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# Causalities of the Taiwan stock market

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## Abstract

Volatility, fitting with first-order Landau expansion, stationarity, and causality of the Taiwan stock market (TAIEX) are investigated based on daily records. Instead of consensus that consider stock market index change as a random time series we propose the market change as a dual time series consists of the index and the corresponding volume. Therefore, causalities between these two time series are investigated. Our results suggest the volume time series is of second-order importance than the index time series. The index time series receives slightly stronger influence from the previous 67th trading day, while the volume time series is slightly stronger influenced by the previous 62nd trading day.

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## 1. Introduction

Physicists are interested in studying stock markets as complex systems. Almost all questions asked can be summarized as searching for price formation theories. Previous researches shown the distribution of price change has pronounced tail distribution in contrast to Gaussian distribution expected. Furthermore, the auto-correlation of price change decays exponentially with a characteristic time scale around 5 min. Stock crash or rally have also been identified by physicists as a kind of herd behaviour [1].

Johansen and Sornette considered fitting most stock markets for the bubbles using Landau expansions of the index [2]. They showed evidence that market crashes as well

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as large corrections are preceded by speculative bubbles with two main characteristics: a power-law acceleration of the market price decorated with log-periodic oscillations. For most markets the log frequency  $\omega/2\pi$  is close to unity. However, most data analysis were done for the index of more mature market like S&P 500. Not all market indexes are defined in the same way. Could different weighting methods reach the same conclusion? Will government intervention play a role in the conclusion? Johansen and Sornette further found emergent markets have larger fluctuations. They extended the expansion up to third order and successfully predicted Nikkei raise in the year 2000 [3]. However, why do these fluctuations exist? The log-periodic oscillation appeared in a wide class of out of equilibrium dynamic systems, like ruptures in heterogeneous media, historic analysis of earthquakes data, and world population. Canessa tried to establish universality for the exponents from a renormalization group theory [4], and used a stochastic theory to show that the log periodicities are a consequence of transient clusters introduced by an entropy-like term. As entropy in thermodynamics corresponds to the information in an information theory. The possibility to arrive at the log-periodic oscillation therefore suggests the log-periodic oscillation is a consequence of information exchange between different species of a large system [5].

The effect of volume is less analyzed in the literature. Volume is a measure of market liquidity while index means the price. Gopikrishnan et al. [6] analyzed the statistical properties of number of shares traded of a particular stock at a given time interval from an empirical rule saying that it takes volume to push the index. Bonanno et al. [7] also analyzed the number of shares traded of selected stocks and find a power spectrum of approximately  $1/f$ .

In the present work we considered the volume effects of Taiwan stock market (TAIEX). In particular, the cause-effect relation between the volume time series and the index time series is analyzed. Taiwan stock market is one of the largest emerging markets. Johansen and Sornette did not studied it because of availability of trading information. In the present work we tried to make up this missing piece.

When people talk about the volume involved, sometimes they mean the number of shares traded, sometimes the amount of money involved. We consider money flow to be more important than share number flow if the whole market is considered, since the person or institute involved should have fixed amount of money.

## 2. Basic properties

Taiwan has two stock markets. TAIEX is the major market [8]. TAIEX definition is taken the yearly average of 1966 as 100. All stocks traded are taken into account.

We analyzed our daily data of TAIEX from January 3, 1991 to December 30, 2000, which include 2814 trading days for a 10 years period. Intra-day time is treated as continuous. Within our data time, several significant events can be identified. In August 26, 1997, the market reached a local peak 10116.84. The highest index happened at February 17, 2000 with an index 10202.2. The lowest point is at January 7, 1993 with an index 3135.56.

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