

Exploring the Dynamic Relationship between Interest Rates and the Movement of the Jamaica Stock Exchange (JSE) Indices: A Time-Series Analysis

Shaneille Samuels*

Division of Mathematics, School of Mathematics & Statistics, Faculty of Science & Sports,
University of Technology, Jamaica, St. Andrew, Jamaica

*Corresponding author: shaneille.samuels@gmail.com

Received October 15, 2024; Revised November 17, 2024; Accepted November 24, 2024

Abstract This research study delved into the intricate relationship between the 88-93-days Treasury Bill Rates and the movement of Jamaica Stock Exchange (JSE) indices within a time-series context during the period of 2012 to 2022. The indices used in this study are the Main Index, the JSE All Jamaica Composite Index, and the JSE Select Index. Through meticulous quantitative analysis, the study aimed to unveil the underlying nature of this relationship by examining how changes in the rates influence the behaviour of the JSE indices for 2012 and 2022. This analysis involved the usage of correlation, time-series, and regression analysis, which was completed with the use of SPSS, R for time-series, and [online] GraphPad. The study explored statistical tests such as Pearson Product Moment Correlation, the Time-Series Differencing method, and the forecasting models HoltWinter and SARIMA models. The findings revealed that there is a significantly strong negative correlation between the JSE indices and 88-93-days Treasury Bill Rates with a correlation of approximately -0.78 or less but not less than -1 and having p-values smaller than 0.05. Thereby an inverse relationship was revealed to exist where almost one unit change in the rates results in approximately 1 unit change of each index. The study also revealed that there was no trend nor randomness seen in the decomposition of the rates or decomposition of the indices, but seasonality was captured which repeated itself each year. It was difficult however to remove the seasonality to ensure that the data was stationary; eventually, after using logarithm transformation followed by differencing of the data, stationary was almost achieved. With the non-stationary datasets, models such as HoltWinter and SARIMA were used to identify trends and patterns using prediction, but both could not fit the data because the data was insufficient mostly because of data unavailability of monthly periods to identify and use appropriate time lags. The study facilitated the use of regression equations to drive the prediction of the JSE indices and how they move along with the rates. Also, there was a slight deviation of the expected pattern found during 2020 and 2021 when a statistically significant perfect correlation [with a coefficient of +1] between the rates and indices as Jamaica recovered from the pandemic, which indicated that as 1 unit of the rates increase so did 1 unit of each index value. The study implied that investors could garner knowledge of the relationship and a greater understanding of both BOJ and the JSE stock market to help minimize their panic during economic downturns such as the COVID-19 pandemic.

Keywords: time-series, interest rates, performance, stock exchange indices

Cite This Article: Shaneille Samuels, "Exploring the Dynamic Relationship between Interest Rates and the Movement of the Jamaica Stock Exchange (JSE) Indices: A Time-Series Analysis." *Journal of Finance and Economics*, vol. 12, no. x (2024): 111-122. doi: 10.12691/jfe-12-4-4.

1. Introduction

The significance of the Jamaica Stock Exchange (JSE) and interest rates are crucial components of Jamaica's financial landscape. Both elements over the years have played pivotal roles in shaping the country's economic environment while impacting businesses, policymakers, and investors. Moreover, the intricate relationship between stock market indices and interest rates constitutes a fundamental aspect of financial markets across the world. Considering the Jamaican context, this relationship holds

particular significance especially since the country's economy has been evolving and it relies on both international and domestic investments. Therefore, policymakers, investors, and financial institutions must understand how fluctuations in interest rates influence the behaviour of the Jamaica Stock Exchange (JSE). Jamaica has experienced economic growth over the years and has been resilient however, it remains sensitive to internal factors and global economic trends. According to Ref [1], the JSE was established to serve as the primary platform housing both primary and secondary markets for trading bonds, equities, and other financial securities.

Interest rates, inflation rates, and macroeconomic

indicators have been influenced by the Bank of Jamaica's (BOJ) policies which have directly impacted consumption patterns, borrowing costs, and investment decisions. For instance, in 2009 and 2015 BOJ decided to implement a series of interest rate cuts on open market instruments to stimulate economic growth and bolster investor confidence as shared by Ref [2] and Ref [3]. Similarly, shifts in interest rates during periods of economic uncertainty underscore the interconnectedness between monetary policies and market behaviour.

The JSE functions, within the Jamaican financial landscape, as a vital platform for wealth creation and capital mobilization which involves offering companies access to financing while enabling investors to participate in the ownership of diverse businesses. The performance of the JSE indices mirrors market sentiment and economic health. Now, market sentiment which reflects investor expectations and perceptions is often influenced by changes in interest rates. For example, in 2020 during the height of the pandemic when the government shut down the country, investors became extremely panicky and decided to find haven. Ref [4] shared that the investors decided to remove their funds from stocks and focus on other guaranteed investments at the time such as real estate. Such instances illustrate the interplay between interest rates, investor behaviour, and the broader market environment.

1.1. Purpose of the Study

This study aimed to comprehensively investigate and analyze the intricacies and dynamics of the relationship between the Jamaica Stock Exchange (JSE) movements and fluctuations in interest rates, particularly since there remains a gap in our understanding of the dynamic relationship between these two crucial components. The nature of the influence that changes in interest rates exerts on the behaviour of JSE indices, whether through direct impact, lagged effects, or bidirectional causality remains a complex and nuanced question. Consequently, this study sought to address this gap by conducting a comprehensive time-series analysis to uncover the underlying trends, patterns, and potential causal relationships that may exist within this relationship, which will provide a deeper understanding of how changes in interest rates influence the behaviour of the JSE indices during 2012 and 2022. Additionally, this study sought to provide valuable insights to enhance investment decision-making, inform policy considerations, and enrich the broader understanding of Jamaica's financial landscape.

1.2. Research Questions

The researcher determined the following research questions to guide the research process:

1. How does the movement of JSE indices respond to changes in the 88-93-days Treasury Bill Rates within a time-series context between 2012 and 2022?
2. Are there instances where the relationship between the 88-93-days Treasury Bill Rates and JSE indices deviates from the expected pattern due to external

shocks or unique economic conditions?

1.3. Preliminaries

This section provides preliminary information related to the mathematical processes involved in the study.

Calculating Yearly Interest Rates - Compound Monthly Rates to Yearly

- a) The formula provides the yearly interest rate calculations when the interest is the same each month within a year: $[(1 + \text{Monthly Interest Rate})^{12} - 1] \times 100$, where the monthly rate is expressed in decimal form.
- b) The formula provides the yearly interest rate calculations when the interest is different each month within a year using the geometric mean:

$[\prod_{i=1}^{12} (1 + \text{Monthly Interest Rate}_i)^{\frac{1}{12}} - 1] \times 100$ where the monthly rate is expressed in decimal form.

Definition of Time Series

A time series $\{y_t\}$ is a set of observations that represent the value of a variable at consecutive points in time t . This is usually described as continuous, discrete, deterministic, or stochastic.

Definition of Trend

A trend is defined as a long-term change in the mean of a time series. An example of a trend-only model is:

$$y_t = \alpha + \beta t + \epsilon_t$$

Now, $\alpha + \beta t$ is described as the [global] linear trend where $\alpha, \beta \in \mathbb{R}$. However, ϵ_t can be described as the random fluctuations which are identically independently distributed [that is, iid $N(0, \sigma^2)$]. This model is free of cyclic behaviour.

Source: Chatfield [5]

Definition of Stationary

Ref [5] stated that the mean function of a time series $\{y_t\}$ is given by $\mu(t) = E[y_t]$, and $\{y_t\}$ is said to be stationary in the mean if μ is a constant function.

Understanding Simple Linear Regression

According to Beers [6], regression can be defined as a statistical method used to test the strength as well as the character-defining relationship between a dependent variable and a series of other variables where necessary. The Linear Regression Model is defined as:

$$y_i = \alpha + \beta x_i + \epsilon_i$$

$$E[y_i] = E[\alpha + \beta x_i] + E[\epsilon_i] \Rightarrow$$

$$E[y_i] = E[\alpha] + E[\beta x_i] + 0 \Rightarrow$$

$$E[y_i] = \alpha + \beta E[x_i]$$

$$\text{Var}[y_i] = \beta^2 \text{Var}[x_i] + \sigma^2 \Rightarrow \text{Var}[y_i] = \sigma^2$$

x_i is not random by y_i is hence $\text{Var}[x_i] = 0$.

$\text{cov}[y_i, y_i] = 0$, by independence.

Source: Chatfield [5]

2. Literature Review

It is important to understand the complex relationship between the two variables, interest rates, and stock market indices. As such, it is essential to identify the theories associated over the years. There have been various theoretical perspectives that underpin the potential causality between interest rates and stock market movements that help to elucidate the mechanisms through which changes in interest rates can influence stock prices. This study will look at the Neoclassical, the market and sentiment and expectations, and the Fisher Hypothesis perspectives. According to Kenton [7] refers to the use of a discounting mechanism to be facilitated by the changes in interest rates that influence stock market movements. For instance, higher interest rates can increase the discount rate used to value future cash flows and thus potentially lead to lower stock valuations. For example, during periods of economic expansion, central banks might opt to increase interest rates to curb inflation which can lead to reduced demand for equities as investors seek higher returns in less risky fixed-income investments. Miller & Modigliani [8] shared that changes in interest rates can impact market sentiment and investor expectations about future economic conditions. Muth [9] and Tardi [10] postulated that the rational expectations theory was developed from a hypothesis that posits that people make decisions based on their human rationality, using the information that becomes available to them along with their past experiences. The theory suggests that people can influence the future state of the economy based on their current expectations of the economy. This theory was developed to explain anticipated economic factors and has been widely used in macroeconomics to refer to business cycles and financial activities. For instance, expectations of higher future interest rates may lead to concerns about reduced corporate profitability and economic slowdown, causing investors to sell stocks.

Fisher [11] proposed the theory of interest that focuses on the Fisher Hypothesis and inflation. The hypothesis suggests a positive relationship between nominal interest rates and expected inflation. If interest rates fail to keep pace with inflation, real interest rates decrease, making stocks relatively more attractive as investment. For example, during periods of high inflation central banks might raise interest rates to combat inflation. However, if nominal rates do not fully offset inflation, real interest rates might remain low, potentially benefiting the stock market.

2.1. Interest Rates and Stock Market Behaviour

The relationship between interest rates and stock market indices is a very important topic that has garnered significant attention from financial analysts, economists, and researchers. This connection is rooted in the fact that interest rates can impact company earnings, borrowing costs, investor behaviour, and the overall economy, thereby influencing stock market movements. Investment decisions of consumer and businesses are mostly driven by their expectations. The level of interest rates can influence investment decisions by affecting the cost of

capital for businesses [whether starting a business or desiring expansions]. Seabury [12] inferred that when there is an increase in interest rates, consumers and businesses usually cut back on their spending which is likely to decrease earnings and thus a decline in stock prices. For example, Rose [13] pointed out that as of last year April with the BOJ increasing policy interest rates in Jamaica to 7%, homeowners have experienced an increase in mortgage while general insurance companies have heightened the premium costs by at least 50%. Consequently, persons desiring to purchase their homes using banks such as Sagicor Bank Jamaica Limited and Victoria Mutual Building Society are facing high loan rates because houses are expensive now. For example, according to Ngubeni [14], in the United States (US) the interest rate increased from 0.5% to 0.75% which affected changes in the prime rate, credit rate and mortgage rate by the commercial banks. Concerning the stock market, as interest rates increase and slow down the economy, decisions must be made to recover from the setback. US Bancorp [15] revealed that the US stock market between January 2022 and July 2023 for example strategized and made a comeback as seen in Figure 1 which followed with significant repricing. Conversely, when interest rates are low, there is a decrease in borrowing costs thus potentially leading to increased business investment and consumption as well as higher stock market valuations.



Figure 1. S&P Index Value during the period of January 3, 2022 to July 14, 2023 (US Bancorp [15])

In referring to market sentiment a yield curve is usually considered. Fidelity Investments [16] defines a yield curve as a tool used to measure the feelings of bond investors about taking on risks along with a significant impact on the returns they would receive on their investments. It has been stated that if an individual understands the yield curve, then it will help him or her to be able to use to gauge the direction of the economy. This curve usually reflects the short, intermediate-, and long-term US Treasury securities rates. The shape of the curve shows the relationship between short-term and long-term interest rates which provides insights into market sentiment and economic expectations. Take for example an inverted yield curve which shows that the short-term interest rates are higher than the long-term interest rates. This curve is often used as a predictor of economic downturns and can impact stock market behaviour. Fidelity Investments [16] went further to say that investors often use this curve to identify when the economy is likely to stagnate [for example the likelihood of a recession]

because of decreasing interest rates that indicate slower economic growth as illustrated in Figure 2.

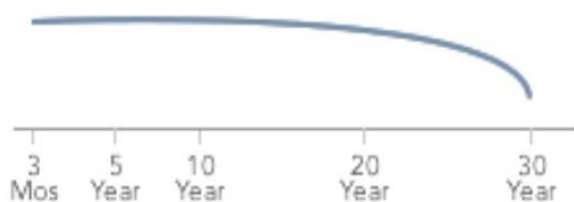


Figure 2. Inverted Yield Curve (Fidelity Investments [16])

According to the Investopedia Team [17], central banks across the world usually make decisions to either lower or raise interest rates which tend to have a significant impact on the economy and financial markets. So, if the central banks increase interest rates, then the cost of borrowing increases which makes investment and credit more expensive. These banks usually increase interest rates because the economy may be much overheated and require slowing down. Conversely, when central banks decrease interest rates, it is now cheaper to borrow money in the economy so there are likely increased investments and increased credit in the financial landscape. This facilitates the stimulation of a stagnant economy as shared by the Investopedia Team [17].

Interest rates influence investor behaviour and risk appetite. As such it is very important for the financial landscape [financial advisors] to have enough information to guide investors to help them identify their risk tolerance and their investment preferences and align them. Pompian [18] shared that coming out of the global financial crisis in 2008, it becomes important to understand panicky and stressed-out clients to help them feel more comfortable and even become more equipped with knowledge in knowing how to deal with financial crises in the future. When investors are exposed to lower interest rates, they are usually encouraged to seek higher returns in riskier assets like stocks [more aggressive investment strategies] to benefit from potential stock market gains. The converse, however, is that higher risk rates might lead to reduced risk-taking [conservative investment strategies] and investors may prefer to invest in lower risk [safer] assets. Also, according to Pompian [18] investors might be prompted to review their asset allocation and portfolio management strategies as interest rate changes under the guidance of a financial advisor. In times of market volatility as well investors may react to changes in interest rates by adjusting their trading activities and investment decisions.

3. Methodology

3.1. Research Design and Approach

This study was designed to collect and analyse quantitative data related to interest rates and JSE indices. This study involved the collection of data from credible sources which include Bank of Jamaica (BOJ) and Jamaica Stock Exchange (JSE) websites to ensure that the data is valid and reliable. The data on interest rates was collected from BOJ, while data on the JSE indices was

collected from the Jamaica Stock Exchange (JSE) from 2012 to 2022. The Jamaica Stock Exchange (JSE) and BOJ are two well-known reputable websites in Jamaica that provide economic [and financial] statistics. BOJ is the central bank of Jamaica that identifies all monetary and fiscal policies and provides economic data such as interest rates, and inflation rates amongst others that are used to drive economic activities in the country. Yearbooks on financial data are provided by the JSE along with stock market reviews publicly shared on their websites. The data was collected in the first week of August 2023.

3.2. Operationalization of the Variables between 2012 and 2022

The operationalized variables in this study are interest rates, JSE indices, and time. The interest rates used in this study were the 88–93-day Treasury Bill Rate which it will be expressed as annual percentage changes. This study examined the most prominent JSE indices which include the JSE Cross Listed Index, the JSE Main Index, the Junior Market Index, the JSE Combined Index, the JSE USD Index, the JSE Select Index, and the JSE All Jamaican Composite Index during 2012 and 2022. The JSE indices data was collected on their annual points. During the time selected, economic, and financial events will be identified and discussed that could impact the relationship between JSE indices and interest rates. The period selected for the analysis was based on the most recent historical data that is available and considered to be crucial in facilitating a meaningful analysis. The sample size involved is 11 years.

3.3. Time-Series Analysis

The time-series analysis can be defined as a statistical approach which involves the analysis of sequence of points over a specified time interval. This analysis requires the use of visuals such as time-series plots that show how variables change over time. In this study, the analysis was done to identify how both JSE indices and 88-93 Treasury Bills Rate change over time. The analysis was done using the following methods:

- ❖ Correlation Analysis: The study described the correlations between interest rates and JSE indices.
- ❖ Regression Analysis: This study explored causality by modelling the relationship between interest rates and JSE indices.
- ❖ ARIMA Modelling: This study will analyse and forecast the time-series data of interest rates and JSE indices.

The presentation of the results of the time series analysis was done using relevant graphs and charts to illustrate key findings. The study discussed any statistical significance found, the correlation coefficients and regression coefficients using statistical software SPSS, R for time-series, and Microsoft Excel.

4. Results of the Statistical Analysis

Empirical results using data presentations such as charts will be provided related to the time-series analysis of the

88-93-day Treasury Bill Rates and the JSE indices. For this study, the following indices were randomly selected: the Main Index, the All Jamaican Composite Index, and the JSE Select Index. The findings will be presented for both research questions addressing the objectives related.

4.1. Research Question 1 Results

How does the movement of JSE indices respond to changes in the 88-93-days Treasury Bill Rates within a time-series context between 2012 and 2022?

This research question looked at data presentation generated from a time-series analysis where patterns and trends are identified in the movement of the 88-93-day Treasury Bill Rates and the JSE indices. Throughout the study, the Treasury Bill Rates will be the independent variable because it is a result of monetary policies which can influence other rates in the economy along with investors' decisions and thus impact the Jamaica Stock Exchange Market performance. Since performance is driven by the indices namely the Main Index, All Jamaican Composite Index and the JSE Select Index then each of them will be regarded as a dependent variable when making a comparison with the Treasury bill rates. Therefore, in looking at the relationship between the indices and the Treasury bill rates the Product Moment Correlation was also used to explain whether changes in the 88-93-day Treasury Bill Rates and concurrent changes in the JSE indices are related to each other. Also, the significance of the correlation coefficient was provided to indicate the level of importance of this relationship.

Statistics		
TreasuryBill		
N	Valid	11
	Missing	0
Mean		4.8700
Median		5.3300
Std. Deviation		2.12765
Minimum		1.33
Maximum		7.66

Statistics		
MainIndex		
N	Valid	11
	Missing	0
Mean		265255.7618
Median		288381.9700
Std. Deviation		152989.78722
Minimum		76353.39
Maximum		509916.44

Figure 3. Summary Statistics for both Treasury Bills and the Main Index

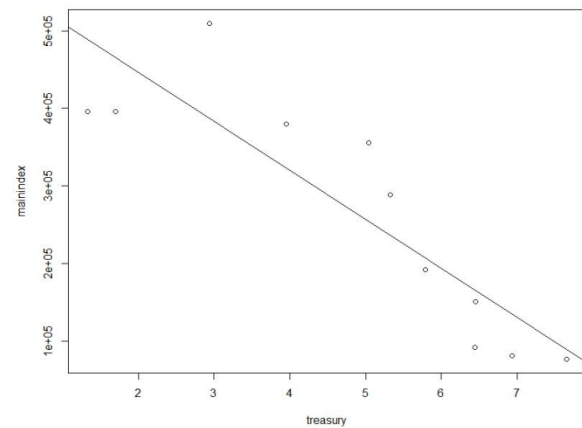


Figure 4. Scatterplot with Regression Line of Treasury Bills and the Main Index

Correlations			
		TreasuryBill	MainIndex
TreasuryBill	Pearson Correlation	1	-.878**
	Sig. (2-tailed)		<.001
	N	11	11
MainIndex	Pearson Correlation	-.878**	1
	Sig. (2-tailed)	<.001	
	N	11	11

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 5. Product Moment Correlation Coefficient and Statistically Significant Level for Treasury Bills and the Main Index

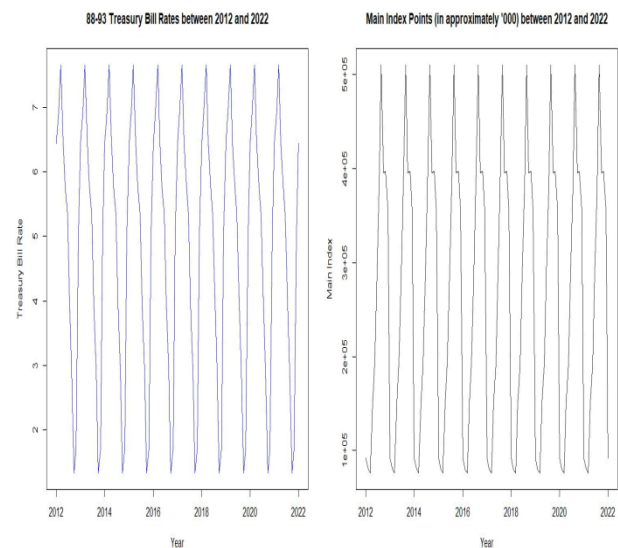


Figure 6. Time-Series Plots of Treasury Bill Rates and the Main Index Points between 2012 and 2022

The data revealed that the mean and median values of the Treasury bill and Main Index data are relatively close suggesting that the distribution might be appropriately symmetric or moderately skewed, particularly for the Treasury bill dataset (see Figure 3). The standard deviation is significantly smaller than the mean for both datasets indicating the variability within both dataset is relatively moderate (see Figure 3). However, there is a strong negative relationship between Treasury bill rates and the Main Index with a correlation coefficient of -0.878 (see Figure 4 and Figure 5). This relationship is statistically significant.

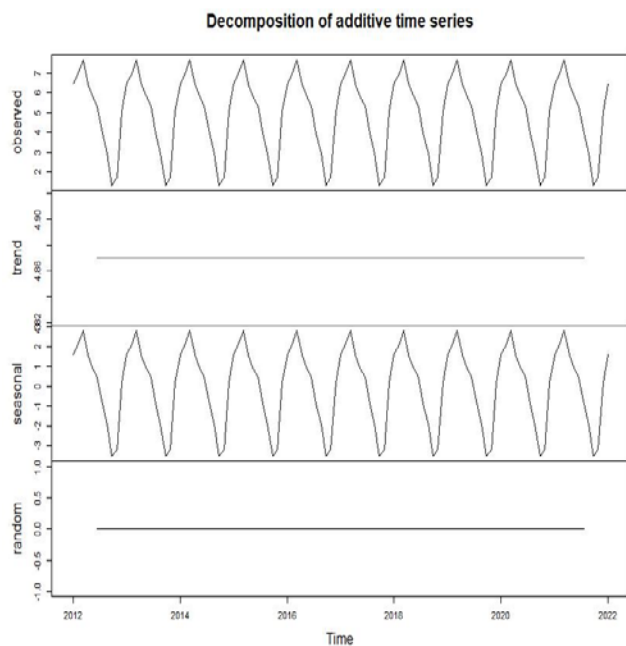


Figure 7. Decomposition of Treasury Bill Rates Time-Series Data

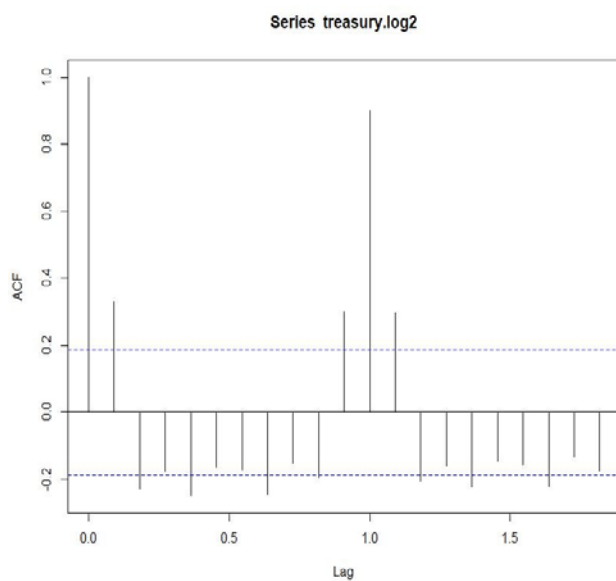


Figure 8. Corelogram (ACF plot) of the First-Difference of the Logarithmic Transformed Treasury Bill Rates

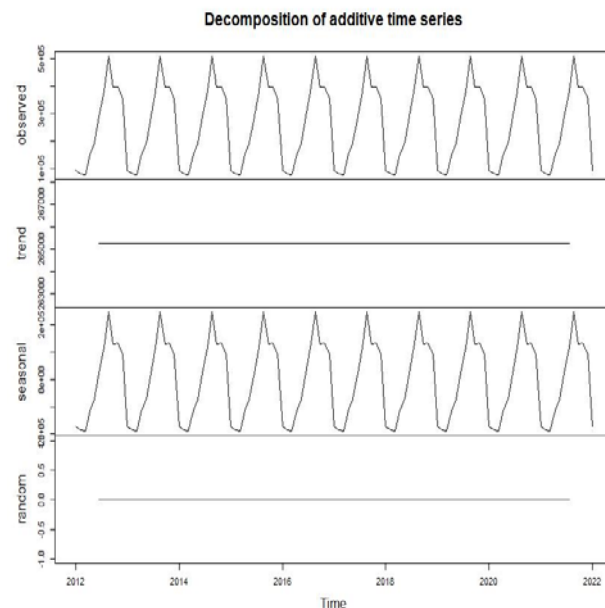


Figure 9. Decomposition of the Main Index Time-Series Data

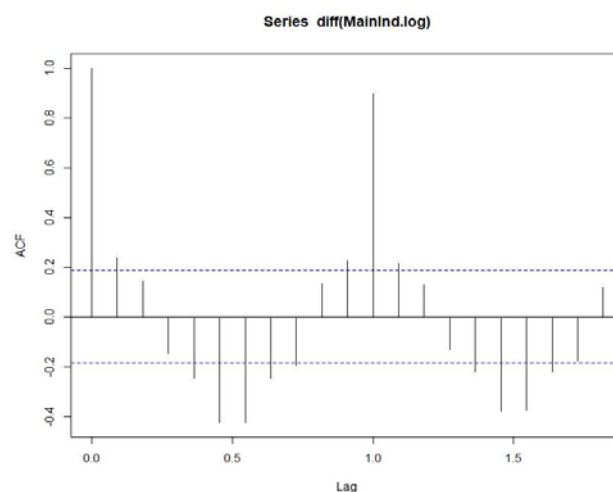


Figure 10. Corelogram (ACF plot) of the First-Difference of the Logarithmic Transform of the Main Index

When the treasury bill rates and main index datasets are decomposed, there is a horizontal pattern representing the trend which indicates a fluctuation of the data randomly around a constant mean of 4.87 and 265,255.76 respectively during the period of 2012 to 2022 (see Figure 6 and Figure 8). This indicated that no trend nor randomness exist, however there is seasonality [repeating itself after each year] within the data so it is not stationary. However, removing the seasonality does not work using second-order differencing without the use of a logarithmic transformation of the data. The data, nevertheless, is almost stationary when a logarithmic transformation of the data was done [to make the seasonal effect additive] followed by first-difference since most of the spikes [the autocorrelation at each lag (excluding lag 0)] lie within the blue horizontal lines [the threshold] (see Figure 7). A

Holt-Winters procedure was used to filter the data to predict the forecast, but this is usually requiring forecasts in months ahead instead of years ahead, thus it gave a prediction of February 2022 to be 80633.55 rather than a forecast for the next 6 years. Since the data is not stationary [though close] identifying a SARIMA model was considered which involved a second difference of the first difference of the logarithmic transformed Main Index was done but was found to be even ineffective particularly because a suitable lag time could not be found in comparison to the first. Also, to use a SARIMA model could not be used because the data was in years [instead of months] which is insufficient consequently its parameters could not be found. Also, there is large fluctuation in the data due to the small sample of 11 data points. However, in using the generated regression equation $[y = -63115x + 572626]$ for the data on Treasury Bill Rates and the Main Index predictions can be made in years to come (see Table 1).

Table 1. Description and equation of the linear regression of the Main Index and Treasury bill rates (GraphPad [19])

Best-fit values	Slope	-63115 ± 11484
	Y-intercept	572626 ± 60584
	X-intercept	9.073
	1/Slope	-1.584e-005
95% Confidence Intervals	Slope	-89091 to -37139
	Y-intercept	435585 to 709667
	X-intercept	7.655 to 12.20
Goodness of Fit	R square	0.7704
	Sy.x	77265
Is slope significantly non-zero?	F	
	DFn,DFd	30.21
	P Value	1,9
	Deviation from horizontal?	0.0004 Significant
Data	Number of XY pairs	11
	Equation	$Y = -63115 \cdot X + 572626$

Statistics		
AllJamCom		
N	Valid	11
	Missing	0
Mean		291158.2945
Median		316516.1100
Std. Deviation		170782.48830
Minimum		81850.04
Maximum		559853.26

Statistics		
JSESelect		
N	Valid	11
	Missing	0
Mean		7099.8718
Median		8516.3800
Std. Deviation		3697.65310
Minimum		2176.17
Maximum		13064.81

Figure 11. Summary Statistics for both the All Jamaican Composite Index and the JSE Index

For the data on All Jamaica Composite and JSE Select Indices, the median is greater than the mean. The mean and median values of the indices are relatively close

suggesting that the distribution is moderately skewed, particularly for the All Jamaican Composite Index dataset (see Figure 11). The standard deviation, however, is not significantly smaller than the mean for both datasets indicating the data points within both datasets are some distance away from the mean (see Figure 11). However, there is a strong negative relationship between the treasury bill rates and the All Jamaican Composite Index with a correlation coefficient of -0.872 but was found to be statistically significant (see Figure 12 and Figure 14). A similar relationship between the JSE Select Index and the Treasury bill rates (see Figure 13 and Figure 15).

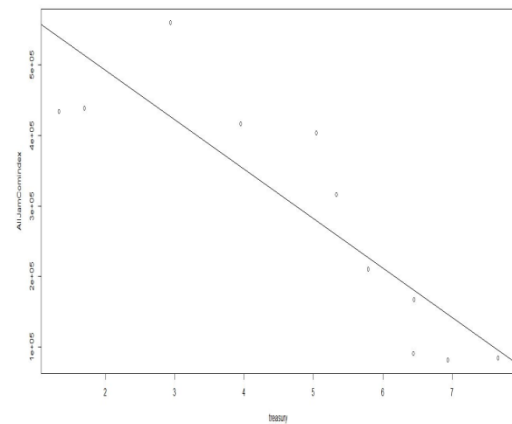


Figure 12. Scatterplot with Regression Line of Treasury Bills and the All Jamaican Composite Index

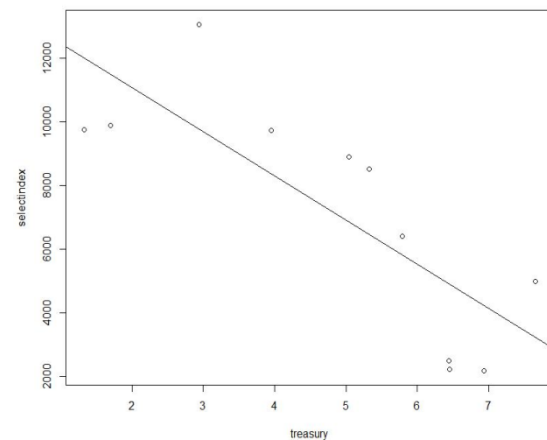


Figure 13. Scatterplot with Regression Line of Treasury Bills and the Select Index

Correlations			
		TreasuryBill	AllJamCom
TreasuryBill	Pearson Correlation	1	-.872**
	Sig. (2-tailed)		<.001
	N	11	11
AllJamCom	Pearson Correlation	-.872**	1
	Sig. (2-tailed)	<.001	
	N	11	11

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 14. Correlation Coefficient and Statistical Significance of the relationship between Treasury Bill Rate and the All Jamaican Composite Index

Correlations			
		TreasuryBill	JSESelect
TreasuryBill	Pearson Correlation	1	-.799**
	Sig. (2-tailed)		.003
	N	11	11
JSESelect	Pearson Correlation	-.799**	1
	Sig. (2-tailed)	.003	
	N	11	11

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 15. Correlation Coefficient and Statistical Significance of the relationship between Treasury Bill Rate and the JSE Select Index

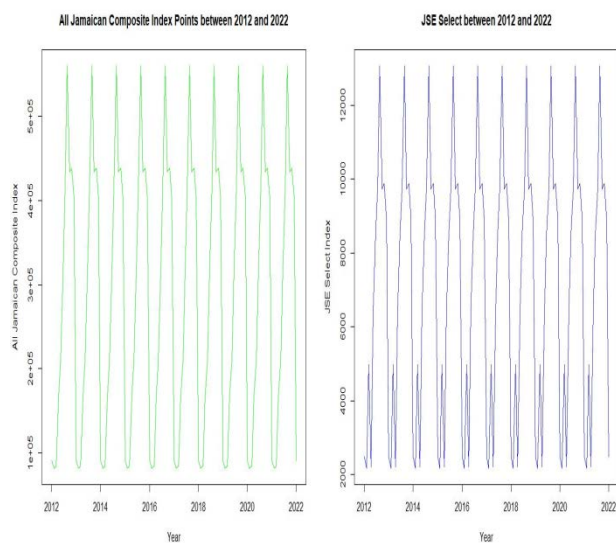


Figure 16. Time-Series Plots of the All Jamaican Composite Index Points and the JSE Select Index Points between 2012 and 2022

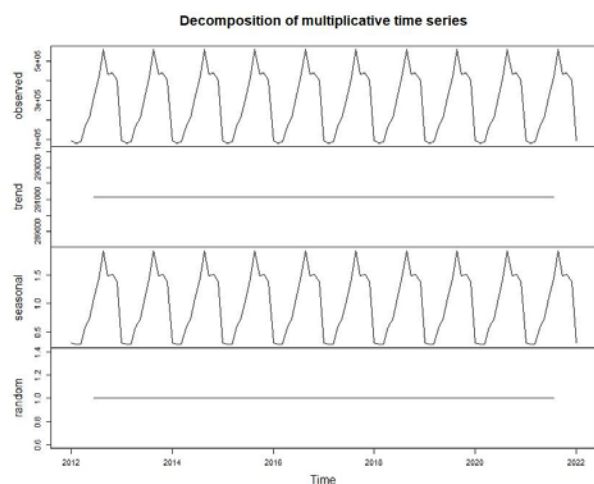


Figure 17. Decomposition of All Jamaican Composite Index Time-Series Data

Based on the decomposition of the All Jamaican Composite Index and the JSE Select Index, the same seasonality form was observed as seen in the decomposition of the Main Index with no trend nor randomness (see Figure 16 and Figure 17). After trying to remove the seasonality by differencing [which did not

seem to work] the All Jamaican Composite and the JSE Select Indices, logarithmic transformation followed by differencing was used. The study revealed that the result was the same as that of the Main Index which also showed an almost stationary (see Figure 10). The regression equation for the All Jamaican Composite Index is given by $y = -70007x + 632092$ while the equation for the JSE Select Index is $y = -70007x + 632092$ to make predictions (see Table 2 and Table 3).

Table 2. Description and equation of the linear regression of the All Jamaican Composite Index and Treasury bill rates (GraphPad [19])

Best-fit values	Slope	-70007 ± 13089
	Y-intercept	632092 ± 69055
	X-intercept	9.029
95% Confidence Intervals	1/Slope	-1.428e-005
	Slope	-99615 to -40399
	Y-intercept	475890 to 788294
Goodness of Fit	X-intercept	7.593 to 12.28
	R square	0.7607
	Sy.x	88068
Is slope significantly non-zero?	F	28.61
	DFn,DFd	1,9
	P Value	0.0005
	Deviation from horizontal?	Significant
		11
Data	Number of XY pairs	11
	Equation	$Y = -70007 * X + 632092$

Table 3. Description and equation of the linear regression of the JSE Select Index and Treasury bill rates (GraphPad [19])

Best-fit values	Slope	-1388 ± 348.5
	Y-intercept	13861 ± 1839
	X-intercept	9.984
95% Confidence Intervals	1/Slope	-0.0007203
	Slope	-2177 to -599.9
	Y-intercept	9702 to 18019
Goodness of Fit	X-intercept	7.909 to 16.93
	R square	0.6381
	Sy.x	2345
Is slope significantly non-zero?	F	15.87
	DFn,DFd	1,9
	P Value	0.0032
	Deviation from horizontal?	Significant
		11
Data	Number of XY pairs	11
	Equation	$Y = -1388 * X + 13861$

Moreover, based on the results from the regression analysis of the All Jamaican Composite Index against Treasury bill rates that showed a negative relationship, the slope of the regression line was revealed to be -70007 ± 13089 . This indicated that for each percentage point increase in the Treasury bill rates, the All Jamaican Composite Index decreases by approximately 70,007 points, on average. The confidence interval for the slope, ranging from -99615 to -40399, suggests that this negative relationship is robust. The y-intercept of 632092 indicates the estimated value of the index when the Treasury bill rate is zero. Also, the R-squared value of 0.7607 indicates that approximately 76.07% of the variation in the All Jamaican Composite Index can be explained by the changes in Treasury bill rates, implying a strong linear relationship. The F-test result, on the other hand, with an F-value of 28.61 and a p-value of 0.0005, confirms that

the slope is significantly different from zero, reinforcing the fact that Treasury bill rates have a significant negative impact on the All Jamaican Composite Index.

Similarly, the regression analysis for the JSE Select Index also shows a negative relationship with Treasury bill rates, but the effect is less pronounced than for the All Jamaican Composite Index. The slope of -1388 ± 348.5 suggests that for each percentage point increase in Treasury bill rates, the JSE Select Index decreases by approximately 1,388 points. The confidence interval for the slope ranging from -2177 to -5999.9, indicates variability but still supports a negative relationship. Additionally, the R-squared value of 0.6381 suggests that around 63.81% of the variation in the JSE Select Index is explained by Treasury bill rates, indicating a moderately strong relationship. The F-test result (F-value of 15.87 and p-value of 0.0032) also confirms that the slope is significantly non-zero, indicating that Treasury bill rates have a significant, albeit strong, negative impact on the JSE Select Index compared to the All Jamaican Composite Index.

4.2. Research Question 2 Results

Are there instances where the relationship between interest rates and JSE indices deviates from the expected pattern due to external shocks or unique economic conditions?

This research question identified external events that occurred from 2012 to 2022. The results provided an analysis of how these events influenced the relationship between the 88-93-day Treasury Bill Rates and the JSE indices. The study also assessed if there are periods where the usual correlation breaks down leading to deviation in the expected pattern.

In December 2012, the auction of the Treasury bill results showed that there was an increase in the 91-days average yields which moved from 6.21% to 7.67% (Jamaica Stock Exchange, 2013). According to Chen [20], treasury yields are interest rates at which governments in countries pay after borrowing money over various periods. Moreover, Chen [20] shared that this increased yield on long-term instruments indicated investors' optimistic outlook and projection of higher inflation expectations. That year the economy was weak as the government sought to negotiate for an International Monetary Fund (IMF) agreement to obtain funds to deal with economic uncertainty looming in the country. Bank of Jamaica [21] shared that the All Jamaica Consumer Price Index (CPI) increased from 6% in 2011 to 8% in 2012. The country experienced food shortages because of drought conditions during the first 6 months in 2012 but later suffer devastation resulting from Hurricane Sandy that occurred in October as revealed by Bank of Jamaica [21]. Also, the unemployment rate increased thus a reduction in consumer demand and consumption spending heavily impacting the economic growth rate. Consequently, investors had to be lending the government of Jamaica money which is a low-risk investments to help stabilize the country's financial situation. Therefore, investments in stocks declined for the Main Index, JSE Select Index, and the All Jamaican Composite Index because trading activities reduced [particularly in the sectors Transport, Storage & Communication, Construction, and Mining &

Quarrying. at the Jamaica Stock Exchange.

By 2013, the government completed the IMF negotiation and signed the agreement which indicated that the country would be required to pay back the loan, therefore the annual 88-93-days Treasury bill rate increased by 0.5%. However, the Main Index decreased by 12.45%, while the All Jamaican Composite Index and the JSE Select Index decreased by 10.21% and 12.45% respectively. From 2017 to 2019, the Treasury bill rates decreased from 5.33% to 3.95% indicating that the economy has improved. Moreover, the Net International Reserves increased by roughly 18.01% in 2017 and by 4.98% in 2019 as shared by Ref [22], Ref [23], and Ref [24]. Over that time the indices increased steadily.

Correlations

		TreasuryBill	MainIndex
TreasuryBill	Pearson Correlation	1	1.000**
	Sig. (2-tailed)		.
	N	2	2
MainIndex	Pearson Correlation	1.000**	1
	Sig. (2-tailed)	.	
	N	2	2

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 18. Correlation and Statistical Significance of Treasury Bill Rates and the Main Index between 2020 and 2021

Correlations

		TreasuryBill	AlJamCom
TreasuryBill	Pearson Correlation	1	1.000**
	Sig. (2-tailed)		.
	N	2	2
AlJamCom	Pearson Correlation	1.000**	1
	Sig. (2-tailed)	.	
	N	2	2

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 19. Correlation and Statistical Significance of Treasury Bill Rates and the All Jamaican Composite Index between 2020 and 2021

Correlations

		TreasuryBill	JSESelect
TreasuryBill	Pearson Correlation	1	1.000**
	Sig. (2-tailed)		.
	N	2	2
JSESelect	Pearson Correlation	1.000**	1
	Sig. (2-tailed)	.	
	N	2	2

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 20. Correlation and Statistical Significance of Treasury Bill Rates and the JSE Select Index between 2020 and 2021

Between the years 2020 and 2021 it was noticed that there is a deviation from the expected pattern of the existence of a negative correlation of the Main Index, JSE Select Index, and the All Jamaican Composite Index with the 88-93-days Treasury bill rates. With the marginal increase of the rate from 1.33% to 1.70%, the Main Index,

JSE Select Index, and the All Jamaican Composite Index also marginally increased (see Figures 18, 19, and 20). During that period, Jamaica started recovering from the COVID-19 pandemic that struck the island in March 2020 when the country went into shutdown to curtail the increased rate of infectious persons. However, by 2022 the 88-93-days treasury rate increased while all the indices value points decreased impacting the stock market performance negatively.

4.2.1. Interpreting the Time-series Analysis Results

The study revealed that the JSE indices and the 88-93 treasury bills move in opposite directions because they are negatively correlated with each other. The relationship between them was found to be statistically significant, indicating that they directly impact each other. This is obvious because the Treasury bill rates exist to provide investments to the Jamaican government which is usually done during the economic downturns at a higher average yield following the auction on treasury bills. Investors are more willing to invest in treasuries because it is a low-risk investment so even if they experience it is minimal. The time series analysis also indicated the inverse relationship between the indices and the treasury bill rates using a regression analysis with regression lines that showed negative slopes which is captured in the regression equations that can be used to predict future rates and index performance as seen in Tables 1, 2 and 3 particularly reflecting a p-value less than 0.05 [the standard comparative test measurement for significance]. The drawback, however, is that the use of a SARIMA model for each of the index performance and the treasury bill rates would have been an excellent predictor similar to the regression equations to provide actual values and visuals as well but it could not be accurately carried out because of limited data points that were available and each model involved the requirement of either day or months particularly because it involve the use of time lags.

The study revealed as well that as the 88-93 days Treasury Bill Rates rise, the JSE indices values decrease between periods of 2012 and 2022. This increase in the rates however is considered while other variables such as sectors of the economy, and investor sentiments amongst other factors are held constant. For example, the decrease in the Main Index, JSE Select Index, and the All Jamaican Composite Index performance in 2012 was expected since there was an increase in the treasury yield, particularly showing that they indeed have a negative relationship. Note, however, that during that time the annual policy interest rates were calculated to be 106.99%, the highest rate during 2012 and 2022.

The study also found that the government borrows money to increase the treasuries of the country and deal with any economic uncertainty or downturn. Consequently, the Treasury bill rates are set based on the economic conditions. For example, Treasury bill rates tend to be higher during periods of economic downturns where investors who lend government money can benefit from their low-risk investments. This all makes sense because during economic downturns people are usually unemployed thus reducing their real wage creating ripple effects such as decreased consumer demand and consumer spending.

Also, businesses are likely to be affected by minimized day-to-day operations if there is less cash flow for them. As a result, investors are not likely to invest in the stock market [indices] because at that time it is very risky for them. Therefore, the JSE indices decline. Conversely, during a booming economy, the rate is lower because there is likely to be less lending and borrowing. One point to note is that both the 88-93 Treasury bill rates and the JSE indices are driven by investments [investors]. So, if investors opt to invest in treasuries, then there will be fewer investors participating in the trading activities at the stock market and vice versa.

The Bank of Jamaica (BOJ) though is important throughout the entire process of the changes in both the JSE indices and the Treasury bill rate. This is particularly because BOJ is responsible for setting the standard interest rates that drive both the treasury bill rates and the ask and bid prices set on the stock market based on activities within the overall financial markets. This is usually done by the adjustment of the money supply in the economy along with policy interest rates that influence asset pricing in the financial markets.

4.3. Further Discussions and Implications

This was developed because it was noticed that while other countries produced work using a time series analysis of interest rates and indices, none was found in Jamaica. Consequently, the researcher was led to develop this study to provide a fresh understanding of the relationship between 88-93-days treasury rates and three JSE indices. This study will provide insight into the need for economists, researchers, investors, and others to be able to understand the relationship and its impact on the stock market and the Jamaican economy based on the techniques used such as correlation, regression, and time series models. The study also revealed there are gaps in existing literature on the JSE indices in the public domain. Hardly any literature besides mostly those from the Jamaica Stock Exchange could be found which was also limited. This study sought to provide possible ways to fill those gaps and offer insights that were previously underexplored or not fully understood. The empirical evidence indicated that investors and potential investors need to know that the negative relationship between treasury bill rates and JSE indices is very dynamic mostly because they are affected by external events or shocks such as the COVID-19 pandemic and the increase of BOJ policy rates. Consequently, rather than panicking as they did in 2020 when the pandemic started and reducing investments in stocks or removing money, they would be able to comprehend how to adjust their strategies by learning new investment and risk management strategies. Moreover, it is also necessary to understand how BOJ functions and operates particularly in influencing what happens such as adjusting policy interest rates [which automatically adjust Treasury bill rates] in the stock market and the overall economy.

4.4 Conclusion

The study uncovered from the correlation analysis that there is a strong negative correlation between the JSE

indices and the 88-93-days treasury bill rates with a coefficient of roughly -0.7 or less but not less than -1 throughout 2012 to 2022. Consequently, their relationship is very significant because the p-values of the test statistics Pearson Product Moment Correlation are extremely small and satisfy the condition of $p < 0.05$. The indices and rate share an inverse relationship when one increases the other decreases. Also, even though they move in opposite directions they change almost by 1 unit. For instance, if the rate increases by almost a unit, then the indices values decrease by the small one unit approximately. When the Regression analysis was completed the relationship between the rates and indices facilitated the provision of statistically significant predictors of the JSE movements [with other factors impacting the stock market movements held constant]. The regression equation for 88-93-days treasury bill rates and the Main Index was computed as $y = -63115x + 572626$, while the equation for the 88-93-days treasury bill rates and the All Jamaica Composite Index is $y = -70007x + 632092$, and the 88-93-days treasury bill rates and JSE Select Index is $y = -1388x + 13861$.

The study also revealed that a time-series analysis was conducted to identify patterns and trends in the movement of interest rates and JSE indices. This analysis revealed that no trend nor randomness (residuals) was evidence [a horizontal line was seen in the decomposition model] when the data for the rates and indices were decomposed; however, there were signs of seasonality within all the data. This seasonality was found to repeat itself after each year. Consequently, the statistical differencing method was used to remove the seasonality but was very futile. Therefore, a logarithm transformation was used followed by differencing it only seemed almost stationary. Furthermore, the forecast method HoltWinter was used but was found to be ineffective because the sample was small and represented every year instead of longer periods such as months throughout each year. So, instead of forecasting for future years, it provided a value of 83055.54 to represent a forecast for February 2022. Since the HoltWinter did not work, SARIMA models were considered but could not be utilized to generate appropriate parameters related to each index because the sample size and length were also found to be insufficient to develop suitable models for forecasting.

Moreover, the study showed that even though the Treasury bill rates and JSE indices have a significantly strong inverse relationship there are moments of deviation from this expectation. For instance, the study revealed that during the years 2020 and 2021, the rates and indices had a perfect positive correlation where they moved in the same direction. So, as each index increased by 1 unit, the rate increased by 1 unit as well. A closer look indicated that this happened because investors apparently whether lending less money to the government and purchasing more stocks at the JSE stock markets, as well as the fact that the country was recovery as well from the COVID-19 pandemic. It was noted however that the inverse relationship happened once more in 2022 when the Jamaican government increased the interest rate to curb inflation which resulted in an increase of the annual Treasury bill rate to 5.04% and thereby the annual JSE

indices values decreased. The study found that while the correlation and regression analysis were effective in providing clear empirical evidence that supports a clear relationship between interest rates and JSE indices, the time-series analysis was challenging.

4.5. Limitations

The study revealed that this study experienced a few limitations mostly because of the limited access to financial data from the Jamaica Stock Exchange market based on the time between 2012 and 2022 and for the study. The study was unable to complete all the analyses as required such as the forecasting models to help concretize the trend and patterns, the Granger causality test to help identify possible causes that can provide deeper insights into the relationship between the Treasury bill rates and the JSE indices. A sector-specific analysis could have been done to reveal trends in different sectors within each JSE indices to give a much better understanding and perspective of the relationship. Consequently, further research would be good once the data can be readily available to the public to address these limitations. Other research could have also been considered such as a time horizon analysis and high-frequency analysis. The time horizon analysis could have been done to investigate how the relationship between JSE stock market behaviour and interest rates varies across different time horizons looking at whether short-term effects differ from medium-term or long-term effects and provide an analysis of how investor behaviour evolves over these periods. The high-frequency analysis, on the other hand, could have been done by analyzing a higher frequency, such as daily or intraday data, to capture finer nuances of the relationship which can provide insights into how market participants react to rapid interest rate fluctuations.

4.6. Recommendations

Based on the findings of the study, policymakers and financial regulators must consider the observed negative relationship between interest rates and the JSE indices when formulating monetary policies. It was revealed that the adjustments in interest rates significantly influenced stock market performance, likely through their impact on investor sentiment and corporate financing costs. As such, the government and the central bank can consider adopting a more balanced approach to interest rate changes, particularly during periods of economic uncertainty to foster a stable and favourable investment environment. This can be done through the implementation of gradual and transparent rate adjustments that can mitigate adverse impacts on market sentiment and enable investors and businesses to be able to better adapt to changing economic conditions. Additionally, financial institutions should diversify their investments as well as focus more on developing financial instruments that facilitate hedging against interest rate fluctuations to help with market stability in Jamaica.

Moreover, investors and market participants are encouraged to consider integrating interest rate trends into their decision-making processes which will allow them to

leverage the insights gained from the study's time-series analysis. Based on the evidence of a strong inverse relationship between Treasury bill rates and the performance of JSE indices as uncovered in the study, investors should monitor interest rate announcements and adjust their strategies accordingly. For example, when interest rates rise, investors might need to consider reallocation of their portfolios for greater diversity to sectors that are less sensitive to borrowing costs or exploring alternative investment options such as fixed-income securities. Similarly, both market analysts and investment advisors can provide their clients with guidance in anticipating market shifts effectively based on predictive models. Additionally, fostering investor education on macroeconomic indicators would be good to empower individuals and institutional investors so that they can be informed to become better equipped in decision-making in a dynamic financial landscape.

ACKNOWLEDGEMENTS

The author would like to thank the JSE stock market personnel who assisted in guiding the data collection process on the indices and all other persons involved including her previous academic advisor at Atlantic International University (AIU).

References

- [1] Jamaica Stock Exchange. A Guide to Jamaica Securities Markets: Providing a Fair Efficient and Transparent Stock Market. 2020. <https://www.jamstockex.com/wp-content/uploads/2020/07/A-Guides-to-Jamaica-Securities-Stock-Market.pdf>.
- [2] BOJ cuts interest rates again. Jamaica Gleaner. 20 August 2009. <https://jamaica-gleaner.com/power/11847>.
- [3] BOJ cuts interest rates again. Jamaica Gleaner. 19 August 2015. <https://jamaica-gleaner.com/article/business/20150817/boj-cuts-interest-rates-again>.
- [4] JSE roiled by virus as investors head for safe haven. Jamaica Gleaner, 21 March 2020. <https://jamaica-gleaner.com/article/business/20200320/jse-roiled-virus-investors-head-safe-haven>.
- [5] Chatfield, C. The Analysis of Time Series: An Introduction (6th ed.). Chapman & Hall/ CRC, 2003.
- [6] Beers, B. Regression: Definition, analysis, calculation, and example. Investopedia, 25 November 2003. Retrieved November 18, 2024, from <https://www.investopedia.com/terms/r/regression.asp#:~:text=Regression%20is%20a%20statistical%20method%20that%20tries%20to%20determine%20the,%2C%20investing%2C%20and%20other%20disciplines>.
- [7] Kenton, W. Neoclassical economics: What it is and why it's important. Investopedia, 28 May 2023. Retrieved August 23, 2023, from <https://www.investopedia.com/terms/n/neoclassical.asp>.
- [8] Miller, M., & Modigliani, F. The Cost of Capital, Corporation Finance, and the Theory of Investment: Reply. The American Economic Review, 1958.
- [9] Muth, J. Rational Expectations And The Theory Of Price Movements. JSTOR. July 1961. https://www.fep.up.pt/docentes/pcosme/s-e-1/se1_trab_0910/se1.pdf.
- [10] Tardi, C. Rational expectations theory definition. Investopedia, 8 June 2020. Retrieved August 18, 2023, from <https://www.investopedia.com/terms/r/rationaltheoryofexpectations.asp>.
- [11] Fisher, I. The Theory of Interest. The Macmillan Company, 1930.
- [12] Seabury, C. How interest rates affect the U.S. markets. Investopedia, 25 March 2023. Retrieved August 23, 2023, from <https://www.investopedia.com/articles/stocks/09/how-interest-rates-affect-markets.asp#:~:text=When%20interest%20rates%20are%20rising,causing%20stock%20prices%20to%20rise>.
- [13] Rose, D. Mortgage rates going up. Jamaica Observer, 26 May 2023. <https://www.jamaicaobserver.com/business/mortgage-rates-going-up/#:~:text=Homeowners%20are%20set%20to%20face%20a%20double%20whammy,per%20cent%20since%20the%20start%20of%20the%20year>.
- [14] Ngubeni, N. What are the effects of interest rates on the stock market? IG, July 2023. Retrieved August 23, 2023, from <https://www.ig.com/en/trading-strategies/what-are-the-effects-of-interest-rates-on-the-stock-market-220705>.
- [15] US Bancorp. How do rising interest rates affect the stock market? | U.S. bank. Consumer banking | Personal banking | U.S. Bank, 19 July 2023. Retrieved August 23, 2023, from <https://www.usbank.com/investing/financial-perspectives/market-news/how-do-rising-interest-rates-affect-the-stock-market.html>.
- [16] Fidelity Investments. What is a yield curve? - Fidelity. Fidelity Investments - Retirement Plans, Investing, Brokerage, Wealth Management, Financial Planning and Advice, Online Trading, 2023. <https://www.fidelity.com/learning-center/investment-products/fixed-income-bonds/bond-yield-curve#:~:text=different%20maturity%20dates,-A%20yield%20curve%20is%20a%20way%20to%20measure%20bond%20investors,the%20direction%20of%20the%20economy>.
- [17] The Investopedia Team. How central banks affect interest rates. Investopedia, 23 August 2023. Retrieved August 23, 2023, from <https://www.investopedia.com/ask/answers/031115/how-do-central-banks-impact-interest-rates-economy.asp>.
- [18] Pompian, M. Risk Tolerance and Behavioral Finance. 2017. <https://investmentsandwealth.org/getattachment/0a603493-fce1-4ab9-8d6a-3e78e1178f93/IWM17MayJun-Risk-ToleranceBehavioral-Finance.pdf>.
- [19] GraphPad. Linear regression calculator. 2023. <https://www.graphpad.com/quickcalcs/linear2/>.
- [20] Chen, J. Treasury Yield: What It Is and Factors That Affect It. Investopedia, 30 June 2023. Retrieved August 24, 2023, from <https://www.investopedia.com/terms/t/treasury-yield.asp#:~:text=Treasury%20yields%20reflect%20investors%20assessments,outlook%20and%20higher%20inflation%20expectations>.
- [21] Bank of Jamaica. Bank of Jamaica 2012 Annual Report. Bank of Jamaica, 2013. https://www.boj.org.jm/uploads/news/boj_annual_report_2012.pdf.
- [22] Jamaica Stock Exchange. JSE Yearbook 2017. 2018, <https://www.jamstockex.com/wp-content/uploads/2018/09/JSE-YEARBOOK-2017.pdf>.
- [23] Jamaica Stock Exchange. JSE Yearbook 2018. 2019, <https://www.jamstockex.com/wp-content/uploads/2020/09/JSE-YEARBOOK-2018-.pdf>.
- [24] Jamaica Stock Exchange. JSE Yearbook 2019a. 2020, <https://www.jamstockex.com/wp-content/uploads/2021/01/JSE-YEARBOOK-2019a.pdf>.

