Unit root tests with application to time series data related to the Qatar Financial Market index price (applied study)

Leila Hakkoum [1] ♦, Semghouni Toufik Faiçal [2]

[1] University of Saida Dr. Moulay Tahar (Algeria), leila.hakkoum20@yahoo.com
ORCID: https://orcid.org/ 0009-0003-6246-8987

[2] University center of Tipaza Morsli Abdellah (Algeria), semghouni.toufik@cu-tipaza.dz
ORCID: https://orcid.org/ 0000-0003-3169-9224

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Abstract

This study aims to investigate the stationarity properties and structural breaks of the Qatar Stock Exchange Index (QSI) using daily data covering the period from January 2010 to October 2023. The study employs conventional unit root tests, including the Augmented Dickey-Fuller (ADF) test, in addition to structural break unit root tests such as the Zivot-Andrews test and Bai-Perron multiple breakpoint tests. The results indicate that the index price series is non-stationary at level, while the return series is stationary. Furthermore, the analysis reveals the existence of several structural breaks associated with major economic and geopolitical events affecting the Qatari economy, particularly the Arab Spring, the upgrading of Qatar to emerging market status, the Gulf blockade, and market developments during the post-pandemic period. These findings highlight the importance of incorporating structural breaks when analyzing financial time series in emerging markets.

Keywords: Unit Root Test; Structural Breaks; Qatar Stock Exchange; ADF Test; Bai-Perron Test.

♦ **Corresponding author.**

I- Introduction

Financial markets are among the most important pillars of any country's economy. The efficiency of financial markets depends on stock price behavior, the randomness of price movements, the development of trading systems, and the ability to reach the fair value of stock prices. For a market to be efficient and effective, a set of conditions must be met, such as disclosure, transparency, and liquidity for the securities traded. Among the most crucial of these conditions is the liquidity of the financial instrument, meaning that investors and participants should be able to trade at fair prices. Market risk and the volatility of asset prices are among the most significant risks affecting financial markets. The field of risk management expanded significantly during the 20th century, encompassing various types of risks, which required the development of mechanisms to manage them in a way that achieves the objectives of companies. Financial markets also advanced greatly, with new technologies introduced for measuring and analyzing them. The changes in these markets have become an essential part of the picture reflecting the development of business sector activity in each country.

The handling of financial market data has evolved considerably over time. Numerous studies on financial time series have identified several stylized characteristics shared by most financial datasets. Therefore, the analysis of financial time series requires statistical models capable of capturing the underlying properties of the data, including stationarity, structural breaks, linear and non-linear dependencies, and other factors that may affect market behavior and price dynamics.

I.1- Research Problem

What are the structural characteristics of the Qatar Financial Market index returns during the study period?

I.2- Research Hypotheses

- Null Hypothesis (H0): The Qatar Stock Exchange return series does not contain any structural break during the study period.

- Alternative Hypothesis (H1) : The Qatar Stock Exchange return series contains at least one structural break during the study period.

I.3 -Research Objectives

- To examine the stationarity of the Qatar Stock Exchange Index.
- To identify potential structural breaks in the index series.
- To relate detected structural changes to major economic and geopolitical events.
- To evaluate the usefulness of structural break tests in financial time-series analysis.

I.4- Importance of the Research

- The significance of this study lies in its quantitative approach to analyzing the returns of financial market indices using forecasting methods, which assists investors in making appropriate investment decisions.
- Formulating the intellectual aspects of recent causes and utilizing them in the development of concepts and standards for forecasting financial market indices.

- Identifying factors affecting the performance of financial markets and analyzing their impact on investor behavior, thereby improving decision-making in investments.

I.5- Previous Studies

Perron, P. (1989).
"The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis."
Journal of Business & Economic Statistics, 7(2), 153–162.

Summary:

This study examined the impact of major economic shocks on the stationarity of macroeconomic time series. Perron argued that traditional unit root tests may incorrectly indicate non-stationarity when structural breaks are ignored. By incorporating exogenous structural breaks into the testing procedure, the study showed that many economic series previously considered non-stationary were actually trend-stationary around structural changes. The findings highlighted the importance of accounting for structural breaks when testing for unit roots in economic and financial data.

Zivot, E., & Andrews, D. W. K. (1992).
"Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis."
Journal of Business & Economic Statistics, 10(3), 251–270.

Summary:

The study developed a unit root test that allows for an endogenous structural break whose timing is determined from the data rather than imposed a priori. Using several macroeconomic time series, the authors demonstrated that ignoring structural breaks may lead to misleading conclusions regarding stationarity. The Zivot-Andrews test provides a more reliable framework for identifying structural changes and assessing the presence of unit roots. The study concluded that structural breaks play a crucial role in time-series analysis and should be incorporated into empirical investigations of economic and financial data.

(2017) by Abdelkader Ramlaoui and Faisal Bishroul titled: "Financial Market Indices as a Means for Financial Crisis Prevention – Forecasting the Movement of the Dow Jones Industrial Average Using the Box-Jenkins Methodology in Time Series Analysis"

This study aimed to analyze the development of the Dow Jones Industrial Average for the New York Stock Exchange from January 2006 to February 2014 to determine the direction of changes in this index and forecast its future value.

The study concluded the following:

- Analyzing the Dow Jones Index to identify the appropriate model for forecasting its future values to minimize financial risks leading to financial crises.
- The Box-Jenkins methodology allowed us to identify the suitable model for the Dow Jones Index, represented by the ARIMA(1.1) model, indicating that this index is significantly influenced by its previous values and the estimated errors from the

previous period. Statistical tests were applied to calibrate the estimated model and examine residuals.

II- General Concepts on Time Series

Definition of Time Series

A time series is defined as a collection of observations generated sequentially over time. Any time series is characterized by its data ordered with respect to time, and successive observations are typically not independent, as they tend to depend on one another. A time series consists of:

The Stochastic Process:

A stochastic process can be mathematically defined as a sequence of random variables recorded over time, denoted as Xt, where T ∈ t. When discussing time series, it is essential to address the stochastic process and the relationship between them. Both are determined by a common variable, which is time (Michaud & M, 1989, p. 9).

Stationary Stochastic Process:

A process Xt is said to be stationary if its probability structure remains constant over time, meaning that the probability distribution of n observations

Xt1 ; Xt2 ; … Xtn is the same as the probability distribution of the n observations Xt1+h ; Xt2+h ; … Xtn+h.
Thus, the moments are independent of time:

$$\mathbf{E(X_t) = \mu \ \forall \ t}$$

$$\mathbf{V(Xt) = \sigma^2 \ \forall \ t}$$

$$\mathbf{COV(X_t, X_t{+}h) = V(h) \ \forall \ t, \forall \ h}$$

Before studying the volatility of any economic phenomenon, it is essential first to examine the stationarity of time series, meaning to check for the presence or absence of a trend. We distinguish between stationary time series, where despite fluctuations in the time series levels over relatively long periods, the average remains constant without any trend, either upward or downward. This type of time series is referred to as a stationary series. On the other hand, non-stationary time series show a continuously changing average that increases or decreases (Salman, Mohammed, & Ibrahim, 1995, p. 197).

The study of stationarity is one of the critical conditions when analyzing time series, as its absence may lead to various econometric problems. To avoid these issues, non-stationary series must be transformed into stationary ones. Two methods have been identified to detect the stationarity or non-stationarity of variables (time series): the first method is the study of "Correlograms," which detects the components of general trends and seasonal components. The second method is the stationarity test (unit root test).

Some researchers prefer to determine the nature of a time series through graphical representation or by dividing the series into two equal parts, then calculating the mean for each section. If the means are similar or close, it is concluded that there is no trend in the time series. However, one of the most prominent tests used by researchers in economics and other fields that require econometric testing is the unit root test, which is considered the most effective tool (Sheikhi, 2011, p. 206).

Unit Root Tests:

1. Dickey-Fuller Test:

The Dickey-Fuller test, developed by Dickey & Fuller in 1979, is the first unit root test. This test is based on identifying the general trend component of a time series to assess its stationarity. It examines whether the component is deterministic or stochastic (Ikeora, Igbodika, & Jessi, 2016, p. 127).

Assuming that Yt is a random walk model, we have:

$Yt = Yt\text{-}1 + \mu t$

Thus, the regression equation becomes:

$Yt = \rho Yt\text{-}1 + \mu t$ …(4)

By subtracting Yt-1 from both sides of the equation, we obtain the following three equations:

$Yt - Yt\text{-}1 = \alpha 1Yt\text{-}1 - Yt\text{-}1 + ut$……..(4.1)
$\Delta Yt = (\alpha\text{-}1)Yt\text{-}1 + ut$…………..(4.2)
$\Delta Yt = (\alpha\text{-}1)Yt\text{-}1 + \alpha 2T + ut$….(4.3)

Where:

- $\alpha = p\text{-}1$
- Δ represents the first difference or change factor in Yt.
- T is the trend component, and ut is the error term.

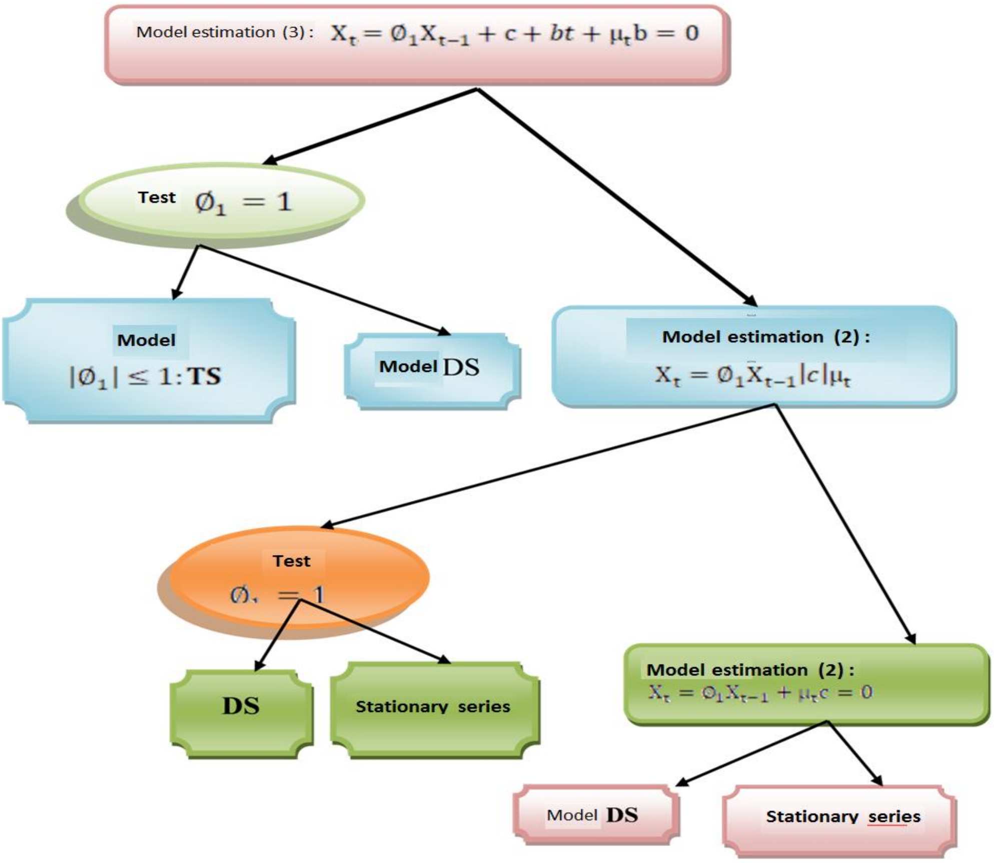
When applying the Dickey-Fuller test, we have the following hypotheses:

- Null hypothesis: $H0 : \alpha = 1$
- Alternative hypothesis: $H1 : \alpha < 1$

If the null hypothesis (H0) is accepted, the time series has a unit root, indicating non-stationarity. However, if the alternative hypothesis (H1) is accepted, the time series is free from a unit root, implying stationarity.

When applying the Dickey-Fuller test to study the stationarity of time series through equations (4.2) and (4.3), it is assumed that the residuals are not linearly correlated. If linear correlation is present, the Augmented Dickey-Fuller test should be applied.

Figure 1-1 - Simplified methodology for unit root testing



Source: Régis Bourbonnais, Terraza M., "Analyse des séries temporelles en économie," Presses Universitaires de France (1998), p. 236.

2- Augmented Dickey-Fuller Test:

Due to the limitations of the original Dickey-Fuller test, which does not account for autocorrelation in the error term, resulting in inefficient ordinary least squares (OLS) estimates, Dickey and Fuller (1981) developed the Augmented Dickey-Fuller test. This improvement involves adding lagged difference terms of the dependent variable to eliminate autocorrelation (Sandrine Lardic, 2002, p. 148).

Thus, three equations are used when conducting the test, as follows:

$$\Delta yt = \rho y_{t-1} - \sum_{j=2}^{\rho} \alpha \, \Delta y_{t-j+1} + \mu_t \ldots..(5)$$

$$\Delta yt = \rho y_{t-1} - \sum_{j=2}^{\rho} \alpha \, \Delta y_{t-j+1} + c + \mu_t \ldots..(6)$$

$$\Delta yt = \rho y_{t-1} - \sum_{j=2}^{\rho} \alpha \, \Delta y_{t-j+1} + c + bt + \mu_t \ldots..(7)$$

It is important to note that the hypotheses of each equation differ based on essential characteristics, such as the time trend and the constant term. From the three equations above, we observe that:

- Equation (5) contains a trend and no constant term.
- Equation (6) has no time trend but includes a constant term.

- Equation (7) contains both a time trend and a constant term.

3- Philips-Perron Test:

The Philips-Perron test, developed in 1988 by Peter Phillips and Pierre Perron, adopts a non-parametric adjustment approach to correct for autocorrelation in the residuals when testing the stationarity of time series. The test allows for the reversal of the series' dynamic nature by considering both autocorrelation of residuals and heteroskedasticity (Dahmani, 2013, p. 119).

This test corrects the Dickey-Fuller statistics in a non-parametric way to account for the errors associated with autocorrelation. It removes biases caused by the specific features of random fluctuations. Phillips and Perron used the same limiting distributions for the DF and ADF tests. This test is conducted in four stages:

1. Estimation by OLS (Ordinary Least Squares)of the three basic models for the Dickey-Fuller test, along with calculation of the corresponding statistics.
2. Estimation of the variance given the short-term effect.

The Lagrange Multiplier statistic is given by the following relationship:

$$LM = \frac{\sum_{=1}^{T} St^2}{\hat{\sigma}S2}$$

Unlike the Augmented Dickey-Fuller test, which assumes that the time series is generated by autoregression (AR), the Philips-Perron model assumes that the time series is generated by an ARIMA model (Phillips & Perron, 1988, p. 338).

Econometrics experts argue that when the results of unit root tests for the same time series conflict, it is preferable to use the Philips-Perron test, especially when the sample size (number of observations) is small (Russell & MacKinnon, 2004, p. 623).

• Choosing the Optimal Lag Length:

The optimal lag length is selected by minimizing the value of five statistical criteria, as follows:

- Final Prediction Error (FPE), 1969.
- Akaike Information Criterion (AIC), 1973.
- Schwarz Information Criterion (SIC), 1978.
- Hannan-Quinn Information Criterion (HQIC), 1979.
- Likelihood Ratio Test.

The number of cointegration vectors is determined using the Johansen test (VAHID & ENGLE, 1993, p. 350).

Unit Root Test with Structural Breaks:

A- Structural Breaks:

A structural break refers to a sudden change in a time series at a specific point in time. These structural breaks can reflect institutional, legislative, or technical changes, as well as shifts in economic policies or significant economic shocks. One common issue when dealing with empirical models is that a time series often contains one or more unit roots. Therefore, it is suggested that it may be necessary to isolate specific economic events and treat them as permanent changes in the pattern of the time series (Perman, 2006, p. 2).

B- Unit Root Tests with Structural Breaks:

Most macroeconomic time series are characterized by instability, meaning that structural breaks can have a lasting effect on the pattern of the time series. Therefore, a unit root test that includes structural breaks has several advantages. It prevents the test results from being biased toward the presence of a unit root and allows for the identification of the time or date of the structural break (Nilsson, 2009, p. 13).

• **Exogenous Structural Break:** Structural breaks in time series can affect the results of unit root tests. In this regard, Perron showed that many time series appear unstable when using traditional unit root tests in the presence of structural breaks, but in reality, they are stable series. These tests tend to bias the rejection of the stationarity hypothesis (Perron, 1989). Furthermore, most macroeconomic series do not actually exhibit unit roots. This is a result of large and infrequent shocks, which indicate that the economy tends to return to its general trend after smaller and repeated shocks. As a result, Perron modified the ADF test by including dummy variables to identify a known external break. This test allows for a break within both the null and alternative hypotheses. When the ADF test indicates the presence of a unit root, it should be considered as a permanent change at a specific point in the stable process or in the trend. Perron relied on three models for structural breaks when testing for unit roots, the first of which is called the "Crash model," which includes a change in the intercept of the time series (Glynn, 2007, p. 68).

Another test for detecting structural breaks is the Chow test, which involves dividing the sample into two sub-periods, estimating the equation for each sub-period separately, and then testing the equality of the coefficients using an F-test to determine if there is a structural break between the two periods (before and after the externally chosen break date). The null hypothesis asserts that the coefficients of the two sub-periods are equal, meaning there is no structural break between the two periods (Bruce, 2001, p. 118).

• **Endogenous Structural Break:** Vogelsang and Perron (1992) and Perron (1997) proposed a category of tests that allow for two different types of structural breaks. The first is the Additive Outlier (AO) model, which allows for sudden changes in the slope, while changes in the Innovational Outlier (IO) model occur gradually, permitting a break in both the intercept and the slope. In both models, the null hypothesis assumes no break under the unit root hypothesis.

Andrews and Zivot (1992) modified Perron's unit root test, based on an external break date, into an unconditional unit root test. Instead of treating the break date as fixed (pre-determined), it is estimated. This test allows for one break in both the intercept and slope of the series. The test is sequential, using the entire sample and dummy variables for each potential break date, and the break date is identified when the ADF statistic is minimized (Andrews & Zivot, 1992).

• **Multiple Structural Breaks:** Many studies suggest that a single internal break is insufficient and may result in the loss of information when there are multiple breaks in reality. In 1998, Clemente, Perron, Montanes, and Reyes extended the statistics of Perron and Vogelsang (1992) to include two changes in slope (Clemente, 1998, p. 175).

Use of Dummy Variables:

Dummy Variable as an Intercept:

The following equation represents a regression for cross-sectional data:

$Y_i = \beta_0 + \beta_1 X_i + u_i$

β_0 In the equation, the intercept represents the average value when X equals zero. β_0 In regression, we assume a constant value for all observations in the study data. However, the coefficient may vary depending on the differences in the data. The question is: how can we convert this information into numerical data to include it in the regression equation and test the significance of this difference? The answer is to use a special type of variable called the "dummy variable," which can represent qualitative effects by using a numeric indicator for possible outcomes, assigning values of one or zero for the two possible outcomes. We use the dummy variable D, which takes the following values:

$$D = \left| \begin{matrix} 1 & for \\ 0 & for \end{matrix} \right|$$

The choice of one or zero for either of the two groups does not affect the result when the dummy variable is included in the equation:

$Y_i = \beta_0 + \beta_1 X_i + \beta_2 D_i + u_i$

To understand the impact of D on the equation, we need to consider the two possible outcomes depending on the value of D and how it affects the equation. First, when D = 0, we get the following:

$Y_i = \beta_0 + \beta_1 X_i + \beta_2 D(0)_i\ X_{1t} + u_i$

$Y_i = \beta_0 + \beta_1 X_i + u_i$

And when D = 1, we get the following:

$Y_i = \beta_0 + \beta_1 X_i + \beta_2 D(1)_i + u_i$

$Y_i = (\beta_0 + \beta_2) + \beta_1)X_i + u_i$

Here, $\beta_0 + \beta_2$ the intercept value changes, which means that using the dummy variable results in a change in the intercept.

❖ **Slope of the Dummy Variable:**

In the previous section, we reviewed the effect of the dummy variable on the regression model and concluded that the intercept is the variable that changes. This is assuming that the relationship between Y and X is not affected by including the dummy variable.

The relationship between Y and X is represented by the derivative or slope of the function in the simple regression model. In multiple regression, using partial derivatives, the slope may be affected by the difference in the dummy variable.

For example, the simple regression model is as follows:

$$Y_t = \beta_0 + \beta_1 X_{1t} + u_{1t}$$

The slope of the regression, denoted by β1, is given by:

$$\frac{dy_t}{dx_{1t}} = \beta_1$$

❖ **Effect of Both Intercept and Slope:**

When using a dummy variable, both the intercept and the slope may be affected. For example, if we have a dummy variable that follows the definition:

$$\begin{cases} for\ \ t = 1, \dots\dots\dots, s \\ . \\ 1\ \ for\ t = s + 1, \dots., T \end{cases}$$

Descriptive Study of the Qatari Stock Market Index (QSI) Price Series:

To analyze any time series, we must start by graphing the observations over time, as the graphical representation shows the descriptive features of the data, such as the general trend, seasonal changes, and other characteristics of the data. Below is a chart illustrating the closing index of the market in the study:

Figure 2 - Graphical Representation of the Qatari Stock Market Index Series

Source: Prepared by the authors based on the outputs from EVIEWS 13.

The figure shows that the beginning of the study period experienced low volatility, followed by higher volatility. The rest of the periods oscillated between increases and decreases, with sharp fluctuations at certain times followed by less volatile periods. Significant changes in return values were followed by other significant changes, while weaker changes were followed by similarly weak changes. This phenomenon, known in financial market analysis as volatility clustering, indicates instability in the Qatari stock market index during the period from 01/01/2010 to 13/10/2023. This instability can be attributed to the following events:

- Raising investment awareness and establishing investment culture among investors by organizing training seminars and conferences such as those in the Middle East, Europe, and New York. Additionally, joint meetings were held in London and Paris with representatives from leading global investment banks. The focus of these meetings was to link the Qatari stock market with global markets in London, Paris, and New York through the SFTI network and to join the BTRADINZ CLOUD network.
- The Arab Spring, which initially alarmed investors, yet the Qatari stock market managed to largely overcome the effects of this crisis due to the strength of the Qatari economy and the confidence investors had in it. Despite these events, Qatar's stock market gained recognition as one of the best markets, with the Qatari stock market being upgraded to an emerging market by both Morgan Stanley and the S&P Dow Jones indices. It also became a full member of the World Federation of Exchanges (WFE). This was reflected in the peak of 2014, which reached 14,350.50 points, the highest performance level since the establishment of the Doha Securities Market.
- Despite the strong Qatari economy, the stock market indices saw a sharp drop at the beginning of 2017 due to diplomatic rifts in the Gulf (Saudi Arabia, Egypt, UAE, Bahrain, Yemen) and the severing of relations with Qatar. Saudi Arabia also forced international companies to choose between operating in Qatar or Saudi Arabia.
- In 2018, the market saw a significant rise despite the blockade, as confirmed by Bloomberg, which reported a reduction in credit risk from Qatar despite the blockade, and an increase in all indices.
- By the end of 2019, particularly on November 20, most Gulf stocks fell due to capital outflows following MSCI's review of index weights.
- Resistance was encountered at levels between 10,500 and 10,600 points, which failed to break through multiple times. Eventually, it was forced to drop to 10,318 points.
- The closest support level for the index is at 10,252 points, which is considered weak, and it is expected not to hold for long in the face of this downward movement. The next targets are 10,000-9,900 as the first target and 9,700-9,500 as the second.
- It is essential to maintain this level and not break it, as doing so could lead to a more substantial downward movement.
- Investors reduced their positions in anticipation of Aramco's IPO, and Gulf markets, particularly Qatar, faced a decline due to global sentiment being affected by the COVID-19 pandemic in early 2020.
- Despite the rise of most Middle Eastern markets, Qatar continued to decline on 14/01/2020.
- On 27/01/2021, Qatar recorded a slight increase in its closing price, rising by 1.3% as markets across the Arab world recovered. The Qatari stock market avoided the

collapse that hit Gulf markets due to the panic caused by the Omicron variant of COVID-19, which spread to the Gulf countries.

- In 2022, the performance of Arab stock exchanges was mixed, with the Qatari stock index rising to 12,571 points, an increase of 0.23%, reaching 12,194 points, up by 28 points.
- The continued rise of 0.9% was supported by the 2.5% increase in the Qatar National Bank's shares after it announced a 10% rise in net profits, driven by loan growth.
- We can see that the Qatari stock market was not significantly affected by the COVID-19 pandemic, due to its reliance on electronic platforms and digital services.
- Qatar's hosting of the 2022 FIFA World Cup had significant positive effects on the stock market and traders, greatly boosting investor optimism, especially with the positive results from companies that are expected to distribute favorable dividends. The strength of the Qatari economy is one of the key factors that made the Qatari market attractive, in addition to initiatives aimed at strengthening the position of the stock market both regionally and globally.
- Recently, the Qatar Investment Authority launched the "Market Maker" initiative to enhance liquidity in the Qatari Stock Exchange as part of its commitment to supporting and developing the stock market and the local economy. As part of this initiative, licensed market makers will have access to part of the stock holdings owned by the Qatar Investment Authority, along with incentive programs to support the liquidity of listed stocks on the Qatar Stock Exchange.
- Investor confidence and optimism are significant drivers of market recovery, and the 2022 World Cup has pushed confidence to the highest level. Positive investor expectations are likely to be reflected in upward stock prices. The Purchasing Managers' Index (PMI) released by the Qatar Financial Centre showed improved business confidence among Qatari companies, reaching its highest levels in two years in October 2022.
- In 2023, the Qatari general index closed the week on a positive note, confirming positive volume and harmonic trends despite geopolitical events in Gaza, as the Qatari financial market remained unaffected by the geopolitical events.

Unit Root Test:

There are several unit root tests, but in this study, we will focus on the ADF test, defined as follows:

Study of the Augmented Dickey-Fuller (ADF) Test:

Table (1): ADF Test Results on the Qatari Stock Market Index Price Series

Models	**Calculated ADF Value**	**ADF Critical Value**			**Decision**
		1%	5%	10%	
No Trend, No Constant	0.29	-2.65	-1.94	-1.61	
Constant Present	-1.96	-3.43	-2.86	-2.56	the series is non-stationary
Constant and Trend Present	-1.84	-3.96	-3.41	-3.12	

Source: Prepared by the authors based on the outputs of EVIEWS 13.

The calculated ADF statistics for all model specifications are greater than the corresponding critical values in absolute terms. Therefore, the null hypothesis of a unit root cannot be rejected. This indicates that the Qatar Stock Exchange price series is non-stationary at level and requires differencing before further econometric analysis.

$$Rt = \frac{\text{Pt}-\text{Pt}-1}{\text{Pt}-1}$$

Where:

- RT: Return in period t
- Pt: Market index price in period t
- Pt-1: Market index price in period t-1
-

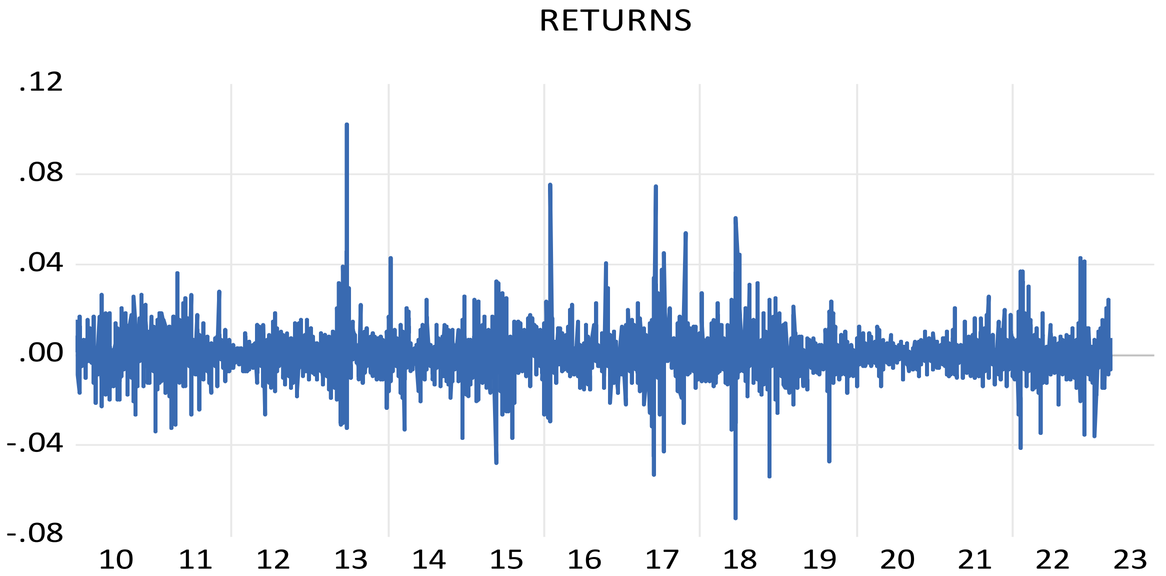
4. Application of the Box-Jenkins Methodology

Before delving into the Box-Jenkins methodology, it is essential to study the stationarity of the Qatari Stock Market Index return series.

4.1 Study of Stationarity of the Qatari Stock Market Index Return Series:

A- Graphically: In this regard, we can use the graphical representation of the return series over the study period:

Figure 3: Graphical Representation of the Qatari Stock Market Return Series



Source: Prepared by the authors based on the outputs of EVIEWS 13.

From the figure above, we observe that the Qatari Stock Market return series is stable at the mean but not constant in variance. There are noticeable fluctuations in the returns.

B-Study of the Stationarity of the Qatari Stock Market Index Return Series:

Table (2): ADF Test Results on the Qatari Stock Market Index Return Series

item	Value
ADF Test Statistic	**-30.18619**
Probability (p-value)	**0.0000**
Critical Value (1%)	**-2.566532**
Critical Value (5%)	**-1.940916**
Critical Value (10%)	**-1.615638**
Lag Length	**23**
Included Observations	**3453**
Method	**Least Squares**

Estimated ADF Regression Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RETURNS(-1)	-0.818191	0.027105	-30.18612	0.0000
D(RETURNS(-1))	-0.073134	0.022726	-3.216659	0.0013
D(RETURNS(-2))	-0.087624	0.016932	-5.932171	0.0001

Goodness-of-Fit Statistics
Interpretation

Statistic	Value
R-squared	0.447101
Adjusted R-squared	0.446730
S.E. of Regression	0.009544
Sum Squared Residuals	0.312918
Log Likelihood	11172.10
Akaike Information Criterion (AIC)	-6.469213
Schwarz Criterion (SC)	-6.458370
Hannan-Quinn Criterion	-6.463726
Durbin-Watson Statistic	1.999501

Source: Prepared by the authors based on the outputs of EVIEWS 13.

The Augmented Dickey-Fuller (ADF) test results indicate that the return series is stationary at level. The calculated ADF statistic (-30.18619) is substantially lower than the critical values at the 1%, 5%, and 10% significance levels. In addition, the associated p-value (0.0000) is lower than the conventional significance level of 5%. Therefore, the null hypothesis of a unit root is rejected, and the alternative hypothesis is accepted. This finding confirms that the return series does not contain a unit root and is stationary during the study period. Such stationarity is an essential prerequisite for reliable econometric analysis and indicates that the statistical properties of the series remain stable over time.

4.2 Unit Root Tests with Structural Breaks:

The result of the ADF unit root test with structural breaks on the Qatari Stock Market Index indicates the presence of a unit root in the series by comparing the critical values at the 1%, 5%, and 10% levels and the ADF statistic. The p-value is also greater than 0.05, indicating the presence of a structural break at the point.

Table (3): Unit Root Test with Structural Break on the Qatari Stock Market Index

Break Date: 17/12/2018
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 3 (Automatic - based on Schwarz information criterion, maxlag=29)

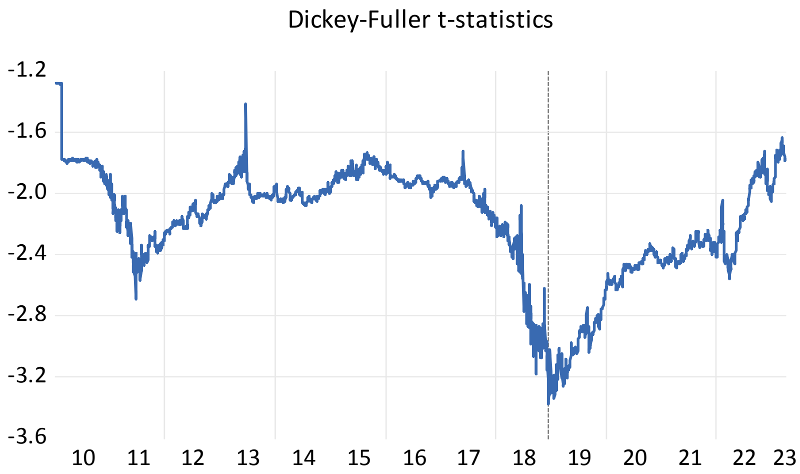
Prob.*	t-Statistic		
0.4516	-3.384405	Augmented Dickey-Fuller test statistic	
	-4.949133	1% level	Test critical values:
	-4.443649	5% level	
	-4.193627	10% level	

Source: Prepared by the authors based on the outputs of EVIEWS 13.

The result of the ADF unit root test with a structural break on the Qatari Stock Market Index shows that the price series exhibits a unit root. This is confirmed by comparing the critical values at the 1%, 5%, and 10% levels with the ADF statistic

Since the calculated test statistic (-3.384) is higher than the critical values at conventional significance levels, the null hypothesis of a unit root cannot be rejected. Consequently, the test does not provide sufficient evidence to conclude that the series becomes stationary after accounting for a single endogenous structural break. The identified date (17 December 2018) should therefore be interpreted only as the most likely break date suggested by the procedure rather than definitive statistical evidence of stationarity around that break.

Figure 4: Dickey-Fuller Test with Structural Breaks



Source: Prepared by the authors based on the outputs of EVIEWS 13.

Unit Root Tests with Multiple Structural Breaks:

Table (4): Unit Root Test with Multiple Structural Breaks on the Qatari Stock Market Index

Multiple breakpoint tests
Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05
Sequential F-statistic determined breaks: 4

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	2784.129	2784.129	8.58
1 vs. 2 *	796.8267	796.8267	10.13
2 vs. 3 *	1595.578	1595.578	11.14
3 vs. 4 *	60.88944	60.88944	11.83
4 vs. 5	0.000000	0.000000	12.25

*** Significant at the 0.05 level.**
**** Bai-Perron (Econometric Journal, 2003) critical values.**

	Sequential	Repartition
1	14/10/2019	20/02/2012
2	7/08/2017	4/11/2014
3	30/05/2012	25/07/2017
4	4/11/2014	1/08/2019

Source: Prepared by the authors based on the outputs of EVIEWS 13.

From the table above, we observe that there are four structural breaks:

- **February 20, 2012:** The closing price recorded 10,858 points, which represents a decrease compared to February 21, 2011, at 14,018 points, a 77.45% decline. In early 2011, the Arab world witnessed security disturbances termed the "Arab Spring," which began in Tunisia in December 2010, followed by Egypt on January 25, 2011, and later Yemen, Libya, and Syria. These revolutions erupted due to various causes, including economic issues such as low living standards, social issues like lack of equal opportunities, increased bureaucracy, corruption, and political issues such as political persecution and the policy of dynastic succession. However, the Qatari stock market was largely unaffected by these geopolitical crises.

  This was due to the launch of the debt instruments market and the listing of the first tranche of treasury bills, as well as the implementation of the delivery-versus-payment (DVP) process in 2011. In 2012, the Qatar Stock Exchange launched a market for emerging companies dedicated to listing small and medium-sized enterprises. Additionally, QNB completed its first bond issuance worth $1 billion.

- **November 4, 2014:** The Qatari Stock Index showed a decline of 738.40 points (or 5.47%) compared to October 2014, closing the month at 12,760.46 points. The trading volumes increased significantly due to the rise in the number of listed companies and the market's increasing market capitalization. This rise reflected the economic boom in Qatar, as the stock market was officially recognized as an emerging market this year, accompanied by improvements in regulations, laws, and asset prices.

  On the first day of the blockade, the general index of the Qatar Stock Exchange fell by approximately 700 points, the highest level since 2014. The blockading countries expected to break Qatar's economic and financial strength by targeting the Qatari Stock Exchange. Investment portfolios from these countries were systematically sold off, aiming to inflict heavy losses on the exchange, hoping to cause its collapse. However, the Qatar Stock Exchange remained resilient.

- **Structural Break 2017:** In the beginning of the blockade, the Qatari Stock Exchange experienced a drop in its index due to some portfolios being sold, which is typical in such circumstances. However, this crisis also facilitated the entry of many foreign investors into direct investments in the exchange due to global interest in Qatar's stock market during this period, owing to the strength, diversity, and stability of the Qatari economy and attractive opportunities with competitive prices. Qatari companies also proved to be generous in their dividend distributions, which was an ideal attraction for investors in these challenging times.

  During the blockade period, the first family-owned company shares were listed on the Qatari Stock Exchange, further confirming the resilience of Qatar’s economy in the face of the challenges posed by the blockade. In just one month, over 70 new foreign portfolios opened accounts on the exchange to start trading Qatari stocks, which experts considered a significant opportunity for investors.

- **Structural Break 2019:** In 2019, Qatari stocks closed up 0.4% at 10,497 points. Qatar Aluminium Industries opened at 18 Qatari riyals, which was nearly 80% higher than the IPO price of 10.10 Qatari riyals, marking the successful debut of the largest stock listing in Qatar this year. The stock later decreased to 13.01 riyals, while Qatar Industries' stock increased by 0.9%.

In Abu Dhabi, the index fell by 0.6% to 4,831 points, affected by selling activities in the shares of the First Abu Dhabi Bank, which dropped by 1%, and a 3.7% decline in Aldar Properties shares.
In the Saudi market, the index saw a slight decline of 0.08% to 7,908 points, but Zain Saudi Arabia's shares rose by 5.8% after announcing that the company reached an agreement with the government to adjust its annual franchise fee.

In other Gulf markets, the Kuwaiti index rose by 0.4%, the Muscat Exchange dropped by 0.7%, and the Bahrain Stock Exchange index remained stable.

Results of the Study:

The results varied across financial markets depending on their level of development and their ability to absorb and reflect information in their returns. Most emerging markets were found to be inefficient, following a random walk and suffering from time series flattening, making stock price forecasting possible through the prediction of previous prices.

Hypothesis Testing:

After conducting the applied study, the pre-formulated hypotheses were verified as follows:

The study showed that the Qatari Stock Market index exhibited structural changes due to the circumstances the market underwent, starting with the crisis that hit the Qatar Stock Exchange, especially after the withdrawal of numerous foreign investments and the subsequent withdrawals following the Arab blockade. The stock market had to close its general index to avoid expected losses from the Gulf Cooperation Council (GCC). However, through the analysis of the phenomenon, it became clear how resilient the Qatari economy was, as despite the damages caused by the COVID-19 pandemic, the Qatari economy was not as affected as other countries around the world.

After analysis and obtaining the results, it was found that these shocks to the market made it stronger and more resilient, heading toward improvement due to the strength of the Qatari economy and its advanced strategy that incorporates modern technologies.

The kurtosis coefficient equals 2.678779, which is slightly lower than the normal benchmark value of 3. This suggests a relatively flatter (platykurtic) distribution than the normal distribution rather than evidence of fat tails.

The Augmented Dickey-Fuller test revealed that the time series of the Qatari Stock Market returns, with or without trend and intercept, did not have a general trend, and the series was stable during the study period.

The Qatar Stock Market experienced many financial fluctuations that impacted investments, which were reflected in the low returns from the listed company shares that were accompanied by high risks. This contradicted the investment rule that suggests an increase in risk should correlate with an increase in stock returns, something we did not observe in the listed companies studied.

The structural break tests confirmed the presence of several significant changes in the behavior of the Qatar Stock Exchange Index over the study period, emphasizing the importance of incorporating structural breaks when modeling financial time series.

Future Research Avenues:

- **Conducting studies that address other factors** that may affect trading volume, such as earnings announcements, exchange rates, price limits, and other factors. This research focused only on one factor, which is the volatility of stock returns, as it is a key element affecting the risks in the financial market.
- **Focusing on hybrid models** when forecasting in the financial market to make informed investment decisions.
- **Emphasizing artificial neural networks (ANNs)** in forecasting to support investment decision-making, as a key complement to traditional ARIMA-GARCH models.
- **Attempting to apply a hybrid model** combining autoregressive models with heteroskedastic errors and long-memory models such as GARCH-ARFIMA.

References:

Michaud, D. M. (1989). "La prévision approche empirique d'une méthode statistique." Paris: Masson.

Bruce, H. (2001). "The New Econometrics of Structural Change: Dating Breaks in U.S. Economic Perspectives." *Journal of Economic Perspectives*.

Clemente, J. M. (1998). "Testing for a unit root in variables with a double change in the mean." *Economics Letters*.

Glynn, J. P. (2007). "Unit root tests and structural breaks: A survey." *Revista de Métodos Cuantitativos para la Economía y la Empresa*.

Ikeora, J. J., Igbodika, M. N., & Jessi, C. (2016). "Financial Liberalization, Economic and Growth in Nigeria." *Journal of Humanities and Social Science*, 21(05), 123-132.

Nilsson, I. (2009). "Unit root Tests and Structural Breaks in the Swedish Electricity." Department of Business Administration and Social Sciences: Lulea University of Technology.

Perman, B. A. (2006). "Unit Roots and Structural Breaks: A Survey." *Department of Economics, University of Glasgow*.

Phillips, P. C., & Perron, P. (1988). "Testing for a unit root in time series regression." *Biometrika*, 75(02), 335-346.

Russell, D., & MacKinnon, J. G. (2004). *Econometric Theory and Methods*. Oxford University Press, 620-634.

Sandrine Lardic, V. M. (2002). "Econométrie des séries temporelles macroéconomiques et financières." *Economica*, 145-159.

Vahid, F., & Engle, R. (1993). "Common trends and common cycles." *Journal of Applied Econometrics*, 335-358.

Abdulrahman bin Mohammed Salman, Anwar Ahmed Mohammed, & Mahmoud Mohammed Ibrahim. (1995). *Applied Statistics*. Riyadh: King Saud University Press.

Mohammed Idrich Dahmani. (2013). *Series of Lectures in Econometrics*. Printed. Sidi Bel Abbes, Algeria: Faculty of Economic Sciences and Management.

Mohammed Sheikhi. (2011). *Econometric Methods: Lectures and Applications*. Algeria: Dar Al-Hamid.