The North African Journal of Scientific Publishing (NAJSP)
مجلة شمال إفريقيا للنشر العلمي (NAJSP)
E-ISSN: 2959-4820
Volume 3, Issue 3, 2025
Page No: 177-187
Website: https://najsp.com/index.php/home/index
SJIFactor 2024: 5.49 **معامل التأثير العربي (AIF) 2024: 0.71** **ISI 2024: 0.696**

Forecasting The Volatilities of Stock Market Returns in Sudan and The Kingdom of Saudi Arabia during The Period 2000-2022

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استشراف تقلبات عوائد أسهم أسواق الأوراق المالية في السودان والمملكة العربية السعودية خلال الفترة من 2000- 2022م

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Received: May 19, 2025	Accepted: July 27, 2025	Published: August 07, 2025

Abstract
The study tested the ability of GARRCH models to forecast the volatilities of stock markets returns in Sudan and Kingdom of Saudi Arabia during the period 2000-2022**,** it used the descriptive analytical approach based on Generalized Autoregressive Conditional Heteroskedasticity model GARCH, the empirical results show that the best model is EGARCH (1, 1), the conditional variance has exponential function, this confirmed the existence of asymmetric shocks, positive financial leverage effect and risk premium parameter, which mean the increasing in volatilities would increase returns, and the significant of model parameters with a complete independence between estimation residuals indicate to removal ARCH effect on the stock exchanges residuals during a specified period, there is a positive relationship between returns and risk, that means the average returns depends on the past innovation and conditional variance, EGARCH (1, 1) model abled to forecast the volatilities of stock markets returns, and it recommended that Expanding the scope of stock markets implementing effective control systems that reduced risks and achieve the safety of financial transactions, and depending on research and development to forecast volatilities in the developing countries stock markets to improve and promote financial services.

Keywords: Stock Market Returns; Volatilities; GARCH Models; Leverage Effect*.*

الملخص:
اختبرت الدراسة قدرة نماذج GARCH على استشراف تقلبات عوائد أسهم أسواق الأوراق المالية في السودان والمملكة العربية السعودية خلال الفترة من 2000- 2022م، واستخدمت المنهج الوصفي التحليلي بالاعتماد على نماذج GARCH، وتظهر النتائج أن أفضل نموذج هو EGARCH (1, 1)، أن دالة التباين الشرطي هي دالة أسية مما يؤكد عدم تماثل الصدمات والأثر الموجب للرافعة المالية وقسط المخاطر، وهو ما يعني أن الزيادة في التقلبات تؤدي إلى الزيادة في عوائد الأسهم، وأن معنوية المعاملات مع استقلالية الأخطاء تشير إلى زوال أثر ARCH في البواقي خلال الفترة المحددة، وجود علاقة طردية بين العائد والمخاطرة، مما يعني أن متوسط العائد يعتمد على التباين الشرطي والابتكارات السابقة، نموذج EGARCH (1, 1) قادر على استشراف تقلبات عوائد أسواق الأوراق المالية، وأوصت بتوسيع نطاق سوق الأوراق المالية وتطبيق نظم رقابية فعالة تقلل المخاطر وتحقق سلامة المعاملات المالية، والاعتمادي على البحث والتطوير لاستشراف تقلبات عوائد أسهم أسواق الأوراق المالية في الدول النامية لتحسين وترقية الخدمات المالية.

Introduction:

The volatilities of stock market returns time series indicates to a heteroscedasticity, and this is reflected in the expected returns series of the stock markets, and from here began thinking about models that have the ability to modeling the variance and analyzing the financial time series and forecasting their volatilities that create a kind of uncertainty, and from these models the GARCH models were used, to forecast the volatility of stock market returns in Sudan as the agricultural country and Kingdom of Saudi Arabia as the oil country, the study problem can be asked in questions next:

1- Is the GARCH model has ability to forecast the volatility of stock markets returns in Sudan and Kingdom of Saudi Arabia?

2- What are the expected levels of volatility?

3- What distinguishes the volatilities in these countries?

The objectives:

- Forecasting the stock markets returns volatilities in Sudan and Kingdom of Saudi Arabia.
- Testing the ability of GARCH model on forecasting the returns volatility in these markets.

The importance:

The volatility of the stock markets returns in Sudan and Saudi: are very important indicators for measuring the risks of these markets, and forecasting the expected returns volatility, enhances the investor's ability and managing these financial institutions in proper planning for how to confront and bear the risks of these volatilities.

The hypotheses:

The study assumes that there are returns volatilities in the stock markets in Sudan and Kingdom of Saudi Arabia.

Methodology:

To forecasting the returns volatilities of stock markets in Sudan and Kingdom of Saudi Arabia, the study used the descriptive analytical approach, based on the models of Generalized Autoregressive Conditional Heteroskedasticity GARCH.

Literature review:

- Ayyashi (2022), using hybrid ARIAMA-GARCH to forecast the stock markets returns index, case study of Saudi stock market during the period 2009-2019, and aims to know the optimal model of ARIAMA - GARCH hybrid to forecast the returns of Saudi stock market index, and how much its ability to estimate and explain the returns volatilities of this indicator, and the results indicated that the hybrid model (ARIMA (1.1.1) - GARCH (1.1) is able to forecast the future trends of the returns volatilities of Saudi stock market index during the study period, which enables them to face the potential volatilities and risks of stock markets.

- Al -Rasheed, Ahamed (2022), using GARCH models to forecast the returns volatilities of Khartoum stock market during the period (2004-2020), and concluded that the (GARCH (1, 2)) model is the best to measure the shares prices volatilities.

- Salah Al-Dien, Mohamed (2019), using ARCH models to forecast the volatilities of capital markets a case study of Saudi Tadawol index, the study aimed to know the effectiveness of ARCH models in estimating the volatilities of Saudi stock market returns during the period 2007-2017, and it emphasized that the Saudi stock market is incompetent at the level of the weak, and ARCH models give the representation of its volatilities.

- Lagogi (2019), modeling the daily time series of the shares returns of companies listed in the telecommunications sector for the Saudi stock market by using the ARCH models, and followed the descriptive and case study approach, it reached that the shares do not follow the natural distribution and not exploited from each other, and recommended not to be satisfied with the technical analysis based on the maps and graphic columns.

-Ali-Bendob(2015), GARCH models using for forecasting of Shocks in the Arab stock exchanges as a mechanism for crises management, this study aims to highlight the importance of GARCH models in the volatility modeling and forecasting as a mechanism for crisis management and early warning, after presenting the theoretical background of the models have been applied at the level of nine Arab stock exchanges indicators, namely: Abu Dhabi, Bahrain, Dubai, Egypt, Kuwait, Morocco, Oman, Qatar and Saudi Arabia, using daily data between 2007- 2012 (1304 daily observation), the study concluded there is the problem of Heteroskedasticity and continuity in shock in light of the crisis, which imposes the use of GARCH models.

These studies were characterized by using asymmetric and corresponding ARIMA-GARCH and ARCH-GARCH models to forecast the stock markets volatilities in some countries at different periods, but this study used these models to forecasting the stock markets volatilities in Sudan and Kingdom of Saudi

Arabia during the period 2000-2022, and combined between two neighbors' countries, one of which is oil and other is agricultural.

Returns of stock markets in Sudan and Kingdom of Saudi Arabia:

The stock market in Sudan was established in 1998 to operate within the locality and international financial system committed to the controls of financial system in Islam, where non-usurious financing instruments were issued and Islamic participation certificates such as central bank's participation certificates (Shamm): It is considered the first Islamic critical tool for managing liquidity, which is rapidly liquefied, which makes it contribute to achieving an additional return represented in issuance and management commissions, and the certificate of government participation (Shahama): It is financial instruments based on participation, it is issued by the ministry of finance with the aim of enabling the central bank to manage liquidity and financing the budget deficit, then government investment instruments (Sarah): These are certificates issued by the ministry of finance to be managed and marketing in the first market by Sudan financial services company limited, and it was issued in the formula of speculation for the purpose of providing financial resources to finance economic development operations, and the central bank leave certificate (Shehab), in addition to Khartoum Petroleum crushed assets certificates (Shama). These instruments and certificates won more than 90% of the trading volume in the secondary market, and the number of operating companies reached 76, whereas the highest number of shares traded reached 1078,670 in 2017, while the lowest number of shares traded is 1731 in 2005, the highest number of certificates traded is 19242 in 2017, while the lowest number 0.04 in 2003, the highest number of instruments traded is 1845 million in 2017, and the lowest number is 0.3 million in 2004.

During the period 2000-2009, we note that the year 2001 witnessed the beginning of the issuance of many investment funds by the financial investment bank and government participation certificates(Shahama) by the government, in 2002 an expansion occurred in the market relations with regional and international financial institutions, and in 2003 was announced the Khartoum stock exchange and the inclusion of the market within the Arab monetary fund database, and in the same year the Sudatel share was intersecting in the Abu Dhabi financial Market, and in 2004 the trading volume reached its highest rate since the establishment of the market where it reached 447.7 million pounds, and in 2005 a great rise occurred in the trading volume reached 1.21 billion pounds, and the index increased by 97.3%, and increased in the market value to 7.47 billion pounds.

According to Arab monetary fund database in 2005, Khartoum stock market ranked first in terms of growth of market value compared to the rest of Arab markets by 50.8%, and in 2006, a great increase in trading rates occurred whereas trading volume reached 2.06 billion pounds with a growth rate 70% in 2005 as a result of large trading in stock and listed shares, and in 2007 the market joined the federation African stock exchanges markets, which opened new opportunities for regional cooperation between the region's markets, in the same year beginning the central deposit and conservation center, it is a qualitative shift in terms of trading and dealing in the balances of listed stock, and the year 2008 witnessed a rise in the trading volume, and the shares of all the companies listed in the Khartoum stock market were completed, which paved the way to complete the procedures for the transformation of electronic trading, and the volume of trading in the market increased from 1,879.4 million pounds in 2008 to 2,246.6 million pounds in 2009 at a rate of 19.6 %, and the number of shares traded decreased from 289 million shares in 2008 to 172.4 million shares in 2009 at a rate of 41.5 %, and Khartoum market recorded in the year 2009 the highest trading rate since its establishment, as the trading volume increased to 2.2 billion pounds compared to the volume of trading in 2008, which amounted to 1.8 billion pounds, with an increase rate 19.5 %, and the electronic trading system began in the same year.

We notice during the period 2010-2014 that the volume of trading in the market has increased to 2,422.3 million pounds in 2010 at a rate 7.8 % and is considered the highest rate of trading volume since the opening of the secondary market in 1995, and the number of shares traded increased to 166.5 million shares in 2010 at a rate 1.1 %, while the number of instruments circulated decreased to 5.8 million instruments by the end of 2010 at a rate 23.5 %, due to the decrease in trading in investment fund instruments, and in 2010 and 2011 the market index reached 2,367.92 and 2,368.64, respectively, and data indicates to an increase in the annual index from 2,748.3 in 2012 to 3,178.1 In 2013, an increase of 429.8 points at a rate of 15%, and then the annual index decreased from 3,178.1 in 2013 to 3,161.6 in 2014, with a decrease of 16.5 points, at a rate of 0.5%.

During the period 2015-2022, we notice the annual index increased from 2,858.5 points in 2015 to 3,118.5 points in 2016 at a rate of 9.1 %, and the annual index increased from 4,202.4 points in 2017 to 13,317.4 points in 2018 at a rate of 216.9 %; due to the high prices of shares traded in the secondary market and the reassessment of the assets of the Sudanese Company for free zones and markets, and the decrease of annual index from 15,964.11 points in 2019 to 18,254.5 points in 2020 at a rate of 14.3 %; This is due to the rise of market value prices of huge listed companies shares in the market, and we

note that the annual index has increased from 18254.5 points in 2020 to 20455.3 points in 2021 at a rate of 12.1%; This is due to the rise of shares market value of the largest companies listed in the market, and figure no (1) below indicates to the development of the closure index of the returns series of stock market in Sudan during the study period.

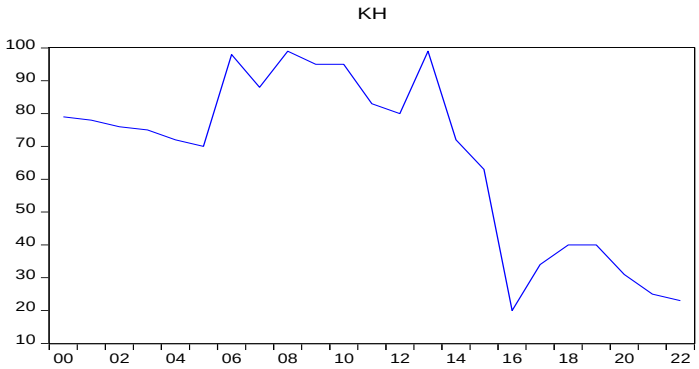

Figure 1: Stock Market Returns Index Series in Sudan.
Source: from the Study data and Eviews10

The government of the Kingdom of Saudi Arabia established the capital market authority in 2003(capital market authority, 1442, p. p: 271-281); the only organizer of the market that supervises the organization and development of the financial market, and issuing the regulations necessary to implement the provisions of the financial market system. The system has also been applied automated Saudi Stock Information (ESIS) by the Saudi Arabian monetary agency (Sama), and in 2007 the ministers council agreed to establish the Saudi capital market company (Tadawol) as a contribution company for a single destination certified as a stock market, in 2015 the financial authorities opened the investment in the Saudi stock market for foreign investment institutions, and in 2016 was established for the stocks depository center (Edaa) that runs the deposit and settlement system, which is used to register, manage stocks, and register their ownership, and in 2018. establishing the stocks clearing center company (Magasa) and it represents the mediator in the trading process and helps to reduce the risks of the other party, and the financial market has been joined to three global indicators: FTSE, the S & B Dow Junes (S&P), and the MSCI, and in 2019 the Saudi financial market became among the ten largest global financial markets, and the Saudi Aramco company was included as the largest subscription in the world, and its joining is a certificate of confidence from foreign investors in the market, and expresses the success of the reforms that the development program aims to develop the financial sector as the Kingdom's vision 2030.

The Saudi commercial banks presented a number of investment funds amounting to 170 funds by the end of 2003(capital market authority, previous reference , p. p:308-310), then to 254 by the end of 2020, and the number of subscribers increased from 172,197 subscribers in 2003 to 563 thousand subscribers in 2005, after that the number of subscribers began to gradually decrease to 358.9 thousand subscribers in 2020, and the total assets of the boxes rose from 53,87 billion riyals in 2003 to 137 billion riyals in 2005, and the value continued to fluctuate to settle at 209.7 billion riyals in 2020, and the value of the issues of instruments and bonds amounted to 387.8 billion riyals in 2020, and the number of instruments and bonds listed in the same year reached (72) issues.

As oil prices uprising and the return of Saudi capitals continued from abroad after the events of 11 September 2001, the value of the index continued until 2002 by medium proportions, and this period witnessed the beginning of (electronic trading system) in 2001.

The next stage was the development of stock index performance in the period (2003-2006), which witnessed the formation of Saudi stock bubble when the value of the index increased by 76% in 2003, and continued to 84% and 104% in 2004 and 2005, respectively, and the index reached its summit on 25 February 2006 to exceed 20 thousand points, then the next day witnessed a sharp decline and the index lost 980 points of its value, and the value of the index continued to decline until the end of 2006. This period witnessed important events, including offering the shares of the Saudi telecom company for subscription in 2003, approval of the financial market system, and the formation of the capital market authority council in 2004, and the offering of the shares of unit telecom (Mobily) for subscription in 2004, and the shares of Albilad bank for subscription were offered in 2005, and retail the nominal value of the shares of all companies listed in the market, to become 10 riyals per share instead of 50 riyals.

In the following years, the general index of stock prices was closed at the level of 11 thousand points, 4 thousand and 800 points and 6 thousand points during the years 2007, 2008 and 2009, respectively,

and the reason for this decline is the emergence of the global financial crisis, which led to the decline in oil prices and growth rates of global and local economy in its all sectors, then the performance declines the market general index to closed at the level of 6 thousand and 600 points in 2010, and at the level of 6 thousand and 400 points in 2011.

In 2012, recovery began from the effects of the global crisis with the high oil revenues of the Kingdom, the improvement of the performance of economic sectors, and the rise in different market indicators; So, the index closed at the level of 6 thousand and 800 points, the rise continued in 2013, to close the index at the level of 8 thousand and 500 points.

With oil prices declining in 2015, in addition to the slowdown in the global economy, the high interest rates, Saudi stock market price index decrease by one thousand and 400 points, to be less than 7 thousand points, and in 2016 and 2017, the price general index exceeded seven thousand points. In 2018, after the Saudi financial market joined some of the indicators of the global markets (Fotshi, Russell, Morgan and Stanley Index), the stock general prices index was closed at the end of 2018 at a level of more than 7 thousand and 800 points. The year 2019 witnessed a historical offering of Aramco Company when the general index of the market rose to 7.2%, to close at 8 thousand and 400 points.
In the year 2020, the boundaries of the virus new Corona (Covid-19) effected the market index; The index achieved the lowest level of 5,960 points in March 2020, and then rose to 8,689 points at the end of 2020.

The market value of the exported shares reached at the end of 2020 (9,101) billion riyals, and the total value of traded shares amounted to (2,087) billion riyals, while the number of deals executed during the same year was (76.69) million transactions, and the total number of shares traded (79.32) billion.
Since local banks have taken over mediation work in trading shares, the financial market faced challenges at the national, regional and international levels, which varied between economic and political conditions and financial crises, which were reflected in the market performance and its indicators up and down, as in Figure 2 below.

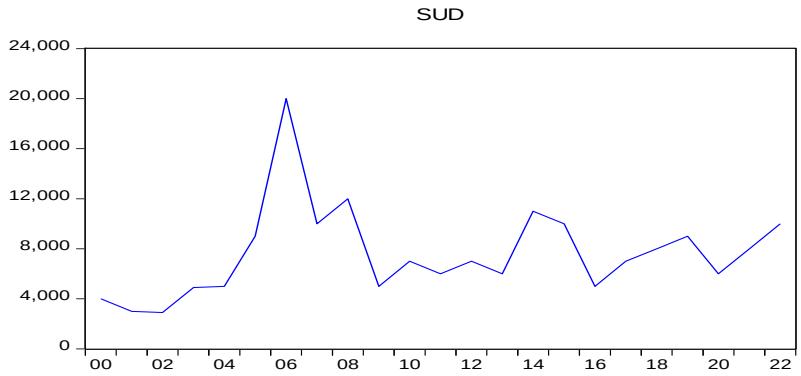

Figure 2: stock market returns index series in Saudi Arabia.
Source: from the Study data and Eviews10

Forecasting the volatilities of stock markets returns in Sudan and Kingdom of Saudi Arabia:
To estimate and choose the best model, some of the following tests must be performed:

- **The ARCH test:**

Table no (1) below, shows the results of ARCH impact in the residuals series in the AR model, where the probability values less than 0.05, and therefore we conclude the presence of the ARCH effect in the residuals series, which indicates to a heteroscedasticity problem, and we can apply GARCH models.

Table (1): ARCH test.

Sudan model			
F-statistic	53.47087	Prob. F statistic	0.0000
Obs*R-squared	16.01123	Prob. Chi-Square	0.0001
Saudi model			
F-statistic	53.47087	Prob. F statistic	0.0000
Obs*R-squared	16.01123	Prob. Chi-Square	0.0001

Source: from the Study data and Eviews10

- **stationary tests:**

We note from table no (2) below that the values of test possibility less than 5%, which means that a returns series of stocks market shares in Sudan and Kingdom of Saudi Arabia has a unit root, and which distinguishes financial time series.

Table (2): Results of unit root tests:

Variables	ADF			PP		
	Level	First Diff	Decision	Level	First diff	Decision
Sudan RT	1.075567	-3.142811	1(1)	0.855952	-3.142811	1(1)
Saudi RT	-2.936330	-6.494147	1(1)	-2.877952	-6.456994	1(1)
critical value at 5%: ADF = -3.004 and -3.012, pp = -3.004 and -3.012						

Source: from the Study data and Eviews10

- **descriptive statistics tests:**

From table no (3) below: The probability of Jarque-Bera (Prob = 0.006) less than 5%. Which means the differences of stock returns series D(RT) subject to natural distribution in Sudan, Kurtosis factor is greater than (3), which means that residuals has thick ends indicating their dispersion and asymmetric of probability distribution, the asymmetric due to the presence of a non -linear structure in the returns series, and this is what distinguishes financial series, also the conditional heterogeneous may be one of the reasons(ARCH effect), and we note that the value of the Skewness coefficient is positive, which means that it is twisted towards the right, for this reason the returns series is effected by positive shocks more than negative shocks.

The table also indicates that the average reached 5332,691, while the mediator is 2368,640, and the lowest value was 176.50, while the highest value was 20455.30; the value of the standard deviation was 6860.5, which is a high value. From table no (4) below: The probability of Jarque-Bera (Prob = 0.014) less than 5%. Which means the differences series of stock returns D(RT) subject to natural distribution in Kingdom of Saudi Arabia, Kurtosis factor is greater than (3), which means that residuals has thick ends indicating their dispersion and asymmetric of probability distribution, the asymmetric due to the presence of a non -linear structure in the returns series, and this is what distinguishes financial series, also the conditional heterogeneous may be one of the reasons(ARCH effect), and we note that the value of the Skewness coefficient is positive, which means that it is twisted towards the right, for this reason the returns series is effected by positive shocks more than negative shocks. The table also indicates that the average reached 7285,652, while the mediator is 7000,000, and the lowest value was 770,000, while the highest value was 20000.00, and the value of the standard deviation was 4373.246, which is a high value.

Table (3): Jarque- Bera test of Sudan RT time series:

Series	RT
Sample	2000-2022
observations	23
mean	5332.691
median	2368.640
maximum	20455.30
minimum	176.5000
Std. Dev.	6860.575
Skewness	1.395924
kurtosis	3.263942
Jarque-Bera	7.536412
probability	0.023093

Source: from the Study data and Eviews10

Table (4): Jarque- Bera test of Saudi RT time series:

Series	RT
Sample	2000-2022
observations	23
mean	7285.662
median	7000.000
maximum	20000.00

minimum	770.0000
Std. Dev.	4373.246
Skewness	1.199418
kurtosis	4.761131
Jarque-Bera	8.486996
probability	0.014357

Source: from the Study data and Eviews10

- **Estimate symmetric GARCH model**

Symmetrical GARCH models were estimated to measure the stock markets returns volatilities in Sudan and Kingdom of Saudi Arabia during the period 2000-2022 to know the effect of shock (volatility) and its signals through the following equation (sheeikhi,2011, P:319):

$$\sigma_i^2 = \omega + \sum_{j=1}^{q} \alpha_j \, \varepsilon_{t-1}^2 + \sum_{i=1}^{p} \beta_i \, \sigma_{t-1}^2$$

Where, p is the number of lagged σ^2 terms and q is the number of lagged ε^2 terms

According to Table no (5) below, the results of the estimation indicate that the GARCH models parameters, despite their absence of heteroscedasticity problem, but most of them are not statistically approved, which means the inability of these models to anticipate the returns volatilities of stock markets in Sudan and Kingdom of Saudi Arabia.

Table (5): symmetric GARCH model.

Sudan model				
Model	GARCH(1.1)		GARCH(1,2)	
Variable	Coefficient	Prob.	Coefficient	Prob.
AR(1)	0.332875	0.2041	0.333399	0.2789
Variance Equation				
C (Constant)	0.079002	0.4759	0.090539	0.6162
α (ARCH effect)	-0.068244	0.0000	-0.070646	0.0000
β (GARCH effect)	0.532919	0.3746	0.482777	0.8672
$\alpha + \beta$	0.464675		0.412131	
GIC	Akaike info criterion	2.891024	Akaike info criterion	2.931166
	Schwarz criterion	2.089981	Schwarz criterion	2.179861
	Hannan-Quinn criteria	2.934203	Hannan-Quinn criteria	2.985139
Heteroskedasticity Test: AECH				
F-statistic	0.024050	0.8785	0.041440	0.8410
Obs*R-squared	0.026686	0.8702	0.045939	0.8303
Autocorrelation tests				
Q-Statistics	Q-stat	prob	Q-stat	prob
	2.4903	0.115	2.6118	0.271
Saudi model				
Model	GARCH(1,1)		GARCH(1,2)	
Variable	Coefficient	Prob.	Coefficient	Prob.
AR(1)	-0.399216	0.2963	-0.519661	0.0085
Variance Equation				
c(Constant)	0.504981	0.8054	1.120291	0.0117
α (ARCH effect)	0.160564	0.7934	0.359782	0.4741
β (GARCH effect)	-0.185523	0.9676	-0.141474	0.2383
$\alpha + \beta$	-0.024959		0.218308	
\GIC	Akaike info criterion	2.496477	Akaike info criterion	2.276202
	Schwarz criterion	2.695434	Schwarz criterion	2.524898
	Hannan-Quinn criteria	2.539656	Hannan-Quinn criteria	2.330176
Heteroskedasticity Test: AECH				
F-statistic	0.062346	0.8057	0.121935	0.7310
Obs*R-squared	0.069034	0.7927	0.134572	0.7137
Autocorrelation tests				
Q-Statistics	Q-stat	prob	Q-stat	prob

	2.2864	0.515	2.0165	0.156

Source: from the Study data and Eviews10

- **Estimate asymmetric GARCH model**

It was completed estimating an asymmetric EGARCH models to measure the returns volatilities of stock markets shares in Sudan and Kingdom of Saudi Arabia during the period 2000-2022 in order to know the effect of shock (volatility) and its signals through the following equation (Ahmed, suliman, 2011, P:119):

$$Ln(\sigma_t^2) = \omega + \sum_{j=1}^{p} \beta_i \, Ln(\sigma_{t-1}^2) + \sum_{j=1}^{q} \alpha_i \left\{ \left\| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right\| - \sqrt{\frac{2}{\pi}} - \gamma_i \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right.$$

According to the results of table no (6) below, the EGARCH model (1, 1) was chosen as the best estimated model for the following considerations:

1- All the parameters of the model are positive and statistically significant through the probability value (prob<0.05).

2- The conditional variance function is exponential and non-linear function, and we note that there is asymmetric shocks effect on the conditional variance called leverage effect (,Sam, AL Husain, Ganim,2013, P: 133) and leverage parameter value (γ) is positive in the results of the stock market models in Sudan and Kingdom of Saudi Arabia, which means that there is financial leverage impact, that is, the market volatilities increase after the positive shocks greater than increasing after the negative shocks of the same level.

3- The probability value of ARCH-LM statistic (Prob. Chi-Square = 0.5185) for Sudan market and (Prob Chi-Square = 0.4345) for the Kingdom of Saudi Arabia market, indicating that there is no heteroscedasticity problem in the models, and these models lead to removal ARCH effect on the entire stock exchanges during a specified period.

4- From (EGARCH (1.1) models the values of Q-Statistics probability greater than 0.05, which means there is no autocorrelation problem and complete independence between estimation residuals, and most autocorrelation functions lags (AC) and partial correlation (PAC); falls within the limits of confidence.

5- To choose the best model among these models abled to forecast the stock market volatilities in Sudan and Kingdom of Saudi Arabia the study depends on the information criteria's (HQC, SIC, AIC), and the results of table no (6) below indicate that the best model is EGARCH (1, 1).

Table (6): RT EGARCH model.

Sudan RT EGARCH model				
	EGARCH(1,1)		EGARCH(1,2)	
Variable	Coefficient	Prob.	Coefficient	Prob.
@SQRT(GARCH)	0.040713	0.0007	0.060243	0.0000
DUM	5.020006	0.0000	2.62E-06	0.0001
Variance Equation				
ω (Constant)	0.563468	0.0005	-4.829977	0.1031
α(ARCH effect)	1.074633	0.0000	2.396076	0.3574
β (GARCH effect	1.072408	0.0435	-1.273765	0.4928
γ (Leverage effect)	0.665569	0.0000	0.640549	0.0756
$\alpha + \beta$	2.147041		1.122311	
GIC	Akaike info criterion	1.244591	Akaike info criterion	2.185490
	Schwarz criterion	1.052966	Schwarz criterion	1.211253
	Hannan-Quinn criteria	1.174496	Hannan-Quinn criteria	2.092029
Heteroskedasticity Test: AECH				
F-statistic	0.432751	0.5185	0.672631	0.4223
Obs*R-squared	0.467652	0.4941	0.718016	0.3968
Autocorrelation tests				
Q-Statistics	Q-stat	prob	Q-stat	prob
	1.0139	0.314	0.0056	0.940
Saudi RT EGARCH model				
	EGARCH(1,1)		EGARCH(1,2)	
Variable	Coefficient	Prob.	Coefficient	Prob.
@SQRT(GARCH)	-0.719079	0.0000	-0.020819	0.0003
DUM	9.42E-05	0.0000	0.000122	0.0000

Variance Equation				
ω (Constant)	0.761247	0.0046	-3.003312	0.6325
α (ARCH effect)	0.070368	0.0000	1.497681	0.6325
β (GARCH effect	1.147693	0.0110	-0.265482	0.6325
γ (Leverage effect)	1.884392	0.0000	0.162397	0.8916
$\alpha + \beta$	1.218061		1.232199	
GIC	Akaike info criterion	1.994427	Akaike info criterion	2.304408
	Schwarz criterion	1.440762	Schwarz criterion	2.651558
	Hannan-Quinn criteria	1.099570	Hannan-Quinn criteria	2.386186
Heteroskedasticity Test: AECH				
F-statistic	0.569032	0.4599	0.080157	0.7801
Obs*R-squared	0.610642	0.4345	0.088222	0.7664
Autocorrelation tests				
Q-Statistics	Q-stat	prob	Q-stat	prob
	7.5176	0.111	0.9728	0.324

Source: from the Study data and Eviews10

- **Estimate GARCH-M model**

The GARCH-M model was used to estimate the relationship between the returns and risk by using the average and conditional variance equations below:

Mean equation $r_t = \mu + \lambda\sigma_t^2 + \varepsilon_t$

Variance equation $\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$

Under the hypothesis of the natural distribution of errors, the GARCH-M Model (1, 1) was chosen according to the information criteria (HQC, SIC, AIC), and from the results of table no (7) below we note that the estimated parameter σ_t^2 (risk premium) in the average equation is positive and significant, which indicates to a positive relationship between returns and the risks in the stock market of Sudan and Kingdom of Saudi Arabia, and the average returns depends on the past innovation and conditional variance (Tuyen,2011, p. 1937), which means the return level related with conditional variance that positively used as an alternative of the return risk, so the increasing of volatility the returns increase by 7,800006 in Sudan stock market, and by 0.000129 in kingdom Saudi Arabia stock market, this result will correspond with the theory of positive risk allowance on the stock indicators, which expected higher returns from higher risks assets, and the significant of ARCH and GARCH parameters indicate to the disappearance of ARCH effect in the residuals.

Table (7): RT GARCH-M model.

Sudan RT GARCH-M model				
	GARCH-M(1,1)		GARCH-M(1,2)	
Variable	Coefficient	Prob.	Coefficient	Prob.
$\emptyset$(Constant	0.062652	0.0000	0.054680	0.0293
λ(risk premium)	7.800006	0.0073	3.22E-06	0.0118
Variance Equation				
ω (Constant)	3.112269	0.0000	-2.987517	0.0000
α (ARCH effect)	1.674745	0.0000	-0.088542	0.8918
β (GARCH effect	0.451612	0.0000	-1.006061	0.0097
$\alpha + \beta$	2.126357		-1.094603	
GIC	Akaike info criterion	2.085358	Akaike info criterion	2.414326
	Schwarz criterion	2.038291	Schwarz criterion	2.067176
	Hannan-Quinn criteria	2.155453	Hannan-Quinn criteria	2.332548
Heteroskedasticity Test: AECH				
F-statistic	0.321538	0.5773	1.214196	0.2843
Obs*R-squared	0.349470	0.5544	1.261397	0.2614
Autocorrelation tests				
Q-Statistics	Q-stat	prob	Q-stat	prob
	0.0238	0.877	0.2758	0.599
Saudi RT GARCH-M model				
	GARCH-M(1,1)		GARCH-M(1,2)	
Variable	Coefficient	Prob.	Coefficient	Prob.
ϕ(Constant	0.029051	0.0145	-0.019285	0.4921
λ(risk premium)	0.000129	0.0000	0.000134	0.0000

Variance Equation				
ω (Constant)	2.024243	0.0000	-5.369502	0.0000
α (ARCH effect)	0.650354	0.0419	1.201968	0.0461
β(GARCH effect	0.881170	0.0029	0.161582	0.5074
$\alpha + \beta$	1.531524		1.36355	
GIC	Akaike info criterion	2.586121	Akaike info criterion	3.566187
	Schwarz criterion	2.933271	Schwarz criterion	3.863744
	Hannan-Quinn criteria	2.667899	Hannan-Quinn criteria	3.636282
Heteroskedasticity Test: AECH				
F-statistic	0.141636	0.7108	0.093621	0.7630
Obs*R-squared	0.155386	0.6934	0.102968	0.7483
Autocorrelation tests				
Q-Statistics	Q-stat	prob	Q-stat	prob
	1.0268	0.311	0.6201	0.431

Source: from the Study data and Eviews10

- **The best model:**

From table no (8) below, the best model to forecast the stock markets volatilities in Sudan and Kingdom of Saudi Arabia is (EGARCH (1, 1)).

Table (8): the best RT GARCH model.

Sudan models	**EGARCH(1,1)**	**GARCH-M(1, 1)**
Akaike info criterion	1.244591	2.085358
Schwarz criterion	1.052966	2.038291
Hannan-Quinn criteria	1.174496	2.155453
Saudi models	**EGARCH(1,1)**	**GARCH-M(1, 1)**
Akaike info criterion	1.994427	2.586121
Schwarz criterion	1.440762	2.933271
Hannan-Quinn criteria	1.099570	2.667899

Source: from the Study data and Eviews10

- **Forecasting:**

There are several tests to examine and evaluate the forecasting ability of generalized autoregressive conditional heteroscedasticity model in the sample, and these tests confirmed the ability of the model EGARCH (1, 1) to forecast through the following table no (9):

Table (9): forecasting tests.

Sudan model: EGARCH(1, 1)				
Tests	Thiel's. I. C	RMSE	MAE	MAPE
Results	0.800932	0.422025	0.208133	1007.532
Saudi model: EGARCH(1, 1)				
Tests	Thiel's. I. C	RMSE	MAE	MAPE
Results	0.621010	0.745509	0.497560	115.413

Source: from the Study data and Eviews10

From the table no (9), the results of all tests indicate to EGARCH (1, 1) model ability to forecast the volatilities of stock markets returns in Sudan and Kingdom of Saudi Arabia.

Conclusion:

Results:

The study confirmed the existence of returns volatilities in the stock markets in Sudan and Kingdom of Saudi Arabia through the flowing results.

- The information criteria's (HQC, SIC, AIC) results indicate that the best model abled to forecast the stock market volatilities in Sudan and Kingdom of Saudi Arabia is EGARCH (1, 1).
- The conditional variance has exponential function, and there is asymmetric shocks and positive financial leverage effect.
- The model is statistically significant, and the sign of the risk premium parameter is positive, the implication is that increase in volatility would increase returns.
- There is no heteroscedasticity problem in the models, and these models lead to removal ARCH effect on the entire stock exchanges during a specified period.

- There is complete independence between estimation residuals, which means there is no autocorrelation problem.
- There is a positive relationship between returns and the risks in the stock market of Sudan and Kingdom of Saudi Arabia, that means the average returns depends on the past innovation and conditional variance.
- EGARCH (1, 1) model abled to forecast the volatilities of stock markets returns in Sudan and Kingdom of Saudi Arabia.

Recommendations:

- Expanding the scope of stock markets in Sudan and Kingdom of Saudi Arabia to keep pace with the accelerated development in the global stock markets.
- enacted the appropriate legislations to attract local and foreign investments.
- Implementing effective control systems that reduced risks and achieve the safety of financial transactions.
- Paying attention to research and development to forecast volatilities in the developing countries stock markets to improve and promote financial services.

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