



Full length article

# Sentiment and stock market volatility revisited: A time–frequency domain approach

Debasish Maitra<sup>\*</sup>, Saumya Ranjan Dash

Department of Accounting and Finance, Indian Institute of Management Indore (IIM Indore), Indore, Madhya Pradesh-453556, India



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## ABSTRACT

The cause and consequences of stock market volatility are considered to be a legitimate concern for market participants, regulators and policy makers. This article examines the relationship between investor sentiment and stock return volatility in the context of Indian stock market. Our empirical analysis for examining the sentiment and volatility relationship focuses on wavelet approach to carry out the time–frequency domain analysis. The results reveal that there is weak conditional correlation between sentiment and volatility. Investor sentiment is found to affect both conditional and realized volatility in the short as well as medium run. Results also show that small size stocks are more prone to the impact of sentiment. Significant co-movement between sentiments and return is noted during different volatile periods (pre-crisis, crisis and post-crisis) at different frequencies.

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## 1. Introduction

The cause and consequences of stock market volatility considered to be a legitimate concern for market participants, regulators and policy makers. An excessively volatile stock market is detrimental to the smooth functioning of capital markets. Stock market volatility raises the required compensation for bearing systematic risk and thereby, pushes up the cost of capital which in turn prevents the efficient allocation of savings, obstructs productive investment, and lowers economic output (Arestis et al., 2001; Guo, 2002; Schwert, 1989; Zulu, 1995). Moreover, the persistence of stock market volatility may have indirect effects on the real economy by affecting consumer confidence, and investment decision (Boone et al., 1998; Ludvigson and Steindel, 1998; Poterba, 2000). The volatility of stock market returns also shows a lot of variability through time. Why stock return volatility is higher at times than others is one of the pertinent questions in academic literature. Existing literature argues that the time varying nature of stock market volatility can be attributed to the macroeconomic or business cycle fluctuation (Schwert, 1989), financial leverage (Black, 1976), changes in expected returns (French et al., 1987), trading activity (French and Roll, 1986), and noise or sentiment induced trading behavior of market participants (Brown,

1999; Shleifer and Summers, 1990; Wang et al., 2006). The present paper attempts to revisit the sentiment and stock market volatility argument using a time–frequency domain approach.

The global financial crisis of 2007–2008 has reinforced the scholarly debate over the possible impact of investor sentiment on stock market volatility. Early research on this issue argued that the unprecedented market movement during boom–bust cycles of the market cannot be only attributed to the fundamental factors (Olsen, 1998; Shiller, 1981). Notably, the stock market crises have led several prominent financial economists to distance themselves from the traditional finance theory (Zouaoui et al., 2011). Until recently, behavioral finance literature contends that financial market at times cannot be completely efficient due to the influence of cognitive biases of investors (Baker and J.R., 2002), uninformed demand shock by noise traders (DeLong et al., 1990), presence of short-sale constraint (Miller, 1977), and limited arbitrage opportunity (Shleifer and Vishny, 1997). In other words, the departure of investor behavior from complete rationality due to cognitive biases makes their investment decisions susceptible to noise (DeLong et al., 1990) and hence, asset prices tend to diverge away from their fundamental value. As Malkiel (2003) cogently put it, “some market participants are demonstrably less than rational, and the collective judgment of investors will sometimes make mistakes”. Noise traders or irrational investors undermine the positive mean–variance trade-off (Yu and Yuan, 2011) and influence equity prices in equilibrium through price pressure and hold more effect (Lee

<sup>\*</sup> Corresponding author.

E-mail address: [debasishm@iimindr.ac.in](mailto:debasishm@iimindr.ac.in) (D. Maitra).

et al., 2002; Wang et al., 2006). As a consequence, stock prices tend to be overvalued (undervalued) in a bullish (bearish) market (Lee et al., 2002). The persistent mispricing of stocks relative to their intrinsic values results in excessive volatility of stock returns and causes substantial resource misallocation (Daniel et al., 2002; Wang et al., 2006). Persuasive empirical evidence supports the theoretical argument that investor sentiment matters for stock market volatility (see for e.g., Aydogan, 2016; Brown, 1999; Kang et al., 2014; Labidi and Yaakoubi, 2016; Lee et al., 2002; Shu and Chang, 2015; Wang et al., 2006). However, the collective empirical evidence so far is inconclusive. The debate whether investor sentiment is the reason for stock returns volatility, or volatility influences sentiment in the market, is unsettled in the empirical literature. For instance, Lee et al. (2002) in the context of US stock market and Aydogan (2016) for the European market advocate that sentiment is a significant factor in explaining conditional volatility. However, Wang et al. (2006) using US stock market data find that sentiment measures are caused by returns and volatility rather than vice versa. Along similar lines, Spyrou (2012) finds that conditional return volatility is significantly affected by lagged volatility rather than sentiment changes. The possible reasons for such inconclusive evidence are due to the use of different sentiment proxies, sample period, use of test asset indices, different market structure, and empirical approach. Another important factor that limits the generalization of sentiment and stock return volatility relationship is the lack of comprehensive work in the context of emerging markets. Therefore, it is important to revisit the sentiment and volatility relationship debate.

Our motivation of the current study can be categorized into three significant aspects. First, the existing literature that highlights the effects of sentiment on volatility does not examine the importance of duration of such effects. Market participants' trade with different investment horizons hence, this is imperative to know how sentiment affect volatility at different frequencies or for different investment horizons. To capture this, we use the wavelet method (Reboredo and Rivera-Castro, 2014) to decompose the time series data of stock returns and sentiment proxies into various timescales. This approach has economic significance from the behavioral finance perspective. The financial markets are subject to varied expectations of different market participants. Each group of traders perceives the market movement differently based on their investment objectives, risk appetite, and available information. Consequently, the importance of investment horizon or trading frequency changes from one group of traders to the other, making the market expectations very heterogeneous (Harrison and Kreps, 1978; Morris, 1996). As observed by Bernard Baruch (1957) "what is important in market fluctuations are not the events themselves, but the human reactions to those events". The heterogeneity created by traders concerning investment horizon or trading frequencies produces divergent responses to the information shock appeared in the market (Chau et al., 2016; Dacorogna et al., 2001; Tiwari et al., 2013). The segregation of time series data into different high and low frequency using wavelet method enables us to mimic the different investment horizons.

Second, we also use wavelet coherence to test the co-movement between stock return and sentiment through the high and low volatile periods at different frequencies. This confers the advantage of identifying breaks and testing the relationship at different investment horizons across time (Barunik et al., 2016). In a recent study, Chau et al. (2016) suggest that sentiment-driven trading is more pronounced during periods of declining sentiment and bear markets. Moreover, investor sentiment increases the probability of occurrence of stock market crises within a one-year horizon (Zouaoui et al., 2011). Therefore, we focus on the global financial crisis (2007–09) period, during which the observable market volatility was too high Appendix A. In this regard, we

hypothesize that if, volatility of returns is affected by sentiment, then there must be a distinctive pattern regarding sentiment and return relationship at high and low volatile periods. Our empirical analysis also extends to the application of wavelet coherence and wavelet phase angle to measure the co-movements and causality between sentiment and volatility. Wavelet multiscale analysis is particularly useful in the case of financial data, where market shocks can result in localized bursts of intense volatility (Bredin et al., 2015; Kim and In, 2005). The localization properties of the wavelet transformation allow an understanding of the frequency contributions of a time series at any point in time, providing insight into the contribution of distinct frequencies to bounded market shocks (Bredin et al., 2015). The application of wavelet coherence and wavelet phase angle allows us to test whether the sentiment and stock return volatility relationship are stronger during high and low volatile period in the market.

Aguiar-Conraria and Soares (2011) observed that wavelets are adequate to capture structural breaks and transient relations. In addition, wavelets can also distinguish between different relations which are time invariant but frequency variant. Spectral analysis has methodological limitations to detect transient, irregular cycle and structural breaks in the periodicity of those cycles. However, the wavelet methodology employed in this study overcomes this limitation and does not lose any information due to structural breaks in the data (Aguiar-Conraria et al., 2012).

Third, existing literature predominantly focuses on the developed markets, which have arguably very different market microstructure and investor participation characteristics. Emerging-market stocks have long been displaying higher volatility than developed-market equities (Bekaert and Harvey, 2003) and investors behavior in these markets are noticeably different from the developed markets (Kim and Nofsinger, 2008). Evidence from the related literature supports the fact that emerging markets are characterized by high stock price volatility, weak market efficiency, low liquidity, macroeconomic and policy uncertainties (Bekaert and Harvey, 1997; Lim and Brooks, 2011; Lesmond, 2005). It has often been argued that understanding volatility in emerging capital markets is critical for determining the cost of capital and evaluating asset allocation decisions (Bekaert and Harvey, 1997; De Santis, 1997; Edwards et al., 2003). Moreover, sentiment and stock return volatility relationship cannot be generalized based on the findings of developed markets. As highlighted by Schmeling (2009), Zouaoui et al. (2011), Baker et al. (2012), and Aydogan (2016) the magnitude of sentiment effect varies from country to country. Apart from their increasing importance for international portfolio diversification, emerging markets are long being characterized with unique investor participation and market microstructure. In this regard, we consider the Indian stock market as an ideal ground to revisit the sentiment and volatility relationship using time–frequency analysis. Similar to other emerging markets Indian stock market is no exception regarding the high volatility of stock returns. For instance, popular financial press and investment managers observe that "the volatility is here to stay and not going to go away very easily" (Kshitij, 2015), in addition, "when asked why emerging market allocations remain low, wealth managers often respond that volatility is too high" (Emerging Global Advisors, 2014). Consistent with the practitioners' observations, empirical research also asserts the time varying nature of stock market volatility in the Indian stock market (Karmakar, 2005; Sah, 2011) and the pertinent role of investor sentiment for the observable stock market volatility cannot be ruled out completely (Kumar and Padhi, 2016; Kumari and Mahakud, 2015; Suresh and George, 2016). Thus, Indian stock market provides an ideal opportunity to highlight impact of investor sentiment on stock market volatility using data from an emerging stock market. Our focus on a single country allows us to pay attention to market-specific features and

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