

Measuring Efficiency of the Indian Asset Market with Tick Data and Hurst Exponent

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ABSTRACT

This paper explores the long-range memory dependency in the Indian asset market. The data for 1-minute, 15-minute, and 60-minute closing prices of the Nifty 50 index have been used for the year 2025. The Rescaled Range Analysis of the Hurst Exponent have been employed. The analysis reveals the presence of a wacky behaviour in the Indian asset market. The study found that the Indian market is informationally efficient in the study period.

Keywords: Tick data, Hurst Exponent, EHM

1. INTRODUCTION

It is now an accepted fact that the stock market index reflects the state of the economy and helps in allocating resources judiciously. The efficient asset market reacts to any changes in economic policy, industrial policy, big or minor geopolitical or even small economic crises. Thanks to the mammoth advancements in information technology and its widespread use in all spheres of market operations, made the financial markets more competitive and helped to discover prices well. Furthermore, these attributes are commonly found and applicable in an informationally efficient market, where random behaviour of markets makes short-term or long-term prediction impossible and prevents the market from being a poaching ground.

Studies based on very high-frequency data to measure the efficiency of the markets are rare in the literature. Most of the scholars have used either weekly or daily data. By definition, an efficient market means each and every information must be absorbed and reflected without any time gap. Hence, the popular belief is that scholars should study the issue with the help of very high-frequency data. Recently, they (Arora & Singh, 2017) used the ARCH and GARCH method on very high frequency data (5 min closing price of Nifty 50 index and top 10 traded stocks in

NSE) and derived that the market inefficiency. Researchers (Parthasarathy, 2013; Khan & G, 2022; Pernagallo, 2025) have estimated the Hurst exponent to trace the presence of long-term memory in daily returns. They concluded that the Indian and the USA markets are informationally inefficient, as the value of the Hurst exponent exceeds the cut-off level. In contrast, few researchers (Mallesha & Archana, 2024) have found that the Indian market follows an unpredictable trend, as the slope of H is exactly 0.5, that is, on the cut-off point over the period 2012 to 2023. Therefore, in the context of India and the USA, we find contradictory conclusions compared to the hypothetical relationship based on the principles of investment theory. Difficulties are found more to formulate any proper policy that may guide the policy planners to shape and function the market orderly. The main focus of this paper is to measure the efficiency of the Indian market by the tick data and the Hurst Exponent to find the position of long-range memory in the Nifty 50 index, in the year 2025. Few politico- economic events have occurred in India during this year. Moreover, unlike earlier studies, in this paper, we have used data of the frequency of 1-minute, 15-minute and 60-minute closing prices of the Nifty 50 index, with the hope that, as the stock market is very sensitive to any kind of information, and analysing based on these data may throw some more light on this issue. This paper is organised as follows: Section 2 presents a brief literature review in this context over the recent years and research gaps. Section 3 deals with the data and methodology. Sections 4 and 5 present the output of the statistical tests and the conclusion of the study, respectively.

2. LITERATURE REVIEW

The efficient market hypothesis is a cornerstone of modern finance, and its foundation was earlier set up by Bachelier in the year 1900 and then popularised by E. Fama in 1970. The theory suggests that all the information reflects on the asset price at the time of the occurrence of any event or information, following Brownian motion. The random price movement makes future price prediction impossible and restricts continuous abnormal earnings. On the other hand, Mandelbrot and Ness proposed a new approach in the year 1968, where asset prices follow a similar pattern across different time horizons, following Fractional Brownian motion. Such contradictory opinion about the behaviour of the financial market makes it an attractive area of research. Therefore, a large number of studies are available which attempted to track the movement of asset prices to examine whether it is informationally efficient or not. Various statistical as well as econometrics methods have been employed to reach conclusive findings, but have been unable to settle the dust. In this section, we have only presented some recent literature where the Hurst

exponent is used to trace the absence of self-similarity patterns in the asset price series, informational efficiency, especially in India and the US stock market.

Caporale et al. (2024) have examined the EuroStoxx 50 futures prices of different frequency data (every tenth of a second or more frequently, daily and monthly closing prices) to trace the long-range memory over the period of 2002-2018. Rescaled Range have used to estimate the Hurst exponent, showing that the monthly data follows highly persistent and anti-persistent behaviour in intra-day data, but no presence of long memory in daily data, confirming the presence of random movement. Aguila et al. (2022) have introduced a new procedure to improve the Hurst exponent estimation based on equality in distribution that provides higher accuracy compared to original approaches. The new approaches are called KS-GSE (1), KS-TA and KS-FD4. They have selected stocks of the S&P 500 index and run the KS-TA method on log price series using Python software and concluded that most of the prices of stocks are self-similar in nature (except CHD, CCL & EQIX). Villena & Araneda (2024) have collected the daily closing price of the S&P 500 index and indices of different sectors (Energy, Materials, Industrials, Consumer Discretionary, Consumer Staples, Healthcare, Financials, Information Technology, Telecommunication Services, Utilities, and Real State). Their study period ranges from 9th October 2002 to 13th July, 2022. The Hurst value is computed using a Multifractional Brownian approach, which reflects that the level of market efficiency varies sector to sector but decreases sharply during the crisis period.

Parthasarathy (2013) has tested the Hurst exponent on seven indices of the Indian stock market. The value of H using Rescaled Range Analysis of selected indices lies between 0.58 and 0.6, exhibiting the presence of long memory. No sign of continuous improvement is noticed in the 5-year rolling Hurst exponent over the period from 1990 to 2010. Hiremath & Naraya (2016) have concluded that market efficiency is time-varying in nature. The value of the Hurst exponent using the Generalized Hurst Exponent confirms the presence of trending behaviour in India stock market. The same method has been applied for a 500-day rolling and fixed window over the period of 23 years (January 1991 to December 2013) have evidenced that the level of market efficiency increases at the time of crisis and an improvement is also perceived after the post-global crisis period. Khan & G (2022) have used Multifractal Detrended Fluctuation Analysis on daily log return series of BSE 100 index from 1st January 2011 to 3rd December, 2021. The value of H is found more than the cut-off level (0.5) for most of the years, and concluded that shock-based herding behaviour appears during the crisis period. A trending behaviour is observed over the years in the Indian stock market (Kumar & 18

Maheswaran, 2013; Bala & Gupta, 2018; Bala & Gupta, 2020; Nargunam & Lahiri, 2022). A strong presence of persistence behaviour is evidenced in the medium- and small-sized indices, but a weaker trend in large-cap indices (Hiremath & Kumari, 2015). On the other hand, Hasan and Ghosh (2024) have investigated the presence of mean-reverting behaviour in the Indian stock market. Daily data of BSE 200 and Nifty 200 indices have been collected over the period of 20 years (1st January 2004 to 31st January 2024). They have estimated the Hurst exponent value using Rescaled Range Analysis and Wavelet Analysis. The H value is below the 0.3 level in both analyses, indicating a tendency towards anti-persistence behaviour. They have measured the speed of return to the long-term mean values using the Ornstein-Uhlenbeck process and claimed that it takes more than 50 days to revert to the mean values.

The studies show that most of the work is done for the developed economies. The studies are very scanty for emerging economies, especially for India, using high-frequency data. This has motivated us to dive into this area.

3. DATA AND METHODOLOGY

We have selected very high-frequency data (1-minute, 15-minute and 60-minute closing prices) of the Nifty 50 index, a pivotal index of the Indian stock market. Closing price of different time frames of the Nifty 50 index has been collected from yahoofinance.com websites. The study period ranges from 1st January, 2025 to 31st December, 2025. Various historical global as well as national incidents took place during this period. Some of these prominent national and international incidents are- (i) announcement to impose reciprocal tariff by the US Government on India on 2nd April 2025, (ii) a tragic terror attack in India on 22nd April 2025, and the measures taken by the country, (iii) India-UK Free Trade Agreement signed on 24th July, 2025, (iv) India-EFTA Trade and Economic Partnership Agreement came into force on October 1, 2025, (v) record breaking surge in gold and silver price over this year etc. As the stock market is very sensitive to any kind of information, we hope that analysing with very high-frequency data may help us to interpret and conclude better. Hurst Exponent using Rescaled Range Analysis (Hurst, 1951; Parthasarathy, 2013) quantifies the presence of self-similarity better. The value of the Hurst exponent ranges from 0 to 1. It identifies whether data series follow a mean-reverting or “Ping-Pong” phase ($H < 0.5$), a random walk or “Coin Toss” ($H = 0.5$), or trending/persistent behaviour or “Follow the Leader” phase ($H > 0.5$).

4. FINDINGS

TABLE 1 represents the value of the Hurst exponent of the Nifty 50 index for different time frames. The values for the Hurst exponent of the 1-minute, 15-minute and 60-minute log return series are 0.528, 0.547 and 0.551 respectively. A gradual change in the value of the H component, towards a pure random walk movement ($H=0.5$), with the increment of the level of data frequency, evidences the absence of long-range memory and ensures the presence of information efficiency. A nominal trending behaviour is observed with the increment of the time horizon. It proves an imperceptible presence of long-range memory, which is mostly inseparable from random walk behaviour over the study period. Therefore, it can be concluded that predicting future prices is nearly difficult, as the market return does not follow exactly, but roughly a random pattern.

TABLE 1: Hurst Exponent of Nifty 50 for the year 2025

Year	1 Min Data	15 Min Data	60 Min Data
2025	0.528	0.547	0.551

5. CONCLUSION

The study mainly focuses on uncovering a clear picture of the informational efficiency of the Indian market by using very high-frequency data rather than slow-moving data, such as weekly or monthly. The study period ranges from 1st January to 31st December, 2025. The findings of the Hurst Exponent evidence the wacky behaviour in market efficiency over different time horizons. Therefore, it is expected to be very difficult for the intraday traders to forecast the future price when the market follows such a wacky behaviour. Policy-makers, analysts, investors, academicians and scholars may get some valuable insights about the dynamics of the market movement over different time horizons, which will help to them to gauge the market movement and take informed decisions accordingly.

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