EXPLORING STRUCTURAL BREAKS IN INTERNATIONAL STOCK MARKETS AND ITS IMPLICATIONS

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Abstract: *Structural breaks are important stylized facts that should be included in the analysis of security market returns. Predictions on stock markets are susceptible to variations in economic events which may not materialise with the passage of time. Accordingly, improving the accuracy of stock market forecasts should embed to a larger extent unobserved heterogeneity which explains structural breaks. Therefore, the aim of this study was to explore structural breaks in asset returns which makes forecasting very difficult. Using the chow and CUSUM square test and a sample period from January 02, 2018 to January 2, 2023, the findings revealed that structural breaks varies across financial markets. More specifically, the Nasdaq and Nikkei 225 displayed significant breaks. However, no significant breaks were observed in the JSE, CAC and DAX. In the BIST, the breaks were insignificant at 5% but significant at 10% confidence level. The implication of this study is that there is a high probability that forecasting the performance of the Nasdaq and Nikkei 225 will not realise and we expect to see volatility persistence in these markets.*
Keywords: *Structural breaks, Chow test, CUSUM square, market returns, stock market forecast.*
JEL Classifications: *D53, G15, G32.*

Introduction

The performance of international stock and bond markets came as a surprise in 2019 despite recession concerns. The broad equity world (MSCI index) finished 20.19% higher than the previous year while the Bloomberg Barclay global aggregate bond index had a 7.43% return (MSCI, 2020). Most often, there are several forecasts that are made at the start of the year by several finance experts regarding the performance of stock markets as well as financial indicators. In more than one occasion, these forecasts don't materialize as expected which has cast several aspersions on the integrity of these analysts. It may therefore imply that there is no reliable approach in predicting trends in financial markets. The preceding statement is in tandem with Swedroe's (2018) paper which tracks predictions made across stock markets and benchmarked the results. The findings of Swedroe's (2018) research revealed that only 32% of these financial forecasts were actually realised. The results corroborate the findings of Bailey, Borwein, Salehipour and De Prado (2018) who also found that less than 50% of stock market predictions made by several analysts are actually correct. It is therefore evident that there may be still some relevant factors that are not considered when predictions are made on financial indicators and performance of stock markets. One of these factors may be structural breaks on stock market returns which is still a grey area with paucity of research. In essence, it is still not clear whether structural breaks were considered when making predictions on the performance of stock markets as this events have severe consequences. Also, accounting for structural breaks has a significant risk and reward impact as contended by Baek and

Lee (2018). Until recently, most estimations and forecasting models had a constant struce conditional mean which may have been a contributing factor to the wrong forecast estimates (Mammen, Nielsen, Scholz & Sperlich, 2019). Structural breaks are the abrupt change in parameters of the conditional mean in stock market returns (Dufays & Rombouts, 2020). This abrupt changes need to be established and considered when making market forecasts (Maheu & Gordon, 2008). In essence, accounting for structural breaks should be an essential component for coefficient stability, forecasting and policy making. The aim of this study was therefore to determine whether there is a notable change in stock market returns coined structural break which makes forecasting difficult. This study adds to the body of knowledge on stock market forecasting and explains why some predictions made by financial market specialists and analysts didn't come true which is a notable advancement in the body of knowledge on stock market forecasting. The section below presents the literature followed by the methodology, findings and conclusion of the study.

Literature

Structural breaks are more of a functional misspecification when the relationship between variables changes over time without accounting for those changes (Hansen, 2001). Accordingly, the trend in a series is distorted and will be significantly different at different points in time. In the context of stock market returns, there will be no correlation between the past and future returns which typifies the efficient market hypothesis (Enow, 2022). The randomness in stock market price movements may be as a result in changes in the residual mean which may affect the conditional mean (Muguto & Muzindutsi, 2022). Below, a summary of prior literature is presented;

Table 1: Summary of prior literature on structural breaks

Study	Model	Period	Country	Findings
Sethapramote & Prukumpai (2018)	GARCH (1,1)	1975 -2010	Thailand	Presence of structural breaks in Thailand stock exchange which were as a result of policy changes.
Baek & Lee (2018)	CUSUM and Bai-Perron	1871 - 2012	United States	Structural changes in price earnings ratio affect long term returns.
Tsuji (2018)	GARCH (1,1)	2000 - 2018	China	Structural breaks causes persistent volatility.
Karavias, Narayan & Westerlund (2022)	Sup-Wald Test	January 3 - September 25 2020.	United States	Structural breaks were observed during the Covid-19 pandemic.

From the table above, it is evident that recent research on structural breaks and asset returns are limited. Although the above studies have explored structural breaks in financial markets, there is still a gap on whether these breaks were significant or not. Hence this study attempts to fill in the gap in literature. The section below highlights the methodology.

Methodology

This study made use of the Chow test to identify structural breaks in the stock market returns. A chow test is designed to identify structural changes in time series data when the parameters of the dummy variable are used as an interactive term to investigate the difference in variance and slope (Özdemir & Akif, 2019). Profoundly, this method identifies structural breaks using exogenous and endogenous variables with break dates and significance levels. This break dates are established by the CUSUM squares while the F-test statistics provides the significance output. More specifically, the CUSUM squares test is a quality control mechanism designed to detect a shift in the mean variable from the expected (Crosier, 1988). In its simplest form, The Chow test equation, parameters and hypothesis is given below

$$r_t = \beta_0 + \gamma_0 r_{t-1} + \cdots + \varepsilon$$

$$F\ Stats = \frac{[SSR_t - (SSR_1 + SSR_2)]/k)}{(SSR_1 + SSR_2)/[n - 2(k+1)]}$$

Where β_(0,) γ_0 are the intercepts and coefficient of lag the lag returns respectively. SSR_t is the Sum of Squares regression while n-2(k+1) is the degree of freedom (Özdemir & Akif, 2019). The null and alternate is given by;
H_0: No structural breaks at specified breakpoints (P-value more than 5% or 10%).
H_1: Structural breaks at specified breakpoints (P-value less than 5% or 10%).
The sample stock markets were the Borsa Istanbul 100 (BIST), the French stock market index (CAC 40 Index), Frankfurt stock exchange index (DAX Index), the Johannesburg stock exchange (JSE Index), NASDAQ Index and Japanese stock index (Nikkei 225). The sample period was from January 02, 2018 to January 2, 2023. The main variable was the daily returns of the sample stock markets. The section below presents the findings of the study.

Results and discussion

In the data analysis process, a descriptive statistic was first computed before the chow test. The aim was to provide a descriptive summary of the sample stock returns. The findings are presented below.

Table 2: Descriptive statistics

	BIST	CAC 40	DAX	JSE	Nasdaq	Nikkei 225
Mean	0.054%	0.028%	0.019%	-0.007%	0.046%	0.020%
Standard Error	0.093%	0.036%	0.038%	0.048%	0.046%	0.036%
Standard Deviation	3.2%	1.2%	1.3%	1.6%	1.6%	1.2%
Kurtosis	697	11.95	11.71	2.80	6.14	3.58
Skewness	-23.01	-0.73	-0.37	-0.11	-0.42	0.04
Range	1.06	0.21	0.23	0.16	0.22	0.14
Minimum	-98.9%	-12.2%	-12.2%	-9.5%	-12.3%	-6.0%
Maximum	6.6%	8.3%	10.9%	6.2%	9.3%	8.0%

Table 2 above provides a summary of the descriptive statistics for all the financial markets under consideration. The average mean returns were very low for the 5-year period but positive with the exception of the JSE. The standard error of mean returns was also considerably low which is by implication a low likelihood that the population mean differs from the sample mean returns. Also, the highest market swings in the most recent 5 years was observed in the BIST 100 with the highest standard deviation and fat tail. This heavy tail may signal large return values in both directions with an infinite probability. Furthermore, all the stock markets considered in this study displayed signs of asymmetry with the BIST, CAC 40, DAX, JSE and Nasdaq skewed to the left while Nikkei 225 skewed to the right. The main analysis for structural breaks is provided below.

Table 3: Chow Breakpoint Test

	F-statistics	Log likelihood ratio	Wald Statistic
JSE	0.564 (0.568)	1.13 (0.567)	1.12 (0.568)
Nasdaq	8.74 (0.000)*	17.42 (0.000)*	17.48 (0.000)*
CAC 40	0.23 (0.794)	0.46 (0.793)	0.46 (0.794)
DAX	0.04 (0.959)	0.08 (0.959)	0.08 (0.959)
Nikkei 225	3.67 (0.025)*	7.35 (0.025)*	7.35 (0.025)*
BIST	2.71 (0.066)	5.43 (0.066)	5.43 (0.066)

Source: Eviews

Figure 1 JSE CUSUM Square Result

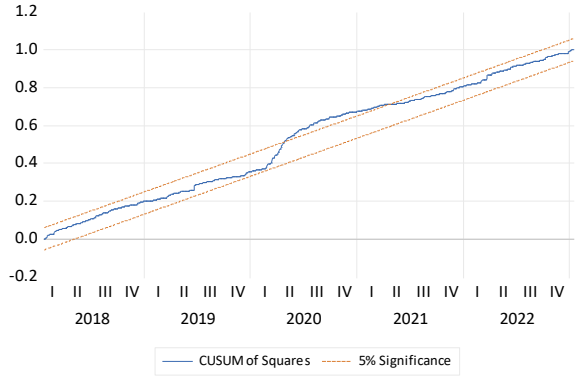

Figure 2: Nasdaq CUSUM Square Result

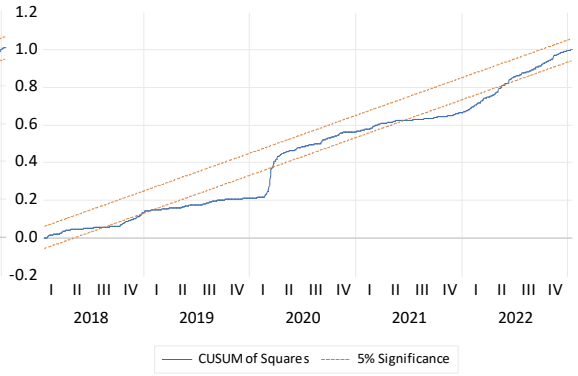

Figure 3 CAC 40 CUSUM Square Result

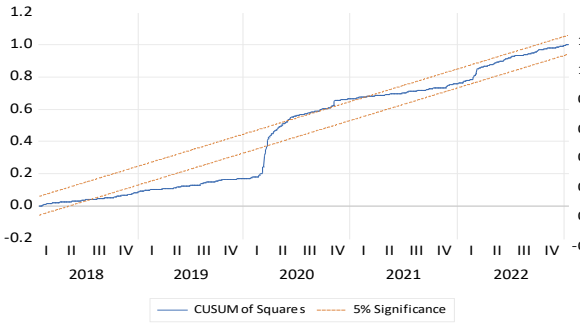

Figure 4: DAX CUSUM square Result

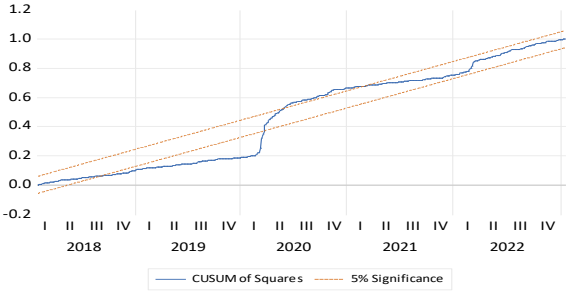

Figure 5: Nikkei 225 CUSUM Square Result

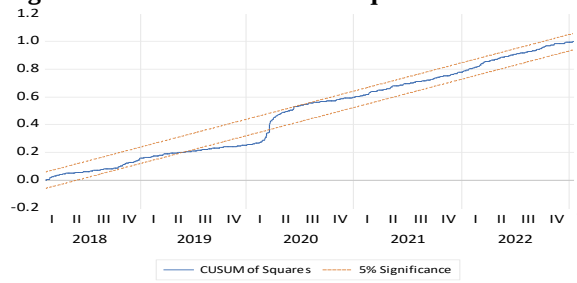

Figure 6: BIST 100 CUSUM Square Result

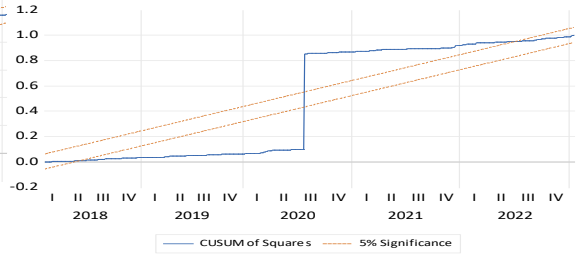

Table 4: Structural break dates and coefficients

	Break dates	Coefficients
JSE	3rd Quarter 2020	0.56
Nasdaq	2019; 1st Quarter of 2020 and 4th Quarter of 2021	8.74
CAC 40	2019 and 1st Quarter of 2020	0.23
DAX	2019 and 1st Quarter of 2020	0.04
Nikkei 225	4th Quarter of 2019 and 1st Quarter 2020	3.67
BIST	From the 3rd Quarter of 2018 till 2nd Quarter of 2022	2.71

Source: Author

Tables 2 and 4 as well as Figures 1 to 6 are significant in the analysis of structural breaks in this study. From Table 2, it can be gleaned that there is a significant F-statistics, log likelihood and Wald test in the Nasdaq and Nikkei 225. This implies a significant variance breaks in the Nasdaq and Nikkei 225 which signals abrupt changes in seasonal adjustments. This can also be gleaned in figures 2 and 5 in the CUSUM square test as well. Figure 6 which is the BIST 100 CUSUM Square results show deviations from in both directions although not significant at 5% but statistically significant at 10%. It is also necessary to point out that most of the deviation occurs in 2019 in figures 1 to 6 although not statistically significant in the JSE, CAC 40 and DAX at 5% and 10%. This truncation may be due to the Covid-19 pandemic which had major effect in stock markets. The break dates are also highlighted in table 4 together with their coefficients. In summarising the analysis of the output in tables 3 and 4, it will be very difficult to forecast returns in the Nasdaq and Nikkei 225 due to this significant breaks in the series. In line with this analysis, it can be suggested that there exists some form of market efficiency in the Nasdaq and Nikkei 225 due to the randomness in the returns. This finding corroborates the findings of Enow (2021) which

also support the notion that the Nasdaq and Nikkei 225 display market efficiency. However, predictions in the JSE, CAC 40 and DAX may well materialised due to the absence of significant structural breaks and investors can take advantage of price clustering (Enow, 2022).

Conclusion

The aim of this study was to empirically explore structural breaks in financial market returns using the most recent 5 years as the sample period. This time frame is important because it includes periods of financial distress which was the Covid -19 pandemic. From these findings, it can be observed that structural breaks vary across markets. More specifically, the returns in Nasdaq and Nikkei 225 experienced significant breaks at 5% and 10% respectively. With this knowledge, predictions about future returns and active management may have no bearings in the Nasdaq and Nikkei 225. Consequently, we expect to see persistent volatility in the Nasdaq and Nikkei 225 due to long range dependence. The VIX volatility index also forecasts significant volatility persistence in the United States markets. Analysts and market participants may therefore find it very difficult to forecast returns in the Nasdaq and Nikkei 225 respectively together with difficult monetary policy decisions.

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