Extreme Value Estimators for Stock Indices in ASEAN Economics Community

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***Abstract*—The paper examines the extremeValue-at-Risk (VaR) model with daily stock indices of selected South East Asian countries consisting of SET index (Thailand), KLSE index (Malaysia), FTSI index (Singapore), and JKSE index (Indonesia). Additionally, the experiment based on extreme value theory (EVT) was conducted to generate extremeVaR estimates at the 99 percent confidence intervals. The paper is tested utilizing Generalized Extreme Value Distribution (GEV) was computed by using negative maximum natural log of weekly returns with block maxima method on AEC marketindices. And Generalized Pareto Distribution (GPD) estimated by using natural log exceeding value of daily returns of stock indices which set threshold limit flooring value as specified and computed with threshold method. According to calculated weekly returns of GEV and calculated natural log of daily returns of GPD on AEC market indices. The output results indicated that KLSE extremeVaR in Malaysia was the AEC attractive equity market when investors invest in these markets.**

***Index Terms*—Extreme Value estimators, extremeVaR, AEC market indices, returns of stock indices.**

I. Introduction

In the near future, ASEAN Economics Community or AEC will be adopted as the prime economic policy for lead to be attractive equity market for investors. However, there is risk when investors invest in capital market associated with daily returns on AEC market indices. Therefore, to manage risk in efficient manners is a prerequisite condition of investment in AEC capital market. The research objective aims to forecast and evaluate the extreme Value-at-Risk (extremeVaR) based on Generalized Extreme Value Theory (GEV) and Generalized Pareto Distribution (GPD) of time-series daily returns on market indices in SET - Bangkok SET (Thailand), KLSE -Kuala Lumpur Composite Index (Malaysia), FTSI - Singapore Straits Industrial (Singapore), and JKSE - Jakarta composite Index (Indonesia), The empirical study focuses on forecasting of daily returns on market indices of four selected AEC countries during the period of 1999-2012.

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II. Extreme Value and Value-at-Risk

Extreme Value Theory (EVT) first proposed by Fisher, Tippet and Gnedenko since 1920. In 1958, Gumbel created a fundamental book on the statistics of extremes. The extreme model focuses on the statistical behavior of $M_n = \max\{X_1,...,X_n\}$, where $X_1,...,X_n$, is a sequence of independent random variables having a common distribution function *F*. In applications, the X_i usually represents values of a process measured on a regular time-scale- so that M_n represents the maximum of the process over *n* time units of observation. If *n* is the number of observations in a scratch, then M_n corresponds to the twelve-monthly maximum. EVT is a branch of research dealing with the extreme departure from objective pdf in term of median. In statistical theory the distribution of M_n can be derived exactly for all values of *n*: $\Pr\{M_n \le z\} = \Pr\{X_1 \le z,\ldots,X_n \le z\};= \Pr\{X_1 \le z\} \times\ldots\times \Pr\{X_n \le z\};= \{F(z)\}^n$. The theorem of extreme value has three pattern distributions. *The first pattern* is Gamble's extreme value distributions (GEV); *the second pattern* is Freshet's extreme value distribution; and the *third pattern* is Weibull's extreme value distributions. The generalized extreme value distribution has cumulative distribution function:

$F(\chi;\mu,\sigma,\xi) = \exp\{-[1+(\frac{\chi-\mu}{\sigma})]^{-1/\xi}\}$ Where:

$1+(\frac{\chi-\mu}{\sigma})>0$ $\mu \in R$ = Location Parameter,

σ >0 = Scale Parameter,

$\xi \in R$ = ShapeParameter

$$\chi \in [\mu-\sigma/\xi,+\infty) \quad \text{when } \xi>0,$$
$$\chi \in [-\infty,+\infty] \quad \text{when } \xi=0$$
$$\chi \in (-\infty,\mu-\sigma/\xi] \quad \text{when } \xi<0$$

The density function is, consequently:

$$F(\chi;\mu,\sigma,\xi) = \frac{1}{\sigma}[1+\xi(\frac{\chi-\mu}{\sigma})]^{(-1/\xi)-1};$$

$$F(\chi;\mu,\sigma,\xi) = \exp\{-[1+(\frac{\chi-\mu}{\sigma})]^{-1/\xi}\}$$

For $1+(\frac{\chi-\mu}{\sigma})>0$ The Generalized Pareto distribution (GPD) was adopted to explain the problem of analyzing extreme values in container of over high thresholds as first proposed by Pickands (1975). The family of GPD has three parameters μ,σ and ξ. The cumulative distribution function is $F_{(\xi,\mu,\sigma)}(\chi) = 1-(1+\frac{\xi(\chi-\mu)}{\sigma})^{-1/\xi}$.

For $\chi \geq \mu$ and $\chi \leq \mu - \sigma/\xi$ when ξ <0 where $\mu \in R$ is the location parameter, σ >0 is the scale parameter and $\xi \in R$ is the shape parameter. Also, GPD has the probability density function which is

$$f_{(\xi,\mu,\sigma)}(\chi) = \frac{1}{\sigma}[1+\xi(\frac{\chi-\mu}{\sigma})]^{(-1/\xi)-1}$$

$$f_{(\xi,\mu,\sigma)}(\chi) = \frac{\sigma^{\frac{1}{\xi}}}{(\sigma+\xi(\chi-\mu))^{1/\xi+1}}$$

by $\chi \geq \mu$ และ $\chi \leq \mu - \sigma/\xi$ when ξ <0

ExtremeVaR in observations follows to real the GEV distribution based on parametric methods as equation

$$VaR_{extreme} = \hat{\mu} + \frac{\hat{\sigma}}{\hat{\xi}}[-In(p))^{-\xi} - 1]$$

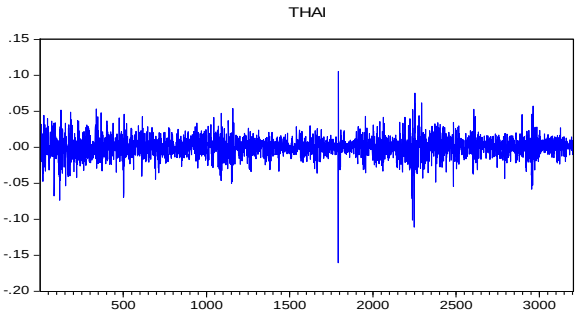
III. Data Description

Daily returns on AEC market indices during period of 1999-2012 were collected as shown in Table 1 and presented by graphically in Figure 1, Figure 2, Figure 3 and Figure 4.The Unit Root test was conducted based on the test developed by Phillips and Perron (1988) proposed a nonparametric method for scheming for higher order serial correlation in time series data.

Table 1: Data Description of daily returns on AECmarketindices during period of 1999-2012.

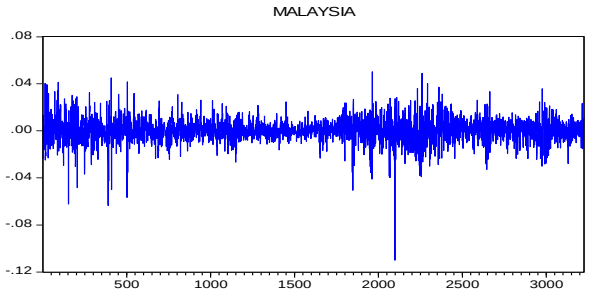
Equity Markets in AEC.	SET Bangkok SET Index		KLSE Kuala Lumpur Composite Index		FTSI Singapore Straits Industrial		JKSE Jakarta composite Index	
ExtremeVaR	GEV	GPD	GEV	GPD	GEV	GPD	GEV	GPD
Number of observations	638	3,204	627	3,223	650	3,286	631	3,189
Mean	0.0015	0.0106	0.0106	0.0073	0.0135	0.0091	0.0156	0.0106
Median	0.0127	0.0080	0.0083	0.0052	0.0108	0.0066	0.0115	0.0076
Min	0.0002	0.0000	0.00004	0.0000	0.00001	0.000008	0.00013	0.0000
Max	0.1606	0.1606	0.1100	0.1100	0.0870	0.0870	0.1095	0.1095
Standard deviation	0.0112	0.0104	0.0089	0.0073	0.0109	0.0090	0.0142	0.0107

Figure 1. Graphical presentation of SET daily closing of stock-index returns during period of 1999-2012



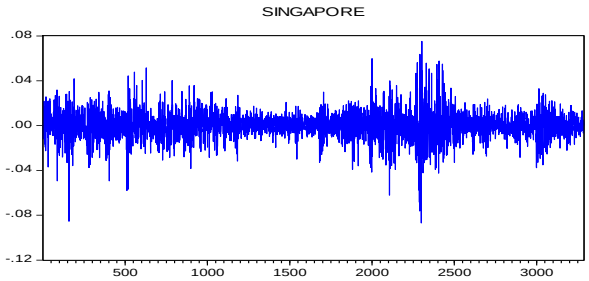
Source: Bangkok SET Index (Thailand)

Figure 2. Graphical presentation of KLSE daily closing of stock-index returns during period of 1999-2012



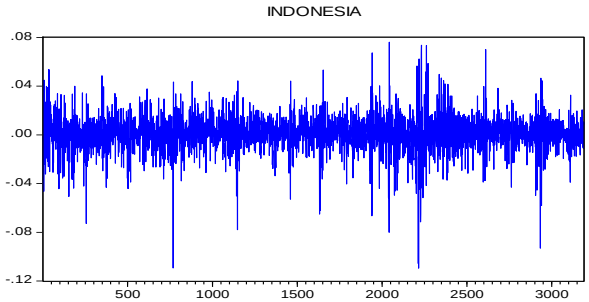
Source: Kuala Lumpur Composite Index (Malaysia)

Figure 3. Graphical presentation of FTSI daily closing of stock-index returns during period of 1999-2012



Source: Singapore Straits Industrial (Singapore)

Figure 4. Graphical presentation of JKSE daily closing of stock-index returns during period of 1999-2012



Source: Jakarta Composite Index (Indonesia)

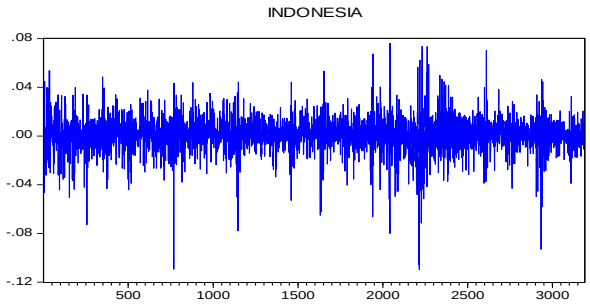
IV. Research Results

The results of Phillip-Perron unit root tests confirmed daily returns of SET, KLSE, FTSI, and JKSE. However, the empirical study found evidence for the non-existence of a unit root *I(0)*. The null hypothesis of Phillips-Perron test is the proposition that implies no effect or no relationship between daily returns for the null hypothesis that x has a unit root *I(1)* against a stationary *I(0)* alternative across four national equity indices to assess intra-daily volatility dynamics in AEC as shown in Table 2.

Table 2: Output Results of Phillip-Perron Unit Root Tests during period of 1999-2012

Equity Markets in AEC.	With intercept and trend	Critical Value	Order level
	At Level	At Level	At Level
SET	-54.98834	-3.960906	I(0)
KLSE	-49.11382	-3.960889	I(0)
FTSI	-55.87696	-3.960834	I(0)
JKSE	-50.53239	-3.960920	I(0)

Note. Significant at 1% level; source: From computed



The comparison studies of extremeVaRs using both Generalized Extreme Value Distribution (GEV) and Generalized Pareto Distribution (GPD) covering five period of intra-yearly volatility 2014- 2018 is to observe at historical VAR during periods of crisis.

However, the findings indicated evidence intra-daily volatility dynamics and the existence of a 'gainer-loser' effect from market to market of four AEC national equity markets. A conclusion of four AEC countries-specific extremeVaR results including SET, KLSE, FTSI, and JKSE were shown on Table 3.

The findings indicated evidence compared the predictability of relative extreme returns of four equity markets in AEC- extremeVaR results cover five period of intra-yearly volatility 2014- 2018 as depicted on table 3. Assessment of relative extreme returns of frequency models used empirical Generalized Extreme Value Distribution (GEV) computed by negative maximum natural log of weekly returns in with block maxima method. Finally, therefore, the evidence deals with specific techniques applicable to weekly data sets of closing of stock-index returns during period of 1999-2012 as short as two years or within two years to six years in the future for GEV model including simulation

Where GEV distribution based on parametric methods as equation

$$VaR_{extreme} = \hat{\mu} + \frac{\hat{\sigma}}{\hat{\xi}}[-In(p))^{-\xi} - 1].$$

Forecasting results of extremeVaR of KLSE representing for Malaysian equity market indicated minimum value of GEV distribution which equal **0.0130***in average. The subordinate extremeVaR were FTSI, SET and JKSE that equal 0.0166, 0.0185 and 1.2815 in average respectively. Assessment of relative extreme returns of frequency models used empirical Generalized Pareto Distribution (GPD) model using exceeding value of daily returns natural log of stock indices which set threshold value and computed with threshold method as depicted on Table 3. Forecasting results of extremeVaR of KLSE indicated minimum value of GPD which equal **0.0587***in average. The subordinate extremeVaR were FTSI, JKSE and SET that equal 0.0749, 0.0854 and 0.0954 by average respectively.

The findings of GEV distribution computed by negative maximum natural log of weekly returns which equal **0.0130*** compared with those findings of GPD distribution using exceeding value of natural log of daily closing of stock-index returns which equal **0.0587***. The study indicated different environmental applications of both the GEV model and GPD model covered three parameters μ, σ and ξ that are typically used to models as introduced.

Table 3 Comparison the predictability of relative extreme returns of four AEC equity markets covering the five-year period 2014-2018

Equity Markets in AEC.	SET Bangkok SET Index		KLSE Kuala Lumpur Composite Index		FTSI Singapore Straits Industrial		JKSE Jakarta composite Index	
Extreme VaR	GEV	GPD	GEV	GPD	GEV	GPD	GEV	GPD
2nd year	0.0122	0.0814	0.0082	0.0524	0.0106	0.0666	0.3735	0.0763
3rd year	0.0164	0.0901	0.0113	0.0565	0.0145	0.0719	0.9698	0.0821
4th year	0.0193	0.0967	0.0136	0.0594	0.0173	0.0757	1.3832	0.0863
5th year	0.0216	0.1021	0.0153	0.0617	0.0195	0.0788	1.7064	0.0897
6th year	0.0234	0.1067	0.0168	0.0636	0.0214	0.0813	1.9744	0.0924
Average	0.0185	**0.0954****	**0.0130***	**0.0587***	0.0166	0.0749	**1.2815****	0.0854

Source: The forecasting of extremeVaR (99%) computed.
Note. * represents minimum value.
** represents maximum value.

V. Conclusion

Writing a study of extremeVaR methods in returns on AEC market indices raises a question regarding the scope of the predictability of relative extreme returns for the selected period of the study. Forecasting AEC returns on AEC market indices seeks investment solutions what spheres should be included within the framework of the extremeVaR study. This paper focuses on forecasting methods based on both GEV model and GPD model covered three parameters μ, σ and ξ that are typically used to models for the presence of evidence for the predictability of relative extreme returns and the existence of a 'gainer-loser' effect from market to market. Secondary data was used to produce forecasts of the returns covering the five-year period 2014-2018 on AEC market indices of SET, KLSE, FTSI, and JKSE. This paper represents extremeVaR of selected four national equity markets in extreme value estimators. According to computed output results, statistical techniques confirmed that a change in percent of expectations in two future years to six future years, KLSE or Kuala Lumpur Composite Index (Malaysia) was the best for investment in ASEAN Economics Community or AEC.

Research results during this period confirm that the model analysis revealed that the best forecasting method based on the boundaries of the term of GEV model and GPD model covered three parameters μ, σ

and ξ. For the top equity market in AEC, KLSE is the equity market which the first rank because the minimum value of GEV distribution which equal **0.0130*** in average and minimum value of GPD which equal **0.0587*** in average.

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