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The trading time risks of stock investment in stock price drop☆

Q2 Jiang-Cheng Li [a,b], Nian-Sheng Tang [a,*], Dong-Cheng Mei [c], Yun-Xian Li [a,b], Wan Zhang [b]

[a] *Department of Statistics, Yunnan University, Kunming 650091, PR China*
[b] *School of Finance, Yunnan University of Finance and Economics, Kunming 650221, PR China*
[c] *Department of Physics, Yunnan University, Kunming 650091, PR China*

HIGHLIGHTS

- We empirically investigate the trading time risk (TTR) of stock investment via escape time in ˆDJI and CSI300.
- A peak distribution for shorter trading days and a two-peak distribution are observed.
- There is the monotonicity (or non-monotonicity) for the stability of the absolute (or relative) TTR.
- The trading day plays an opposite role on the absolute (or relative) TTR and its stability between ˆDJI and CSI300.

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ABSTRACT

This article investigates the trading time risk (TTR) of stock investment in the case of stock price drop of Dow Jones Industrial Average (ˆDJI) and Hushen300 data (CSI300), respectively. The escape time of stock price from the maximum to minimum in a data window length (DWL) is employed to measure the absolute TTR, the ratio of the escape time to data window length is defined as the relative TTR. Empirical probability density functions of the absolute and relative TTRs for the ˆDJI and CSI300 data evidence that (i) whenever the DWL increases, the absolute TTR increases, the relative TTR decreases otherwise; (ii) there is the monotonicity (or non-monotonicity) for the stability of the absolute (or relative) TTR; (iii) there is a peak distribution for shorter trading days and a two-peak distribution for longer trading days for the PDF of ratio; (iv) the trading days play an opposite role on the absolute (or relative) TTR and its stability between ˆDJI and CSI300 data.

Q3

1. Introduction

Econophysics is a new branch of physics, which uses physical ideas and methods to study economic or financial problems [1,2]. Theories of econophysics present some new explanations for classical financial problems such as market data of peak fat-tail characteristic [3,4], long range memory and clustering of volatility [5]. For example, Mantegna & Stanley [2],

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* Corresponding author.
E-mail address: nstang@ynu.edu.cn (N.-S. Tang).

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Gopikrishnan et al. [6] and Malevergne et al. [7] portrayed the financial asset prices for various time scales of statistical features, and explained commendably the peak fat-tail characteristics by using the stable Lévy distribution [5,8], power-law tail distribution, and tensile index distribution, respectively; Peters [9] used the chaos and fractal theory to study the financial markets, and proposed the fractal market hypothesis that is different from the efficient market hypothesis [10]; Mantegna & Stanley [2] employed the probability theory, critical phenomena in physics and turbulence theory to analyze financial time series, and proposed a new stochastic model; Bouchaud et al. [11] adopted the method of statistical physics to empirically investigate statistical characteristics of financial prices, and threw doubt on the rationality of the central limit theorem for the cornerstone of the classical financial risk theory. On the other hand, physicists studying the financial system broadened the research field of the traditional finance. For example, Mandelbrot [12] pointed out that the Wall Street stock market data present multi scale fractal features; Jiang & Zhou [13] and Yuan & Zhuang [14] found the universality of multi scale fractal phenomenon in studying China's capital market; Huang [15] in the "Physics Reports" systematically elaborated the experimental econophysics concerned with statistical physics of humans in the laboratory. This is based on the controlled human experiments developed by physicists for studying some economic or financial problems. In addition, the escape time as a physical quantity has been widely used in various fields such as chemical reaction system [16,17], gene expression dynamics [18], stochastic resonance phenomenon in a vegetation ecological system [19]. Also, the noise enhanced stability phenomenon is observed by the method of escape time [20–22]. For example, Dubkov et al. [20] found the noise enhanced stability phenomenon in a piece-wise linear dichotomously fluctuating potential with metastable state; Spagnolo, Agudov and Dubkov [21] experimentally and numerically discussed the noise enhanced stability in different physical systems; Spagnolo et al. [22] reviewed the noise enhanced stability and the resonant activation for models of interdisciplinary physics. The escape time can be usually employed to describe the stability of stochastic system, e.g., in a stochastic single-gene network [23], active Brownian motion [24] and an ecological system [25]. Soon afterwards, since a Langevin equation approach to a model for stock market fluctuations and crashes was proposed [26], the stock price escape phenomenon in stock market crashes has been widely discussed. For example, Valenti et al. [27] and Spagnolo and Valenti [28] investigated statistical properties of the hitting times for stock market evolution for several models, Masoliver and Perellö [29,30] presented exact expressions for the survival probability and the mean exit time, Bonanno et al. [31,32] studied the mean escape time for financial markets, Bonanno & Spagnolo [33] discussed escape times of stock price returns for the Wall Street market, and Li and Mei [34] and Li et al. [35] analyzed the returns and risks of investment.

Risk of stock investment is widely studied by investors and scholars [31,32,34–41]. For example, Markowitz [36,37] developed the mean–variance model for risk of stock investment in which mean was used to represent the expect return and variance was employed to measure the risk; Turner, Startz & Nelson [38] discussed the heteroskedasticity, risk and learning in the stock market via a Markov model; Lo & Repin [39] observed significant differences among physiological responses across 10 traders in discussing the psychophysiology of real-time financial risk processing; Tang & Tsitsiashvili [40] discussed the ruin probability of the finite horizon in a discrete-time model with heavy-tailed insurance and financial risks; Christoffersen [41] investigated the elements of financial risk management; Bonanno, Valenti & Spagnolo [31,32] used the Heston model and mean escape time to discuss the returns and risks in stock market crashes. Hence, risk of stock investment in a financial market is worthy to be further investigated.

The main purpose of this paper is to discuss the trading time risk (TTR). If the time of the stock price from high to low is shorter in the case of stock price drop, the time of investors to trade their stocks is less. In this case, investors will face a higher TTR. In particular, in the case of stock market crashes, investors lack the time to sell their stocks in the region of the right price. In other words, an increase of TTR for investors trading in stock price drop leads to a decrease of time from high to low (i.e., the escape time). Hence, to investigate the TTR, we here employ the escape time [31,32,34,35] to calculate the time of the stock price from high to low. Also, we investigate the TTRs of stock investment for the Dow Jones Industrial Average (ˆDJI) and Hushen300 (CSI300) data.

The rest of this paper is organized as follows. Section 2 presents a model of the TTR in the case of stock price drop based on the escape time [31,32,34,35]. Section 3 investigates statistical properties of TTR. Section 4 presents a theoretical model. Some discussions are given in Section 5.

2. The trading time risks in stock price drop

If the time of the stock price from high to low is shorter in the case of stock price drop, the time of selling stock for investors is less. In this case, investors will face a higher risk. In particular, when the stock market crashes, investors lack the time to sell their stock in a reasonable price range, i.e., when stock price drops, the time decrease from high to low leads to an increase of investors' TTR. Hence, to investigate the TTR, we employ the escape time [31,32,34,35] to calculate the time of the stock price from high to low.

A real stock price is a stochastic time series with respect to the data selection period (e.g., 1 min, 1 h, 1 day, ...). Let $P_1, P_2, \ldots$ be a stock price time series. To find the maximum and minimum values of N data periods at the tth point-in-time, we take $N_{\text{max-min}}$ periods before the tth time point (including the tth time point) to be a data window in calculating the following maximum and minimum values of $N_{\text{max-min}}$ periods:

$$P^{\max}_{t,N_{\text{max-min}}} = \text{Max}\{P_{t-N_{\text{max-min}}}, P_{t-N_{\text{max-min}}+1}, \ldots, P_{t-1}, P_t\},$$
$$P^{\min}_{t,N_{\text{max-min}}} = \text{Min}\{P_{t-N_{\text{max-min}}}, P_{t-N_{\text{max-min}}+1}, \ldots, P_{t-1}, P_t\}.$$