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Macroeconomic uncertainty and ETF return volatility in South Africa: Implications for sustainable passive investment strategies

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Abstract: *Purpose*: This study investigates the effect of macroeconomic uncertainty, namely inflation, money supply, long-term interest rates and the real effective exchange rate, on the return volatility of four South African exchange-traded funds listed on the Johannesburg Stock Exchange, addressing a gap in emerging-market ETF volatility literature. *Methodology*: Monthly data from November 2010 to December 2025 were analysed using univariate GARCH, GJR-GARCH, and E-GARCH models, with model selection guided by the Schwarz information criterion and robustness confirmed via ARCH-LM, unit root, and Nyblom stability tests. *Results*: All four ETF indices exhibit ARCH effects and volatility clustering; for three of the four ETFs, positive return shocks increase volatility more than negative shocks of equal magnitude, and inflation, money supply, and long-term interest rate growth significantly raise volatility only for the STXSWX index. *Theoretical contribution*: The paper extends the largely spillover-focused literature on South African ETF volatility by isolating the direct macroeconomic drivers of volatility, offering an emerging-market counterpoint to studies concentrated on developed markets. *Practical implications*: Findings suggest that passive investors and fund managers should treat the STXSWX index with caution during periods of macroeconomic instability and factor asymmetric shock behaviour into portfolio rebalancing decisions.

Keywords: exchange-traded funds, macroeconomic variables, South Africa, GARCH, return volatility

Sustainable Development Goals (SDGs): SDG 8: Decent Work and Economic Growth; **SDG 9:** Industry, Innovation and Infrastructure; **SDG 10:** Reduced Inequalities

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1. Introduction

Exchange-traded funds (ETFs) are pooled investment vehicles that track the performance of a specific index, sector, commodity, or basket of assets traded on a stock exchange (Moodley et al., 2025). The first ETF can be traced to 1993, when the SPDR S&P 500 was introduced in the United States to track the S&P 500, a market proxy (Lettau & Madhavan, 2018). Since then, ETFs have grown exponentially in developed and emerging markets because they offer investors a cost-effective way to gain exposure to diversified portfolios while maintaining liquidity and trading flexibility. Therefore, in emerging markets, where volatility is heightened, ETFs provide a safe space for passive institutional and retail investors who want to limit exposure while maintaining stable returns (Blitz & Huij, 2012).

In South Africa, the ETF market has expanded considerably since the introduction of the Satrix 40 ETF in 2000 (Shenjere et al., 2025). This growth in South Africa is linked to increased awareness and advances in financial markets, which demand low-cost investment products (Charteris, 2013). Despite increased demand for ETFs and their growing importance in portfolio construction and wealth management, understanding the factors that influence their performance and risk characteristics has become an important concern for investors, portfolio managers, and policymakers. That being said, the key underlying determinant of financial market behaviour is macroeconomic uncertainty (Moodley et al., 2025). Economists use macroeconomic uncertainty to describe economic agents' inability to forecast economic conditions because parameters such as inflation, money supply, interest rates, and real effective exchange rates move dynamically (Caldara et al., 2016). Consequently, periods of heightened uncertainty are directly associated with increased market volatility, reduced investor confidence, and shifts in asset allocation strategies. Economic shocks such as the global financial crisis of 2008, the European sovereign debt crisis, the COVID-19 pandemic, and episodes of domestic political and economic instability have demonstrated the significant influence of uncertainty on financial markets (Abaidoo & Agyapong, 2023).

According to behavioural finance theory, macroeconomic uncertainty affects investors' expectations about future cash flows and discount rates, increasing asset price volatility (Kapoor & Prosad, 2017). Therefore, understanding how macroeconomic uncertainty affects ETF return volatility is crucial, especially in an emerging market setting such as South Africa, where financial markets are often more vulnerable to external shocks, exchange rate fluctuations, and domestic economic challenges. Given the growing popularity of ETFs and their increasing role in facilitating market participation, assessing their sensitivity to macroeconomic uncertainty provides valuable insights into risk management and portfolio diversification strategies (Gastineau, 2010).

Despite the growing literature on the effects of macroeconomic uncertainty on stock markets, relatively little attention has been devoted to ETFs, particularly in the South African context. Existing studies have primarily focused on macroeconomic determinants of ETF returns and liquidity, rather than ETF return volatility (Kunjal et al., 2021; Radev et al., 2023; Moodley et al., 2025; Gvazava, 2026). Studies that have examined ETF return volatility have approached the issue from the standpoint of country risk (Kunjal et al., 2022; 2024). These empirical limitations create a significant gap in the empirical literature, as the unique structure of ETFs, which combines characteristics of both stocks and collective investment schemes, suggests that their volatility behaviour may differ from that of traditional financial assets.

To this end, the study aims to examine the effect of macroeconomic uncertainty on South African ETF return volatility. In doing so, the study contributes to the empirical literature in several ways: first, from a practical perspective, the results will help investors and portfolio managers improve portfolio risk assessment and investment decision-making during periods of economic uncertainty. Secondly, policymakers may benefit from a better understanding of how macroeconomic conditions influence financial market stability and investor behaviour within the South African ETF market. Lastly, the study shifts the empirical literature away from risk-return dynamics of ETFs toward return volatility, creating a pathway for future scholarly work in the emerging market setting.

The remainder of the manuscript is outlined as follows: Section 2 reviews the theoretical framework and empirical literature on ETF return volatility. Section 3 presents the methodology, including data aggregation and model specification. Section 4 presents the empirical results and discussion, while Section 5 concludes the study by deriving implications from the findings.

2. Literature review

2.1. Conceptualisation of market volatility

Financial asset prices are affected by two main factors, namely fundamental and behavioural elements (Kunjal et al., 2022). That said, the traditional finance approach uses the rational expectations hypothesis to argue that investors exhibit rational behaviour. Therefore, investment decisions are based on fundamental factors, such as macroeconomic conditions, which cause changes in asset prices (Cutler et al., 1988). Consequently, financial markets should behave efficiently, as all known information is already reflected in asset prices, rendering technical and fundamental analysis inefficient. However, behavioural finance contests these notions, arguing that investors are not rational; instead, past experiences and current expectations shape their investment decisions, making markets inefficient (Barberis & Thaler, 2003). In this view, financial market volatility is driven by investors' expectations about future risk and return, aligned with proposed investment decisions, in what is known as investor sentiment (Moodley et al., 2025).

In addition to investor sentiment, fluctuating macroeconomic variables could influence fundamental factors that dictate asset prices. For example, Radev et al. (2023) contend that macroeconomic factors such as inflation, money supply, interest rates, and exchange rates drive ETF returns. If so, investors' expectations about future macroeconomic announcements may increase or decrease ETF returns and contribute to return volatility. These observations are further amplified when investors reconstitute their portfolios in response to enhanced return volatility (Ali et al., 2010). Accordingly, macroeconomic variables are likely to affect ETF return volatility in financial markets significantly.

2.2. Empirical review

Existing literature on ETF price volatility in both developed and developing settings is plentiful, but much is focused on factors beyond macroeconomic uncertainty. For instance, Ozcelebi et al. (2025) investigated the dynamic spillovers between United States (US) technology ETFs and (US) uncertainty indices. Using quantile-frequency spillover and wavelet methodologies, the findings revealed enhanced connectedness between the uncertainty indices and ETF returns in the upper and lower quantiles. Moreover, ETFs are net transmitters while the uncertainty indices are net receivers. These findings suggest that macroeconomic uncertainty is linked to ETF return performance, increasing contagion risk and portfolio losses. Despite these findings, Pandey (2025) challenges them: the generalised autoregressive conditional heteroskedastic (GARCH) BEKK model found no cross-volatility spillovers between ETF returns and fund flows, rejecting the volatility-transmission hypothesis prevalent in developed-market ETF studies.

Hussain and Chen (2025) also examined spillover effects in the US technology ETF market, but their analysis was limited to comparisons between ETF sectors and stock market indices. The exponential GARCH (E-GARCH) model revealed similar findings: ETF sectors and the stock market index are interconnected, transmitting shocks and volatility. Market fluctuations significantly affect ETF sectors, with negative shocks having a larger impact on volatility. Similar findings emerged in the Chinese ETF market, as Wang (2025) examined idiosyncratic contagion between ETFs and stocks using a high-dimensional network framework. The study uncovers substantial heterogeneity in ETF-driven spillover patterns across sectors. The energy, utilities, and real estate sectors transmit strong idiosyncratic shocks to individual stocks, while consumer discretionary and financials ETFs primarily receive cross-industry spillovers. During market stress, contagion sources become more dispersed, suggesting that policymakers should monitor a broader set of ETFs.

In the South African context, similar observations hold. That being said, Starr (2025) examined the volatility spillovers between Johannesburg Stock Exchange (JSE) ETF returns. Using the Diebold and Yilmaz spillover index, the findings revealed that the STX40 ETF is a net volatility transmitter in the alternative asset ETF system. Within the equity ETF system, STXFIN and STXRES are net volatility receivers, and STXIND fluctuates between receiver and transmitter over the period analysed. In the alternative asset system, ETFSAP and STXGVI are net volatility receivers, while the GLD ETF oscillates between being both a net receiver and a net transmitter. Similarly, Shenjere et al. (2025) examined the effect of investor sentiment on JSE ETF return volatility. Using a newly constructed market-wide investor sentiment index for the period 2008 to 2023 with the Markov regime-switching model, the findings revealed that investor sentiment is an important determinant of South African ETF return volatility. That said, in periods marked by investor uncertainty, sentiment negatively affects ETF returns, thereby increasing volatility, while the opposite is true in phases marked by investor optimism.

Madondo and Kunjal (2025) also used the Markov regime-switching model, but the academics investigated the role of foreign ETFs in providing South African investors with diversification against market volatility. Findings from 2019 to 2024 show that foreign equity ETFs do not serve as an effective diversification tool for South African investors under either bullish or bearish market conditions. Therefore, local market conditions reduce the diversification benefits available to South African investors by increasing volatility. These findings were further supported by Kunjal (2023b), who showed that South African ETF returns are adversely affected by market volatility, as the COVID-19 pandemic reduced JSE ETF returns.

Kunjal et al. (2022) extended these studies in South Africa by showing that JSE ETFs are adversely affected not only by investor sentiment and market conditions but also by country-specific risk. Using the GARCH-MIDAS model from 2000 to 2019, the authors find that country risk components are significant sources of volatility in ETF markets. However, financial risk does not significantly affect ETFs with international benchmarks, suggesting these ETFs can help minimise an investor's exposure to financial risk. Overall, this study provides new insight into using ETFs to diversify an investor's exposure to different country-risk components. In a subsequent study, Kunjal et al. (2022) also examined the effect of country-specific risk on JSE ETF returns, but they assessed the short- and long-run relationships using the nonlinear autoregressive distributed lag (ARDL) model. The findings revealed that country risk shocks have significant asymmetric effects on returns. In the long run, ETFs with domestic benchmarks are most sensitive to decreases in political risk, while ETFs with international benchmarks are most sensitive to increases in political risk. In the short run, ETFs with domestic benchmarks are influenced only by political and financial shocks, while all country risk components affect ETFs with international benchmarks.

While empirical literature on determinants of ETF price volatility other than macroeconomic variables is extensive, studies that include macroeconomic variables are largely limited to the developed ETF market. For example, Radev et al. (2023) examined the effect of macroeconomic variables on the US ETF market over a 15-year period. Using the Newey-West estimator, the findings show that inflation, exchange rates, and interest rates negatively affect ETF prices, which, in turn, expose investors to higher return volatility. Similarly, the US economic policy uncertainty index enhances ETF prices, which, in turn, reduces return volatility.

Concomitantly, Gvazava (2026) also examined the effect of macroeconomic announcements on ETF performance in the US, but focused on monetary policy announcements. Using an event-study methodology for the period 2013 to 2022, the author found that monetary policy decisions increase ETF return volatility. That said, the Federal Reserve and the European Central Bank, a US trade policy shock, and a Chinese currency intervention significantly affected ETF returns and volatility. The results show that ETFs are active price-discovery settings whose response to macroeconomic shocks depends on asset-class composition and the type of information shock. Similar findings appear in a study by Algieri et al. (2026), which examined the determinants of US ETF return volatility. The authors applied a two-step process that entailed assessing the drivers of ETF returns and then comparing the dynamic correlations of ETF returns over time. The findings from the univariate and multivariate GARCH models showed that inflation, interest rates, exchange rates, and economic policy uncertainty influence ETF return volatility and the dynamic connectedness of each ETF index.

2.3. Research gap

Collectively, the empirical literature on the determinants of ETF return volatility is dominated by international settings rather than emerging markets such as South Africa. Where studies have examined ETF return volatility, they have focused on investor sentiment, country-specific risk, and macroeconomic policy announcements, which were isolated within the spillover framework. To date, no evidence exists on the direct impact of macroeconomic variables on ETF return volatility, especially in South Africa, where macroeconomic uncertainty is elevated. Consequently, the study attempts to rectify this empirical gap by examining the effect of inflation, money supply, interest rates and real effective exchange rates on JSE ETF return volatility. If left unstudied, it will adversely affect passive investors, as no empirical literature can be relied on to rebalance portfolios containing ETF indices during macroeconomic fluctuations, thereby exposing investors to adverse portfolio losses.

3. Methodology

3.1. Data

This study uses monthly data spanning November 2010 to December 2025. The sample period is constrained by data availability, as the Invest Top 40 and Invest SWIX 40 ETFs commenced trading in October 2010. The analysis focuses on four ETF indices (Invest Top 40, Invest SWIX 40, Satrix SWIX Top 40, and Sygnia Itrix Top 40), consistent with those examined by Kunjal et al. (2021; 2023a), Starr (2025), and Shenjere et al. (2025). The selection of the explanatory variables is informed by both theoretical and empirical evidence. Moodley et al. (2025) report that macroeconomic variables, including inflation, money supply, long-term interest rates, and the real effective exchange rate (REER), significantly influence JSE ETF returns. In addition, Islamiah and Kusmayadi (2026) argue that central bank monetary policy interventions affect stock prices by influencing investors' purchasing power and investment decisions. Consequently, changes in macroeconomic conditions alter ETF demand and supply dynamics, ultimately affecting prices and returns. ETF data were obtained from the IRSS, while macroeconomic data were sourced from the South African Reserve Bank (SARB). Table 1 provides a detailed description of all variables included in the analysis.

Table 1: Sample of ETF and macroeconomic variables

Variable	Abbreviation	Description	Start date
Panel A: ETF returns			
Invest Top 40 ETF	ETFT40	Tracks the JSE Top 40 index by market capitalisation	10/2010
Invest SWIX 40 ETF	ETFSWX	Tracks the JSE All-Share index	10/2010
Satrix SWIX Top 40 ETF	STX40	Tracks the JSE shareholders' weighted Top 40 index	11/2000
Sygnia Itrix Top 40 ETF	STXSWX	Tracks the JSE Top 40 index by market return	04/2006
Panel B: Macroeconomic variables			
Inflation rate	CPI	-	
Money supply (M2)	M2	-	
Long-term interest	LT-INT	-	
Real effective exchange rate	REER	-	

Notes: Author's own compilation (2025).

3.2. Empirical model

To achieve the study's objective, this study uses a univariate GARCH approach, aligning with studies by Nawaz et al. (2026) and Moodley and Lawrence (2026). These models include GARCH(1,1), GJR-GARCH(1,1), and EGARCH(1,1), which help assess the characteristics of the data. The generalised mean equation for the GARCH-specific models is specified as follows:

$$K_{it} = w + a_i \varepsilon_{t-1} + B_i \sigma_{t-1}^2 \quad (1)$$

Where K_{it} is the ETF return at time t. w is the constant term that represents the long-term average variance level. a_i is the ARCH effect, B_i represents the GARCH coefficient, which measures the effect of the past term variance (σ_{t-1}^2) on current variance, while ε_{t-1} indicates the past squared residuals.

The study considers three GARCH-type models: GARCH (1.1), GJR-GARCH (1.1), and E-GARCH (1.1). The specification of the variance equation of each model is given by equations 2, 3 and 4, respectively:

$$\sigma_t^2 = w + a_i \varepsilon_{t-1} + B_i \sigma_{t-1}^2 + c_{1i} INF + c_{2i} M2 + c_{3i} LT\_INT + c_{4i} REER \quad (2)$$

$$\sigma_t^2 = w + (a_i + \gamma i\, I_{t-1}) \epsilon_{t-1}^2 + B_i \sigma_{t-1}^2 + c_{1i} INF + c_{2i} M2 + c_{3i} LT\_INT + c_{4i} REER \quad (3)$$

$$\sigma_t^2 = w + a_i \left(\frac{|\varepsilon_{t-1}|}{\sigma_{t-1}} - \sqrt{\frac{2}{\pi}} \right) + \gamma i \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + B_i \ln(\sigma_{t-1}^2) + c_{1i} INF + c_{2i} M2 + c_{3i} LT\_INT + c_{4i} REER \quad (4$$

Where σ_t^2 is the ETF return volatility.

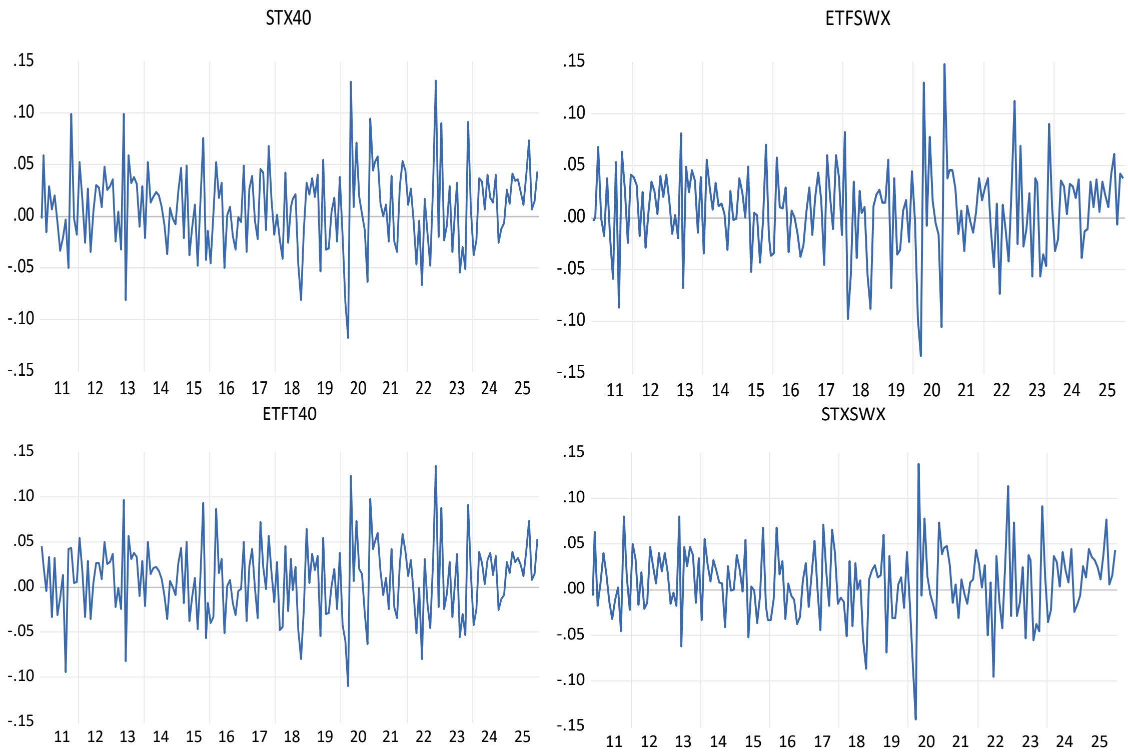
In equation 3, γi captures the asymmetric effect, I_{t-1} is an indicator function, such that when $\varepsilon_{t-1} < 0$ it indicates bad news and 0 otherwise. If $\gamma i > 0$, bad news increases volatility more than good news. Whereas in Equation 3, γi also captures the asymmetric effect (leverage effect), but if $\gamma i < 0$, bad news increases volatility more than good news. The ln form ensures that $\sigma_t^2 > 0$ automatically (no non-negativity constraints). c_{1i} to c_{4i} represent the South African macroeconomic variables, namely inflation growth rate, money supply growth rate, long-term interest growth rate and real effective exchange growth rate, respectively.

4. Results

4.1. Graphical representation

Figure 1 presents graphical plots of South African ETF returns for the full sample. Visually, ETF returns appear sporadic, with peaks and troughs that coincide with evolving return variance. These observations show that ETF returns exhibit an autoregressive pattern and share inherent volatility-clustering characteristics. Similarly, some periods are riskier than others, as shown by heightened volatility during specific periods. These periods are notably 2011, 2013, and 2020, which coincide with the Eurozone debt crisis, the United States Fed taper tantrum, and the COVID-19 pandemic. Despite these historical events, ETF returns tend to recover from downward pressure, as subsequent periods show positive and consistent returns. Therefore, the mean of ETF returns is constant, although volatility clustering is inherent, indicating stationary properties.

Figure 1: ETF return graphical plots



Source: Author’s own depiction (2026)

4.2. Summary statistics

Table 2 presents the summary statistics for ETF returns and macroeconomic variables. The ETFT40 attains the highest average return, followed by STX40, ETFTSWX and STXSWX. However, the ETFSWX and STX40 attain the highest and lowest maximum values, respectively. Similarly, the highest and lowest minimum values correspond with the STXSWX and ETFT40 index returns. Therefore, investors seeking sustained, long-term returns with minimal fluctuations should invest in companies tracked by the ETFT40 index, whereas investors seeking a single period of heightened returns will find the ETFSWX index companies more attractive. Although the STXSWX index reflects the highest minimum returns, it has the lowest standard deviation among the ETF index returns, making it the least risky. Although ETFSWX has the highest maximum return, it also has the highest standard deviation, making it the riskiest in the pool of ETF indices. Consequently, a risk-tolerant individual will find the ETFSWX index companies the best suited for their investments, as it is the riskiest. Similarly, a risk-averse individual will find the STXSWX index companies most attractive, as it has the lowest risk and the highest period return. The STX40 and ETFT40 index returns are positively skewed, whereas the ETFSWX and STXSWX index returns are negatively skewed. The former suggests that the median lies to the right of the mean, as there are more positive returns than negative returns, whereas the latter suggests that there are more extreme negative returns, as the median lies to the left of the mean. Kurtosis further confirms these findings, as the Jarque-Bera statistic yields values above 3, consistent with a peaked-tail distribution.

Turning to the macroeconomic variables, the inflation growth rate has the highest mean, maximum, minimum, and standard deviation. However, the real effective exchange rate has the lowest mean value, the long-term interest growth rate has the lowest minimum and maximum values, and the money supply growth rate has the lowest standard deviation. These observations suggest that the inflation growth rate was the riskiest, as it peaked at 5.90%, dropped to 2.50%, and averaged around 4.39%. These observations also align with Cheteni et al. (2025), who found inflation in South Africa to be inconsistent and time-varying. The skewness of the inflation growth rate and real effective exchange growth rate is negative, whereas the money supply growth rate and long-term interest growth rate are positive. The kurtosis is positive and greater than 3 for all macroeconomic variables, suggesting non-normality. This is confirmed by the Jarque-Bera statistics, as the null hypothesis of normal distribution is rejected for all macroeconomic variables except the real effective exchange growth rate.

Table 2: ETFs' returns and macroeconomic variables descriptive statistics results

	STX40	ETFSWX	ETFT40	STXSWX	CPI	M2	LT-INT	REER
Mean	0.007641	0.006649	0.007649	0.006963	4.398901	0.006180	0.003692	-0.000256
Median	0.008444	0.009472	0.011777	0.007746	4.450000	0.005454	0.000000	0.003116
Maximum	0.130207	0.147071	0.134321	0.137503	5.900000	0.062295	0.406667	0.066138
Minimum	-0.118299	-0.134369	-0.110446	-0.142629	2.500000	-0.020543	-0.099057	-0.085792
Std. dev.	0.039134	0.041711	0.040458	0.038962	0.879728	0.012564	0.052800	0.026014
Skewness	0.106087	-0.207264	0.026876	-0.152310	-0.149709	0.650056	2.751178	-0.329459
Kurtosis	3.704986	4.165357	3.387881	4.154701	1.917306	4.275311	21.26202	3.333410
Jarque-Bera	4.110340	11.60166	1.162832	10.81481	9.569235	25.15173	2758.645	4.135465
Probability	0.128071	0.003025	0.559106	0.004483	0.008357	0.000003	0.000000	0.126472
Observations	182	182	182	182	182	182	182	182

Source: Author's own estimation (2026).

4.3. ARCH test results

Before estimating the univariate GARCH models, it is essential to test for the presence of heteroscedasticity. In doing so, the study estimates and presents the ARCH-LM test results in Table 3. The F-statistics for the surveyed ETF index returns are significant at the 5% level. Therefore, the null hypothesis of the ETF index returns containing no ARCH effects is rejected in favour of the alternative hypothesis that the ETF index returns exhibit ARCH effects. These findings are further confirmed by the Chi-squared probability figures, which are significant at the 5% level. Consequently, ETF index returns exhibit heteroskedasticity, allowing estimation of GARCH-type models.

Table 3: ETFs' returns from ARCH test results

Variable	F-statistic	Prob.	Obs*R-squared	Prob. Chi-square
STX40	16.10239	0.0001	14.93248	0.0001
ETFSWX	30.56228	0.0000	26.37683	0.0000
ETFT40	5.203894	0.0237	5.112888	0.0237
STXSWX	20.06962	0.0000	18.23869	0.0000

Source: Author's own estimation (2026).

4.4. Unit root and stationarity test results

In addition to the requirement of ARCH effects, the variables surveyed should exhibit stationary properties. To account for these requirements, the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root and stationarity tests are estimated and presented in Table 4. The ADF test statistics for the ETF index returns are more negative than the critical values at all significance levels. Therefore, the null hypothesis of the ETF index returns attaining a unit root is rejected in favour of the alternative hypothesis that the ETF index returns are stationary. The KPSS test further confirms these findings, as the test statistic is smaller than the critical values, leading to a failure to reject the null hypothesis that ETF index returns are stationary. Similar findings are evident for the macroeconomic variables, except for the inflation growth rate. The ADF and KPSS tests confirm that the variables are not stationary in levels. However, when the tests are run in first differences, both tests confirm that the inflation growth rate is stationary. Consequently, the ETF index returns and macroeconomic variables (except the inflation growth rate) are stationary in levels, whereas the inflation growth rate is stationary in first differences. Therefore, we use the differenced inflation growth rate variable henceforth.

Table 4: ETFs' returns and macroeconomic variables' unit root and stationarity test results

	STX40	ETFSWX	ETFT40	STXSWX	CPI	M2	LT-INT	REER
				Levels				
ADF	-14.71712	-15.66713	-15.02997	-14.85430	-1.392780	-7.836622	-13.44487	-12.05035
KPSS	0.140832	0.138539	0.137361	0.151237	0.471397*	0.024064	0.174133	0.186134
				First Difference				
ADF	-	-	-	-	-12.95873	-	-	-
KPSS	-	-	-	-	0.266527	-	-	-

Notes: 1. The critical values associated with the ADF test at a 1%, 5% and 10% significance level are -3.466580, -2.877363 and -2.575284, respectively. 2. The critical values associated with the ADF test at a 1%, 5% and 10% significance level are 0.739000, 0.463000 and 0.347000, respectively.
Source: Author's own estimation (2026)

4.5. Univariate GARCH model selection results

Having satisfied the two preliminary tests for estimating the GARCH model, one now needs to specify the type of GARCH model. To this end, the three GARCH-type models are estimated at three distributions (normal, student-t and GED), and the minimised Schwarz criterion is used to determine the model specification. For the STX40, ETFT40, and STXSWX index returns, the information criteria are minimised for an E-GARCH (1.1) model with a GED distribution. However, for the ETFSWX index return, the GARCH (1.1) model with a normal distribution contains the minimised information criteria. In light of this, the E-GARCH (1.1) model with a GED distribution will be estimated for the STX40, ETFT40 and STXSWX index returns, and the GARCH (1.1) model with a normal distribution will be estimated for the ETFSWX index return.

Table 5: Model specification results

	GARCH (1.1)			GJR-GARCH (1.1)			E-GARCH (1.1)		
	Normal	**Stud T**	**GED**	**Normal**	**Stud T**	**GED**	**Normal**	**Stud T**	**GED**
STX40	-3.477713	-3.441214	-3.441696	-3.041961	-3.481564	-3.016754	-3.542060	-3.472551	-3.478487
ETFSWX	-3.353925	-3.330239	-3.327419	-3.348813	-3.323240	-3.320558	-3.346869	-3.319555	-3.318202
ETFT40	-3.375492	-3.346763	-3.351665	-3.374990	-3.346258	-3.358684	-3.391517	-3.353182	-3.377871
STXSWX	-3.473790	-3.445069	-3.445075	-3.474164	-3.472275	-3.490957	-3.575647	-3.436340	-3.572087

Notes: 1. The associated values represent the Schwarz criterion. 2. The bold figures indicate the superior model.
Source: Author's own estimation (2026)

4.6. Univariate GARCH model results

Table 5 presents the mean and variance equations for the univariate GARCH model specifications. In Panel A, average returns for all surveyed ETF returns are positive and significant at the 5 per cent significance level. However, the ARCH term is negative and significant for the STX40 and STXSWX index returns, while the GARCH term is significant and positive only for the STX40 index return. Consequently, total risk explains the average positive returns associated with the surveyed ETFs. Similarly, lagged negative returns associated with STX40 and STXSWX can explain future returns, whereas past positive shocks associated with STX40 can be used to derive future returns.

Panel B presents the variance equation. The intercepts associated with STX40, ETFT40, and STXSWX returns are negative and significant, with only ETFSWX positive. This suggests that total volatility explains average positive (negative) return volatility. Similarly, the ARCH term is positive and significant for ETFSWX and negative and significant for STXSWX. Accordingly, one-period-lag positive/negative return volatility can predict future return volatility. The GARCH term shows negative and significant parameters for STX40, ETFT40, and STXSWX, suggesting that past negative shocks are an important factor in explaining future return volatility. The leverage parameter remains positive and significant for STX40, ETFT40 and STXSWX, indicating that positive shocks increase return volatility more than negative shocks of the same magnitude. Turning to the macroeconomic variables, only the inflation growth rate, money supply growth rate, and long-term interest growth rate have significant effects on the selected ETFs. The effect is positive and significant for only STWSWX. This suggests that changes in inflation, money supply, and long-term interest rates increase the return volatility of STWSWX. However, for STX40, ETFSWX and ETFT40, macroeconomic variables have no direct influence on return volatility, suggesting that the selected indices are not affected by changes in macroeconomic variables.

Collectively, the findings align with the rational expectation hypothesis rather than loss aversion theory. The significant ARCH and GARCH terms in the mean and variance equations show that ETF volatility responds quickly to new information and is persistent. Therefore, investors update their expectations rationally following market innovations. Similarly, the insignificant effects of macroeconomic variables imply that publicly available economic information is efficiently incorporated into ETF returns. In contrast, the asymmetric volatility results do not support loss aversion theory. Rather than negative shocks generating greater volatility, the positive and significant leverage parameter indicates that favourable news has a larger impact on ETF volatility, implying that investor behaviour during the sample period was characterised by stronger responses to positive information than to adverse news.

Table 6: GARCH model results

	E-GARCH (1.1)		**GARCH (1.1)**		**E-GARCH (1.1)**		**E-GARCH (1.1)**	
	STX40		**ETFSWX**		**ETFT40**		**STXSWX**	
	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistic	Coefficient	z-Statistic
Panel A: Mean equation								
μ	0.007736**	2.368515	0.008889***	3.125666	0.006992**	2.323238	0.009820***	5.703119
ϕ	-0.763298***	-2.993055	-0.171696	-0.262658	-0.318597	-0.586832	-0.519110*	-1.750773
ζ	0.743788***	2.813107	0.056537	0.085162	0.192586	0.346872	0.411091	1.326916
Panel B: Variance equation								
φ	-0.829756*	-1.755645	0.000990**	2.414123	-1.570010**	-2.128542	-0.711720***	-397.3011
ω	-0.069715	-0.693758	0.263185**	2.383065	0.021938	0.149616	-0.417787***	-14.37515
ϑ	-0.170966**	-2.495417	0.174573	0.700343	-0.205343**	-2.342343	-0.151666***	-3.885230
γ	0.873856***	13.88100	-	-	0.769836***	7.544517	0.855955***	7.58E+13
D(CPI)	0.212395	0.820299	0.000905	0.802904	0.355107	0.985149	0.326542**	1.997855
M2	6.971544	0.911552	-0.010262	-0.686235	7.321245	0.893703	13.10727***	3.496108
LT-INT	0.902476	0.837312	0.002380	0.589834	0.884575	0.742858	1.866645**	2.547470
REER	-3.007287	-1.261354	-0.000466	-0.083112	-0.342546	-0.097691	0.142023	0.096700

Notes: 1. *, ** and *** are present at 10%, 5% and 1% significance levels, respectively. 2. μ, ϕ and ζ represent the intercept, ARCH and GARCH terms, respectively, associated with the mean equation. 3. φ, ω, ϑ and γ represent the intercept, ARCH, GARCH and leverage effect, respectively, associated with the variance equation.
Source: Author's own estimation (2026)

4.7. Robustness tests

To confirm the robustness of the univariate model specification, we consider and present the Nyblom parameter stability test, ARCH test, and Jarque-Bera normality tests in Table 7. In Panel A, all parameters in the mean and variance equations are stable. That said, the statistical values are smaller than the associated critical values, so we fail to reject the null hypothesis that the parameters exhibit stability. Similarly, the F-statistic in Panel B, associated with the ETF index returns, is insignificant, suggesting that the study fails to reject the null hypothesis of no conditional heteroscedasticity. Similarly, normality holds, as shown in Panel C; the associated Jarque-Bera statistic is insignificant, so we fail to reject the null hypothesis of normality. Collectively, the estimated models for each ETF index return present stable parameters, i.e., residuals that are normally distributed and without heteroscedasticity, which enhances the reliability of the findings.

Table 7: GARCH model diagnostic test results

	STX40	ETFSWX	ETFT40	STXSWX
Panel A: Nyblom parameter stability test				
Mean Equation				
μ	0.350850	0.118964	0.341103	0.049335
ϕ	0.191138	0.262639	0.611115*	0.052078
ζ	0.209344	0.289865	0.696576*	0.051587
Variance equation				
φ	0.285473	0.180239	0.194460	0.044148
ω	0.260103	0.132456	0.153009	0.045702
ϑ	0.065820	0.155202	0.041912	0.041705
γ	0.281710	-	0.184815	0.138774
D(CPI)	0.064546	0.353973	0.102406	0.054646
M2	0.364443**	0.130620	0.280728	0.042624
LT-INT	0.061135	0.168183	0.029856	0.068333
REER	0.131199	0.177190	0.278757	0.051600
Panel B: ARCH test				
F-Stat	1.115013 (0.2924)	1.809886 (0.1802)	0.057643 (0.8105)	1.497335 (0.2227)
Panel C: Jarque-Bera normality test				
J-B	0.893490 (0.639707)	3.926627 (0.140392)	1.918006 (0.383275)	3.923794 (0.140591)

Notes: 1. The critical values associated with the Nyblom test at a 1%, 5% and 10% significance level are 0.748, 0.470, and 0.353, respectively. 2. The figures contained in parentheses represent the associated p-values.
Source: Author's own estimation (2026)

5. Conclusion and implications

The study's findings show that macroeconomic uncertainty drives South African ETF return volatility. These uncertainties are asymmetrical and index-specific rather than uniform across ETF markets, as total volatility explains the average positive (negative) return volatility. One-period-lag positive/negative return volatility can forecast future return volatility, and past negative shocks are an important factor in explaining future return volatility. Moreover, positive shocks increase return volatility more than negative shocks of the same magnitude, with inflation growth rate, money supply growth rate and long-term interest rate growth rate enhancing STXSWX return volatility. Consequently, these findings align with the rational expectations view rather than loss aversion, as investors update their expectations rationally following market innovations. Collectively, the findings have important implications for stakeholders. Practically, fund managers should apply differentiated risk monitoring across indices rather than treating the ETF market uniformly. Similarly, from the scientific front, the study extends the debate on volatility asymmetry documented by Kunjal et al. (2022; 2024) and Moodley et al. (2025) into a macroeconomic rather than country-risk or sentiment framework.

Despite these noteworthy findings, the study has limitations. Firstly, the study surveys four ETF indices listed on the JSE, which do not capture the entire scope of listed ETFs. Second, the study uses a selected set of macroeconomic variables, which are not exhaustive. Future studies can extend this analysis by incorporating additional ETFs and macroeconomic variables to provide a more comprehensive analysis. Similarly, studies can conduct a comparative analysis between developed and emerging markets to determine the nature and interaction between the two markets, thereby assisting both developed- and emerging-market investors. Academics can strengthen the study's methodological rigour by conducting a comparative cross-country GARCH-based analysis and incorporating regime-switching macroeconomic uncertainty indices rather than growth rates alone. Collectively, the study presents nuanced findings applicable to the South African context, which enhances emerging market literature and helps investors and fund managers identify investment strategies that reduce return uncertainty.

Conflict of interest statement

The author declares no conflicts of interest.

Declaration of generative AI and AI-assisted technologies in the writing process

Grammarly was used to check grammar and enhance language. The author reviewed, verified, and took full responsibility for all content in the final manuscript.

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