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Real or spurious long memory characteristics of volatility: Empirical evidence from an emerging market

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ABSTRACT

We examine whether real or spurious long memory characteristics of volatility are present in stock market data. We empirically distinguish between true and spurious long memory characteristics by analysing different types and measurements of volatility, utilising different sampling frequencies and evaluating different financial markets. Because it is well known that long memory characteristics observed in data can be generated by either non-stationary structural breaks or slow regime-switching models, we additionally assess how the results of the analyses change during crisis periods by considering the effects of the US subprime mortgage crunch. The results support the presence of long memory characteristics that vary for diverse types and measurements of volatility, different financial markets, and distinct sampling periods, such as the pre-crisis and crisis periods. This result suggests that empirical investigations must be particularly careful in addressing long memory issues.

1. Introduction

Long memory issues arise in many different fields, including hydrology, Internet traffic, economics and finance (Ohanissian et al., 2007). The behaviour and volatility of prices have long been greatly important to financial economists. Understanding the dynamics of stock market volatility poses an extremely puzzling challenge. In this paper, we aim to examine this difficult puzzle by investigating whether real or spurious long memory characteristics of volatility are present in emerging stock market data.

The long memory issue is intriguing because of its importance for capital market theories. In particular, the presence of long memory in stock market volatility elucidates the higher-order correlation structure of a financial time series and supports the possibility of predicting the behaviour of these series in a market setting. The analysis of long memory in stock market volatility is important for practitioners, investors, academicians, financial institutions, and policy makers because its presence can have significant implications for risk management, portfolio selection and trading strategies (Kumar, 2012). From the literature, we know that long memory characteristics may differ in contexts involving various types of volatility measurements (such as squared returns, absolute returns, the log of squared returns, realised volatility (RV) and different types of RV), different types of financial markets (such as spot and future markets), and the presence of one or more structural breaks (Ding et al., 1993; Leccadito and Urga, 2009).[1] Thus, we distinguish between true and spurious long memory characteristics by analysing different types of volatility measurements and different types of financial markets. Moreover, we also examine how long memory characteristics vary during crisis periods.

On the whole, this paper aims to make the following contributions to the existing literature by testing for the presence of long memory characteristics of volatility in Turkey. First, this study tests long memory characteristics by considering level shifts; in particular, it uses the recent Modified GPH test developed by Smith (2005) rather than methods such as the Hurst R/S, modified R/S and GPH tests, which have demonstrable shortcomings. Second, this investigation examines volatility measures that are based on low- and high-frequency data to compare the effects of different sampling frequencies and different types of volatility measurements on long memory characteristics. Finally, we test how the long memory characteristics of volatility change during crisis periods by considering the 2007–2009 US subprime mortgage meltdown. The results of this study demonstrate that the existence of long memory characteristics differs according to the types and measurements of volatility, the different sub-samples, and the different financial markets that are examined. This paper is organised as follows: Section 2 provides a literature review; Section 3 explains the data and research methods of the study; Section 4 emphasises the limitations of the research; Section 5 presents the empirical evidence of this

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[1] That various structural break models are able to exhibit long memory characteristics (Diebold and Inoue, 2001; Leccadito and Urga, 2009).

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investigation; and Section 6 consists of the summary and conclusion of the paper.

2. Literature review

Several studies investigate long memory in very different financial markets, such as spot markets (Aydogan and Booth, 1988; Barkoulas and Baum, 1996; Cheung and Lai, 1995; Greene and Fielitz, 1977; Henry, 2002; Lo, 1991), bond markets (Peters, 1989), foreign exchange markets (Cheung, 1993), commodity markets (Barkoulas et al., 1997) and futures markets (Corazza et al., 1997; Fang et al., 1994; Fung and Lo, 1993; Fung et al., 1994; Helms et al., 1984; Shieh, 2006). Additionally, many different studies in the literature investigate the question of how quickly financial markets forget large volatility shocks (Baillie et al., 2007; Disario et al., 2008; Tang and Shieh, 2006). Moreover, there are many different types of long memory tests that are used in the literature. For example, the most widely used tests are the classical rescaled range (R/S) analysis suggested by Hurst (1951), the modified R/S analysis proposed by Lo (1991), and the spectral regression method developed by Geweke and Porter-Hudak (1983) (the GPH method). There is no consensus in the literature with respect to the best method for testing long memory. Although classical R/S analysis is superior to several other analysis techniques because of its robustness in capturing long-range dependence in non-Gaussian distributions in the presence of skewness and kurtosis (Mandelbrot and Wallis, 1969) and its ability to detect non-periodic cycles (Mandelbrot, 1972), it has certain shortcomings, such as its sensitivity to short-term dependence (Lo, 1991). To overcome several of these shortcomings, including the inability of classical R/S to distinguish between short-run and long-run dependence, Lo (1991) proposes a modified R/S analysis method. Teverovsky et al. (1999) show that Lo's modified R/S approach tends to accept the null hypothesis of no long-range dependence, regardless of whether long-range dependence is actually present. Thus, these authors do not suggest using Lo's modified R/S as the only technique to test for long-range dependence but instead recommend using this technique in combination with several other graphical and statistical methods to assess the robustness of long-range dependence.

Another analytical method is the spectral regression approach proposed by Geweke and Porter-Hudak (1983). The semiparametric structure of the GPH method is an advantage of this approach because a semiparametric structure does not require assumptions about the underlying distribution of the data and the eventual short-run dependencies (Sibbertsen, 2004).

We present the shortcomings and advantages of these three analytical methods in Table 1.

Smith (2005) demonstrates that if the GPH method is applied to time series processes that incorporate occasional level shifts, the GPH estimator often inaccurately finds the existence of long memory. Furthermore, Smith (2005) derives an approximation to address this bias. Given the aforementioned shortcomings of the other widely used models and the advantages of the model derived by Smith (2005), we use the modified GPH estimator created by Smith (2005) to test long memory.

Please see Table 2a to c for comparative literature addressing the topic of long memory in financial markets.

Based on Table 2a to c, the existence of long memory characteristics has mostly been supported in previous examinations of stock market data by the classical R/S, modified R/S and GPH analysis methods (Cheung et al., 1993; Greene and Fielitz, 1977; Helms et al., 1984; Nawrocki, 1995; Peters, 1989). However, there is also evidence indicating that no long memory exists in stock markets (Ambrose et al., 1993; Cheung and Lai, 1993; Cheung et al., 1993; Fung and Lo, 1993; Hiemstra and Jones, 1997; Huang and Yang, 1995; Lo, 1991).

There are many studies that test for the presence of long memory characteristics in Turkey in contexts such as stock exchange markets (Kilic, 2004; Korkmaz et al., 2009a; Ozun and Cifter, 2008), futures market returns (Korkmaz et al., 2009b), and *foreign exchange markets* (Turkyilmaz and Ozer, 2007); in addition, one study examined the long memory of volatility in spot markets (Disario et al., 2008).

Kilic (2004) analyses long memory in the Istanbul Stock Exchange (ISE) using the GPH estimator, the local Whittle estimator and the FIGARCH model for the 1988–2003 time period. This analysis indicates that daily returns do not have long memory, but it does demonstrate evidence of long memory in the conditional variance, a conclusion that is consistent with the established literature. Ozun and Cifter (2008) investigate long memory in the ISE by applying both Daubechies wavelet analysis and the OLS estimator based on the GPH test. Although the evidence from the GPH test indicates that stock returns do not have long memory, the fractional integration parameters based on the Daubechies wavelets do provide evidence of long memory in ISE. Korkmaz et al. (2009a) examine long memory in the ISE by testing for structural breaks in variance and utilising the ARFIMA-FIGARCH model. These researchers use the daily closing prices of the ISE for the period between 1988 and 2008. They find no evidence of long memory in return series, but they do detect long memory in volatility series. These results indicate that the ISE is not weak-form efficient. Korkmaz et al. (2009b) test the existence of long memory for the ISE-30 index, the ISE-100 index, and the dollar and euro contracts traded in the Turkish Derivatives Exchange using unit root tests, structural break tests and long memory models; however, these researchers find no evidence of long memory in the Turkish Derivatives Exchange.

3. Data and research methods

We use 5-minute and daily closing prices of the ISE-30 stock market index and ISE-30 stock index futures for the period between February 4, 2005 and April 30, 2010. Because, Turkish Derivatives Exchange was launched on February 4, 2005 and it is necessary to use this date as a starting date of analyses to get comparable results with those of Istanbul Stock Exchange. April 30, 2010 indicates the date of the last available data. The data for the ISE-30 stock market index are obtained from the Central Bank of the Republic of Turkey, and the data for the ISE-30 stock index futures are obtained from the Turkish Derivatives Exchange. We use news based data to identify crisis period. In the literature there are some studies which use the date of 17 July 2007, announcement day of problems related to Bear Stearns hedge funds, as a starting date of the Global Financial Crisis (Dungey, 2009). Following the related literature, we use 17 July 2007 as starting point of crisis period. Therefore, pre-crisis period

Table 1
Comparison of classical R/S, Lo's modified R/S and GPH test.

Method/features	Robustness to short range dependence	Robustness to small sample	Robustness to heteroskedasticity	Robustness to non-Gaussian distributions	Robustness to structural breaks	Robustness to level shifts
Classical R/S	×	×	×	✓	×	×
Lo's Modified R/S	✓	✓	✓	✓	×	×
GPH	✓	✓	✓	✓	×	×

Note: This table is formed by referring from following resources: Lo (1991), Ambrose et al. (1993), Cheung and Lai (1995), Nawrocki (1995), Barkoulas et al. (1997, 1999), Teverovsky et al. (1999), Henry (2002), Sibbertsen (2004), Carles (2005), Di Matteo et al. (2005).