the different risk characteristics of the loans in the portfolio, and it also enables obtaining the total losses of the portfolio, i.e. the value at risk.

Table (5) includes the value of all variables of estimating the expected credit losses for each risk level for each year separately for the period 2018-2022.

	<b>Risk Levels</b>	EAD	LGD	PD
2022	Low Fair Risk	66966856	0.65	0.04
2022	Watch List	2840214	0.5	0.08
2022	Default	3510584	0.5	100%
2021	Low Fair Risk	57840055	0.65	0.04
2021	Watch List	3429865	0.5	0.08
2021	Default	3802553	0.5	100%
2020	Low Fair Risk	48369969	0.65	0.04
2020	Watch List	4292091	0.5	0.08
2020	Default	3120959	0.5	100%
2019	Low Fair Risk	43319278	0.65	0.04
2019	Watch List	3862170	0.5	0.08
2019	Default	3080292	0.5	100%
2018	Low Fair Risk	35768046	0.65	0.04
2018	Watch List	4433404	0.5	0.08
2018	Default	1197813	0.5	100%

Table (5) Parameters of Estimating Expected Losses and the Economic Capital.

Source: Calculated By the Authors.

# 3.4 Analysis of Results

The study used R software to estimate the expected credit losses and then estimating the economic capital model as R software is considered one of the precise statistical programming languages due to its ability to deal with data processing, display, and statistical analysis. Here are the Steps of analysis using R software:

In our analysis of Expected Credit Loss (ECL) across different years, we employed R, a powerful statistical computing environment, to execute a comprehensive Monte Carlo simulation study. This approach enabled us to delve into the variability and risk profile of the credit portfolio for the period 2018 to 2022. The study used R software in this analysis as follows:

- Data Preparation: Organizing data for each year, including Exposure at Default (EAD), Loss Given Default (LGD), and Probability of Default (PD) for different risk levels.
- Monte Carlo Simulation Setup: Deciding on the number of simulations (1000 in this case) and determining or assuming the standard deviations for PD and LGD.
- Execution of the Simulation: Running the simulations for each year, where random

samples for PD and LGD are generated, and ECL is calculated for each risk level and aggregated for each iteration.

- Confidence Interval Calculation: After running all simulations, calculating the mean ECL and determining the confidence intervals at 99.8 by finding the appropriate percentiles in the distribution of simulated ECLs.
- Result Compilation: Organizing the mean ECL and confidence intervals for each year into a table format, as shown in table (6)

Table (6) showed results of the estimated economic capital model as results from the Monte Carlo simulations for each year for the period 2018 - 2022 provided valuable insights into the expected credit loss (ECL) and its variability. The mean ECL generally increases from 2018 to 2022. This trend could indicate a growing exposure or increasing risk in the portfolio over time, possibly due to changes in portfolio composition, market conditions, or risk profile. On the other hand, the unexpected losses i.e. the standard deviation of the loss distribution reflected the economic capital which was sensitive to the interval level.

Year	Expected losses	Unexpected losses (Economic Capital)	VAR (Value At-Risk)	CI 99.8% (0.1% - 99.9%)	CI 98.5% (7.5% - 92.5%)	CI 95.5% (22.5% - 77.5%)
2022	3 598 628	313 617	3 012 245	2,363,104 -	2,991,072 -	3,266,055 -
2022	5,570,020	515,017	5,712,245	4,917,046	4,217,405	3,912,403
2021	3 533 772	305 345	3 839 117	2,400,032 -	2,979,834 -	3,237,129 –
2021	5,555,772	505,545	5,659,117	4,557,231	4,104,166	3,823,367
2020	3 001 673	248 180	3 249 853	2,098,749 –	2,537,666 -	2,761,365 -
2020	3,001,075	240,100	5,249,655	4,031,433	3,471,414	3,237,230
2010	2 822 115	240.657	3 072 072	1,860,947 –	2,389,937 -	2,598,775 –
2019	2,022,415	249,037	3,072,072	3,668,938	3,276,890	3,044,366
2018	1 607 657	130 703	1 937 450	1,116,207 -	1,384,300 -	1,537,930 -
2010	1,097,037	159,795	1,057,450	2,282,511	2,018,513	1,860,228

## Table (6) Results of the Economic Capital Model.

R Software Outputs %99.8 Confidence Intervals.

Results were sensitive to confidence interval as shown below

Confidence Level (99.8%):

• This indicates a high degree of certainty about the interval. It suggests that if we were to take many samples and calculate the 99.8% CI for each, approximately 998 out of 1,000 of these intervals would be expected to contain the true population parameter.

Range (0.1% - 99.9%):

- The lower bound (0.1%) and upper bound (99.9%) of the interval represent the percentiles in the distribution of the sample data.
- The 0.1% mark is very close to the minimum value in the sample data, while the 99.9% mark is very close to the maximum.
- This means that the 99.8% CI is calculated by excluding the extreme 0.1% of data on both ends of the distribution. This interval will be wider than lower confidence intervals (like 95% or 98.5%) to account for this high level of certainty.

Confidence Level (98.5%):

• This CI suggests a high level of confidence. It implies that if we were to take many samples and calculate a 98.5% CI for each sample, about 985 out of 1,000 of these intervals would contain the true population parameter.

Range (7.5% - 92.5%):

- The lower bound of the CI starts at the 7.5th percentile, and the upper bound ends at the 92.5th percentile of the sample data.
- It means that the 98.5% CI is calculated by excluding the lowest 7.5% and the highest 7.5% of the data points in the distribution, making it narrower than the 99.8% CI but wider than the 95.5% CI.

Confidence Level (95.5%):

• This is a standard level of confidence used in many statistical analyses. It indicates that in about 955 out of 1,000 samples, the CI would contain the true population parameter.

Range (22.5% - 77.5%):

- Here, the lower bound is the 22.5th percentile, and the upper bound is the 77.5th percentile of the sample data.
- This interval excludes the lowest and highest 22.5% of the data points. The 95.5% CI is narrower than both the 98.5% and 99.8% CIs, reflecting a balance between confidence and the width of the interval.

Results Are Represented Using Bell-Shaped Distribution as Follows:



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Table (7) showed that the bank had expected losses greater than the actual allocation for loan losses by the bank i.e. the bank should have increased the allocations for loan losses from the bank's revenues over the study's period. That is, the bank was under Provisioning.

 Table (7) Expected Credit Losses Vs Actual Allocations for Loan Losses

Year	Expected losses	Actual allocations for loan losses	Under Provisioning
2022	3,598,628	2718645	879,983
2021	3,533,772	2637997	895,775

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2020	3,001,673	2192997	808,676
2019	2,822,415	1009167	1,813,248
2018	1,697,657	933505	764,152

R software outputs & the bank annual financial statements.

#### 3.5 Risk Adjusted Return on the Economic Capital

The risk-adjusted return on capital (RAROC) is one of the most important risk-adjusted performance indicators, as it is based on concept of the economic capital. As the study calculated the risk-adjusted return on capital (RAROC) as follows:

 $RAROC=EI-(OE+IE)-EL/EC \quad (3)$ 

Whereas: RAROC= risk-adjusted return on capital; EI =Expected income from interest income generated by the investment. OE =Operating expense included all expenses assumed by banks except interest expenses and the allocation for loan losses. IE refers to interest expenses paid on bank's deposits and interest -bearing liabilities. EL =Expected losses. EC = Economic capital based on the economic capital model. Table (8) showed that the study used the ratio of net loan portfolio to total assets as the basis to allocate the operating expenses to loan portfolio to calculate the risk adjusted return on the economic capital as explained in table (8).

	2022	2021	2020	2019	2018
Loans –net of Allowance	70599009	62434476	53961211	49660119	40896891
Assets	115848797	102827321	92088874	86544344	73003198
Loans/assets %	0.6094065	0.6071779	0.585969	0.573811	0.560207
Operating expenses	1,919,366	1769889	1696460	1711064	1626026
Allocated Operating expenses	1169661	1074637.5	994072.7	981827.8	910910.9

Table (8) Allocating Operating Expenses to the Credit Portfolio

Author's Calculations

The bank did not disclose interest income on loan portfolio or interest expenses on the loan portfolio separately. Therefore, for the purpose of measuring the risk-adjusted return on economic capital, the study assumed that the bank achieved a net interest margin of 7%, i.e. the difference between the interest rate on loans and the interest rate on deposits. The proposed interest margin suits the case of Saudi banks, as most sources of funds are non -interest-bearing funds. Table (9) indicated that the bank achieved positive, risk-adjusted returns on the economic capital for 2018 and 2022, while it achieved negative returns during 2019, 2020, and 2021.

Table (9) Risk - Adjusted Performance Indicator Based on the Economic Capital

Tuble ()) Hisk Hujusted Ferrormanee meneator based on the Economic Capital						
Items	2022	2021	2020	2019	2018	
Loan Portfolio-Net of Allowance	70599009	62434476	53961211	49660119	40896891	
Net Interest Income (%)	7%	7%	7%	7%	7%	
Net Interest Income	4941931	4370413	3777285	3476208	2862782	
Operating Expenses	1169661	1074638	994072.7	981827.8	910910.9	
Net Operating Income Before Expected Losses	<b>3,</b> 772 <b>,</b> 270	3,295,776	2,783,212	2,494,381	1,951,871	

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Expected Loss	3,598,628	3,533,772	3,001,673	2,822,415	1,697,657
Risk Adjusted Return	173,642	-237,996	-218,461	-328,034	254,214
Economic Capital	313,617	305,345	248,180	249,657	139,793
Risk Adjusted Return on Capital (RAROC)	0.553674	-0.77943	-0.88025	-1.31394	1.818506

Source: Researcher's Own Calculations.

Table (10) showed the results of measuring risk-adjusted returns based on the regulatory capital using actual loan provisions calculated by the bank instead of expected losses derived from simulations and using the regulatory capital of 8% as per Basel regulations instead of the economic capital derived from the model. The results indicated that the bank achieved positive returns over the study period.

 Table (10)
 Non-Risk -Adjusted Performance Indicator Based on the Regulatory Capital.

				0	
Items	2022	2021	2020	2019	2018
Loan Portfolio-Net of	70599009	62434476	53961211	49660119	40896891
Allowance					
Net Interest Income (%)	7%	7%	7%	7%	7%
Net Interest Income	4941931	4370413	3777285	3476208	2862782
Operating Expenses	(1169661)	(1074638)	(994072.7)	(981827.8)	(910910.9)
Net Operating Income	3 772 270	3 295 776	2 783 212	2 494 381	1 951 871
Before Expected Losses	5,772,270	5,275,770	2,705,212	2,171,301	1,751,071
Allocation for loan losses	(2,718,645)	(2,637,997)	(2,192,997_	(1,009,167)	(933,505)
Non Risk Adjusted Return	1,053,625	657,779	590,215	1,485,214	1,018,366
Regulatory Capital 8%	5647921	4994758	4316897	3972810	3271751
Non risk Adjusted -Return or	<sup>1</sup> 0.186551	0 131694	0 136722	0 373845	0.31126
regulatory Capital	0.100331	0.131094	0.130/22	0.373643	0.51120
0 D 1 1 0 0	1 1 .				

Source: Researcher's Own Calculations.

Table (11) indicated that under the standard approach using the concept of regulatory capital, the bank maintained allocations for loan losses and regulatory capital greater than sum of the expected losses and economic capital derived from the economic capital model, as the regulatory authorities required banks to maintain greater capital than internal capital to absorb credit risks to protect depositors. Comparative results indicated that under the concept of economic capital the bank had expected losses greater than the allocations for loan losses and economic capital less than the regulatory capital.

1 able (11)	Standardized App	roach vs IKD E	Approach.
	Allocations for	Regulatory	Evn

	Allocations for loan losses	Regulatory capital	Total	Expected losses	Economic capital	Total
2022	2718645	5647921	8366566	3,598,628	313,617	3,912,245
2021	2637997	4994758	7632755	3,533,772	305,345	3,839,117
2020	2192997	4316897	6509894	3,001,673	248,180	3,249,853
2019	1009167	3972810	4981977	2,822,415	249,657	3,072,072
2018	933505	3271751	4205256	1,697,657	139,793	1,837,450

Source: Researcher's Own Calculations.

# 3.6 Discussions and Conclusions

This study aimed to estimate the economic capital model to develop risk adjusted return on the economic capital and compare the results with the regulatory capital under the standardized approach. As there are many concepts of capital in banks. The accounting capital refers to shareholders' equity reported in the equity section on the balance sheet. The regulatory capital refers to the capital whose components are determined by the regulatory authorities, as it includes accounting capital in addition to some other elements. The economic capital refers to the capital required to absorb risks to protect against banks' default. The use of accounting capital and regulatory capital to measure performance from risk perspectives did not protect the banking system against collapse and they did not distinguish between risks and losses. Therefore, Basel ii Accord required banks to calculate both economic capital and regulatory capital in parallel. The study used the case study method because the objective of the study is to get in- depth understanding of concepts of the economic capital and the regulatory capital and their calculations and uses. The empirical study conducted on Bank AlJazira to estimate the economic capital model for the period 2018-2022. The study used R software and Monte Carlo simulations to estimate parameters of the economic capital model. R software and Monte Carlo simulation generated expected losses which should be covered by interest rate margin by estimating parameters of probability of default, loss given defaults and exposure at default then calculating the unexpected loss losses by generating losses distributions.

The trend indicated that there was an increase in credit risks during the years of study as per the standard deviation values which reflect the unexpected losses i.e. the economic capital needed to absorb the credit portfolio risk. In addition, the expected losses measured by the mean increased over the study's period due to the increase in the credit portfolio volume. The study used expected losses and unexpected losses to develop risk adjusted returns on the economic capital. The results indicated that the bank realized positive risk adjusted returns on the economic capital in 2018, 2022. However, the bank realized negative risk adjusted returns on the economic capital in 2019, 2020, and 2021. For comparison purposes, the study calculated risk adjusted returns on the regulatory capital and compare the results with risk adjusted returnes on the economic capital. The results showed that the bank realized positive returns on the regulatory capital over the study period. That is, returns on the regulatory capital were risk insensitive. The bank had greater regulatory capital than the economic capital but had allocations for loan losses less than the estimated expected losses. It can be inferred that banks keep greeter regulatory capital to protect depositors and creditors. Based on the study results, the study rejected null hypotheses and accepted the alternative hypotheses as there are differences between the levels of the estimated capital and provisions for loan losses under the concept of economic capital and the regulatory capital.

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