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Examine Segment-Specific Weak-Form Efficiency in India: Empirical Evidence from Equity and Commodity Indices

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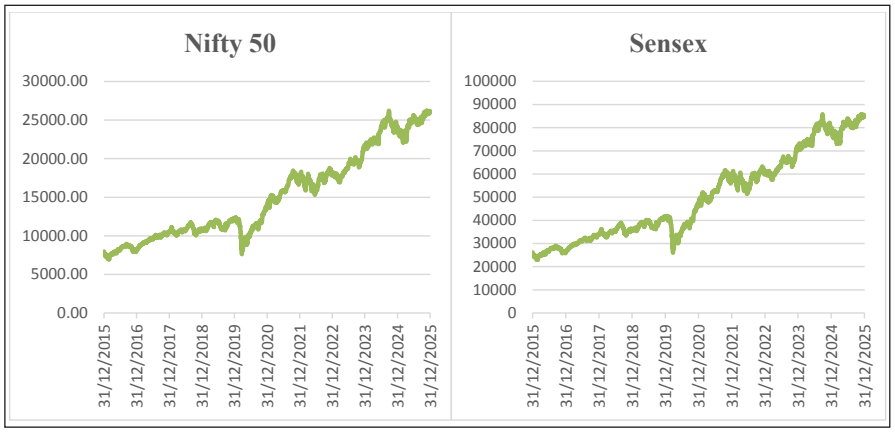
Abstract: This study examined weak-form market efficiency in the Indian equity market across various segments from January 2021 to December 2025 using Runs and Autocorrelation tests. The analysis has employed daily returns of Nifty 50, Sensex, Nifty Smallcap 250, BSE Smallcap, Nifty Commodities and BSE Commodities indices to offer broader perspective across market segments. Stationarity property of all series has found at levels i.e., I(0) using ADF and PP tests. Runs test results exhibited statistically significant Z-statistic of all series. Thus, it implies dependence in returns sequence. Furthermore, Autocorrelation results revealed that returns of large-cap and commodities indices have followed randomness, consistent with weak-form efficiency. However, small-cap indices have exhibited significant autocorrelation, indicating market inefficiencies and short-term returns predictability. Therefore, these divergence highlights market disparities across segments, with small-cap stocks being more prone to informational asymmetry and speculative tendencies.

Keywords: Autocorrelation, Financial market, Investors behaviour, Runs test, Weak-form efficiency.

I. Introduction

Indian equity market has undergone tremendous transformation driven by comprehensive regulatory and structural reforms over the past few decades. These reforms have aimed at strengthening investor protection and enhancing the efficiency of market operations. Furthermore, greater access for foreign investors have contributed to substantial growth in market volume and liquidity. Hence, it is perceived as a key indicator of the Indian economy.

The overall performance of the market is reflected through movements in key indices. In this regards, Nifty 50 increased from 7,946.35 in Dec, 2015 to 26,129.60 in Dec, 2025, while the Sensex increased from 26,117.54 to 85,220.60 during same period, reflecting growth of about 229 percent and 226 percent, respectively. Thus, financial markets are perceived as a captivating way to earn substantial returns. However,



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possibility of consistently earning abnormal returns is inherently associated with market efficiency. In an efficient market, asset prices have fully reflected available information, making the search for mispriced securities ineffective and shifting investor toward managing portfolio risk and return [1], [2]. Conversely, in inefficient markets, finding mispriced assets has elevated portfolio performance. Hence, market efficiency has performed a crucial role in shaping investment strategies. However, empirical evidence over the years has been far from unanimous. While several studies supported market efficiency while many others reported inefficiency, particularly in emerging markets and during crisis periods [3]–[6].

Against this backdrop, this study is undertaken to examine weak-form efficiency considering key Indian indices from January 2021 to December 2025. Thus, it aims to address the existing empirical gap by analyzing various NSE and BSE market cap-based indices alongwith commodity indices. Hence, it offers comparative insights into market dynamics across segments. Using daily return data and a comprehensive suite of statistical tests, the study assesses whether price movements adhered to a random pattern or diverged from the expectations of the EMH.

II. Literature Review

Market efficiency, pioneered by E. F. Fama [1], argued that security prices fully incorporate all available historical information. This idea laid the foundation for the Efficient Market Hypothesis (EMH). Since then, EMH has been an extensively debated aspect in financial economics. Previous studies suggested that information asymmetries and investors behaviour constrains EMH [2], [7], [8]. Lo and MacKinlay [4] found prices don't follow random walk, implying market inefficiency. They further suggested that inefficiency primally driven by small-cap companies rather than irregular trading and volatility. Similarly, Kung and Wong [9], Borges [10] and Lim and Brooks [5] observed that prices follow serial dependence and calendar affects, thus rejecting EMH. Pant and Bishnoi [11] rejected the hypothesis of randomness in price, reflecting market inefficiency. Thus, investors can earn excess return if they study past patterns. Sarma [12], Hiremath and Bandi [13], Thomas and Kumar [14] and Saji and Harikumar [15] further observed predictable returns pattern in Indian market, contradicting EMH. Sharma and Kennedy [16] examined randomness in stock indices of BSE (India), NYSE (US) and LSE (England) during 1963-73. Their findings supported random movement, implying market efficiency. Similarly, Gupta [17] tested market efficiency using five indices from BSE during 1979-87. The study supported hypothesis, reflecting weak form efficiency. Sharma [18], Barnes [2], Claessens *et al.* [19], Poshakwale [20], Kalsie [21] further reported randomness in security prices, indicating market efficiency.

A recent study by Jain *et al.* [22] examined market efficiency in India from April 2010 to March 2019. They exhibited that prices are not random, implying inefficiency in market. Similarly, Patel *et al.* [23] revealed that market follow predictable returns pattern using daily prices from April 2015 to March 2018. Sarkar [24] found predictable returns pattern in market. Thus, it indicates prices don't fully and rapidly reflect information, thereby contracting EMH. Elangovan *et al.* [6] analysing 21 BSE indices during 2011-20, found that market deviates from random walk.

Therefore, the findings are mixed and inconclusive. Thus, this study is undertaken to address market efficiency by considering key commodities and market-cap based indices in India.

III. Methodology of the Study

A. Selection of Variables and Period

This study is based on secondary data comprising daily closing prices from January 2021 to December 2025. To examine market efficiency across market cap-based indices in India, the Nifty 50, Sensex, Nifty Smallcap 250 and BSE Smallcap indices have been chosen. The Nifty 50 and Sensex have been chosen as they track major large-cap stocks and serve as key market benchmarks, representing highly traded and financially robust companies. The inclusion of Nifty Smallcap 250 and BSE Smallcap indices enables the analysis to encompass small-cap segment, reflecting diverse set of emerging and relatively higher volatile firms. To provide a commodity sector perspective, the study incorporates key commodity benchmarks, namely Nifty Commodities and BSE Commodities indices. These indices are representing a broad range of commodity-related firms and reflect sectoral movements.

Therefore, these indices facilitate a comprehensive both large-cap and small-cap segments of the Indian equity market.

Further, the daily returns for each index are calculated as follows:

$$r_t = Ln\left(\frac{Price_t}{Price_{t-1}}\right)$$

Where, $Price_t$ = closing price of respective index at time t. $Price_{t-1}$ = closing price of respective index at time t-1. Ln = Natural logarithm.

B. Data Sources

The data on selected indices have been collected from websites of BSE and NSE.

C. Tools for the Study

Several statistical tools have been used for analysing the dataset. Initially, descriptive statistics have been calculated to show basic characteristics of variables in dataset. Since the analysis is based on time series data, unit root tests have been applied through Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods to check stationarity. Thereafter, Runs and

Autocorrelation tests have been employed to test random walk hypothesis and efficiency.

The Runs test is a non-parametric method that checks whether the sequence of price changes is random rather than their magnitude. The test statistics to check randomness is expressed as:

$$Z = \frac{R - E(R)}{\sigma_R}$$

Where,

R = Observed no. of runs.

$E(R)$ = Expected no. of runs.

σ_R = Standard deviation of no. of runs.

The values of $E(R)$ and σ_R are computed as follows:

$$E(R) = \frac{2n_1n_2}{n_1 + n_2} + 1$$

And,

$$\sigma_R = \sqrt{\frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1 + n_2)^2(n_1 + n_2 - 1)}}$$

Where,

n_1 = Number of observations above the median.

n_2 = Number of observations below the median.

R = Total number of runs observed in the series.

In contrast, the autocorrelation test is used to measure the linear relationship between current returns and their lagged values to detect any predictable patterns. It is calculated as follows:

$$P_k = \frac{\sum_{t=k+1}^{T}(X_t - \bar{X})(X_{t-k} - \bar{X})}{\sum_{t=1}^{T}(X_t - \bar{X})^2}, \qquad [k = 1,2, \dots, m]$$

Where,

X_t = Value of the series at time t.

$\bar{X}$ = Mean of the series.

T = Total number of observations.

k = Lag order.

m = Maximum lag considered.

IV. Results and Discussion

The key results are discussed here, along with their relevance to understanding efficiency in Indian equity market:

From Table I, the descriptive statistics show that the mean and median values of all return series have been very close to zero, indicating that the returns have been well-centered around zero and consistent with typical financial return behaviour. The wide range between maximum and minimum values reflects substantial volatility in all series. Furthermore, all series have been negatively skewed, implying longer left tails. Kurtosis values have been substantially greater than three, reflecting presence of highly leptokurtic in all series. Moreover, Jarque–Bera statistics have been statistically significant for all variables, leading to the rejection of the null hypothesis of normality. This indicates that that none of the return series follows normal distribution.

From Table II, all variables have been observed statistically significant ADF and PP test statistics at the 1% level under both intercept and trend specifications, indicating stationarity at levels i.e., I(0). Thus, all series have been suitable for subsequent analysis.

Table III presents Runs test results. The Z-statistics for all series have been statistically significant, thereby rejecting the null hypothesis of randomness. Hence, this reflect non-random behaviour, implying that sequence of past price changes may influence future returns sequence.

From Table IV, the autocorrelation results have revealed distinct patterns across market segments. For large-cap indices i.e., Sensex and Nifty 50, autocorrelations have been statistically insignificant across lags. Thus, it indicates market efficiency and randomness. In contrast, small-cap indices, including BSE Smallcap and Nifty Smallcap, have been exhibiting statistically significant autocorrelations across lags. Hence, it highlights short-term predictability in small-cap indices. Commodity indices, namely BSE Commodity and Nifty Commodity, have been showing insignificant autocorrelations across all lags. Thus, it reflects return patterns broadly consistent with random behavior and market efficiency. Therefore, these results indicate that large-cap and commodity segments indices conformed to weak-form efficiency, whereas small-cap indices followed predictable return patterns that indicates weak-form inefficiency.

V. Conclusion

This study examined weak-form efficiency across key Indian indices from January 2021 to December 2025. The study employed daily closing prices of key Indian indices, including Nifty 50, Sensex, Nifty Smallcap 250, BSE Smallcap, Nifty Commodities, and BSE Commodities. Thus, it provided valuable insight across large-cap, small-cap, and commodity segments, thereby offering a broad perspective on informational efficiency within the Indian market. Descriptive statistics have been exhibited negatively skewed, leptokurtosis and deviations from normality across all series. Furthermore, using Runs test, Z-Statistic have been found statistically significant for all series.

Thus, it indicates that past price movements affect subsequent returns pattern. In contrast, Autocorrelation test have been revealed that large-cap and commodity indices exhibited random behaviour, consistent with weak-form efficiency. However, small-cap indices shown non-randomness and short-term return predictability, indicate market inefficiency. This deviation reflects market disparities across segments, with small-cap stocks being more prone to informational asymmetry and speculative tendencies. Therefore, these findings underscore necessity for investors to adopt segment-specific investment strategies and robust risk management practices.

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Appendix

Table I: Results of Descriptive Statistics

Statistic	Sensex	Nifty 50	BSE Smallcap	Nifty Smallcap 250	BSE Commodities	Nifty Commodities
Mean	0.000466	0.000503	0.000837	0.000806	0.000681	0.000737
Median	0.000490	0.000550	0.002569	0.002710	0.001537	0.001472
Maximum	0.048802	0.046333	0.040909	0.041725	0.043811	0.052446
Minimum	−0.059119	−0.061124	−0.070290	−0.077385	−0.087822	−0.112140
Standard Deviation	0.008836	0.008807	0.011344	0.011593	0.012382	0.011940
Skewness	−0.351206	−0.434588	−1.156177	−1.205272	−0.813901	−1.093530
Kurtosis	7.154307	7.371573	7.041694	7.384710	6.771856	10.818630
Jarque–Bera	916.4290	1025.588	1119.347	1292.504	871.2562	3402.824
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Source: Authors' Computation.

Table II: Results of Unit Root Test

Returns	ADF Test (t-Statistic)		PP Test (Adjusted t-Statistic)		Order of Integration
	Intercept (No Trend)	Intercept with Trend	Intercept (No Trend)	Intercept with Trend	
Sensex	−34.68686*	−34.67500*	−34.68917*	−34.67697*	I(0)
Nifty 50	−34.73720*	−34.72556*	−34.74160*	−34.72963*	I(0)
BSE Smallcap	−30.84297*	−30.86416*	−30.82261*	−30.83869*	I(0)
Nifty Smallcap	−31.32005*	−31.33751*	−31.33310*	−31.35648*	I(0)
BSE Commodities	−33.87841*	−33.88774*	−33.86542*	−33.86876*	I(0)
NSE Commodities	−35.27366*	−35.27622*	−35.29787*	−35.31445*	I(0)

Notes: * Significant at 1% level; I(0): Stationary at level.

Source: Authors' Computation.

Table III: Results of Runs Test

Returns	Test Value (Median)	Cases < Test Value	Cases ≥ Test Value	Total Cases	Number of Runs	Z-Statistic	Asymp. Sig. (2-Tailed)
Sensex	0.000490	619	620	1239	573	−2.700*	0.007
Nifty 50	0.000550	619	620	1239	567	−3.041*	0.002
BSE Smallcap	0.002569	619	620	1239	539	−4.633*	0.000
Nifty Smallcap	0.002710	619	620	1239	543	−4.405*	0.000
BSE Commodities	0.001537	619	620	1239	581	−2.245*	0.025
NSE Commodities	0.001472	619	620	1239	585	−2.018**	0.044

Notes: * and ** indicate significance at 1% and 5% level, respectively.

Source: Authors' Computation.

TABLE IV: RESULTS OF AUTOCORRELATION TEST

Returns	Lags →	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9	Lag 10
Sensex	AC	0.013	−0.028	−0.043	0.037	−0.001	−0.018	−0.027	−0.030	−0.001	−0.045
	Prob.	0.635	0.541	0.314	0.261	0.384	0.459	0.468	0.460	0.561	0.419
Nifty 50	AC	0.012	−0.026	−0.045	0.035	−0.001	−0.019	−0.028	−0.028	−0.006	−0.040
	Prob.	0.671	0.608	0.317	0.280	0.407	0.480	0.483	0.489	0.586	0.485
BSE Smallcap	AC	0.130*	0.017*	0.000*	−0.018*	0.004*	−0.024*	−0.074*	−0.053*	−0.020*	0.032*
	Prob.	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000
Nifty Smallcap	AC	0.115*	0.018*	0.012*	−0.008*	0.013*	−0.038*	−0.068*	−0.039*	−0.022*	0.033*
	Prob.	0.000	0.000	0.001	0.002	0.004	0.004	0.001	0.001	0.001	0.001
BSE Commodities	AC	0.039	0.002	−0.019	0.017	−0.014	−0.023	−0.037	−0.007	−0.018	−0.016
	Prob.	0.172	0.393	0.506	0.612	0.708	0.730	0.620	0.716	0.759	0.804
NSE Commodities	AC	−0.003	−0.003	−0.030	0.030	−0.009	−0.039	−0.038	0.006	−0.016	−0.004
	Prob.	0.926	0.989	0.760	0.689	0.797	0.645	0.538	0.641	0.702	0.781

Note- * Significant at 1% level.

Source: Author's Computation.