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The Application of α-stable Distribution in Modeling Several Indexes in Vietnamese Stock Market

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Abstract. Recently, there has been numerous research investigating the application of α-stable distribution to finance. The family of symmetric α-stable distribution was discovered by Paul Levy. In the developed countries, α-stable distribution is widely used in the analysis of the stock market, however, very few (if any) has been applied it in Vietnamese stock market. In this article, results from the application of α-stable distribution in modeling several indices in Vietnamese stock market will be presented. Our research showed the applicability of α-stable distribution in this market.

Keywords: Modeling Index, Stock Market, Stable Distribution.

1. Introduction

The economic reform in Vietnam launched in 1986 has transformed Vietnam from one of the poorest countries into a country with an economic growth rate of 7%. Since then, Vietnam has joined into several international communities, e.g. Association of South East Asian Nation (ASEAN), World Trade Organization (WTO), and Asia Pacific Economic Cooperation (APEC). This joining has created both opportunities and challenges, one of which is the opening of a stock market. Having a stock market in Vietnam plays vital role in the implementation of Socio-Economic Development Strategy 2001-2010. The first official trading of Vietnamese stock market on 28 July 2000 was well received by many Vietnamese and foreign investors. After 12 years of development, few research has been conducted regarding stock market predictions and modeling indexes in the market. To characterize and model the stock market, several approaches have been introduced using time series model ARCH, GARCH, as well as Gauss distribution or α-stable distribution [1], [4], [5]. For example, according to Ghahfarokhi & Ghahfarokhi [5], α-stable distribution is widely applied for indexes such as ISEQ, CAC40, DAX30. In addition, Emmenegger & Serbinenko [4] have pointed out that α-stable distribution is more appropriate than a normal distribution in 83% of cases to predict local currency/US currency. The question is whether this approach will be applicable for the Vietnamese stock market which is characterized as new and socialist-oriented. In this article, we will apply the α-stable distribution into some of the main indexes in Vietnamese stock market such as VNINDEX, total value and volume of shares traded.

2. Content

2.1 The α-stable Distribution

The α-stable distribution is a family of statistical distributions which is indexed by a parameter α which can be any positive number less than or equal to 2 [3]. When α = 2 the α-stable distribution becomes a normal distribution. When α = 1 the distribution becomes a Cauthy distribution. As α is decreased larger extreme values become more likely. The definition of function characteristics as follow:

$$\varphi(t)=\begin{cases}\exp\left\{-\sigma^{\alpha}.|t|^{\alpha}.\left[1-i.\beta.\mathrm{sign}(t).\tan\frac{\pi\alpha}{2}\right]+i\mu t\right\} & \text{when} \quad \alpha\neq 1\\ \exp\left\{-\sigma.|t|.\left[1+i.\beta.\frac{2}{\pi}.\mathrm{sign}(t).\ln|t|\right]+i\mu t\right\} & \text{when} \quad \alpha=1\end{cases}$$

Where:

$$\alpha \in (0,2]\ ;\ \sigma \geq 0\ ;\ \beta \in [-1,1]\ ;\ \mu \in \mathbb{R}\ ;\ \operatorname{sign}(t) = \begin{cases} 1 & \text{when} \quad t > 0 \\ 0 & \text{when} \quad t = 0 \\ -1 & \text{when} \quad t < 0 \end{cases}$$

A second parameter, β measures the skewness of the distribution. β can take values from −1 to 1. When β = 0 the distribution is symmetric. A positive value of β implies that the distribution is skewed to the right (i.e. Large positive values are more likely than large negative values). Larger values of β imply greater positive skewness. Similarly negative values of β imply that large negative values are more likely than large positive. It is sometimes thought that equity return distributions are negatively skewed. As the normal distribution is symmetric it can not model any skewness in the data. The α-stable distribution requires two more parameters: a scale parameter, μ and a location parameter, δ. These are similar in interpretation to the mean, μ and standard deviation, δ, respectively, of the normal distribution.

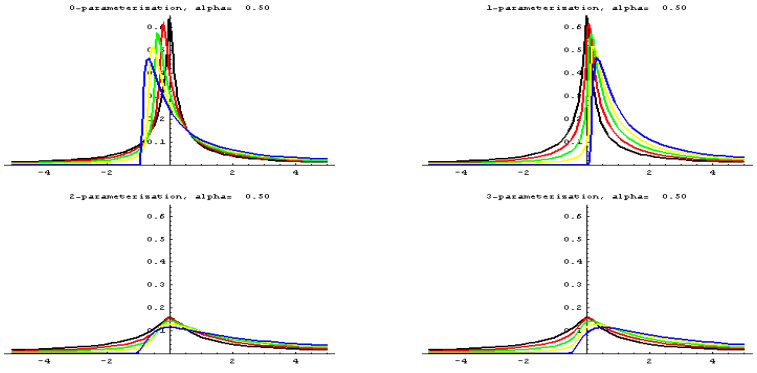

Figure 1: α-stable distribution (Mandelbrot, 2001).

2.2 Application to Vietnam Stock Market

2.2.1 VNINDEX

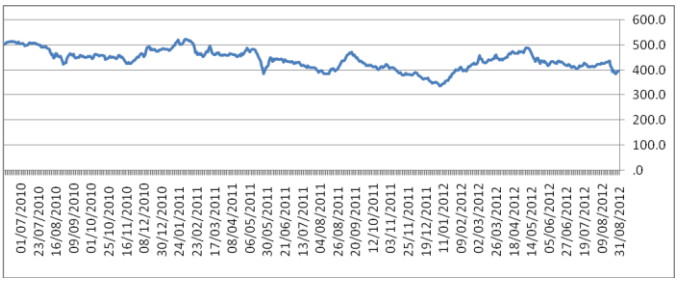

Figure 2: VNINDEX from July 2010 to August 2012 (CafeF, 2012)

Analyzing histogram of the index and using maximum likehood method we estimates parameter for α-stable model [4], [6]. Results are presented in Figure 3.

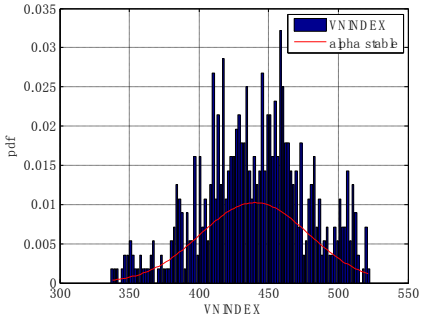

Figure 3: Fitting result VNINDEX using α-stable distribution

The parameters of the model are $\alpha = 2$, $\beta = 1$, $\mu = 27.5$, $\delta = 439{,}9$. As discussed earlier in the paper, when $\alpha = 2$ the α-stable distribution becomes a normal distribution. Explanation for this result could be: the range restriction of not exceeding 5% for VNINDEX makes this index lose its natural. In other words, the index will be similar to the normal distribution, which is considered common to a new stock market. Meanwhile, there is no difference between using Gaussian model or α-stable. Gauss model for simplicity in calculation is also recommended.

2.2.2 Total Value of Shares Traded / Day

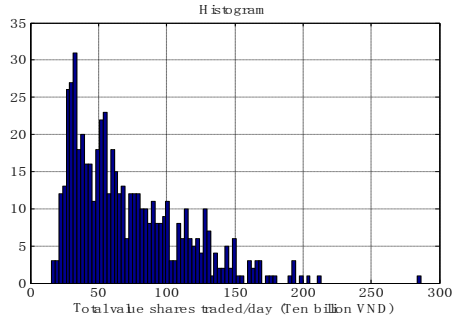

Figure 4: Histogram total value shares traded/day from July 2012 to August 2012

As shown from Figure 4, the average of total value shares is about 750 billion VND. However, there is session, in which the total value is up to 3000 billion VND. This can be understood as a market having a fat tail phenomenon.

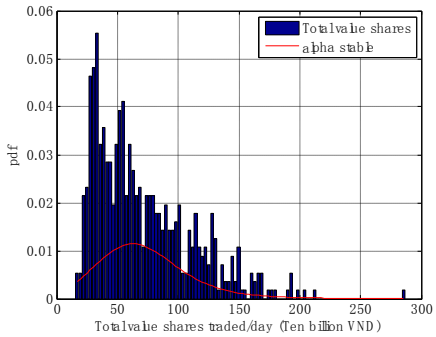

Figure 5: Fitting total value shares traded result using alpha stable

When fitting the total value shares traded/day, the results obtained by alpha stable model with parameters $\alpha = 1.72$, $\beta = 1$, $\mu = 24.51$, $\delta = 75.68$. The value $\delta = 75.68$ can be considered as average values illustrate that the total market value of the transaction is often reaches 756 billion VND per day.

2.2.3 Volume of Shares Traded per Day

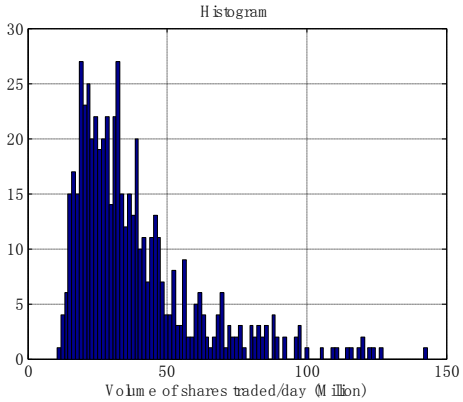

Figure 6: Histogram volume of shares traded per day from July 2010 to August 2012.

Figure 6 indicates that the volume of shares traded shared similar characteristics as the total value shares traded. It had the long tail. Therefore, it can be seen as the evidence for the comformity of using α-stable model.

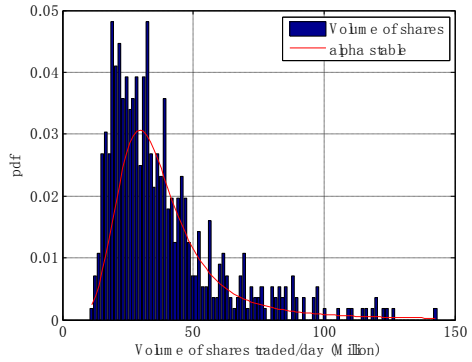

Figure 7: Fitting volume of shares traded using **α** - stable distribution.

The parameters of the model are: $\alpha = 1.33$, $\beta = 1$, $\mu = 9.10$, $\delta = 37.65$. Normally the total number of shares traded is about 37.6 million shares / day.

3. Conclusion and Discussion

Results from this research indicated that the application of alpha stable distribution is suitable to build forecasting models for stock market index in Vietnam. For some limited range index changes as VNINDEX, we propose to continue to apply the normal distribution model for simplicity in calculations. Applying this prediction model will provide a useful tool for the investors will in their decision-making processes and hence making stock market in Vietnam more effective. However, more research is needed on modeling multivariate stable alpha to improve the accuracy of predictive model.

4. References

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