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# Historical Risk Measures on Stock Market Indices of Asian Countries

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**Abstract**

*This article is mainly conducted in accordance with the following steps. Firstly, we do a qualitative analysis to Asian stock markets, including China, Korea, Japan, Malaysia, India and Philippines. Secondly, we divide each sample into three intervals, 2004-2006, 2007-2009 and 2010-2014. Then we use the EGARCH-VaR method to analyze the yield sample with normal distribution, t distribution and GED distribution. Finally, we put forward some suggestion according to the empirical results.*

***Key words: Market Risk; Volatility; Asian stock markets; EGARCH model; Value at Risk.***

**1. Introduction:** Under the background of economic globalization, the rapid development of the economy brought all kinds of risk, market risk, operational risk, credit risk, management risk, and so on. With the communication and influence among the economies, the financial risk has been enlarged. In 1997, the devaluation of Thai baht lead to the Asian financial crisis, and the currencies of Thailand, South Korea, Indonesia depreciated significantly, causing the rapid falling in most Asian stock markets, which followed by industrial bankruptcy, unemployed workers and the depression. The lack of effective risk management experience and risk estimation system in most financial institutions is one of the factors which lead to the crisis. However, the financial risk prediction methods are not mature during that time, and most companies went bankrupt because of excessive risk-taking. In 2008, the subprime mortgage crisis in United States triggered the global financial crisis, Asian countries suffered during that time. From the September 16 to October 17, the nikkei index was down by 25.1%. After the crisis, Asian countries were aware of the importance of the construction of the Asian financial market integration, especially the stock and bond market integration, which could for lay the solid market foundation for financial stability. Moreover, a growing number of financial institutions become realize the importance of risk prediction and take the risk management as a top priority.

Under the complicated financial market, the fierce competition between financial institutions, the innovation of financial products and the speculators speculation, brought more and more complex financial instruments. With the easing financial system and policy, and the lack of effective management and supervision of financial institutions, more and more financial problems aroused. Because of the risk decision-making errors, large number of enterprises incurred a loss. In 2004, the top large loss of $554 million of hyping the options in Singapore is a best example. Thus, the traditional risk measurement methods already cannot adapt to the rapid development and changes of the needs of the development of financial markets. In 1993, J.P. Morgon put forward the VaR method after examining derivatives, and the VaR method has been adopted by major financial institutions. The advantage of this method is simple. It can cover a multitude of risk factors and summarized the asset combination into a simple digital. Thus, it became one of the most suitable methods. The VaR method becomes increasingly mature, which will help to reduce the risk of financial markets, and promote the Asian regional stock market integration.

Asia as an integral part of the global economic development, the development of its economy is of great importance in the development of the global economy. Since the Asian financial crisis in 1997, how to recover as soon as possible from the crisis and how to prevent the crisis happen again become a national event for all the Asian countries. And the stock price index is representative signal of a country's financial development, its rising or falling represents a development status and trend of a particular field, which is the key to financial research. The volatility and unpredictability of the stock market has been concerned by scholars. The normal operation of the stock market is also based on the clear understanding of the risk. How to use a highly efficient and easy way to measure risk and find a proper operation risk measurement method is particularly important. The VaR method, which digitalizes and specifics the market risk that regulators and investors could understand easily, is the first choice method of market risk for financial institutions and non-financial institutions supervisors. After estimating the loss under a certain confidence level, regulators and investors can take concrete measures to spread the risk.

Therefore, research of the characteristics and the risk of the stock market, and applicability of the VaR risk management methods on the Asian stock markets, are of great importance to guard against financial risks and promote the normal operation of the stock market so as to promote the development of Asian financial market integration. With the research of the stock index after the Asian financial crisis in 2008, we can try to draw the influence degree of the financial crisis and processes, so as to prevent the financial crisis from happening again. Comparing the results of several Asian countries, learning from each other, and the measurement of stock price index returns volatility are very important.

**2. Literature Review:** In the early 80s, scholars have done some research for risk prediction and measurement. The Autoregressive conditional variance model, which could be used for variance model was first put forward by Engle in 1982. Bollerslev (1986) improved the ARCH model, and formed the generalized autoregressive conditional heteroscedastic model named GARCH model. Since then, more and more scholars began to use GARCH model to do research. Bollerslev (1987) used the GARCH model to analyze the stock market price fluctuation time serie. Nelson (1991) put forward EGARCH model, which can reflect the leverage effect of stock price and could have a very good description of heteroscedasticity. However, the GARCH model can only roughly reflect the risk, but unable to estimate the loss of specific values. In 1994, J.P.M outraged company put forward the VaR risk measurement under the normal distribution method formally. After that, the VaR method has received the attention of the every scholar, financial regulators, and quickly brecome popular in the world. Currently, the VaR method is still the mainstream tool of risk measurement. Taufiq (1995) used the GARCH model to analyze the stock volatility of five European countries, with the conclusion that the volatility of the stock market has a great relationship with external factors. Morgan (1996) expounded the VaR method again in detail, while the Basel rules take the VaR method as one of the financial regulatory risk measure method.

Many scholars used the VaR method under the normal distribution assumption. Hull and White (1998) proposed for the VaR calculation method under the non-normal distribution first time, and t distribution and GED distribution were introduced into the VaR method for the first time. They found that the fitting effect of VaR values is better under t distribution and GED distribution than under the traditional normal distribution. Dowd and Kevin (1999) also pointed out that the GARCH model is not good to descript the rush fat-tailed features of yields under normal distribution. Chiang et al. (2001) used TAR-GARCH model to stock markets return on month, week and daily yield of seven Asian countries respectively. Poon et al. (2003) once again emphasis the importance of financial market risk prediction, and take the VaR approach as a first choice for risk prediction. The VaR method has got more and more attention in the next ten years. Alexander et al. (2006) analyzed the volatility of exchange rate based on the normal distribution of GARCH (1, 1) model, and found that the GARCH (1, 1) model can depict the change of exchange rate in a better way than other methods. Jiang et al. (2009) applied the ideas of VaR method under different confidence levels into the insurance policy and different insurance contracts. This is a representative new application field of VaR. Sabiruzzaman (2010) used the GARCH and TGARCH model to study the volatility of the stock yield in Hong Kong. The TGARCH model results show that the Hong Kong stock market has the leverage, and the TGARCH model is better than GARCH model to fit. Emma et al. (2011) applied the maximum likelihood method to ARCH and GARCH (1, 1) model, used the modified GARCH model to do the empirical analysis the U.S. stock market, and the model fitting effect is very good. Javed et al. (2013) used four information standard of SIC, AIC, HQ, AIC, under six GARCH models with different parameters, with the Conclusion that BIC and HQ should be used on the low-order GARCH model, AIC and AICc standards are more suitable for high order GARCH model. The application of VaR method has been used widely. Many financial companies have applied VaR method to daily management of assets and capital. Many scholars have been focused on the improvement of GARCH model and the accuracy of the VaR calculation method.

In general, Scholars have done much research on the VaR method with the family of GARCH model. However, the research of most scholars was limited to a single stock market, and there is very few papers focus on regional stock markets, especially the research on Asian stock markets. There are few articles about ASEAN countries and Asian stock market correlation research. So, research of the regional stock markets will be concerned by scholars in the future. With the important position of Asian stock markets in the international market, we believe that more scholars will explore the applicability of the VaR method in Asian countries. Additionally, many scholars often used one distribution or one model in the empirical analysis, which id not good for fitting. Therefore, the choice of different distribution and different GARCH models are necessary to be improved.

The VaR method could help financial institutions to predict risk and utilize VaR method in the daily operation management of the assets, funds, asset allocation effectively. So in the future, there will be more research on the applicability of the VaR method in the different asset allocation problem, such as portfolio, real estate, securities, and so on. The VaR method takes the assets as a variable, but in reality the policy risk is most important. How to use the policy risk factor into the model, and how to combine the VaR method with other measurement methods, will be very worth studying topics.

## 3. Methodology:

**3.1 Value at Risk:** VaR means Value at Risk, is a method of quantitative risk measurement, which would calculate the potential loss of assets under a certain confidence level. Within normal market conditions, given a certain amount of time interval and the confidence level, the VaR could assess the largest risk loss. Definition of the VaR could be summarized as: have a probability of X% to get a correct result, and loss will be less than V in the future N days. Where V is the VaR value, X % is confidence level. VaR value that is to say, in the next N days, the probability for losses to be more than V is (100–X) %. For example, the Bakers Trust bank announced its daily VaR value in annual report of 1994, and the average loss within 99% confidence interval is \$3500. That is to say, the probability that the daily loss of assets caused by market risk is over \$3500 will be only 1%, which means the basic risk loss can be controlled within the \$3500.

From the above definition of VaR, we need three aspects to calculate the VaR value; they are the size of the confidence interval, the length of the holding period, asset distribution characteristics. There are different types of VaR calculation method, historical simulation method, the Monte Carlo simulation method, parameter method semi-parameter method, and so on. This paper uses the semi-parameter method. Semi- parameter method is a combination of parametric and nonparametric method. We use the parameter method to get a sample sequence condition mean and standard deviation, and use the nonparametric method can get the sample sequence distribution quantile, so as to calculate the VaR value. GARCH model is needed in the semi-parameter method. We use the EGARCH (1, 1) model.

The calculation formula of VaR is expressed as：

$$VaR=w_0(\mu-z_\alpha\sigma)\sqrt{\Delta t} \qquad (1)$$

Where $w_0$ is the initial value of assets, μ is the conditional mean value of assets，σ is the conditional standard deviation of the portfolio sequence, $z_\alpha$ presents the quantile within different confidence levels, Δt is the mature time of holding the assets.

The calculation steps of VaR value are mainly：

a. Use the method of parameters based on the distribution characteristics of yield sequence, to construct the EGARCH model, and estimate the mean equation and conditional heteroscedasticity equation, and predicts the yield condition mean and standard deviation of the sequence.
b. Use the nonparametric method calculating quantile. Different distributions under different confidence levels have different quartiles. For example, quartiles of normal distribution are 2.3263 for 99% confidence level, 1.9599 for 97.5% confidence level, 1.6448 for 95% confidence level, and 1.2815 for 90% confidence level. Quartiles of t distribution and GED distribution under different confidence levels will be calculated according to degrees of freedom estimated by EGARCH models.
c. Plug the condition mean and standard deviation into formula of VaR, we can get VaR value of series.
d. Robustness testing of VaR values. The VaR values are estimated by models with inevitable error, and we have to do robustness test to assess the fitting effect of VaR values to measure the maximum loss of assets. We often use chi-square method to do the test, which will be illustrated afterward.

**3.4 GARCH Model:** The most mainstream computing method of VaR is to use the ARCH family models. The main reason is that the family of the ARCH model has a very good performance in fitting the financial market volatility of return on assets. Engle (1982) put forward the autoregressive conditional heteroscedasticity (ARCH) model to describe the volatility of the stock market and clustering problems, then the ARCH model has been widely used with its superior continuous variance and thick tail processing power. Based on the ARCH model, Bollerslev (1986) proposed GARCH model, which is the generalized autoregressive conditional heteroscedastic model. Relatively, the GARCH model simplifies the parameter and improves the accuracy, and according to the different applicable characteristics the GARCH model family was formed, including GARCH, TARCH, EGARCH and IARCH.

According to the descriptive statistics of the yield sequence, we find that the yield sequences of stocks do not fit normal distribution, but have obvious rush fat-tailed features. Yield sequences do not change with random fluctuations in time, but often have gather effect, namely a big fluctuations will be accompanied by another one, a little fluctuation with followed by another one. Apparently, stock yield sequences have obvious leverage effect。The leverage performance has asymmetric influence on the stock market returns with bad and good news, and normally the impact of bad news is greater than that of good news. The good news can reduce the volatility, and bad news will lead to greater volatility. And the EGARCH model with the asymmetric term can better fit the conditional heteroscedasticity. So this paper uses the EGARCH (1, 1) model. The Formula of EGARCH（1,1）is：

$$Ln\sigma_t^2=W+\beta \ln(\sigma_{t-1}^2)+\alpha|\mu_{t-1}/\sigma_{t-1}|+\Upsilon\mu_{t-1}/\sigma_{t-1} \qquad (2)$$

The left of the equation is logarithm of conditional heteroscedasticity, which presents the effect of leverage, is exponential form, rather than a second. So the conditional variance forecasted must be negative. As long as coefficient of ϒ in the equation is not equal to zero, it indicates that the impact to the market is asymmetric. But under normal circumstances, the coefficient of ϒ is less than zero, namely market shocks have obvious lever effect, and the impact of stock prices falling are higher than the impact of stock prices rising.

## 4. Empirical Results:

**4.1 Data analysis:** In this paper, we choose the Shanghai composite index of China, KOSPI index of South Korea, Nikkei 225 index of Japan, SET index of Thailand, KLSE index of Malaysia, Mumbai index of India, and PSI index of Philippines as the representation of the stock markets in Asia. And we use these stock market indexes as empirical research sample. In this paper, we use the daily closing price sequence of each stock index from 2004 to 2014. Because of the influence of the global financial crisis in 2008, almost every Asian countries suffered from the crisis, which leads to the doldrums of stock markets for a time. So, in order to study the applicability of value at risk (VaR) method in Asian stock markets deeply, which will make us better understand the changes of stock indexes before and after the financial crisis, we divided the data into three intervals, they are 2004 to 2006, 2007 to 2009 , 2010 to 2014. Because most of the time series does not conform to the characteristics of the normal distribution, so we use three distributions, the normal distribution, t distribution and GED distribution, for each interval data. We get all the stock daily closing price data from the great wisdom software, the number of samples every sample interval may differ from each other because of the opening dates of different countries. We use Excel2007 and Eviews7.0 to do all empirical analysis.

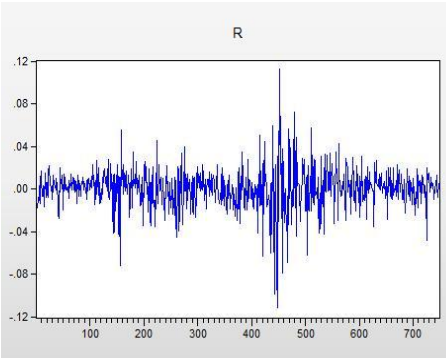
We take the fluctuation of stock index volatility as the main performance of yield sequence; therefore we need to calculate the returns of the seven stock indexes first. We use a formula followed:

$$R_t = \ln P_t - \ln P_{t-1} \qquad (3)$$

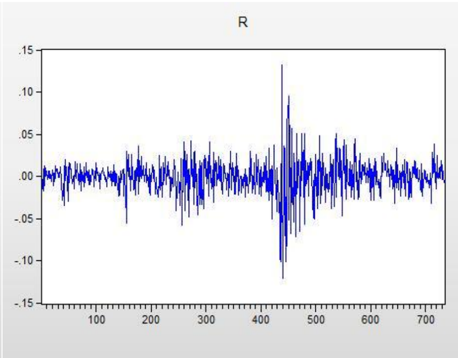
$P_t$ and $P_{t-1}$ present the stock prices of t day and t-1day respectively. $R_t$ is return of stocks on t day. According to the formula above, we get the return series of different intervals.

First of all, we need to find the changing rules of the sample sequences. From the graph of the stock yield observation, we can find that the stock yield sequences show the characteristic of volatility and aggregation. In some period, the yield fluctuation is bigger, but in some periods, the fluctuation seems less volatile, and this presents obvious phenomenon of "in" together. All sample sequence charts show the characteristics of the volatility and stock return sequence clustering. And the volatility of individual countries in

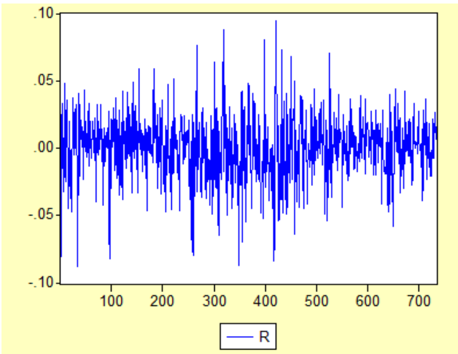
2007-2009 intervals seems significantly bigger than that of in 2004-2006 intervals. In 2010-2014 intervals, however, the volatility is still greater than that of other intervals even the volatility has decreased. So we can find that the stock markets have been more or less affected by the financial crisis in 2008, and after the crisis there was a slower recovery for all the markets. The clustering of KOSPI index and Nikkei 225 index are of significant, while the Shanghai composite index in 2004-2014 interval volatility is relatively fierce, which presents the frequent fluctuations of the Shanghai composite index. We can find from g Figure 1.



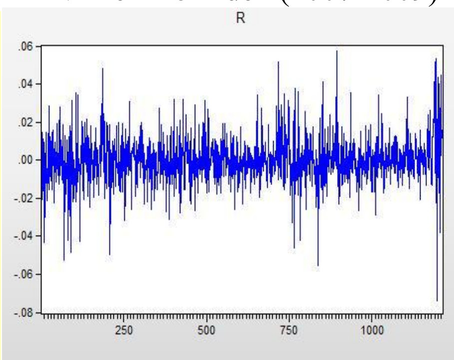
KOSPI index (2007-2009)



Nikkei 225 index (2007-2009)



Shanghai composite index (2007-2009)



Shanghai composite index (2010-2014)

Figure 1 Stock index sequence trend chart

Secondly, we need to do preliminary statistical analysis for each interval series, and get the descriptive statistics of the sequences in Table 1. From the point of the mean, during 2004-2006 intervals, most countries got the highest mean value; only SET index of Thailand had a smaller mean value in 2004-2006 intervals than that of other intervals. For most countries, the annual average mean value is the lowest during 2007-2009. During 2004-2006, SET index of Thailand had the minimum mean value, and Shanghai composite index of China had the maximum mean value. During 2007-2009, the Nikkei 225 index had the average minimum value; Mumbai index of India had the average maximum value. During 2010-2014, Shanghai composite index of China had the average minimum value; PSI index of Philippines had the average maximum value. From the point of the standard deviation, the KLSE index of Malaysia had the smallest value, which means stock market in Malaysia is relatively stable. Shanghai composite index of China had the maximum value among 2004-2006; Shanghai composite index of China had the maximum value among 2007-2009. During 2010-2014, the Nikkei 225 index had the largest average standard deviation. In general, volatility of the Shanghai composite index is obvious more than that of other countries. From the perspective of skewness, the interval sequences have characteristic of asymmetry, including negative skewness means left skewness, and is the positive skewness means right skewness. From the point of kurtosis and J-B statistics, each interval stock index does not conform to the characteristics of the normal distribution, which means the yield sequence has the characteristics of the typical "rush thick tail". Therefore, before we use the EGARCH model, we need to do stationary test yield sequence.

**Table 1 Descriptive statistics of samples**

| Samples | | Mean | Standard Deviation | Skewness | Kurtosis | J-B statistics |
|---|---|---|---|---|---|---|
| **China** | 2004-2006 | 0.00117 | 0.01569 | 0.714452 | 6.593003 | 451.658 |
| | 2007-2009 | -2.95E-05 | 0.025321 | -0.19858 | 4.273107 | 54.17135 |
| | 2010-2014 | 5.85e-05 | 0.012720 | 0.105859 | 6.402498 | 585.9334 |
| **Korea** | 2004-2006 | 0.00075 | 0.012428 | -0.48783 | 4.645656 | 113.4623 |
| | 2007-2009 | 0.000213 | 0.018846 | -0.53557 | 8.776194 | 1072.741 |
| | 2010-2014 | 9.84E-05 | 0.010598 | -0.40657 | 6.870129 | 805.4123 |
| **Japan** | 2004-2006 | 0.000629 | 0.01094 | -0.28762 | 4.094185 | 46.99025 |
| | 2007-2009 | -0.00068 | 0.020864 | -0.35334 | 9.525101 | 1313.828 |
| | 2010-2014 | 0.000402 | 0.013854 | -0.72772 | 7.968007 | 1369.002 |
| **Philippines** | 2004-2006 | 0.000942 | 0.011557 | -0.68408 | 4.415434 | 62.26606 |
| | 2007-2009 | 3.44E-05 | 0.017603 | -0.77516 | 9.959154 | 1548.298 |
| | 2010-2014 | 0.000728 | 0.011035 | -0.64943 | 7.18298 | 971.1988 |
| **Malaysia** | 2004-2006 | 0.000445 | 0.005889 | -0.07243 | 4.863134 | 107.6778 |
| | 2007-2009 | 0.000176 | 0.011071 | -1.22735 | 13.18515 | 3388.925 |
| | 2010-2014 | 0.000252 | 0.005687 | -0.30076 | 5.942539 | 460.0386 |
| **Thailand** | 2004-2006 | -0.000207 | 0.01371 | -1.63629 | 33.28201 | 28295.16 |
| | 2007-2009 | 0.000147 | 0.01695 | -719539 | 8.665052 | 1044.841 |
| | 2010-2014 | 0.000581 | 0.011276 | -0.30748 | 6.519101 | 645.5568 |
| **India** | 2004-2006 | 0.001133 | 0.0147 | -0.98374 | 11.40966 | 2316.872 |
| | 2007-2009 | 0.000308 | 0.022771 | 0.197793 | 7.564005 | 641.841 |
| | 2010-2014 | 0.000375 | 0.010556 | -0.02189 | 3.831858 | 35.53367 |

**4.2 Unit-root test of samples:** Normally, the ADF (Augmen - Dickey Fuller) method and PP (Phillips & Perron) method are used to do unit-root test of yield sequences. In this paper, we use the ADF test method to test if the testing sequence is in line with the unit root process, test results are shown in Table 2. From the table, P values of all the yield series are close to 0, and ADF values are less than the critical value of 1% significance level, which reject the yield sequence unit root of the null hypothesis. Therefore, the yield sequences is not random walk but stable sequences, so that they could be carried out to do the subsequent empirical analysis.

**Table 2： Unit-root test results**

| Samples | | ADF value | P value |
|---|---|---|---|
| **China** | 2004-2006 | -25.98436 | 0.0000 |
| | 2007-2009 | -27.75389 | 0.0000 |
| | 2010-2014 | -35.20012 | 0.0000 |
| **Korea** | 2004-2006 | -26.09881 | 0.0000 |
| | 2007-2009 | -26.90687 | 0.0000 |
| | 2010-2014 | -34.22439 | 0.0000 |
| **Japan** | 2004-2006 | -27.53942 | 0.0000 |
| | 2007-2009 | -28.54232 | 0.0000 |
| | 2010-2014 | -36.07356 | 0.0000 |
| **Philippines** | 2004-2006 | -24.16044 | 0.0000 |
| | 2007-2009 | -23.87960 | 0.0000 |
| | 2010-2014 | -31.18485 | 0.0000 |
| **Malaysia** | 2004-2006 | -24.01852 | 0.0000 |
| | 2007-2009 | -24.09706 | 0.0000 |
| | 2010-2014 | -30.70236 | 0.0000 |
| **Thailand** | 2004-2006 | -30.07251 | 0.0000 |
| | 2007-2009 | -25.23937 | 0.0000 |
| | 2010-2014 | -33.0846 | 0.0000 |
| **India** | 2004-2006 | -21.62134 | 0.0000 |
| | 2007-2009 | -25.5425 | 0.0000 |
| | 2010-2014 | -32.91072 | 0.0000 |

**4.3 ARCH effect:** Known from the analysis above, the yield of each interval sequence has the characteristics of the "back" rush. From the autocorrelation figure and the lag of 20 order regression equation, we can find that most of the sequence of yield has the lagged effect, so before we establish the mean equation, we need to find the proper lag order number of the regression equation. The ARCH - LM lag order inspection results for all the samples are shown in Tables 3 and Table 4 respectively. From the perspective P values, most of the sequences have very obvious ARCH effect, except KOSPI index series from 2004 to 2006, the PSI index from 2010 to 2014 and from 2007 to 2009. So the EGARCH (1, 1) model can be used for subsequent modeling analysis.

**Table 3 Lag orders of sample series**

| | 2004-2006 | 2007-2009 | 2010-2014 |
|---|---|---|---|
| **China** | 6 | 8 | 7 |
| **Korea** | 0 | 6 | 7 |
| **Japan** | 5 | 5 | 9 |
| **Philippines** | 1 | 1 | 1 |
| **Malaysia** | 1 | 1 | 1 |
| **Thailand** | 1 | 2 | 6 |
| **India** | 2 | 8 | 11 |

**Table 4 ARCH-LM Effects of Sample Series**

| Sample series | | P Value（F-statistic/Obs*squared） |
|---|---|---|
| **China** | 2004-2006 | 0.012330/0.012682 |
| | 2007-2009 | 0.000376/0.000430 |
| | 2010-2014 | 0/0 |
| **Korea** | 2004-2006 | 0.1046/0.1043 |
| | 2007-2009 | 0/0 |
| | 2010-2014 | 0.0280/0.0295 |
| **Japan** | 2004-2006 | 0/0 |
| | 2007-2009 | 0/0 |
| | 2010-2014 | 0.1369/0.1717 |
| **Philippines** | 2004-2006 | 0.0003/0.0003 |
| | 2007-2009 | 0.1065/0.1062 |
| | 2010-2014 | 0/0 |
| **Malaysia** | 2004-2006 | 0.0267/0.0267 |
| | 2007-2009 | 0.0001/0.0001 |
| | 2010-2014 | 0/0 |
| **Thailand** | 2004-2006 | 0/0 |
| | 2007-2009 | 0/0 |
| | 2010-2014 | 0/0 |
| **India** | 2004-2006 | 0/0 |
| | 2007-2009 | 0/0 |
| | 2010-2014 | 0/0 |

**4.4 Establishing EGARCH Model:** We use EGARCH（1,1）model，and take the empirical processes of Shanghai Composite Index between 2010-2014 as example of the empirical analysis. First, we establish the mean equation as followed,

$$R_t=0.078871R_{t-7}+\varepsilon_t \qquad (5)$$

Base on the normal distribution, we establish the EGARCH（1,1）model as followed，

$$Ln\sigma_t^2 = w + \beta * \ln(\sigma_{t-1}^2) + \alpha * |\mu_{t-1}/\sigma_{t-1}| + \Upsilon * \mu_{t-1}/\sigma_{t-1}$$

W presents the constant term of the equation, α presents the coefficient of $|\mu_{t-1}/\sigma_{t-1}|$, ϒ presents the coefficient of $\mu_{t-1}/\sigma_{t-1}$, β presents the coefficient of $\ln(\sigma_{t-1}^2)$. Under 1% significant level, all the coefficient estimated are significant. Therefore, we get EGARCH model as followed：

$$Ln\sigma_t^2 = -0.291757 + 0.975824 \ln(\sigma_{t-1}^2) + 0.109186|\mu_{t-1}/\sigma_{t-1}| + 0.025291\mu_{t-1}/\sigma_{t-1} \quad (6)$$

With the same method, we get EGARCH（1,1）models within normal distribution shown in Table 5, within t distribution shown in Table 6, within GED distribution shown in Table 7.

**Table 5 EGARCH（1,1）model with normal distribution**

| Sample series | | w | β | ϒ | α |
|---|---|---|---|---|---|
| **China** | 2004-2006 | -0.307417 | 0.973805 | 0.023966 | 0.120871 |
| | 2007-2009 | -0.366698 | 0.953504 | -0.101928 | 0.024136 |
| | 2010-2014 | -0.291757 | 0.975824 | 0.025291 | 0.109186 |
| **Korea** | 2004-2006 | -1.278587 | 0.867709 | -0.283222 | 0.118522 |
| | 2007-2009 | -0.410435 | 0.964626 | -0.123909 | 0.149925 |
| | 2010-2014 | -0.230888 | 0.983491 | -0.107481 | 0.097077 |
| **Japan** | 2004-2006 | -0.752969 | 0.934493 | -0.141442 | 0.192152 |
| | 2007-2009 | -0.391821 | 0.969826 | -0.124467 | 0.183406 |
| | 2010-2014 | -0.638914 | 0.945706 | -0.070239 | 0.217611 |
| **Philippines** | 2004-2006 | -0.642831 | 0.947940 | 0.008638 | 0.222701 |
| | 2007-2009 | -1.079201 | 0.893400 | -0.154877 | 0.25128 |
| | 2010-2014 | -0.729328 | 0.938460 | -0.12922 | 0.210728 |
| **Malaysia** | 2004-2006 | -0.395763 | 0.972124 | 0.004418 | 0.137955 |
| | 2007-2009 | -0.734519 | 0.941325 | -0.153192 | 0.254334 |
| | 2010-2014 | -0.948932 | 0.924596 | -0.115923 | 0.208748 |
| **Thailand** | 2004-2006 | -1.015244 | 0.885998 | -0.217761 | 0.015063 |
| | 2007-2009 | -0.482962 | 0.963750 | -0.071472 | 0.232095 |
| | 2010-2014 | -0.553418 | 0.956982 | -0.109363 | 0.202802 |
| **India** | 2004-2006 | -1.320371 | 0.870989 | -0.218629 | 0.229556 |
| | 2007-2009 | -0.553797 | 0.951790 | -0.107518 | 0.239740 |
| | 2010-2014 | -0.394900 | 0.966233 | -0.885640 | 0.106998 |

**Table 6 EGARCH（1,1）model with t distribution**

| Sample series | | w | β | ϒ | α |
|---|---|---|---|---|---|
| **China** | 2004-2006 | -0.485244 | 0.953602 | 0.013483 | 0.131303 |
| | 2007-2009 | -0.382125 | 0.953097 | -0.106035 | 0.036510 |
| | 2010-2014 | -0.187034 | 0.986452 | 0.025130 | 0.098070 |
| **Korea** | 2004-2006 | -1.210555 | 0.876182 | -0.288557 | 0.123644 |

| | | | | | |
|---|---|---|---|---|---|
| | 2007-2009 | -0.414613 | 0.964560 | -0.138208 | 0.151070 |
| | 2010-2014 | -0.251623 | 0.981483 | -0.125939 | 0.099610 |
| **Japan** | 2004-2006 | -0.750368 | 0.934642 | -0.144501 | 0.190037 |
| | 2007-2009 | -0.326339 | 0.975861 | -0.125211 | 0.160712 |
| | 2010-2014 | -0.620427 | 0.943490 | -0.102643 | 0.170104 |
| **Philippines** | 2004-2006 | -0.810649 | 0.930386 | 0.002291 | 0.235896 |
| | 2007-2009 | -1.064153 | 0.895569 | -0.125595 | 0.254283 |
| | 2010-2014 | -0.796402 | 0.932793 | -0.120021 | 0.224612 |
| **Malaysia** | 2004-2006 | -0.344946 | 0.977174 | 0.006009 | 0.141999 |
| | 2007-2009 | -0.782580 | 0.934577 | -0.132665 | 0.234065 |
| | 2010-2014 | -0.687867 | 0.948672 | -0.098862 | 0.197595 |
| **Thailand** | 2004-2006 | -0.393315 | 0.964090 | -0.087230 | 0.092448 |
| | 2007-2009 | -0.581761 | 0.953515 | -0.868240 | 0.249156 |
| | 2010-2014 | -0.568954 | 0.955066 | -0.118912 | 0.197609 |
| **India** | 2004-2006 | -1.127127 | 0.892655 | -0.208865 | 0.213045 |
| | 2007-2009 | -0.514361 | 0.954805 | -0.146264 | 0.217817 |
| | 2010-2014 | -0.394150 | 0.966504 | -0.093613 | 0.109644 |

**Table 7 EGARCH（1,1）model with GED distribution**

| **Sample series** | | **w** | **β** | **ϒ** | **α** |
|---|---|---|---|---|---|
| **China** | 2004-2006 | -0.417279 | 0.961327 | 0.018975 | 0.126551 |
| | 2007-2009 | -0.386207 | 0.952376 | -0.106258 | 0.034162 |
| | 2010-2014 | -0.187034 | 0.986452 | 0.025130 | 0.098070 |
| **Korea** | 2004-2006 | -1.214160 | 0.875798 | -0.281599 | 0.121818 |
| | 2007-2009 | -0.416515 | 0.964711 | -0.131394 | 0.151840 |
| | 2010-2014 | -0.241350 | 0.982523 | -0.117166 | 0.098861 |
| **Japan** | 2004-2006 | -0.764145 | 0.933202 | -0.147058 | 0.191258 |
| | 2007-2009 | -0.355017 | 0.973344 | -0.123198 | 0.170505 |
| | 2010-2014 | -0.632898 | 0.943751 | -0.088323 | 0.190298 |
| **Philippines** | 2004-2006 | -0.727847 | 0.938850 | 0.003976 | 0.226385 |
| | 2007-2009 | -1.083213 | 0.893220 | -0.138708 | 0.253463 |
| | 2010-2014 | -0.762110 | 0.935784 | -0.122771 | 0.216606 |
| **Malaysia** | 2004-2006 | -0.367152 | 0.975079 | 0.005721 | 0.140853 |
| | 2007-2009 | -0.760882 | 0.937102 | -0.137285 | 0.237072 |
| | 2010-2014 | -0.806217 | 0.938120 | -0.102917 | 0.203086 |
| **Thailand** | 2004-2006 | -0.639100 | 0.934852 | -0.124307 | 0.080144 |
| | 2007-2009 | -0.538545 | 0.957940 | -0.079807 | 0.240777 |
| | 2010-2014 | -0.547355 | 0.957775 | -0.112438 | 0.201271 |
| **India** | 2004-2006 | -1.265223 | 0.878272 | -0.213764 | 0.228913 |
| | 2007-2009 | -0.532385 | 0.953287 | -0.131448 | 0.226216 |
| | 2010-2014 | -0.391713 | 0.966680 | -0.090259 | 0.108085 |

From the simulation results of leverage effect of EGARCH (1,1) model, we can find that:

a. Estimated values of ϒ in all intervals are not 0, which indicates that the shock of market information is asymmetric. Based on normal distribution, t distribution and GED distribution, we find that ϒ values of Shanghai composite index in 2004-2006 and 2010-2014 intervals are less than zero; ϒ values of PSI index and KLSE index in 2004-2004 interval is not less than 0. In other intervals, the value of ϒ is less than zero, which illustrates that the impact of bad news about the stock market is greater than that of the good news. Bad news of the stock market will cause panic and large fluctuations of the stock market; this also shows the importance of investor's sentiment. The leverage effect simulation results of the three kinds of distribution are the same that the choice of distribution does not change the fact that if there is the leverage effect.

b. During 2004-2006， the impact of bad news for South Korean stock market is the most significant, followed by the impact for India and Thailand, then is the impact of bad news for Japan. The impact of good news for stock markets of China, Philippines and Malaysia is great. During the financial crisis of 2007-2009, the impact of bad news for stock markets of Philippines and Malaysia is the greatest, but the impact to Thailand and India stock markets is the smallest. During 2010-2014, the tolerance of bad news in stock market of Japan is the greatest, but the tolerance of bad news in stock market of Thailand is the weakest. After the financial crisis, the change of defense capabilities in the stock markets changes of Thailand and India is the largest, which indicates the further development of the stock market in Thailand and India. And after the crisis, the stock markets in South Korea, Japan, Philippines and Malaysia have been improved.

**4.5 VaR Calculation and Effectiveness Test:** According to the formulation, we set the initial value of the asset as 1, the holding period as the 1st day, then the formulation could be：

$$VaR=\mu-z_{\alpha}\sigma \quad (7)$$

Within EGARCH model, we get the conditional mean value and the conditional standard deviation series, and degree of freedom for t distribution and GED distribution. Use the formula to calculate the quantile, conditional mean and standard deviation, then we get the VaR series. Since the data are too much, we will not show the values in this paper.

VaR values will be forecasted with VaR method, there would be a certain error, so we need to do the robustness test after the prediction. Under a certain confidence level, if the error is acceptable, then the VaR values will pass the test. If the error deviation is too big, we need to consider the applicability of the model. The robustness test method commonly used is issued by Kupiec (1995), which is also known as LR inspection, the original hypothesis is expressed as the equation followed.

$$LR = -2\ln[(p^*)^N(1-p^*)^{T-N}] + 2\ln[(N/T)^N(1-N/T)^{T-N}] \quad (8)$$

In this formula，T is the actual number of days, N is the number of days for failure, namely the number of days that the actual loss is more than the VaR value. The failure frequency p = N/T, the expected frequency of $p^* = 1 - c$. Under the condition of the null hypothesis, the LR value comply the Chi square distribution with freedom degree of one. If LR value exceeds a certain confidence interval of the critical value, then the null hypothesis will be rejected, which means that this model is not very good fitting. the critical value of 99% confidence interval is 6.635, the critical value of 97% confidence interval is 5.024, the critical value of 95% confidence interval is 3.841, the critical value of 90% confidence interval is 2.706. The LR value of each sample is obtained by this method, and the result of the test has been marked. In this article, only the chi-square test results on the Shanghai composite index and the Philippines were listed.

**Table 8** Chi square test of Shanghai composite index

| Sample series | Distribution | Confidence level | LR |
|---|---|---|---|
| **2004-2006** | N | 0.99 | 1.694165 |
| | | 0.975 | 0.526216 |
| | | 0.95 | 0.476067 |
| | | 0.9 | 0.533578 |
| | T | 0.99 | 8.470976 |
| | | 0.975 | 23.48291 |
| | | 0.95 | 22.32788 |
| | | 0.9 | 13.68604 |
| | GED | 0.99 | 8.470976 |
| | | 0.975 | 7.11038 |
| | | 0.95 | 0.000293 |
| | | 0.9 | 0.07423 |
| **2007-2009** | N | 0.99 | 5.046182 |
| | | 0.975 | 2.45535 |
| | | 0.95 | 3.176488 |
| | | 0.9 | 0.022271 |
| | T | 0.99 | 1.729999 |
| | | 0.975 | 0.248141 |
| | | 0.95 | 1.148361 |
| | | 0.9 | 1.071754 |
| | GED | 0.99 | 1.722912 |
| | | 0.975 | 1.826024 |
| | | 0.95 | 4.385839 |
| | | 0.9 | 0.347813 |
| **2010-2014** | N | 0.99 | 3.47997 |
| | | 0.975 | 8.54E-05 |
| | | 0.95 | 3.238663 |

| | | | |
|---|---|---|---|
| | | 0.9 | 9.152816 |
| | T | 0.99 | 3.36E-05 |
| | | 0.975 | 1.843377 |
| | | 0.95 | 14.05591 |
| | | 0.9 | 21.51245 |
| | GED | 0.99 | 1.205864 |
| | | 0.975 | 0.146727 |
| | | 0.95 | 5.661168 |
| | | 0.9 | 7.358536 |

**Table 9** Chi square test of PSI index

| **Sample series** | **Distribution** | **Confidence level** | **LR** |
|---|---|---|---|
| **2004-2006** | N | 0.99 | 2.4691775 |
| | | 0.975 | 0.35342649 |
| | | 0.95 | 0.00064189 |
| | | 0.9 | 0.69588595 |
| | T | 0.99 | 0.86789203 |
| | | 0.975 | 1.82311815 |
| | | 0.95 | 3.04291593 |
| | | 0.9 | 3.97977841 |
| | GED | 0.99 | 0.34016783 |
| | | 0.975 | 0.0182208 |
| | | 0.95 | 0.09935494 |
| | | 0.9 | 0.33953614 |
| **2007-2009** | N | 0.99 | 6.30906016 |
| | | 0.975 | 0.41343096 |
| | | 0.95 | 0.06846895 |
| | | 0.9 | 1.2538752 |
| | T | 0.99 | 1.79330164 |
| | | 0.975 | 1.09043015 |
| | | 0.95 | 2.82271684 |
| | | 0.9 | 8.08217443 |
| | GED | 0.99 | 1.64972226 |
| | | 0.975 | 0.41343096 |
| | | 0.95 | 0.00869452 |
| | | 0.9 | 0.12972375 |
| **2010-2014** | N | 0.99 | 6.53721724 |
| | | 0.975 | 3.48E+00 |
| | | 0.95 | 0.09469711 |

| | | |
|---|---|---|
| | 0.9 | 0.00082501 |
| T | 0.99 | 4.02E-01 |
| | 0.975 | 1.01910844 |
| | 0.95 | 2.0884623 |
| | 0.9 | 3.58723215 |
| GED | 0.99 | 2.49758141 |
| | 0.975 | 0.43982015 |
| | 0.95 | 0.32123398 |
| | 0.9 | 0.53319974 |

**4.6 The empirical result analysis:** For the Shanghai composite index, the VaR values within normal distribution in each sample series pass the chi square test. In contrast, the Shanghai composite index of 2004-2006 is suitable for the normal distribution. The sample series of 2007-2009 is suitable for the t distribution. The sample series of 2010-2014 is suitable for normal distribution. For the PSI index, the VaR values of each sample series with any of the three distributions pass the Chi square test, especially the sample of 2004-2009, and the EGARCH model can fit the sample series very well. But in comparison, GED distribution can better describe the characteristics of the stock market in the Philippines. For the KLSE index of Malaysia, the VaR values of three sample series pass the Chi square test. For KOSPI index of South Korea, the VaR values of three sample series pass the Chi square test. For the Nikkei 225 index and SET index of Thailand, the VaR – GED values pass the Chi square test. For the SENSEX index of India, the VaR – t values of sample series in 2004-2006 and 2010-2014 pass the Chi square test.

With the analysis, we find that EGARCH (1, 1) model with t distribution and GED distribution can better depict the characteristics of the "back" rush of the yield. In addition to KOSPI index of South Korea, the VaR values of other indexes pass the Chi square test, which shows that the VaR - GED is a good method to predict the stock market risk when the stock market risk is great.

The VaR values of Shanghai composite index in 2007-2009 pass the Chi square test, which means that China is not affected in the 2008 crisis. In contrast, the VaR values of the PSI index, the Nnikkei 225 index, the KLSE index of Malaysia have not past the Chi square test, which suggests that the risk of these countries keep rising during the financial crisis. The samples series of most indexes in 2010-2014 pass the Chi square test except of the Shanghai composite index, which means that the risk has been reduced but recover slowly after the financial crisis.

**5. Conclusions:** In this paper, we use the EGARCH (1, 1) model to do empirical research of market risk in seven stock markets of Asia, and mainly have the following conclusions.

The return series of stock indexes do not abbey a normal distribution, but have obvious peak fat-tailed features. The stock indexes yield presents certain characteristic of volatility and aggregation. And the clustering of KOSPI index and the nikkei 225 index are significant, and the volatility of Shanghai composite index is significant. And the volatility during the financial crisis is significantly greater than that of normal years.

The asymmetry of crisis impact is shown in all the stock markets of the Asian countries. There is leverage of market risk in some Asian countries, which means the impact of bad news of the stock market is greater than that of good news, except for the Shanghai composite index, KLSE index and PSI index. And after the financial crisis, the defense capabilities of the stock markets in Thailand and India become greater.

The results of EGARCH model with t distribution and GED distribution seem better than that with normal distribution. According to the result of chi-square test, when the stock market risk is great, the VaR - GED can predict the stock market risk better. The results of stock markets in Philippines, Japan, Malaysia do not pass the test, which mean that these countries were greatly influenced by the financial crisis. By contrast, the Chinese stock market was not affected by too much during the financial crisis. The VaR - GED or VaR - t results for most countries have passed the test, which have shown the slow recovery after the crisis in these countries.

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