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Long range dependence in the Bitcoin market: A study based on high-frequency data

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HIGHLIGHTS

- This paper examines the long memory property in the Bitcoin data.
- High frequency data at different time scales are used.
- We examine the variation in information perceived by traders at different time scales.
- The long memory property remains quite stable across different time scales.
- The long memory property is the inherent characteristic of the Bitcoin.

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ABSTRACT

Using the high-frequency data of Bitcoin, this paper investigates the long memory characteristics of the unconditional and conditional volatilities of Bitcoin at different time scales using the local Whittle (LW) estimator, the exact local Whittle (ELW) estimator and the ARMA–FIAPARCH model. The results show that the long memory parameter is significant and quite stable for both unconditional and conditional volatility measures across different time scales. This paper also examines the long memory characteristics of the unconditional and conditional "realized" volatilities of Bitcoin at different time scales using the local Whittle (LW) estimator, exact local Whittle (ELW) estimator and the ARFIMA model. Long memory is found to be significant and stable also in case of unconditional and conditional "realized" volatilities. The study also undertakes quarterly non-overlapping rolling window analysis to develop deeper insights into the evolution of long memory parameter, d, over the period. The results indicate high persistence in the Bitcoin market. This study has useful implications for different investors and market participants having varying exposures in the Bitcoin market depending on their trading horizons. The findings can help them in forecasting the expected volatility in the Bitcoin market and thereby in developing and implementing trading strategies.

1. Introduction

Bitcoin, the first peer-to-peer cryptocurrency ever mined, is drawing a considerable attention worldwide from economists, investors and academicians. The genesis of Bitcoin lies in Nakamoto [1] and understanding its working mechanism[1] demands a technical knowledge of algorithms and cryptography [2]. Even some academic studies (see e.g., Garcia,

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1 Understanding the working mechanism of Bitcoin is not the main contribution of this study and therefore such details are not included in the main text. For a detailed discussion on Bitcoin mining, please refer to Bhaskar and Chuen (2015) and Kroll et al. (2013). For a deep understanding of Bitcoin–BlockChain principles and further technical knowledge, please refer to [2].

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Tessone [3]), describe Bitcoin as a mystery to most ordinary people in a way that it is an intangible and difficult to understand currency with limited use in the real economy. However, despite its complex nature, the considerable growth of Bitcoin cannot be ignored. Bouoiyour, Selmi [4] argue that the Bitcoin is the major financial innovation of the recent times. The market capitalization of Bitcoin grew rapidly from $3.3 billion on 16 Feb 2015 [5] to $213.8 billion on 20 Jan 2018 (coinmarketcap.com). Bitcoin, therefore, currently has become a fascinating phenomenon and holds an important place in the financial markets [6], as it also provides investors an opportunity to diversify their portfolios. This popularity of Bitcoin can be attributed to its novel features, transparency, and simplicity [7]; and low cost of foreign exchange [8].

In the midst of recognition of Bitcoin in financial markets and the legal implications it carries, many academic studies emerged to explore its economics and finance. Yermack [9] consider Bitcoin as a speculative investment rather than a currency, as the market capitalization of Bitcoin is very high in comparison to the economic transactions it assists. Kristoufek [10] explores the dynamic relationship between Bitcoin price and the interest of investors in it. Bornholdt and Sneppen [11] investigate the dominance of Bitcoin over alternative cryptocurrencies, and Rogojanu and Badea [12] study Bitcoin vis-à-vis other monetary systems. Fink and Johann [13] provide detailed insights into the market microstructure issues of Bitcoin. Garcia, Tessone [3] investigate the bubble creation with respect to the Bitcoin market. Brandvold, Molnár [14] and Ciaian, Rajcaniova [15] discuss the price discovery process in the Bitcoin market. Bouri, Azzi [16] explore the role of trading volume in understanding Bitcoin return and volatility.[2]

The investors participating in the Bitcoin market can have different trading horizons which can affect the market dynamics both in the short and long run. For a high-frequency investor to gain in the Bitcoin market, the market dynamics at different time scales become even more relevant. In this light, the long memory property of the Bitcoin volatilities in a high-frequency context can be very useful in forecasting the Bitcoin volatility at different time scales. This will in turn aid the high-frequency investors to develop and implement different trading strategies at different time scales, in the Bitcoin market. Therefore, investigating the long-range dependence in the Bitcoin volatilities is very useful especially because of the speculative nature of the market and the implications it draws for a high-frequency investor.

Some recent academic studies have focused on examining the issue of long-range dependence in the Bitcoin market, using the daily Bitcoin price data. Bariviera [17] study the time-varying behavior of long memory of Bitcoin returns and volatility using the Hurst exponent. The author advocates the use of De-Trended Fluctuation Analysis (DFA) to study the presence of long memory in the Bitcoin returns since Rescaled Range (R/S) is found to be biased. The author concludes that the market is informationally efficient (since 2014) and volatility clustering is a key feature of the Bitcoin market. Tiwari, Jana [18] examine the issue of informational efficiency of Bitcoin by deploying a set of computationally efficient long-range dependence estimators. The authors report that Bitcoin is efficient as consistent with the findings of previous three studies. Most recently, Kristoufek [19] use efficiency index based on the combined effects of long-range dependence, fractal dimension and entropy. The author reports inefficiency in the Bitcoin market between 2010 and 2017. The other relevant studies are Urquhart [7] and Nadarajah and Chu [20] Though these studies serve as a basic motivation for the current study, their focus is primarily on the informational efficiency of Bitcoin. Moreover, these empirical studies are conducted using the daily data. The absence of empirical studies in investigating the long-range dependence in high-frequency Bitcoin volatility estimates, at different time scales, is the motive of this paper. The current study focuses on the variation in the long memory property of the Bitcoin volatilities at different time scales.

In addition to the fact that the study is conducted in a high-frequency context, we contribute to the literature in three important aspects: First, we confirm if the stylized facts of the high-frequency data, in general, hold true for the Bitcoin market. In order to build models that can explain the main properties of high-frequency Bitcoin data, we first need to know the stylized facts on the behavior of the time series under consideration. The stylized facts of the high-frequency data include three important aspects, as described in [21]: autocorrelation in returns, heavy tails of returns and the seasonality in volatility. Therefore, we check if the stylized properties of the traditional financial data at higher frequencies can be confirmed for high-frequency Bitcoin data. Second, we expand the empirical studies by examining the stability of the long memory property across different time scales of unconditional and conditional Bitcoin volatilities. Third, we investigate the long memory property in the realized volatility measures, based on different time scale data of Bitcoin.

The purpose of this study is twofold: First, we study the long memory characteristics of the unconditional and conditional Bitcoin volatilities at different time scales. To explore the long memory property in the unconditional volatility, we make use of the local Whittle (LW) and exact local Whittle (ELW) estimators. To explore the long memory property in the conditional volatility, we make use of the ARMA–FIAPARCH model. Second, we explore the long memory characteristics of the unconditional and conditional "realized" volatilities of Bitcoin at different time scales. To investigate the long memory property in the unconditional "realized" volatility, we make use of the local Whittle (LW) and exact local Whittle (ELW) estimators. To investigate the long memory property in the conditional "realized" volatility, we make use of the appropriate ARFIMA model.

The rest of the study is organized as follows. Section 2 presents the methodology and the tests used. Section 3 describes the data used and its stylized facts. In Section 4, we present the empirical results and findings. Finally, Section 5 provides some conclusions of our study.

[2] The list is selective and incomplete.