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A Study on Silver Exchange-Traded Funds (ETFs) in India: Performance Evaluation

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ABSTRACT:

Exchange Traded Funds (ETFs) *are hybrid investment vehicles that possess the features of stock shares and index mutual funds, created and redeemed by Authorized Participants* ***(APs)****. This paper analyzes the short-run performance of the recently launched Silver* ***ETFs*** *in India for a one-year period from 2022 to 2023. The empirical assessment of the study used various performance metrics such as tracking error, appraisal ratio, Ulcer Index, Amihud's Illiquidity, and Yang-Zhang range-based Volatility to understand the Silver* ***ETFs****. The sample data proves to be efficient with the robustness tests such as the Augmented Dickey-Fuller* ***(ADF)*** *StationarityTest, Durbin Watson Autocorrelation* ***(DWA)*** *test, and Breusch-Pagan Heteroscedasticity* ***(BPH)*** *test. The tracking errors of the selected five silver* ***ETFs*** *traded on the National Stock Exchange* ***(NSE)*** *show prudent deviations from the benchmark indices yet can be considered low. The level of tracking errors obtained by the well–run silver* ***ETFs*** *suggests that it is possible to attain low levels of tracking error under Indian market conditions. Notably, the Silver* ***ETFs*** *have adjusted efficiently to the risk dynamics and outperformed their benchmark indices. The regression results reveal that the tracking errors are highly impacted by liquidity and volatility. In addition, the silver* ***ETFs'*** *returns and downside risks are affected by the underlying benchmark indices significantly.*

KEYWORDS:

Exchange-Traded Funds (ETFs); Silver ETFs; Tracking error; Illiquidity, Range-based Volatility.

JEL classification numbers: G14, G34

Introduction

The Securities Exchange Board of India ***(SEBI)*** and the Indian Government have established a role for fifteen Market Makers ***(MMs),*** appointed by stock exchanges that are contracted by Asset Management Companies ***(AMCs)*** to engage in market-making in a range of Exchange-Traded Funds ***(ETFs)***, to maintain constant liquidity on the market. The Employees' Provident Fund Organization ***(EPFO)*** has heavily invested in the equity market through ***ETFs***, and the Government of India ***(GOI)*** has decided to use ***ETFs*** to sell off holdings in Public Sector enterprises. Reasoning these prominent decisions, ***ETFs*** are hybrid investment vehicles that possess the features of stock shares and index mutual funds, created and redeemed by Authorized Participants ***(APs)***. There is a financial motivation for ***APs*** and***MMs*** to seize market arbitrage opportunities. When it comes to maintaining a close relationship between the series of ***ETFs***, Net Asset Value ***(NAV)***, and index performance in the ***ETF*** market, APs are crucial. ***APs'*** arbitrage action usually eliminates the return discrepancies. ***MMs*** or ***APs*** trade both ***ETFs*** and underlying assets simultaneously, a process known as creation-redemption, to maintain ***ETF*** prices in line with the values of their underlying portfolios. For example, ***APs*** purchase or sell the basket of securities and ***ETF*** shares if the price of the ***ETF*** is higher or lower than its ***NAV***. When an ***ETF's*** market price rises beyond its ***NAV***, ***APs*** purchase the underlying securities to create a creation unit and send it to the ***ETF*** issuer. ***APs*** sell the ***ETF*** shares to the market after obtaining them from the ***ETF*** issuer.

In recent years, ***ETFs*** have gained new popularity among Indian investors as the National Stock Exchange ***(NSE)*** accomplished a new milestone of listing 190 ***ETFs*** by December, 2023 *(Nifty Passive Insights)*. The growing volumes of ***ETFs*** traded every year in all of its types strengthened the substantial financialization of passive investing. In India, ***ETFs***are commonly classified into five types viz., Equity *ETFs* ***(EETFs)***, Commodities ETFs ***(CETFs)***, Debt *ETFs* ***(DETFs)***, International *ETFs* ***(IETFs),*** and Thematic *ETFs* ***(TETFs)***.

The paper aims to explore the performance of silver ETFs that fall under the ***CETFs,*** which are classified into energy products (Natural gas, Crude Oil), basic materials (Steel, Aluminium), or precious metals (Gold, Silver). Specifically, the precious metals market in India is due to its strong association with Indians for decades, and Indians are among the world's largest consumers of it. India's total demand for industrial silver in 2022 was estimated to be 42.6 million troy ounces, up around 24% from the year before. Additionally, during the consideration period, it was India's greatest demand volume for industrial reasons (India: industrial silver demand 2022 | Statista).

Review of Literature

According to **(Prakash and Sundararajan, 2014)[1]** gold and silver as precious metals, have shown that the co-movement of these metals emphasized a high positive correlation between the gold and silver spot prices. They have also indicated a strong linkage in their spot pricing mechanism as the gold prices are 97% dependent on Silver prices**. (Saishree and Padhi, 2022)[2]** stated that the ***ICM*** has shownthat the returns of base metals futures and

precious metals futures exhibit higher unison than energy futures, thus marking energy futures as most favorable for potential diversification benefits.

(**Corbet and Twomey, 2014)**[3] explained the profound performance of precious metals in the commodities market concerning spot prices and index futures explains the opportunities set for gold and silver ***ETFs*** in the stock exchanges in India because ***ETFs*** have made an efficient trading ecosystem to the commodities market by increasing liquidity and the flow of information among the investors, on the other hand, the extremely large ***ETF*** holdings have triggered enormous volatility in the market.

In the attempt to explore the performance of gold ***ETFs***, there are countable contributions documented in India. For example **(Kaur and Singh, 2020)**[4]explained the lack of awareness among investors, especially ***ETFs*** in the forms of precious metals as Indians acquire physical gold predominantly increases the relative inefficiency of ***ETFs*** in India which contributes more to the liquidity issues of the ***ETFs***. However, the growing works of literature on gold ***ETFs,*** notably**(Verma and Dhiman, 2020)**[5] suggested that investors are advised to analyze the underlying ***BI*** of the precious metals as a major estimator, as the benchmark index has affected their respective ***ETFs*** along with their spot prices.

The results of gold ***ETFs*** documented a negative correlation between gold ***ETFs*** and their underlying ***BIs*** **(Eshwara, 2015)**[6]**.** Later, the gold ***ETFs*** are statistically insignificant as they neither underperform nor outperform their benchmark indices as the returns of the funds and indices are closer to Zero **(Tripathi and Sethi, 2021)**[7]. Gradually, the average returns of the gold ***ETFs*** recorded a positive relationship with the increasing number of Novel ***COVID-19*** cases **(Gaba and Kumar, 2021)**[8].

According to (**Hillier et al., 2006**[9]**; and Daskalaki and Skiadopoulos, 2011**)[10], the precious metal returns recorded low correlations indicating their potential as hedging and diversification techniques. Additionally, they discovered that precious metals can increase the reward-to-risk ratio and enhance portfolio efficiency compared to standard equity portfolios.

Gold ***ETFs*** have a tracking record of 16 years in the ***NSE,*** with the first ***ETFs*** launched in 2007, and **(Garg, 2022)**[11] have proven to be a good hedge against inflation and market recessions, with increasing investors investing in gold during the Novel coronavirus pandemic.

(Lau et al., 2017)[12] stated that formerly, white precious metals such as Silver, palladium, and platinum were initially used for production intentions rather than as investment vehicles but recently they have been popular among investors due to the launch of Silver ***ETFs***. **(Hu, 2021)**[13] found that silver is also used as a risk hedger and asset optimizer by investors and especially noted that Silver's demand increases during economic downturns.

The significant other of gold is claimed to be silver according to the track record trading history on the precious metals index. The International markets have witnessed Silver ***ETFs*** track the performance of the underlying assets have contributed more to price discovery than the corresponding futures markets using tracking error and pricing deviation metrics **(Ivanov, 2013)**[14], and the tracking error of Silver ***ETFs*** is often more volatile over time and yields noisy returns in the Asian markets **(Guo and Leung, 2015)**[15], and are highly associated with their underlying volatility indices which approve positive patterns in sound

prediction of intraday pricing dynamics when the market volatility is high **(Xu et al., 2020)**[16]. Gradually, the volatility of the Silver ***ETFs*** in the US market has shown a positive correlation as the fear of uncertainty in the market spiked among investors during the peak of ***COVID-19*** **(Naeem et al., 2023)**[17].

As far as Indian markets are concerned it is noteworthy that there is a minimal number of studies available on the Silver market, and especially there is a need to explore the recently launched Silver ***ETFs*** primarily in the areas of tracking, risk, liquidity, and volatility performance.

Need for the Study

Several studies have been conducted in the developed economies, that is the United Kingdom ***(UK)***, the United States ***(US)***, China, and Australia to examine the performance and operational characteristics of ***ETFs***. However, there is paucity in the literature investigating the role of commodity ***ETFs*** in the Indian Stock Exchange. Particularly there is a compelling need to understand the blooming investment additions such as Silver ***ETFs*** in India. Although the size of the ***ETF*** industry is much less compared to that of developed nations, the industry has seen substantial growth in terms of the number of ***ETFs*** listed at the Stock Exchanges as well as the size of funds under management. Given the conditions in India, the methods used in the study are the potential estimators of short-run performance. The extended contributions focus on the importance of investor awareness about the Silver ***ETFs*** in India by being part of the ongoing literature on the role of newly added fund types in the stock market in India. The specific objectives and hypotheses associated are as follows. The primary objective of the study is to analyze the performance of Indian Silver *ETFs* and their underlying benchmark indices during the study period, and their specific motives attempts;

1. To test the robustness of Silver ***ETFs*** and their underlying benchmark indices during the study period.
2. To study the tracking performance and risk relevance of Silver ***ETFs***during the study period.
3. To study the impact of silver ***ETFs'*** daily return on their underlying benchmark indices daily return during the study period.
4. To study the impact of the drawdown risk performance of Silver ***ETFs*** on the drawdown risk performance of their underlying benchmark indices during the study period.
5. To assess the impact of silver ***ETFs'*** tracking errors on their liquidity during the study period.
6. To assess the impact of silver ***ETFs'*** tracking errors on their volatility during the study period.

Hypotheses of the study

$H0^1$: The daily return series of ***ETFs*** are non-stationary; there is no first-order autocorrelation in the daily return series; the variance of errors is constant in the daily return series.

$H0^2$: There is no significant impact of silver ***ETFs'***daily return on their underlying benchmark indices daily return during the study period.
$H0^3$: There is no significant impact of the drawdown risk performance of Silver ***ETFs*** on the drawdown risk performance of their underlying benchmark indices during the study period.
$H0^4$: There is no significant impact of silver ***ETFs'*** tracking error on their liquidity during the study period.
$H0^5$: There is no significant impact of silver ***ETFs'*** tracking error on their volatility during the study period.

Before pursuing any form of performance metrics, the financial data time series of 243 observations of daily returns of ***ETFs*** and the Benchmark Indices **(BIs)** each underwent a robustness investigation of the *Augmented Dickey-Fuller* ***(ADF)*** *StationarityTest, Durbin Watson Autocorrelation* ***(DWA)*** *test, and Breusch-Pagan Heteroscedasticity* ***(BPH)*** *test to support the reliability and validity of the overly sensitive conditions.* Further, the performance metrics focused on tracking error, risk relevance, and the volatility estimators of the ***ETFs***.

Data and Methodology:

Data

The first ever Indian Silver **ETF** was launched under commodity **ETFs** on 24 August 2022. Since then, a few **ETFs** have been listed on ***NSE***, and at present (as on December, 31st 2023), the segment comprises ten **(10)** silver **ETFs**. *Source: Nifty Passive Insights*

The study engages the detailed time series data of the five **(5)** Indian Silver ***ETFs*** launched on the National Stock Exchange in the year 2022. Collectively, the study covers the data series of the daily prices ranging from 31st January 2022 to 27th September 2023 for Silver ***ETFs*** and their underlying ***BIs***. The detailed time series data includes the daily open, high, low, and close prices and daily volume trades of the sample ***ETFs*** and their underlying ***BIs***viz., London Bullion Market Association ***(LBMA)*** and Nifty Metals ***(NM)*** are obtained from the official portals of https://www.nseindia.com/; https://www.niftyindices.com/; and https://www.lbma.org.uk/. However, considering the independent launch dates of each ***ETF***, the raw data series have some missing values on the whole in comparison to the Silver ***ETFs*** and their underlying ***BIs***. Therefore, the data series is adjusted to the indices perfectly aligned with the raw Silver ***ETFs*** data series by removing the day from the indices that are not documented in the Silver ***ETFs*** data series for incorporating a one-year analysis with a total of 243 observations on each data series. Table I explains the profiles of the Silver ***ETFs*** launched in India.

Table I
Profile of the Silver *ETFs*

Symbol	Underlying Index	Name of Issuer	Launch Date
ICICISILVE	LBMA Silver prices, Nifty Metal	ICICI Prudential Mutual Funds	31-Jan-22
SILVERBEES	LBMA Silver prices, Nifty Metal	Nippon India Mutual Funds	07-Feb-22
DSPSILVETF	LBMA Silver prices, Nifty Metal	DSP Mutual Funds	25-Aug-22
HDFCSILVER	LBMA Silver prices, Nifty Metal	HDFC Mutual Funds	07-Sep-22
AXISILVER	LBMA Silver prices, Nifty Metal	Axis Mutual Funds	27-Sep-22

Source: *https://www.nseindia.com/*

Methodology

Testing of the ETFs and their UIs based on the robustness metrics

The pre-testing process of time series data becomes inevitable in stock market analysis. Particularly, an efficient market situation probes whether the data series taken for the analysis follows a non-randomness, ensures independence among their residuals, and standard errors or variance of errors being constant across the trading observations.

Stationarity Test

The most viable estimator employed to test the presence of stationarity in the sample time series data is the ***ADF*** test. To test whether the time series data follows randomness or not the ***ADF*** test proves when the time series data's desirable property is to be stationary with no unit root outcomes signifying the time series data has predictable patterns of the price dynamics and is best suited for financial analysis because the absence of stationarity and the presence of unit root in the time series results in random walk behavior and the variance of the time series grows exponentially **(Dickey and Fuller, 1979)**[18].

Autocorrelation test

To invoke non-autocorrelation in regression errors, we report the ***DWA*** statistics to examine whether the autocorrelation is present in the sample time series data. The presence of autocorrelation in the sample series data results in a biased coefficient estimated in the regression models. Generally, the DW value ranges between 0 to 4, and the practical value of no autocorrelation ranges from 1.5 to 2.5, indicating the optimal value where the residuals ensure independence.

Heteroscedasticity test

The sample time series data demands to be generally homoskedastic, where the variance of the residuals or the standard error is constant across observations. The varying levels of volatility in the residuals are estimated with two-step ordinary and auxiliary

regression models with the ***BPH*** test. The absence of heteroscedasticity in the sample time series data leads to efficient estimates and accurate statistical inferences.

Examining the performance based on the tracking error

Tracking error ***(TE)*** is the significant deviation that is present between the returns of the ***ETFs*** and their ***BIs***. The differing magnitude of the returns reflects how attentively an ***ETF*** tracks its ***BI***. A lower TE is the representation of the tracking efficiency of the ***ETF*** with its ***BI***. In the present computation, the TE equation 1 ***(TEe1)*** is the standard deviation of the active returns, which is the difference from the annualized ***ETF*** returns to the ***BI***. TE equation 2 ***(TEe2)*** is measured by summing the squared active returns divided by the total number of trading days observed. Further, the output carried was square-rooted according to annualized estimation.

$$TEe1 = \sigma(R_p - R_b)$$

Where R_p denotes the returns of the ***ETF***, R_b denotes the returns of the benchmark index, and σ denotes the standard deviation.

$$TEe2 = \sqrt{\frac{\sum_{i=1}^{n}(R_p - R_b)}{N-1}}$$

Here TE is the tracking error, $R_p$which denotes the returns of the respective ***ETF***, $R_b$denotes the returns of the benchmark index of the ***ETF,*** and N denotes the number of return periods observed.

Examining the performance based on the risk relevance

The two most important things for any investor to have are steady investment performance and risk management skills. An ***ETF*** is often a portfolio of securities that are exchanged like stocks. ***ETFs*** mimic an index's risk and return characteristics by tracking it **(Stankeviciene and Petroniene, 2019)[19].**

Appraisal Ratio

The basic compound risk of the ***ETF*** issues from the market risk related to its underlying index that it tries to replicate. The fund manager's active management achieves the logical performance evaluation of risk relevance through a value-added strategy.***AR***iswhere the excess returns are divided by the residual risk or idiosyncratic risk where the market fluctuations remain challenging to explain. It expresses the excess returns adjusted for each unit of individual risk incurred, taking into account the systematic risk. In the computation, the excess return is the intercept function of the ***ETF*** and ***BI*** returns. The sensitivity of the ***ETF*** is the slope function of the ***ETF*** and ***BI*** returns. Further, the abnormal return is the addition of Intercept and slope multiplied by***BI's*** normal return subtracted from the ***ETF's*** normal return.

$$AR = \frac{\alpha}{\sigma(\varepsilon)}$$

Here α is the excess return and,$\sigma(\epsilon)$ the residual risk defines the standard deviation of the abnormal returns.

Ulcer Performance Index

The latter shocks in the stock market around the world rehashed panic in investment strategies, particularly the Buy and Hold Strategy ***(BHS)***. A common approach to addressing this type of risk is the buying of a diversified stock portfolio. ***The ETF*** is a relatively growing investment vehicle that could be considered particularly well-suited to the requirements of the ***BHS*** **(Sanderson and Lumpkin Sowers, 2018)[20]**. ***ETFs*** have the leverage of representing diversified portfolios and are the best fit for the ***BHS***. Encountering the shocks and anomalies in the market, informativeness about the downside risk is crucial as it comprehensively assesses how well the funds have performed during favorable market conditions but also how resilient they are during crises.

The commonality of using the conventional Sharpe ratio as the risk metric has been a constant measure for assessing the risk. However, an efficient alternative, downside-risk measure known as the Ulcer Performance Index ***(UPI)*** is concerned with the levels of risks measuring the depth and duration of drawdown's from recent peaks of the funds. A drawdown measures peak-to-trough decline during a specific record period of a fund usually quoted as a percentage between the peak and the trough.

The ***UPI*** initiates the computation, firstly, the drawdown's which calculate the buy and hold returns of the next day of the ***ETFs*** and the corresponding ***BIs***, basically determine whether the performance is at the level of an all-time high or not. Secondly, the root means squared error of the drawdown's is averaged by the number of trading observations with a square root taken.

$$\boldsymbol{UPI} = \sqrt{\frac{\sum_{i=1}^{n} \boldsymbol{D_i^2}}{\boldsymbol{n}}}$$

Here ***D*** is the drawdowns of the ***ETF*** on the day *t,* and ***n*** is the number of trading observations.

Amihud Illiquidity

The lack of liquidity in non-popular ***ETFs*** may impede market makers from building proper markets, resulting in higher transaction costs for ***ETF*** investors. Low liquidity in underlying assets might lead to tracking mistakes because it discourages ***APs*** from duplicating the index while trading the basket securities. Examining the effect of liquidity on tracking mistakes is better using daily-level measures than monthly-level measures since ***APs*** manipulate the ***ETF*** market through arbitrage operations that affect ***ETF*** tracking errors daily **(Bae and Kim, 2019)[21]**.With this connection, the insight from Amihud (2002) is used to assess the illiquidity ***(ILLIQ)*** of the funds with a measure to relate the absolute returns of the fund or the absolute price change in the valuation of a fund to its daily dollar volume called

ILLIQ. Amihud measure derives the price-impact measure ***ILLIQ*** to capture the level of illiquidity and to determine the relationship between illiquidity and returns over time **(Czauderna et al., 2015)**[22].

$$\boldsymbol{ILLIQ} = \frac{\sum_{i=1}^{t} |\boldsymbol{R_t}|}{\boldsymbol{DVOL_t}}$$

Here, $R_t$are the absolute returns of the ***ETF*** and $DVOL_t$ the daily volume in crores of the respective ***ETF***.

Examining the performance based on volatility

To understand the comprehensive volatility performance of the ***ETFs***, the ***OHLC***, i.e., Open **(O)**, High **(H)**, Low **(L)**, and Close **(C)**, the four potential data points of a fund is used to gather relevant patterns of the daily traded prices along with its dynamics, and to produce efficient estimation of the volatility status of movements for the study period. The deviations present in the closing and opening prices constitute the intraday trend. On the other hand, the deviations present in the low and high prices indicate the intraday range and serve as a measure of volatility **(Fiess and MacDonald, 2002)**[23].Measuring the range-based four-point volatility would be a steady start to assess the first-hand volatility present in the Silver ***ETF*** market. Several historical range-based volatility estimators are carried out including the standard Closet-to-Close ***(CC)*** and quite advanced volatility estimators such as Parkinson **(P)** in 1980, Garman-Klass ***(GK)*** in 1980, Rogers and Satchell ***(RS)*** in 1991, and Yang-Zhang ***(YZ)*** in 2000. This paper will incorporate the advanced ***YZ***volatility estimator to compute the volatility of the ***ETFs***. However, the scheme of sequential formulae enforced by the academicians viz., Parkinson, Garman-Klass, and Rogers-Satchell have major contributions to the***YZ*** volatility estimator.

Firstly, the standard ***CC*** method is the often employed volatility measure where the obvious computation of the closing price of the day is divided by the closing price of the previous day minus 1, resulting in the daily returns of the funds and further the volatility computation if the standard deviation of the daily returns of the funds. This method of ***CC*** volatility focuses on capturing only the closing prices and possibly encounters a large sample of data. Secondly, the ***P*** and the ***GK*** volatility estimators which were derived independently of each other in 1980, incorporate high-low, and high-low-close-open prices respectively in different ways to factor in different sources of the stock market volatility. Additionally, **(Korkusuz et al., 2023)**[24] stated that the Independent variables such as the overnight volatility, and jumps have a direct relationship with the dependent variable as they capture the conventional facts of volatility.

The opening price jumps are very common in stock markets when the previous day's closing price is not necessarily equal to the next day's opening price. So, these opening jumps and drifts are not incorporated in the ***P*** and ***GK*** volatility estimators. To address the involvement of opening price jumps, more advanced ***OHLC*** volatility estimators have been devised that seek to incorporate all possible sources of stock market volatility. The first measure that manifests the limitations of ***CC,P,*** and ***GK*** is the ***RS*** volatility measure.

$$\sigma_{RS}^2 = \frac{1}{n}\sum_{i=1}^{n}\left(u_i(u_i - C_i) + d_i(d_i - C_i)\right)$$

Where u is the normalized up, natural logarithm of the current day's high divided by the current day's open of the ***ETF***; C is the normalized close, natural logarithm of the current day's close divided by the current day's open of the ***ETF***; d is the normalized down, natural logarithm of the current day's low divided by the current day's open of the ***ETF***. The square root of the sum average of ***RS***components$u$, C, and d results in ***RS*** volatility.

However, the ***RS*** volatility estimator underestimates the opening jumps in their computation, therefore, Yang and Zang in the year 2000, basically strived to take the best outcomes out of ***CC, P, GK,*** and ***RS*** volatility estimators. This ***YZ*** method of range-based volatility measure explicitly employed the ***RS*** volatility as one of the components in their equation.

$$\sigma_{YZ}^2 = \sigma_{Overnight\ volatility}^2 + kn_{Close\ volatility}^2 + (1-k)\sigma_{RS}^2$$

$$Where\ k = \frac{0.34}{1.34 + \frac{N+1}{N-1}}$$

The opening jumps are accounted for by the normalized open, natural logarithm of the current day's open divided by the previous day's close of the ***ETF;*** the overnight volatility is the standard deviation of the logarithms of opening jumps of the ***ETF***. The close volatility is the standard deviation of the natural logarithm of the normalized close of the ***ETF***.k is the weighting coefficient of the overall variance estimator, the weighted factor is dependent on the number of trading observations taken for the study, basically the sample size adjustments. $k$factor is used as the weighting coefficient of the closing volatility and the ***RS*** volatility.

Empirical Results

Descriptive statistics

The results reveal that the Silver ***ETFs*** and the underlying ***BIs*** display equal mean returns. In terms of standard deviation, the silver ***ETFs*** exhibit the least volatility, while the ***LBMA*** and ***NM*** display the higher volatility. The series displays positive skewness, for silver ***ETFs*** and ***LBMA***, but excess skewness, with negative skewness for ***NM***, indicating that the empirical distributions of the returns exhibit slight asymmetry with a right-leaning tail for silver ***ETFs*** and ***LBMA*** and slightly more asymmetric with a left-leaning tail for ***NM***. Positive excess kurtosis is observed for all three series; silver ***ETFs*** and ***LBMA*** exhibit comparatively lower excess kurtosis than the ***NM*** excess kurtosis, explaining that their empirical returns distributions are leptokurtic, i.e. with substantially fatter tails compared to the normal distribution.

Table II
Descriptive Statistics of the Silver *ETFs, LBMA* Index, and *NM* Index during the study period (2022-2023)

Descriptive Statistics	ETFs	LBMA	NM
Mean	0.001	0.001	0.001
Minimum	-0.04	-0.047	-0.061
Maximum	0.06	0.077	0.061
Standard deviation	0.014	0.019	0.017
Skewness	0.33	0.239	-0.159
Kurtosis	1.201	0.98	1.798
Observations	243	243	243

Source: Author computations based on secondary data compiled from https://www.nseindia.com/; https://www.niftyindices.com/; and https://www.lbma.org.uk/.

The prime component of all the computations is the daily returns of the sample. The daily returns are the key indicator for performing the short-run metrics of ***TE, AR, UPI, ILLIQ,*** and volatility of the Silver ***ETFs*** of India. Therefore, the daily return is estimated as follows:

$$Dret = \left(\frac{DP_1}{DP_2}\right) - 1$$

Where $\boldsymbol{Dret}$ are the daily returns, $\boldsymbol{DP_1}$ is the closing price of the current day; $\boldsymbol{DP_0}$ is the closing price of the previous day, and is the subtraction of 1 denoted percentage conversion factor from ratio.

Robustness tests Results

To address the issue of unit root presence in the daily return series of the Silver ***ETFs***, the ***ADF*** (1979) test is employed and the results are presented in Table 2. The values presented in the table indicate the computation of test statistics and their corresponding p-values which state the statistically significant level of 0.01 or 1% for the rejection level of the null hypothesis (***H0***), which implies the presence of unit-root in daily return series.

The ***ADF*** test explains the drift, drift, and trend, and no drift of the return series using a regression model. The drift is referred to as the constant which indicates the daily returns remain persistent over time and the trend is referred to as the time trend which indicates the daily return series tend to follow a systematic increase or decrease over time. The presence of a unit root indicates the return series are non-stationary, which is an unfavorable event and signifies that the nature of the Silver ***ETF*** market is inefficient. Table 2, exhibits that the daily return series of both silver ***ETFs*** are free from non-stationarity, i.e., the returns do not suffer from the unit root, and confirms the nature of the Silver ***ETF*** market is efficient.

Table III
Results of *ADF* test on daily returns of the *ETFs* during the study period (From 2022 to 2023)

SL. No.	SYMBOL	DRIFT		DRIFT + Trend		No Drift	
		t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
1	ICICISILVE	-16.162***	0.001	-16.161***	0	-8.865***	0
2	SILVERBEES	-15.819***	0.001	-15.822***	0	-9.158***	0
3	DSPSILVER	-16.056***	0.001	-16.053***	0	-9.867***	0
4	HDFCSILVER	-14.641***	0.001	-14.700***	0	-9.303***	0
5	AXISILVER	-16.184***	0.001	-16.294***	0	-8.918***	0

Source: Author computations based on the secondary data compiled from https://www.nseindia.com/.
*** indicates the statistical significance at the 1% level.

The computed values of ***'ICICISILVE', 'SILVERBEES', 'DSPSILVER', 'HDFCSILVER',*** and ***'AXISILVER'*** presented in Table III are significant at 1% level in every aspect of drift, drift and trend, and no trend estimations. Hence, ***H0:*** *'The daily return series of* ***ETFs*** *are non-stationary'* is *rejected*, and therefore the daily return series have no unit root; in other words, these return series are stationary during the study period.

To address the issue of the potential existence of first-order autocorrelation in the daily return series of the silver ***ETFs*** and the underlying ***LBMA*** Benchmark Index, the ***DWA*** test is employed and the results are presented in Table IV. The ***DWA*** test uses the regression model to examine the possible residuals (errors) existing in the daily return series. The daily returns of the silver ***ETFs*** are accounted as the dependent variable and the daily returns of the ***LBMA*** Benchmark Indices are accounted as the independent variable in the analysis using the regression model to detect the first-order autocorrelation.

Table IV
Results of *DWA* test on daily returns of the *ETFs* and their underlying *LBMA* benchmark Index during the study period (From 2022 to 2023)

Variables	t-statistic	f-statistic	p-value
ICICISILVE-LBMA INDEX	2.54**	952.49	0.06
SILVERBEES-LBMA INDEX	2.53**	1083.55	0.06
DSPSILVER-LBMA INDEX	2.55**	952.77	0.07
HDFCSILVER-LBMA INDEX	2.56**	1214.70	0.06
AXISILVER-LBMA INDEX	2.33**	92.65	0.05

Source: Author computations based on the secondary data compiled from https://www.nseindia.com/ and https://www.lbma.org.uk/.
*** indicates the statistical significance at the 5% level.*

The presented values in Table IV are test statistics, f-statistics, and their corresponding p-values which state the range of autocorrelation, the overall relationship among the variables, and the statistically significant level of 0.05 or 5% for the rejection of the ***H0***, which implies the presence of first-order autocorrelation in the daily return series.

The test statistics of the ***DWA*** test range from zero (0) to four (4). Where zero indicates the positive autocorrelation and four indicates the negative autocorrelation. The

ideal value to exhibit no autocorrelation is 2. However, the ideal span that is relatively accepted ranges from 1.5 to 2.5 in case of limited observations.

The test statistics of silver ***ETFs*** and the underlying index come under the range of 1.5 to 2.5, and the indication of *'no autocorrelation'* revolves around the ideal value 2. Additionally, the p-values exhibited are higher than 0.05 or 5% level of significance. Hence, ***H0:****'There is no first-order autocorrelation in the daily return series'* is *accepted*, and therefore, the daily return series are free from autocorrelation, which suggests the series do not have any residual errors in the regression model of the daily return series. Finally, the higher f-statistics confirm the strong association between the variables used.

Following the establishment of no errors in the regression model, the study extends to detect whether the errors (variance in residuals) in the regression model are constant or not, as there was a generalization of ***DWA*** *t*-statistics as they deviated from the ideal value of 2. To address the issue of the possible presence of heteroscedasticity in the daily return series of the silver ***ETFs*** and the underlying ***LBMA*** and ***NM*** Benchmark Indices, the ***BPH*** *t*est is employed and the results are presented in Table IV. The daily returns of the silver ***ETFs*** are accounted as the dependent variable, and the daily returns of the ***LBMA*** **and** ***NM*** Benchmark Indices are accounted as the independent variable in the analysis.

The presented values in Table V are the test statistics and their corresponding p-values, the ***BPH*** test follows chi-square distribution, and its statistical significance level for rejection is 0.05 or 5% of the ***H01***, which implies the presence of heteroscedasticity in the residuals of the regression model explaining the daily return series.

Table V
Results of *BPH* test on daily returns of the *ETFs* and their underlying *LBMA* and *NM* benchmark Indices during the study period (From 2022 to 2023)

Variables	t-statistic (Chi.Sq.)	p-value
ICICISILVE-LBMA INDEX-NM INDEX	3.2826	0.1937
SILVERBEES-LBMA INDEX-NM INDEX	2.4467	0.2942
DSPSILVER-LBMA INDEX-NM INDEX	0.6508	0.8632
HDFCSILVER-LBMA INDEX-NM INDEX	4.4930	0.1058
AXISILVER-LBMA INDEX-NM INDEX	0.6678	0.7161

Source: Author computations based on the secondary data compiled from https://www.niftyindices.com/; and https://www.lbma.org.uk/.

The test statistics are derived from the chi-squared distributions, as the ***BPH*** test focuses on the variance of errors. The p-values associated with the test statistics are higher than the significance level of 0.05 or 5%. Hence, ***H0:*** 'The variance of errors is constant in the daily return series' is accepted and therefore, explains that there is no heteroscedasticity present in the regression model. In other words, the daily return series is homoscedastic, and it proves the daily return series is reliable for further analysis.

Core performance metric results

The computed results from the core performance metrics of the Silver ***ETFs*** in India are presented in Table VI. The table documents the estimated performance of tracking errors,

appraisal ratio, liquidity, volatility, and the downside risk is recorded separately for the ***ETFs*** and the benchmark index as per the requirements of the Ulcer Index metric.

According to the results shown in Table VI under Panel I, the study includes two separate tracking error metrics for each ***ETF***. As seen from the presented values both metrics have predominantly exhibited similar outputs. The results ranged from 4% to 7%, the ***ICICISILVE, SILVERBEES, DSPSILVER, HDFCSILVER,*** and ***AXISILVER*** documented its one-year tracking error to 4.2%, 4.1%, 3.9%, 3.8%, and 7.3% respectively. Comparatively, ***HDFCSILVER*** has recorded the lowest tracking error, which explains that it travels close to its benchmark index and ***AXISILVER*** recorded the highest tracking error, which explains a maximum deviation from the benchmark index. However, ***ICICISILVE, SILVERBEES, DSPSILVER,*** and ***HDFCSILVER*** exhibited close to similar deviations from their benchmark index.

The computed result ***AR*** as presented under Panel II in Table VI, ***DSPSILVER, HDFCSILVER,*** and ***AXISILVER*** have substantially exhibited higher 0.2076 (21%), 0.3164 (32%), and 0.3227 (32%) ability to provide excess returns when compared to their benchmark index respectively. On the other hand, **ICICISILVE** and **SILVERBEES** exhibited lower yet positive magnitudes of 0.0390 (4%) and 0.0714 (7%) respectively suggesting that the excess returns generated are comparatively lower. However, the results of the ***AR*** depicted a positive representation of the magnitude of excess returns generated and the risk taken by the fund managers of the Silver ***ETFs*** as an ability to outperform its benchmark Index.

Further, the study concentrates on the most peculiar risk assessment; the ***UPI*** represents the downside risk considering the longer and deeper drawdown's relevance of both silver ***ETFs*** and their benchmark index independently. As per the results shown in Table V, except for ***HDFCSILVER*** and ***AXISILVER***, the ***UPI*** of ***ICICISILVE, SILVERBEES, and DSPSILVER*** recorded a lower ***UPI*** of (0.86%, 1.80%), (0.70%, 1.86%), and (4.18%, 8.19%) respectively compared to their benchmark index. This indicates that the silver ***ETFs*** with lower ***UPI*** recover sooner from their troughs compared to their benchmark index, which confirms their ability to bounce back from their downside risk reasonably faster. In the cases of ***HDFCSILVER*** and ***AXISILVER***, which exhibit (0.00%, 0.00%), and (0.34%, 0.00%) of ***UPI*** respectively, indicate that despite their lower risk in ***AXISILVER***, the remaining ***UPI*** with no record of downside risk might be an anomaly considering the one-year analysis. However, the silver ***ETFs*** regaining their peak-to-trough at a quicker pace compared to their benchmark index is considered favorable from a risk relevance perspective.

Table VI
Results of the core performance of silver *ETFs* in India based on their tracking, risk-relevance, and volatility metrics during the study period (2022-2023)

SILVER ETFs SYMBOL	PANEL I		PANEL II				PANEL III
	TEe1	TEe2	AR	UPI		ILLIQ	VOL
				ETFs	Index		
ICICISILVE	0.0424	0.0423	0.0390	0.0086	0.0180	0.1953	0.0170
SILVERBEES	0.0414	0.0413	0.0714	0.0070	0.0186	0.2354	0.0205
DSPSILVER	0.0392	0.0388	0.2076	0.0418	0.0819	7.8705	0.0248
HDFCSILVER	0.0378	0.0376	0.3164	0.0000	0.0000	0.0767	0.0181
AXISILVER	0.0733	0.0730	0.3227	0.0034	0.0000	60.8462	0.0173

Source: Author computation based on the secondary data compiled from https://www.nseindia.com/ and https://www.lbma.org.uk/.

The computed results of the Amihud Illiquidity measure exhibit lower illiquidity of 0.1953, 0.2354, and 0.767 for ***ICICISILVE, SILVERBEES,*** and ***HDFCSILVER,*** but in the case of ***DSPSILVER,*** comparatively a slightly increased illiquidity of 7.0767. It indicates that the lower illiquidity explains the lower risk in buying and selling. On the other hand, these silver ***ETFs*** are highly liquid. However, ***AXISILVER*** exhibits severely high illiquidity of 60.8462, which indicates a higher risk in exchange for transacting it in the market and is poorly liquid.

The results of the volatility of the ***ETFs*** recorded considerably lower range-based for all the silver ***ETFs*** is shown under Panel III of Table VI. The ***DSPSIVER*** is more volatile with an estimate of 0.0248, and ***ICICISILVE*** is the least volatile with an estimate of 0.0170. The remaining ***ETFs*** follow the range of 0.0173, 0.0181, and 0.0205 for ***AXISILVER***, ***HDFCSILVER***, and ***SILVERBEES***. However, the silver ***ETFs*** have proximity of generalizing the volatility to 2% for all the silver ***ETFs***. Therefore, the silver ***ETFs*** project stable volatility throughout the study period without any drastic anomalies.

Regression analysis of returns

The results of regression on the impact of ***ETFs'*** returns on Index returns have been summarized in Table VII. It can be found that the independent variable viz., 'Index returns' is positively significant at 0.01 or 1% level with a p-value of 0.000.

The F-statistic shows a significant impact (0.000) at 0.01 or 1% level. The adjusted R-squared recorded (0.817), indicates that 'Index returns' impacted the ***ETFs'*** returns to the extent of 82%, the remaining 18% is influenced by the other unobserved variables. There is a significant impact of ***ETFs'*** returns on Index returns at 0.01 or 1% level.

Table VII

Results of Regression Analysis on the Impact of *ETFs'* Returns on Benchmark Index (BI) Returns of Silver *ETFs* in India during the Study Period (From 2022 to 2023)

Variables	Coefficients	Standard Error	t-statistic	Prob. Value
ETFs Returns	0.0001	0.0003	0.2420	0.8089
BI Returns	0.6664	0.0202	32.9173	0.0000***
R	0.9044			
R-square	0.8180			
Adjusted R Square	0.8172			
F-statistic	0.0000***			

Source: Computed results based on secondary data compiled fromhttps://www.nseindia.com/ and https://www.lbma.org.uk/.

**** indicates the statistical significance at the 1% level.*

Hence, ***H0²:****'There is no significant impact of silver* ***ETFs*** *daily return on their underlying benchmark indices' daily return during the study period'* in India is rejected.

Regression analysis of Drawdown risks

The results of regression on the impact of ***ETFs'***drawdowns on Index drawdowns have been summarized in Table VIII. It can be found that the independent variable viz., 'Index drawdown's is positively significant at 0.01 or 1% level with a p-value of 0.000.

The F-statistic shows a significant impact (0.000) at 0.01 or 1% level. The adjusted R-squared recorded (0.564), indicates that 'Index drawdown's impacted the ***ETFs'***drawdowns to the extent of 56%, the remaining 44% is influenced by the other unobserved variables. There is a significant impact of ***ETFs'***drawdowns on Index returns at 0.01 or 1% level.

Table VIII

Results of Regression Analysis on the Impact of *ETFs*' Drawdowns on Benchmark Index (BI)Drawdowns of Silver *ETFs* in India during the Study Period (From 2022 to 2023)

Variables	Coefficients	Standard Error	t-statistic	Prob. Value
ETFs' Drawdowns	-0.07	0.00	-14.03	0.000
BI Drawdowns	-0.34	0.073	33.52	0.00***
R	0.698			
R-square	0.566			
Adjusted R Square	0.564			
F-statistic	0.000***			

Source: Computed results based on secondary data compiled from https://www.nseindia.com/ and https://www.lbma.org.uk/.

**** indicates the statistical significance at the 1% level.*

Hence, ***H0³:*** *There is no significant impact of the impact of drawdown risk performance of Silver* ***ETFs*** *on the drawdown risk performance of their underlying benchmark indices during the study period'* in India is rejected.

Regression Analysis of Illiquidity

The results of regression on the impact of ***TE*** on ***ILLIQ*** have been summarized in Table IX. It can be found that the independent variable viz., '***ILLIQ***' is positively significant at 0.01 or 1% level with a p-value of 0.003.

Table IX
Results of Regression Analysis on the Impact of TE on ILLIQ of Silver *ETFs* in India during the Study Period (From 2022 to 2023)

Variables	Coefficients	Standard Error	t-statistic	Prob. Value
Tracking Error	0.0391	0.0017	22.0010	0.0002
ILLIQ	0.0005	0.0000	08.5020	0.0034***
R	0.9798			
R-square	0.9601			
Adjusted R Square	0.9468			
F-statistic	0.0034***			

Source: Computed results based on secondary data compiled from https://www.nseindia.com/and https://www.lbma.org.uk/.
**** indicates the statistical significance at the 1% level.*

The F-statistic shows a significant impact (0.003) at 0.01 or 1% level. The adjusted R-squared recorded (0.946), indicates that '***ILLIQ***' impacted the ***TE*** to the extent of 95%, and the remaining 5% is influenced by the other unobserved variables. There is a significant impact of ***TE*** on ***ILLIQ*** at 0.01 or 1% level. Hence, ***H0⁴:*** *'There is no significant impact of silver **ETFs**' tracking error on their liquidity during the study period'* in India is rejected.

Regression analysis of Volatility regression

The results of regression on the impact of ***TE*** on Volatility have been summarized in Table X. It can be found that the independent variable viz., 'Volatility' is positively significant at 0.05 or 5% level with a p-value of 0.0282.

The F-statistic shows a significant impact (0.0282) at 0.05 or 5% level. The adjusted R-squared recorded (0.788), indicates that 'Volatility' impacted the ***TE*** to the extent of 79%, the remaining 18% is influenced by the other unobserved variables. There is a significant impact of TE on Volatility at 0.05 or 5% level.

Table X
Results of Regression Analysis on the Impact of TE on Volatility of Silver *ETFs* in India during the Study Period (From 2022 to 2023)

Variables	Coefficients	Standard Error	t-statistic	Prob. Value
Tracking Error	0.0175	0.0008	20.8476	0.0002
Volatility	0.0873	0.0218	03.9894	0.0282***
R	0.9172			
R-square	0.8414			
Adjusted R Square	0.7885			
F-statistic	0.0282***			

Source: Computed results based on secondary data compiled fromhttps://www.nseindia.com/ and https://www.lbma.org.uk/.
**** indicates the statistical significance at the 1% level.*

Hence, ***H0*^{5}*:*** *'There is no significant impact of silver* ***ETFs*** *' tracking error on their volatility during the study period'* in India is rejected.

Conclusion

This paper attempted to examine the short-run performance based on the tracking efficiency, risk relevance, and volatility of silver ***ETFs*** and their underlying benchmark Indices. The study reveals that tracking errors have a significant record of relatively higher deviation from the benchmark but are considerably low where their average returns have a substantially closer run, and the fund's age, initial portfolio costs, creation and redemption process are concerned during the beginning of the investment launch. Fortunately, the risk-relevances of the ***ETFs*** are highly favorable as ***ETFs*** generate excess returns for every ounce of risk taken compared to their respective benchmark indices. The excess returns indicate a fund manager's ability to actively assess the market promptly and be aware of the risk horizons. Additionally, the ***ETFs*** recorded lower downside risk, making them resilient to dynamic market conditions, as they recover sooner from the troughs than their benchmark. The higher liquidity throughout the study period confirms the magnitude of recovering from downfall quicker. The lower volatility suggests stable deviations between the silver ***ETFs***, indicating that investors can predict expected outcomes from their investment objectives rather than speculate.

Silver ***ETFs*** are versatile according to the short-run performance results and can benefit novice or retail investors to invest in predictable investment vehicles rather than riskier ones. Subsequently, seasoned investors can implement the buy-and-hold strategy considering the imperial effect of the two-in-one durability of the stock and mutual fund under the same ecosystem. Also, it suits investors at all levels, as ***ETFs*** primarily focus on the mechanism of replicating the index.

In terms of academic literature, this paper tries to rule out the initial informational inefficiency that gold ***ETFs*** faced in India. With the limited literature about commodities ***ETFs*** in India, especially in the precious metals arena, studies from emerging countries must equate their contributions towards underrated investment vehicles like ***ETFs***. It would be interesting to explore the relationship of silver ***ETFs*** with silver futures and comparative analysis with gold ***ETFs***. However, extending the silver ***ETFs*** in the concerns of volatility forecasting using advanced heterogeneous autoregressive and stochastic models is essential.

References

1. Prakash, P., and S. Sundararajan. "An empirical analysis on the relationship between gold and silver with special reference to the national level commodity exchanges, India." *International journal on recent and innovation trends in computing and communication* 2, no. 8 (2014): 2224-2233.
2. Saishree, Ipsita, and Puja Padhi. "Financialization of Commodity Market in India: Implications for Intragroup Investing." In *Studies in International Economics and Finance: Essays in Honour of Prof. Bandi Kamaiah*, pp. 571-597. Singapore: Springer Singapore, 2022.
3. Corbet, Shaen, and Cian Twomey. "Have Exchange Traded Funds influenced commodity market volatility?." *International Journal of Economics and Financial Issues* 4, no. 2 (2014): 323-335.
4. Kaur, Prabhdeep, and Jaspal Singh. "Price formation in Indian gold market: analysing the role of gold Exchange Traded Funds (ETFs) against spot and futures markets." *IIMB Management Review* 32, no. 1 (2020): 59-74.
5. Verma, Rajit, and Dinky Dhiman. "A causal study on gold, SENSEX, and gold exchange traded funds." *Gold Bulletin* 53, no. 2 (2020): 121-128.
6. Eswara, Madhavi. "An empirical study on performance of gold ETFs in India-post crash period." *Research journal of finance and accounting* 6, no. 13 (2015): 75-83.
7. Sethi, Aakanksha, and Vanita Tripathi. "Excess volatility and costly arbitrage in exchange traded funds (ETFs): Evidence from India." *Global Business Review* 23, no. 2 (2022): 334-353.
8. Gaba, Ashima, and Ravinder Kumar. "Reaction of Indian Gold Exchange Traded Funds to Covid-19 Cases and Fatalities." *International Research Journal of Business Studies* 14, no. 3 (2021).
9. Hillier, David, Paul Draper, and Robert Faff. "Do precious metals shine? An investment perspective." *Financial analysts journal* 62, no. 2 (2006): 98-106.
10. Daskalaki, Charoula, and George Skiadopoulos. "Should investors include commodities in their portfolios after all? New evidence." *Journal of Banking & Finance* 35, no. 10 (2011): 2606-2626.
11. Garg, Sandeep. "Impact OF COVID-19 on performance of gold ETFs in India." *International Journal of Research in Commerce and Management Studies* 4, no. 5 (2022): 01-09.
12. Lau, Marco Chi Keung, Samuel A. Vigne, Shixuan Wang, and Larisa Yarovaya. "Return spillovers between white precious metal ETFs: The role of oil, gold, and global equity." *International Review of Financial Analysis* 52 (2017): 316-332.

13. Hu, Wenbin. "Volatility Forecasting of China Silver Futures: the Contributions of Chinese Investor Sentiment and CBOE Gold and Silver ETF Volatility Indices." In *E3S Web of Conferences*, vol. 253, p. 02023. EDP Sciences, 2021.
14. Ivanov, Stoyu I. "High-frequency analysis of exchange traded funds' pricing deviation." *Managerial Finance* 39, no. 5 (2013): 509-524.
15. Guo, Kevin, and Tim Leung. *Understanding the tracking errors of commodity leveraged ETFs*. Springer New York, 2015.
16. Chen, Jilong, Liao Xu, and Yang Zhao. "Do ETF flows increase market efficiency? Evidence from China." *Accounting & Finance* 60, no. 5 (2020): 4795-4819.
17. Naeem, Muhammad Abubakr, Sitara Karim, Larisa Yarovaya, and Brian M. Lucey. "COVID-induced sentiment and the intraday volatility spillovers between energy and other ETFs." *Energy Economics* 122 (2023): 106677.
18. Dickey, David A., and Wayne A. Fuller. "Distribution of the estimators for autoregressive time series with a unit root." *Journal of the American statistical association* 74, no. 366a (1979): 427-431.
19. Stankevičienė, Jelena, and Ieva Petronienė. "Bond mutual funds vs. bond exchange traded funds: Evaluation of risk adjusted performance." *Administrative Sciences* 9, no. 2 (2019): 31.
20. Sanderson, Rohnn, and Nancy L. Lumpkin-Sowers. "Buy and hold in the new age of stock market volatility: A story about ETFs." *International Journal of Financial Studies* 6, no. 3 (2018): 79.
21. Bae, Kyounghun, and Daejin Kim. "Liquidity risk and exchange-traded fund returns, variances, and tracking errors." *Journal of Financial Economics* 138, no. 1 (2020): 222-253.
22. Czauderna, Katrin, Christoph Riedel, and Niklas Wagner. "Liquidity and conditional market returns: Evidence from German exchange traded funds." *Economic Modelling* 51 (2015): 454-459.
23. Fiess, Norbert M., and Ronald MacDonald. "Towards the fundamentals of technical analysis: analysing the information content of high, low and close prices." *Economic Modelling* 19, no. 3 (2002): 353-374.
24. Korkusuz, Burak, Dimos Kambouroudis, and David G. McMillan. "Do extreme range estimators improve realized volatility forecasts? Evidence from G7 Stock Markets." *Finance Research Letters* (2023): 103992.