Time-Varying Properties of Stock Returns: An empirical Perspective

Samuel Tabot Enow
Research associate, The IIE Varsity college, Durban, South Africa
enowtabot@gmail.com

ABSTRACT

Properties of stock returns have always been an integral aspect in asset allocation and portfolio management. More specifically, the dynamic nature of stock returns, provides nuanced patterns that highlight the inherent complexity of financial markets. The aim of this study was to explore the time varying properties of stock returns in international markets. A GARCH and Chow Test was used for four financial markets from June 04, 2018, to June 04, 2023. The findings revealed that stock returns exhibit time-dependent behaviour, challenging traditional assumptions of constant parameters with distinct phases of volatility clustering, illustrated by periods of heightened market turbulence followed by relative calmness. Additionally, the study revealed a shift in structural breaks which provided valuable insights into the evolving relationships between stock returns. These findings have significant implications for investment strategies, risk management, and financial modelling as recognizing the evolving nature of stock returns allows for more robust portfolio construction and improved decision-making in an ever-changing financial landscape.

Keywords: Time Varying Properties, GARCH Model, Chow Test, Stock Market Returns.

1. INTRODUCTION

Stock market returns are subject to various dynamic characteristics that changes over time. One prominent characteristics of time-varying property of stock returns is volatility where the degree of variation or dispersion in stock prices changes over time (Folorunso & Adekunle, 2023). It is well-established that volatility fluctuates over time, and periods of high volatility are often followed by periods of low volatility, and vice versa (Huber et al. 2022). Factors such as economic conditions, market sentiment, and news events can significantly influence volatility and recognizing and accounting for these changes is crucial as it helps investors adjust their portfolios and hedge against adverse market movements. Another important time-varying property is seasonality where recurring patterns in stock returns at specific times of the year are observed (Wen et al., 2022). For instance, the "*January effect*" suggests that stock returns tend to be higher in January compared to other months (Patel, 2016). Seasonality can also be driven by various factors such as tax considerations, holidays, and investor behaviour. Investors can take advantage of these seasonal patterns by adjusting their trading strategies accordingly as the correlation between stocks and other assets or market indices is not constant but changes over time (Yoshinaga & De Castro Junior, 2012). During periods of high correlation, diversification benefits may diminish, as assets tend to move in tandem. Conversely, during periods of low correlation, diversification becomes more effective as assets exhibit greater independence. Also, stock market returns may exhibit different market regimes or states over time. Market regimes refer to distinct periods characterized by specific market conditions and behaviours (Dua & Tuteja, 2021). For example, bull markets are characterized by prolonged periods of rising prices and optimistic investor sentiment, while bear markets witness declining prices and pessimistic sentiment which causes difference in distributions of returns (Enow, 2023). This distribution of stock market returns is not static and can change over time. Traditional financial models often assume a normal distribution of returns, but empirical evidence suggests deviations from normality (Borowski, 2018). Stock returns can also exhibit skewness and kurtosis, indicating asymmetry and fat/thin tails in the return distribution. By recognizing and analysing these time varying trends, market participants will be able to understand how stock returns change over time which will in turn help investors to anticipate and manage risk. Understanding these time-varying properties are essential for investors to make informed decisions and develop effective investment strategies. Therefore, this study seeks to answer the following questions: What are the current trends in stock market returns? Are there predictable structural breaks in stock market returns over time? Knowledge of these time varying properties of stock market returns over time will allow for effective diversification as a well-diversified

portfolio that can help spread risk and potentially enhance returns which can help investors take advantage of potential opportunities or avoid downturns. In essence, examining the time-varying properties of stock returns provides a deeper understanding of the dynamic nature of financial markets, enabling more informed and effective investment decisions. The section below highlights the literature review.

2. LITERATURE

There are several theories that are used to provide theoretical foundations for time varying properties of stock returns such as the Efficient Market Hypothesis. The Efficient Market Hypothesis (EMH) is a cornerstone theory in financial economics that posits that financial markets are efficient in processing and reflecting all available information (Enow, 2023). The EMH assumes that all investors are rational, process information accurately and make decisions that maximize their expected utility (Fama, 1965). At the heart of the EMH are several key assumptions. Firstly, it assumes perfect information, suggesting that all relevant information, whether public or private, is immediately and freely available to all market participants which implies that no investor has an informational advantage over others. Secondly, EMH presumes that all investors are rational and seek to maximize their expected utility or wealth together with the absence of transaction costs, taxes, or other frictions that might impede trading activities. Additionally, EMH presupposes homogeneous expectations, meaning that all investors in an efficient market have the same beliefs and expectations regarding future returns and risks associated with different assets (Fama, 1965). However, time varying properties in stock market returns are critical aspects that emanates from the EMH theory, and they provide insights into the behaviour of stock markets, which can be crucial for investors, traders, and financial professionals. Some of these properties include cyclical trends in returns which refers to the recurring patterns of expansion and contraction in economic activity and stock prices which align with the broader economic business cycle. For instance, during economic expansions, stock prices tend to rise, while during contractions or recessions, they tend to fall. Another important pattern includes seasonal patterns which involve regular, recurring movements in stock prices that are linked to specific times of the year such as the January Effect, where stocks tend to perform well in January. The possibly reason may be due to year-end tax planning and portfolio rebalancing and the 'Sell in May and Go Away' strategy, which suggests that markets tend to underperform in the summer months. Trend following is an investment strategy that aims to capitalize on existing market trends involving buying assets that have been performing well and selling those that have been performing poorly, with the expectation that the existing trends will continue. This strategy relies on the assumption that markets exhibit momentum. Investors with a long-term horizon may focus less on short-term patterns and more on fundamental analysis. Short-term traders, on the other hand, may use technical analysis and trend-following strategies to exploit short-term price movements. Time varying properties in stock market returns are integral components of financial analysis as they provide valuable insights into market behaviour, allowing investors to make informed decisions. However, investors should approach the properties of stock returns with a balanced perspective, combining technical analysis with fundamental research and risk management strategies for optimal investment outcomes.

3. METHODOLOGY

Two models were used as blueprint of the study to achieve the aim of this study. Firstly, a Generalized Autoregressive Conditional Heteroskedasticity (GARCH model) was applied to capture the time-varying nature of volatility in the time series as it assumes that the variance of the returns is not constant over time (Engle, 1982). A GARCH model also provides valuable information on predicting volatility which is crucial for making informed decision on stock returns variability. A GARCH model is presented below:

$$h_t = \alpha + \phi h_{t-1} + \beta \mu_{t-1}^2$$

Where h_t = Conditional variance, α = error term, ϕ = ARCH term, h_{t-1} = Lag values of Conditional variance, β = GARCH coefficient and μ_{t-1}^2 = Lag square error term.

Also, a Chow test was applied to identify structural changes in stock returns when the parameters of the dummy variable are used as an interactive term to investigate the difference in variance and slope

(Ozdemir & Akif, 2019). With significance levels, this method effectively locates structural breaks utilizing exogenous and endogenous factors. The CUSUM squares are used to determine the break dates, and the F-test statistics are used to determine their significance. The CUSUM squares test is a quality assurance tool created to find deviations from expected mean values. (Crosier, 1988). The Chow test equation, parameters and hypothesis is given below.

$$r_t = \beta_0 + \text{below}.r_{t-1} + \cdots + \varepsilon$$

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

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). Four financial markets were used as samples to investigate the time varying properties of stock returned. These markets were, the Johannesburg Stock Exchange (JSE index), the French stock market index (CAC 40 index), Frankfurt stock exchange (DAX index), Nasdaq index, from January 2, 2018, to June 14, 2023. The main variables were the daily stock prices. The section below highlights the results and discussion.

4. RESULTS AND DISCUSSION

The results and discussion presented below objectively presents the analysed data as well as some key discussions that are linked to the findings. Table 1 below highlights the GARCH outputs.

Table 1: GARCH output results

JSE				
Variable	Coefficient	Std Error	Z-statistics	P-value
Log (GARCH)	0.10%	0.10%	0.8	0.423
Intercept	1.10%	1.50%	0.77	0.4366
Lag Return	-10.40%	2.80%	-3.63	0.0003*
Variance Equation				
Intercept	0.01%	0.00%	3.29	0.001
GARCH	0.935	1.47%	63.21	0.000*
CAC 40				
Variable	Coefficient	Std Error	Z-statistics	P-value
Log (GARCH)	0.14%	0.06%	2.54	0.0108*
Intercept	1.47%	0.54%	2.68	0.0073*
Lag Return	-1.26%	2.85%	-0.44	0.65
Variance Equation				
Intercept	0.01%	0.00%	7.07	0.000*
GARCH	77.70%	2.55%	30.49	0.000*
DAX				
Variable	Coefficient	Std Error	Z-statistics	P-value
Log (GARCH)	0.16%	0.06%	2.51	0.011*
Intercept	1.56%	0.59%	2.61	0.008*
Lag Return	-4.44%	3.14%	-1.41	0.157
Variance Equation				
Intercept	0.00%	0.00%	5.95	0.000*
GARCH	81.62%	2.13%	38.21	0.000*
Nasdaq				
Variable	Coefficient	Std Error	Z-statistics	P-value
Log (GARCH)	0.04%	0.05%	0.85	0.393
Intercept	0.50%	0.45%	1.115	0.264

Lag Return	-6.48%	2.98%	-2.169	0.03*
Variance Equation				
Intercept	0.01%	0.00%	4.06	0.000*
GARCH	83.10%	2.06%	40.16	0.000*
**Significant at 5%*				

The p-values of the lag returns that are more than the 5% level of confidence show that the past returns of the sampled financial markets have a very poor capacity to predict future returns. Therefore, it may be inaccurate to estimate future performance by looking at previous returns. Additionally, the sampled financial markets exhibit time-varying characteristics and volatility clustering because all GARCH coefficients are positive and less than one, satisfying the stability criterion. Also, because the GARCH coefficients are very near to one, the results also show a significant clustering impact. This result supports Nguyen et al.'s (2020) study, which discovered a strong clustering impact in financial markets. These volatility patterns may be due the market disruptions that have occurred in the past such as the dotcom crisis, 2007-2008 financial crisis and the most recent covid-19 pandemic (Topcu et al., 2021). The findings of the Chow test are presented below.

Table 2: 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)
Source: Eviews			

From table 2, it can be gleaned that there is a significant F-statistics, log likelihood and Wald test in the Nasdaq. This implies a significant variance breaks in the Nasdaq which signals abrupt changes in seasonal adjustments. In summarising the analysis of the output in tables 2, it will be very difficult to forecast returns in the Nasdaq due to this significant break in the series. In line with this analysis, it can be suggested that there exists some form of market efficiency in the Nasdaq due to the randomness in the returns. This finding corroborates the findings of Enow (2023) which also support the notion that the Nasdaq 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.

5. CONCLUSION

The aim of this study was to empirically explore the time varying properties of stock returns which provides valuable insights into the dynamic nature of financial markets. The evidence presented in this study unequivocally supports the notion that key characteristics of stock returns in some financial markets are subject to significant temporal fluctuations. The observed patterns of volatility and structural breaks in these financial markets reveal periods of heightened market uncertainty, punctuated by intervals of relative stability. This underscores the importance of robust risk management strategies that can adapt to changing market conditions. Investors and portfolio managers must remain vigilant and agile in response to evolving volatility regimes. Furthermore, the shifts in correlation structures highlight the dynamic nature of asset relationships. Recognizing these changes can lead to more diversified and resilient portfolios, as well as more effective hedging strategies. These time varying analysis of stock returns emphasises the need for a dynamic approach to investment decision-making. Acknowledging the evolving nature of time varying properties allows for more precise timing and execution of trades. Overall, the findings underscore the imperative for market participants to adopt a flexible and adaptive approach in navigating the complexities of financial markets. Static models and strategies that assume constant properties of stock returns may fall

short in capturing the nuances of dynamic market behavior. This research not only contributes to the academic understanding of financial markets but also has practical implications for investors, portfolio managers, and risk analysts. By acknowledging and accounting for the time-varying properties of stock returns, market participants can enhance their ability to make informed and timely decisions, ultimately leading to more robust and resilient investment portfolios.

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