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The impact of trading volume on the stock market credibility: Bohmian quantum potential approach

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HIGHLIGHTS

- The quantum potentials for the stock markets are extended to multivariable functions.
- Joint quantum potential of price return and trading volume is studied.
- The results show the strong relationship between price return and trading volume.

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ABSTRACT

Price return is an interesting factor for many investors; however, it is expected that the price return to be affected by the trading volume of any given market as a complex system. The Bohmian quantum mechanics is used due to the time correlation of return and volume of the stock markets under consideration. Recent studies have shown that the quantum potential given by the Bohmian quantum mechanics confines price return variations into a definite interval. In this study, we extend the quantum potential concept to investigate the behavior of trading volume and its possible influences on the price return. The obtained results show that the quantum potential behaves in the same manner for trading volume as the price return, and confines the variations of the volume into a specific domain. Furthermore, a joint quantum potential as a function of return and volume is derived by the probability distribution function (PDF) constructed by the real data of a given market. It serves as a suitable instrument to investigate the relationship between these variables and to check the credibility of the market at higher volumes. The resultant PDF and the corresponding joint quantum potential illustrate that the variations of price return at higher volumes decrease as the trading volume increases, making the market more credible which is more pronounced in developed markets.

1. Introduction

Investigating the relationship between trading volume and stock return has attracted the attention of many finance and economics researchers. The available evidence shows that some stock market studies have focused on stock price and its behavior over the time. However, due to the variability and non-stationary behavior of stock price, most researchers mainly focus on stock return, defined as the logarithm of the relative change of price [1,2], rather than stock price or raw price return. When the trading volume of a stock market is concerned, different definitions are proposed by the relevant literature,

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including the number of shares traded [3–5], the number of transactions [6,7], and the turnover ratio [8], etc. In the present work, the amount of traded shares is used as a proxy for trading volume.

In Karpoff's view, there are four reasons for the importance of discussing the relationship between volume and stock return as follows. First, the existing models in the financial markets predict the volume–return relationships of the stocks according to the volume of the inputs into the market, the dissemination of information, the size of the market and the conditions of the transactions. Thus, exploring the relationship between trading volume and stock return may help distinguish and decide between different hypotheses proposed about the market structure. Second, for those studies that use a combination of volume and stock return data, it is important to know how these two are interrelated. Third, volume–return relation is critical to the debate over the empirical distribution of speculative pricing. Finally, the mechanism and modality of the relationship between trading volume and return have important implications for future market studies; where the price changes have a considerable impact on the volume of futures contracts, see [9].

The correlation between trading volume and price return is widely studied and discussed by many authors. For example, Granger and Morgenstern [10] conducting an empirical study and using the data from the New York Stock Exchange found that daily price changes has no relation with trading volume for both in absolute terms. Habib [11] using OLS and GARCH models concluded that there exists no casual relation between volume and return for the Egyptian market. On the other hand, Campbell et al. [1] and Wang [12] have shown that the relation between volume and return is not a simple linear relationship; rather there exists a complex nonlinear relation between them. Podobnik et al. [13] studied the behavior of volume changes and their relationship to price changes using the data recorded for the (S&P 500) index and obtained a power-law cross-correlation between them. Ausloos and Ivanova [14] by generalizing the classical technical analysis and taking into account the trading volume, introduced a mechanistic approach to predict the evolution of the stock markets. Ahmad [15] investigated the relationship between price return and trading volume using the monthly data of Muscat security market from 2009 to 2013. He concluded the existence of a significant interaction between trading volume and returns for this market.

Using sequential arrival information hypothesis, Copeland [16] illustrates the existence of at least a unidirectional causality between these variables, since the information dissemination does not happen contemporaneously among market participants. Unidirectional relationship from volume to return has been acknowledged by Saatcioglu and Starks [17] as well. The existence of bidirectional causality between return and volume is supported by Chen et al. [18] and Chuang et al. [19]

Among the different approaches employed to study the behavior of the financial markets, two have been attractive for some other disciplines as well: Statistical and physical approaches. For instance, the starting point of investigating the price–volume relations dates back to Osborne [20] who modeled the stock price trend using a diffusion process and showed theoretically that the volume could affect the price variance. Mantegna and Stanley [21] obtained new ideas about financial markets' behavior by implementing statistical and physical methods. Chakraborti and his associates [22] and Chen [23] applied the chaos theory to study the dynamics of a financial system. Moreover, Baaquie [24] and Baaquie and his colleagues [25] investigated the basic concepts of economics based on the statistical mechanics, using classical potential and Hamiltonian dynamics.

During the last decades, the correlation between the stock markets and their corresponding variables has increased to be inevitably entangled. This property and the collective behavior of the financial assets have persuaded researchers to use the quantum potential model taken from Bohmian quantum mechanics. Since the pioneering work of Khrennikov [26], many researchers have been engaged in this area. Haven [27,28], for instance, utilized the principles of quantum mechanics to describe the stochastic processes inherent in the financial markets. Similarly, Choustova [29] used Bohmian quantum mechanics as a theoretical framework to develop a model for describing the dynamics of the financial systems.

An empirical study that implemented Bohmian quantum mechanics in financial markets is done by Tahmasebi et al. [30]. They showed that the entanglement between today's and yesterday's prices of stock markets implies the existence of quantum potential which confines the price return changes into a specific domain. Shen and Haven [31] followed the same method by considering both classical and quantum potentials and concluded that, in addition to stock markets, there exist potential walls for commodity markets as well. Likewise, Nasiri and his colleagues [32] used the same technique to study the collective behavior of some targeted emerging and developed markets. Using the empirical data of the market indices, they showed that the quantum potential walls confine the variations of the price return into a definite interval where the distance between the walls can be a proxy for the risk of the respective stock index.

In the present study, as in Nasiri et al. [32], we follow the logic adopted by Tahmasebi et al. [30] and Shen and Haven [31] and use the data extracted from Thomson Reuters Eikon for the stock market indices including Dow Jones Industrial Average (DJIA) index as a developed market and Shanghai Stock Exchange Composite (SSEC) index as an emerging market, from January 2010 to December 2017, to investigate the collective behavior of joint volume and price return.

In Section 2, the methodology of the study is introduced. Then, the results and discussions will be presented in Section 3, and finally, Section 4 presents conclusion and suggestions for possible future studies.

2. Methodology

In this section, we describe how Bohmian quantum mechanics helps us understand the dynamics of stock markets. It seems that modeling a real stock market as a complex system, may not be performed by considering only a single variable of price return. In addition, the existing evidence shows that different factors (such as volume) have their impacts on the