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The Relationship between Risk and Term Structure of Interest Rates in the Nigerian Bond Market

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ABSTRACT

This study investigates the impact of risk on the term structure of interest rates of 3-year federal government Sukuk bonds in Nigeria. Time series data from 1990 to 2021, obtained from the Central Bank of Nigeria Statistical Bulletin, publications of the Nigeria Bureau of Statistics, and the Nigeria Debt Management Office, are used in the analysis. The yield on federal government Sukuk bonds is modeled as a function of various risk factors, including liquidity risk, interest rate risk, exchange rate risk, and default risk. The analysis employs ordinary least squares regression, cointegration analysis, granger causality tests, unit root tests, and vector error correction models. The findings of the study reveal that 69.4% of the variations in federal government Sukuk bond yields can be explained by the variables included in the model. The lag selection procedure supports the use of a lag of one period. At this lag, the study finds a positive relationship between the variables and the yield of federal government Sukuk bonds. Consequently, the study concludes that risk factors significantly influence the yield of bonds in the Nigerian bond market. Based on the findings, it is recommended that the Nigerian bond market ensures that the security exposures of bonds are adequately protected through careful scrutiny of investors. This will help mitigate the risks associated with different bonds in the Nigerian bond market.

1. INTRODUCTION

The business environment is inherently risky due to uncertainties in the operating environment. Risks can arise from systemic factors within the business (systemic risk) or from external factors (unsystematic risk). The cost of bearing risk is a crucial consideration for corporations as it influences various financial policy decisions such as capital structure, dividend policy, investment, capital budgeting, and hedging strategies (Hawkins, 2002). According to classical economists, the interest rate plays a key role in balancing investment demand and saving willingness (Umoh, 2003).

The bond market is a dynamic investment channel (NCMSO, 2015) that depends on several factors, particularly the viability of the primary (new issue) market, which affects the liquidity of the secondary market (Mu, Phelps, & Stotsky, 2013). The primary bond market serves the dual function of promoting a savings culture and facilitating investment, while the secondary market provides a foundation for price discovery for subsequent capital issues (Onaolapo & Adebayo, 2010). The development of the primary bond market is crucial for capital formation and industrial development. Corporate bond finance offers multiple benefits to issuers, investors, and the public interest, including mutual gains for global investors (Tendulkar, 2015). The growth of a country's bond market depends on the efficiency of institutions such as regulators and the judiciary system (Giesecke, et al., 2011). Reducing information asymmetry is essential for promoting direct finance culture and fostering industrial growth. Direct financing has the advantage of lower transaction costs for investors compared to the indirect market, where higher intermediation fees are incurred.

Variance bounds tests are a conceptually appealing approach to studying the relationship between short-term and long-term interest rates. The term structure relation expresses the long-term interest rate as a weighted average of current and expected short-term rates, implying that the variance of the long rate is bounded by the variance of the short rate. Variance bounds tests utilize the variance of the short rate or the variance of the perfect foresight long rate as upper bounds on the variance of the long rate or the

expected holding period yield. Economists and policymakers have long been interested in understanding the relationship between risks and the term structure of interest rates across different maturities. The expectations theory of the term structure is the most commonly discussed explanation, stating that in equilibrium, expected returns from different investment strategies with the same horizon should be equal (Nwiado & Deekor, 2013). This theory suggests that long-term rates can be expressed as a weighted average of current and expected short-term rates and highlights the importance of policymakers influencing market expectations of future interest rates to impact long-term rates.

Inadequate matching of long-term assets with long-term debt financing can negatively impact firms' and households' long-term investment decisions. Financing long-term investments with short-term debt exposes borrowers to balance sheet mismatches between their assets and liabilities. However, short-term bonds can contribute to the overall development of the domestic bond market by allowing for bond recycling or restructuring. On the other hand, if firms rely on borrowing from international bond markets to compensate for the lack of a domestic bond market, they may expose themselves to excessive foreign exchange risk (Dickie & Fan, 2015). Additionally, as bond markets become more liquid, the cost and reliability of hedging maturity risks improve (Fink, Haiss, & Hristoforova, 2003). The simplified example above characterizes developed financial markets with lower market imperfections compared to Nigeria, where market imperfections are more prevalent. This study aims to examine the relationship between risk and the term structure of interest rates in the Nigerian bond market.

2. LITERATURE REVIEW

2.1 Conceptual Review

2.1.1 Risk

Risk refers to the potential that a chosen action or activity, including the choice of inaction, may result in a loss. It implies that a decision can influence the outcome, and the potential losses themselves are considered risks (Ahmed, 2013). In the context of business, risks can arise from various sources, including market risk, which involves the risk of losses due to market movements (Ahmed, 2013). Sensitivity analysis and scenario analysis are methods used to measure and prepare for risks. Sensitivity analysis examines how uncertainties in the model inputs affect the model's output, while scenario analysis involves analyzing possible future events and their potential outcomes (Ahmed, 2013).

2.1.2 Interest Rate Risk

The allocation of interest rate risk plays a role in the transmission of monetary policy. If banks bear the interest rate risk, changes in interest rates affect their net worth and, consequently, the supply of loans through the bank balance sheet channel (Bernanke and Gertler, 1995; Jiménez et al., 2012). On the other hand, if households and firms bear the interest rate risk, monetary policy affects consumption and investment through borrowers' balance sheets (Auclert, 2017; Di Maggio et al., 2017; Ippolito et al., 2018). The allocation of interest rate risk also has implications for financial stability.

2.1.3 Inflation Rate

Inflation is a vital macroeconomic indicator used to analyze the economic conditions of an economy. Several studies have examined the relationship between inflation and stock prices. Fama (1990) suggested that macroeconomic variables have predictive power for stock market performance. Agawam (1981) and Soenen and Hennigar (1988) investigated the relationship between inflation rates and stock prices.

2.1.4 Bond Market

The bond market is a component of the financial market where participants can issue new debt securities (primary market) or buy and sell existing debt securities (secondary market) (SIFMA, 2011). The bond market serves the purpose of providing long-term funding for public and private investments and expenditures. It consists of different categories, including corporate bonds, government/agency bonds, municipal bonds, mortgage-backed securities, and collateralized debt obligations (Ogilo, 2014). The participants in the bond market include government entities, corporate bodies, individuals, institutional investors, and traders. Bond market instruments include bills, notes, and other types of bonds.

2.1.5 Nigeria Bond Market

The bond market in Nigeria, like in other countries, comprises primary and secondary markets. The primary market allows borrowers to raise funds by issuing securities to investors, while the secondary market enables investors to restructure their investments. The bond market plays a crucial role in bringing issuers and investors together, facilitating the flow of long-term funds at the right price (Okumagba, 2006). The efficiency of bond markets is characterized by a competitive market structure, low transaction costs, low levels of fragmentation, a robust market infrastructure, and a diverse range of market participants (APEC, 1999). In Nigeria, two major types of bonds are traded: corporate bonds and government bonds. Historically, corporate bonds have had higher yields compared to government bonds due to their riskier nature (Al Faki, 2007). However, the trend has reversed in recent years, indicating the dominance of government bonds in the Nigerian bond market.

2.2 Theoretical Framework

2.2.1 Term Structure Theory

The term structure theory focuses on the relationship between yields and changes in yields of bonds with different maturities. It provides insights into why long-term bonds offer different yields compared to short-term bonds and helps predict the future outlook of the long-term bond market and inflation patterns (Ackley, 1978; Hull, 2009). Interest rates summarize the repayment terms of bonds or loans and vary based on characteristics such as creditworthiness, tax treatments, maturities, and macroeconomic forces (Dornbusch et al., 2011).

The behavior of the term structure has a significant impact on bond pricing and is crucial for successful bond issuance. Generally, bond prices are negatively related to market interest rates. As interest rates increase, the present value of a bond's cash flow decreases, resulting in a lower bond price, and vice versa (Chandra, 2005). In a competitive securities market, fluctuations in interest rates can lead to capital gains or losses for bondholders.

2.2.2 Keynesian Theory

The Keynesian theory assumes an equilibrium with less than full employment and considers interest rates as a reward for parting with liquidity. According to this theory, the demand and supply of money determine interest rates. The supply of money is controlled by monetary authorities, while the demand for money depends on income and interest rates. The theory suggests that low interest rates, as a cost component, discourage savings and investment (Anyingang & Udoka, 2012).

Keynesian theory argues that increasing the real interest rate positively affects savings, leading to increased investment. Higher interest rates incentivize individuals with excess liquidity to save, allowing banks to lend more to investors for productive investment. However, the theory also introduces the concept of a liquidity trap, where low interest rates discourage savings and reduce investments due to a lack of investable funds.

The Keynesian theory considers interest rates as a monetary phenomenon that links the present and the future. It departs from the assumption of full employment and takes into account the relationship between income, savings, and investment. However, opponents criticize it for being indeterminate, incomplete, inadequate, and unrealistic as a theory of interest rates.

2.2.3 Preferred Habitat Theory

The preferred habitat theory proposes that the interest rate for a given maturity depends on the preferences of investors for specific maturity segments. It suggests that there are investor clienteles for different maturity segments, and interest rates are influenced by shocks that affect the demand of these clienteles. This theory recognizes a degree of segmentation in the term structure (Culbertson, 1957; Modigliani & Sutch, 1966).

The preferred habitat view has been used to explain various market episodes. For example, in the 2004 U.K. pension reform, pension funds purchased long-maturity bonds to hedge against drops in long rates, leading to record low levels. This behavior was driven by the preferred-habitat view, as pension funds had to evaluate their pension liabilities using long-maturity bond yields. The theory also informed decisions by major central banks to engage in quantitative easing (QE), where large-scale purchases of long-maturity bonds aimed to drive down long rates and stimulate corporate investment.

2.3 Empirical Review

Several empirical studies have examined the relationship between risk management and financial performance in different contexts. The findings of these studies shed light on the impact of risk management practices on shareholder value and investment decisions. Here is a summary of some of these studies:

Hoque, Rakhi, Hassan, and Le (2020) conducted a study in Malaysia using the capital asset pricing model and non-parametric stochastic dominance approach. They compared the performance of Islamic and Conventional Stock Portfolios across five industrial sectors and the overall market. The study found that both portfolios had equal productivity in the market. However, the Islamic Stock Portfolio had a higher return with a lower systematic risk, confirming the principles of Markowitz's Modern Portfolio Theory.

Iwedi, Oriakpono, Barisua, and Zaagha (2020) investigated the effects of business risks and risk management on shareholder value using data from non-financial firms in the Nigerian Stock Exchange. The study found that increased business risk lowered both dividend per share and earnings per share of the firms. On the other hand, financial risks were shown to have a positive impact on shareholder value, particularly on the value not related to dividend payout. The study also highlighted the effectiveness of risk management based on institutional shareholding in creating shareholder value.

Beasley et al. (2018) examined the benefits of enterprise risk management by analyzing the stock market reactions to the adoption of enterprise risk management practices. They found that the appointment of a Chief Risk Officer or equivalent did not result in a significant stock price reaction for the overall sample of companies. However, after a cross-sectional analysis, they observed that firms in non-financial industries were more likely to have a positive stock price reaction around the adoption of enterprise risk management.

Teoh et al. (2017) investigated the impact of enterprise risk management on the performance of Malaysian public listed firms. The study used survey research and found that enterprise risk management implementation had a positive impact on firm performance.

However, the study also highlighted the need for more oversight from regulatory authorities in the implementation of risk management practices.

Ohiorenoya et al. (2016) analyzed the risk-return dynamics of quoted stocks in the Nigerian stock market across different sectors. They found that the size of the risk and return varied among sectors and changed differently but directly with the size of returns. The study emphasized the importance of understanding the risk-return characteristics of stocks in different sectors for rational investment decisions.

Tendulkar (2015) examined the domestic and international bond markets of 62 emerging market economies. The study found mixed results regarding the impact of interest rate spread on bond market development. Negative impacts were observed in the international bond market under certain categorizations, while a positive impact was found in the domestic market's activity category.

Manab and Ghazali (2013) examined the effectiveness of enterprise risk management practices in creating shareholder value for Malaysian public listed companies. Their analysis focused on financial characteristics and the influence of financial ratios and risk management on shareholder wealth. The study found that different financial ratios and risk management factors were significant for financial and non-financial companies. The effectiveness of risk management in boosting shareholder value was found to be more pronounced in financial firms.

Eduardus et al. (2007) conducted a study to investigate the effect of risk management on bank performance. They used both primary and secondary data analysis and found that the relationship between corporate governance, risk management, and bank performance depended on the type of bank ownership. The study highlighted the sensitivity of these relationships to different ownership structures.

3. METHODOLOGY

The study adopts a quasi-experimental research design since the variable under study cannot be manipulated and is not under the control of the researcher. The study utilizes secondary data from the Central Bank of Nigeria, specifically the Financial Stability Report. The data collected is time series data, covering the period from 1990 to 2022.

The Augmented Dickey Fuller (ADF) unit root test was used to test the stationarity property of the time series data. The null hypothesis is that the series has a unit root, and the alternative hypothesis is that the series is stationary. The test statistic is compared against the critical values to determine whether to reject or fail to reject the null hypothesis. Furthermore, the study employs the Johansen's and Juselius (1990) and Johansen (1991) multivariate cointegration technique to test for the presence of a long-run equilibrium relationship among the variables. The test determines whether the variables can cointegrate or not. The cointegration test is based on a specified equation, and the results are interpreted to identify a cointegrating relationship. The Granger causality test was used to investigate the presence and direction of causality between risk and the term structure of interest rates in the Nigerian bond market. The test determines whether one variable causes the other or if there is a bi-directional causality. The coefficients of the variables in the equation are analyzed for statistical significance to identify the presence and direction of causality. Based on financial theories and empirical results, the variables are expected to have a positive effect on the dependent variable. Mathematically, this is expressed as NBM = f (LQR, INR, EXR, DFR, DGR) > 0. The model specification is as follows:

$$NBM = \beta_0 + \beta_1 LQR + \beta_2 INR + \beta_3 EXR\ \beta_4 DFR + \beta_5 DGR + \mu$$

Where

NBM = Yield on Nigeria bond Market

LQR = Liquidity risk measured by variation in rate of money supply

INR = Interest rate risk measured by variation in real interest rate

EXR = Exchange rate risk measured by variation in exchange rate of Naira per US Dollar

DFR = Default risk measured by anticipated return on a bond minus the return a similar risk-free investment would offer

DGR = Downgraded risk measured by dummy variable of 1 for downgraded and 0 for no downgrade

$\beta 0$= Constant

$\beta_1 - \beta_5$ = Coefficients of independent variables

μ_{it} = Error Term

4. RESULTS AND DISCUSSION

Table 1: Unit Root Test

Variable		1% critical value	5% critical value	10% critical value	Order of integration	Summary
	ADF at level					
NBM	-4.619928	-3.661661	-2.960411	-2.619160	1(1)	Stationary
DFR	-4.634953	-3.752946	-2.998064	-2.638752	1(1)	Stationary
DGR	-2.668066	-3.689194	-2.971853	-2.625121	1(0)	Stationary
EXR	-1.221569	-3.661661	-2.960411	-2.619160	1(0)	Not Stationary
LQR	-3.194750	-3.661661	-2.960411	-2.619160	1(0)	Not Stationary
INR	-3.380101	-3.661661	-2.960411	-2.619160	1(0)	Not Stationary
ADF at Difference						
NBB	-5.749617	-3.769597	-3.004861	-2.642242	1(1)	Stationary
DFR	-6.898034	-3.679322	-2.967767	-2.622989	1(1)	Stationary
DGR	-11.06884	-3.689194	-2.971853	-2.625121	1(1)	Stationary
EXR	-6.718217	-3.679322	-2.967767	-2.622989	1(1)	Stationary
INR	-9.842100	-3.679322	-2.967767	-2.622989	1(1)	Stationary
LQR	-11.56192	-3.679322	-2.967767	-2.622989	1(1)	Stationary

Extract from E-view 9.0

The unit root test is conducted to determine the stationarity of the time series. The null hypothesis in these tests is that the underlying process generating the time series is non-stationary, while the alternative hypothesis is that the time series is stationary. If the null hypothesis is rejected, it indicates that the series is stationary (integrated to order zero). Conversely, if the series is non-stationary, it is integrated to a higher order and needs to be differenced until it becomes stationary (Gujarati, 2003).

Upon examining the results presented in Table 1, it is observed that all the variables are not stationary in levels. This implies that the null hypothesis of non-stationarity cannot be rejected, and the time series need to be differenced. Subsequently, the same tests are performed on the first difference of the time series. The test results, as shown in the table, indicate that the null hypothesis is rejected for all the variables. This implies that all the variables become stationary at their first difference and are integrated of order zero, denoted as I(0). Therefore, further differencing is not required for these variables (Gujarati, 2003). In summary, the unit root tests confirm that the variables are non-stationary in their original form but become stationary when differenced once. Consequently, the variables are integrated of order 1(1), indicating that they are stationary at the first difference level.

Table 2: Co-integration Test

Series: NBM INR LQR EXR DGR DFR

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.752741	121.4243	95.75366	0.0003
At most 1 *	0.717304	79.50472	69.81889	0.0069
At most 2	0.473832	41.60322	47.85613	0.1701
At most 3	0.314809	22.33918	29.79707	0.2800
At most 4	0.274616	10.99745	15.49471	0.2117
At most 5	0.044507	1.365840	3.841466	0.2425

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.752741	41.91959	40.07757	0.0307
At most 1 *	0.717304	37.90150	33.87687	0.0156
At most 2	0.473832	19.26404	27.58434	0.3944
At most 3	0.314809	11.34174	21.13162	0.6132
At most 4	0.274616	9.631606	14.26460	0.2373
At most 5	0.044507	1.365840	3.841466	0.2425

Source: Extract from E-view 9.0

Table 2 presents the test statistics for the unit root tests. Upon examining the reported test results in Table 2, it is evident that the test statistics exceed the critical values, both with and without trend, as indicated in table 4.3. This implies that the variables in question are co-integrated, indicating the necessity for an error correction model (ECM) (Gujarati, 2003). In summary, the results from the unit root tests, as shown in Table 2, indicate that the variables are co-integrated, as the test statistics surpass the critical values. Therefore, an error correction model should be employed to account for the co-integration among the variables.

Table 3: Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.	Summary
INR does not Granger Cause NBM	30	2.01683	0.1542	No causality
NBM does not Granger Cause INR		2.11234	0.1420	No causality
LQR does not Granger Cause NBM	30	1.14656	0.3339	No causality
NBM does not Granger Cause LQR		0.16203	0.8513	No causality
EXR does not Granger Cause NBM	30	9.50836	0.0008	causality
NBM does not Granger Cause EXR		0.07328	0.9295	No causality
DGR does not Granger Cause NBM	30	0.32738	0.7239	No causality
NBM does not Granger Cause DGR		0.09617	0.9086	No causality
DFR does not Granger Cause NBM	30	0.08353	0.9201	No causality
NBM does not Granger Cause DFR		1.84683	0.1786	No causality

Source: Extract from E-view 9.0

Table 3 provides a summary of the causal relationships among the variables. The analysis reveals that, except for a uni-directional causality from exchange rate risk to the yield on federal government sukku bond, there is no evidence of a causal relationship among the variables (Gujarati, 2003). Based on the results presented in Table 3, it can be concluded that the variables do not exhibit significant causal relationships with each other, except for the finding that exchange rate risk influences the yield on federal government sukku bond in a one-way direction.

Table 4: Error Correction Model and lag selection Criteria

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NBM(-1))	-0.097032	0.473644	-0.204864	0.8403
D(NBM (-2))	-0.327967	0.343633	-0.954411	0.3541
D(NBM (-3))	0.028943	0.271320	0.106673	0.9164
D(INR(-1))	0.004654	0.002566	1.814050	0.0885
D(INR(-2))	-0.000948	0.002146	-0.441972	0.6644
D(INR(-3))	0.000131	0.002552	0.051482	0.9596
D(LQR(-1))	0.002649	0.001257	2.108135	0.0511
D(LQR(-2))	-0.000190	0.001334	-0.142600	0.8884
D(LQR(-3))	-0.000769	0.001236	-0.621971	0.5427
D(EXR(-1))	0.001312	0.001219	1.076582	0.2976
C	-0.040284	0.022197	-1.814860	0.0883
ECM(-1)	-1.384217	0.546582	-2.532498	0.0222
R-squared	0.818703	Mean dependent var		-0.008571
Adjusted R-squared	0.694061	S.D. dependent var		0.168473
S.E. of regression	0.093185	Akaike info criterion		-1.610927
Sum squared resid	0.138936	Schwarz criterion		-1.039982
Log likelihood	34.55297	Hannan-Quinn criter.		-1.436383
F-statistic	6.568434	Durbin-Watson stat		2.179592
Prob(F-statistic)	0.000431			
Endogenous variables: NBM INR LQR EXR DGR DFR				

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-659.6471	NA	7.55e+11	44.37648	44.65672	44.46613
1	-594.4506	99.96804*	1.14e+11*	42.43004*	44.39172*	43.05760*
2	-560.5995	38.36459	1.80e+11	42.57330	46.21641	43.73876

Source: Extract from E-view 9.0

The ECM results, as presented in Table 4, demonstrate the equilibrium structure of the over-parameterized error correction model (ECM 1). The estimated error correction models exhibit a good fit, indicated by an R-squared value of 0.694061. This implies that approximately 69.4% of the variations in federal government sukku bonds are explained by the variables included in the model. Furthermore, the Durbin Watson (DW) statistic is used to assess the presence of positive first-order serial correlation in the estimated models. In this case, the computed Durbin Watson value of 2.179592 surpasses the tabulated value of 1.900. This indicates that the estimated models are free from the issue of positive first-order serial correlation.

The f-statistic was employed to determine the overall statistical significance of the model. The f-calculated value of 6.568434 exceeds the f-tabulated value of 2.42 at a 95% confidence level, demonstrating that the model is statistically significant. In addition to these diagnostic statistics, the error correcting terms exhibit the expected negative signs, in line with theoretical predictions. This suggests that the error correction mechanism is appropriately capturing the adjustments from short-run disequilibrium to long-run equilibrium. The lag selection process validates the application of lag I. Based on this lag selection, the study finds that the variables are positively related to federal government sukku bonds within the time scope of the study.

To summarize, the ECM results indicate a well-fitting model with a high explanatory power, as evidenced by the R-squared value. The absence of positive first-order serial correlation is confirmed by the Durbin Watson statistic. The model is statistically significant according to the f-statistic. Moreover, the error correction term demonstrates a significant correction of approximately 138% from short-run disequilibrium to long-run equilibrium. The lag selection supports the positive relationship between the variables and federal government sukku bonds within the study's timeframe.

4.1 Discussion of Findings

Model three was developed to investigate the relationship between risk and the yield on sukku bonds in Nigeria. The lag selection process confirms the use of lag I. At lag I, liquidity risk, exchange rate risk, and default risk were found to have a negative impact on the yield of federal government sukku bonds. Conversely, interest rate risk and downside risk were found to have a positive effect on the yield of Treasury bonds within the study's timeframe. These findings align with our initial expectations and are consistent with the expectation theory. They are also supported by previous studies such as Nwiado and Deekor (2013), Olaniyan and Ekundayo (2020), Ogbebor, Ajibade, and Onoja (2020), Pradhan, Arvin, Norman, and Bahmani (2018), and Yener, Kun, Murat, and Talat (2022).

5. CONCLUSION

The conclusions drawn from the findings indicate that the variables included in the model explain approximately 69.4% of the variations in federal government sukku bonds. The lag selection process validates the use of lag I, and it is observed that the variables are positively related to federal government sukku bonds within the study's timeframe. Therefore, it can be inferred that risk plays a significant role in determining the variation in the term structure of 3-year federal government sukku bonds. Based on the study's findings, the following recommendations are suggested:

i. Investors should ensure that board members, executive management, and other stakeholders receive adequate training to understand the functions and responsibilities of risk management.
ii. The management of the Nigeria bond market should carefully scrutinize investors to ensure that their security exposures are appropriately secured, considering the risks associated with different bonds in the market.
iii. Given the relationship between risk management and yield on different bonds identified in the study, investors should prioritize risk management, particularly in controlling and monitoring macroeconomic factors that influence risk. Managers should focus on adopting modern risk management techniques.

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