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# TESTING THE ASYMMETRIC VOLATILITY IN THE EMERGING MARKET: E-GARCH MODEL OF THE INDONESIAN BOND MARKET

***MIVTHAHUL RAHMA***
***STUDENT***
***SCHOOL OF BUSINESS***
***BOGOR AGRICULTURAL INSTITUTE***
***BOGOR, INDONESIA***

***NOER AZAM ACHSANI***
***LECTURER***
***DEPARTMENT OF ECONOMICS***
***FACULTY OF ECONOMIC & MANAGEMENT***
***BOGOR AGRICULTURAL INSTITUTE***
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***TONY IRAWAN***
***LECTURER***
***SCHOOL OF BUSINESS***
***BOGOR AGRICULTURAL INSTITUTE***
***BOGOR, INDONESIA***

**ABSTRACT**

*High composition of government bond to total government debt could be seen as an Indonesian government's strategy in obtaining sources of financing with favorable payment scheme. Currently, for about 91% of government bond is being tradable in secondary market. Yet, the increment of tradable bond ownership by foreigners is like two side of coin. It could be beneficially or potentially harmful to Indonesia capital market volatility. This study aims to identify asymmetric return volatility in the Indonesian government bond using E-GARCH model. The results show that the longer maturities bond, the higher its ordo, either in conventional or Islamic bond traded domestically. Besides, the longer maturities conventional bond, increasingly found no asymmetric volatility. Meanwhile for Islamic bond series, found no asymmetric return volatility neither on short, medium nor long term maturities. Moreover, it also found high risk yet low returns on conventional and Islamic bond series which compared based on maturities. Yet, high risk high return applies when comparing between conventional and Islamic bond series. In addition, this study also to identify asymmetric return volatility in the Indonesian government bond traded internationally as further comparison.*

**KEYWORDS**

E-GARCH, asymmetric volatility, Indonesian government bond.

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## 1. INTRODUCTION

Learning from 1998 financial crisis hit Indonesian capital market where huge amount of capital flow out of the market causing illiquidity, bond market was developed since then. Issuing government bond can be said as strategy in exploring sources of financing internally and externally in form of favorable payment scheme. Currently, according data issued by Directorate General of Financing and Risk Management Indonesia, as much 2.733 trillion Indonesia government bonds has been issued to cover deficit in state budget and more than 91% is being tradable in secondary market. Many years goes by, foreign ownership in Indonesia government bond reach 38.09% until now, where most of it on the long-term bond series. Ervina (2014) stated volatility increase with foreign ownership in Indonesia government bond. In addition, for Indonesia government bond traded internationally, an excess of liquidity in international market and an attractive bond return, make it more saleable. This condition should be wary since recovery US economy encourage interest rate hike which can reverse the situation. Instead of incur lower cost of fund, potential risk even lurks.

Volatility measures the magnitude percentage changes either price or return on securities during period observed. Volatility could be either symmetric or asymmetric, yet in financial data hardly found symmetric but asymmetric volatility. Asymmetric volatility explains by Engle and Ng (1993) as negative shocks give more volatility than positive shock. This concept first noticed by Black (1976) and Christie (1982) with leverage effect theory as an explanation of its existence. Another theory called volatility feedback also explains how negative shocks move the market differently from positive shocks (Pindyck 1984 and Campbell and Hentschel 1992). The existence asymmetric volatility mostly can be found during market crashes as decreasing in asset market prices associated with increasing in market volatility (Wu 2001). Knowing the existence of asymmetric volatility can be useful for portfolio selection, risk management, hedging strategies and pricing of financial derivatives such as options and futures (oskooe and shamsavari 2011).

Many studies regarding volatility, asymmetric and its factors triggers have been conducted either in Indonesia or foreign countries, where most of them using stock as an object such as Ajireswara (2014), Cakan et al. (2015), Federova et al. (2014), Oseni and Nwosa (2011), Turnel and Weigel (1992), Kurniawan (2008), Wu (2001), Caporale et al (2014), Aggarwal et al. (1999), and Wulandari (2016). Some studies in foreign countries regarding volatility, asymmetric and its factors triggers were found with bond as an object which conducted by Goeij and Marquering (2006), Evans and Marshall (1998), Huang and Lu (2009), Chee and Fah (2013), and Viceira (2012), while less studies were found in Indonesia. Besides, they were focusing more on macroeconomic factors affecting Indonesia government bond such as conducted by Hariyani (2009), Asih (2013) and Ervina (2014).

The objectives of the study are to identify and analyze the existence of asymmetric volatility by comparing Conventional and Islamic of Indonesia government bond return which categorize based on denomination and maturities where they are traded domestically and internationally.

Main contribution of this study by focusing on Indonesia government bond return by comparing type, denomination and maturities of its series which traded domestically and internationally is to analyze series which can be found asymmetric volatility by using E-GARCH model, whether any series can be combined in order to minimize portfolio risk.

The result of this research could be useful for academicians who is interested to study further on bond market as well as econometrics in analyzing financial data. Moreover, this result could help investors or fund manager in optimizing portfolio allocation. In addition, it could be used as the government's discretion in making decision of bond issuance in terms of type, maturities, denomination and market target which contribute to stabilization in bond market.

The rest of the paper is organized as follows. In section 2 we explain the data and methodology. Section 3 gives empirical results and discuss about financial strategic implementation. Section 4 summarized the research finding and gives concluding remarks.

## 2. DATA AND METHODOLOGY

The data used in this research is daily bond series closing prices obtained from Bloomberg from period January 1st, 2013 to December 31st, 2015. Bond series which observed as shown on table 1:

**TABLE 1: INDONESIA GOVERNMENT BOND SERIES OBSERVED**

| Bond Series | Bond Type | Issuance Date | Maturity Date | Denomination | Market |
|---|---|---|---|---|---|
| **Conventional bond compared to Islamic bond in Rupiah denomination** | | | | | |
| FR0042 | Conventional | 25-Jan-07 | 20 years | Rupiah | Domestic |
| IFR0006 | Islamic | 1-Apr-10 | 20 years | Rupiah | Domestic |
| **Conventional bond compared based on maturities** | | | | | |
| FR0055 | Conventional | 23-Sep-10 | 06 years | Rupiah | Domestic |
| FR0031 | Conventional | 16-Jun-05 | 15 years | Rupiah | Domestic |
| FR0057 | Conventional | 21-Apr-11 | 30 years | Rupiah | Domestic |
| **Conventional bond compared to Islamic bond in US Dollar denomination** | | | | | |
| RI0521 | Conventional | 5-May-11 | 10 years | US Dollar | Global |
| SNI22 | Islamic | 21-Nov-12 | 10 years | US Dollar | Global |
| **Islamic bond compared based on maturities** | | | | | |
| IFR0005 | Islamic | 21-Jan-10 | 07 years | Rupiah | Domestic |
| IFR0002 | Islamic | 26-Aug-08 | 10 years | Rupiah | Domestic |
| IFR0006 | Islamic | 1-Apr-10 | 20 years | Rupiah | Domestic |
| **Islamic bond compared based on market and denomination** | | | | | |
| IFR0002 | Islamic | 26-Aug-08 | 10 years | Rupiah | Domestic |
| SNI22 | Islamic | 21-Nov-12 | 10 years | US Dollar | Global |

The data in table 1 is processed in three steps. This study is to analyze asymmetric volatility on government bond return, so the first step is to transform daily closing price into return. The common way to calculated return as follow:

$$r_{it} = ln \frac{CP_t}{CP_{t-1}} \quad (1)$$

Where CPt is closing price bond series at day t and CPt-1 is closing price bond series at day t-1. The next step is data processing through some test before constructing E-GARCH model. First test is stationarity. Times series data called stationary if mean and variance of its data does not move systematically over time. The null hypothesis is rejected when value of the t-ADF is smaller than critical value means the data stationary and can be used for the next step. Further, using correlogram autocorrelation (ACF) and partial correlation (PCF), best ARMA (autoregressive moving average) model could be looking for. An AR model is one where the current value of a variable y depends upon only the values that the variable took in previous periods plus an error term while MA model is simply a linear combination of white noise processes, so that y depends on the current and previous values of a white noise disturbance term (Brooks 2008). Hereinafter, best ARMA model will be tested first to see whether the ideal condition meet in order to have good estimate also known as blue (best linear unbiased and efficient) assumptions by testing its normality and autocorrelation. Normality is tested by observing probability value of Jarque-Bera to see whether the data distributed normally. Autocorrelation is found when the data is non stationary (Ekananda 2014). This will generate estimate coefficient consistent and unbiased, yet with greater variance causing inefficient estimates that tend to receive null hypothesis. Next test is ARCH LM test to determine whether the data can be processed further using ARCH/GARCH family. If the probability value of R-squared is smaller than the critical values, the null hypothesis is rejected means the ARCH effect exists then E-GARCH model can be constructed.

The E-GARCH model in this research refers to the model developed by nelson (1989) in Ajireswara 2014, which is shown in the equation 2 where the existence of asymmetric volatility is present if $\gamma_r \neq 0$:

$$\log(h_t) = \omega + \sum_{q=1}^{q} \beta_q \log(h_{t-1}) + \sum_{p=1}^{p} \alpha_p \left| \frac{\varepsilon_{t-p}}{\sqrt{h_{t-p}}} - \sqrt{2/\pi} \right| + \sum_{r=1}^{r} \gamma_r \left( \frac{\varepsilon_{t-r}}{\sqrt{h_{t-r}}} \right) \quad (2)$$

In determining best model (p,q) by trial and error combination p (1,2,3) and q (1,2,3). Best model is chosen with akaike information criterion (AIC) and schwarz information criterion (SIC) the smallest. The p value indicates previous variance and q value indicates volatilities. The third step is analyzing return and risk calculated using standard deviation of bond series observed.

## 3. RESULTS AND DISCUSSION

The E-GARCH output on Table 2 has passed ARCH-LM test which means the model chosen free from heteroscedastic or assumption homoscedastic fulfilled. Table 2 shows the estimation results for asymmetric volatility on conventional bond return represented by FR0042 compared to Islamic bond return represented by IFR0006 for Rupiah denomination which traded domestically. Ordo for both series show that current volatility tends to be affected by less recent (t-3) previous variance but differ with previous volatility in which FR0042 as affected by more recent (t-1) volatility, while IFR0006 is affected by (t-3) volatility.

Besides, Table 2 shows the estimation result for comparative asymmetric volatility return based on maturities for Rupiah denomination which traded domestically represented by FR0055 for short term bond, FR0031 for medium term bond and FR0057 for long term bond. Both ordo for FR0055 and FR0031 show that current volatility is affected by more recent (t-1) previous variance and less recent (t-3) previous volatility. On the other hands the longer bond maturities (FR0057), its current volatility is affected by less recent (t-3) previous variance and volatility.

The next estimation results for asymmetric volatility on conventional bond return represented by RI0521 compared to Islamic bond return represented by SNI22 for US Dollar denomination which traded internationally. Ordo for RI0521 shows that current volatility is affected either by more recent (t-2) previous variance or (t-1) volatility than ordo for SNI22 which affected by (t-3) previous variance and (t-2) volatility.

Moreover, Table 2 shows, the higher ordo found with the longer-term Islamic bond series where current volatility long term Islamic bond represented by IFR0006 is affected by less recent (t-3) previous variance and volatility while current volatility short and medium Islamic bond represented by IFR0005 and IFR0002 are affected by more recent (t-1) previous variance and volatility.

The last comparison between Islamic bond in Rupiah denomination traded domestically represented by IFR0002 and in US Dollar denomination traded internationally represented by SNI22 where current volatility IFR0002 is affected more recent (t-1) previous variance and volatility than SNI22 which affected by (t-3) previous variance and (t-2) volatility. From this comparison we can say for current volatility Islamic bond series traded domestically is more recent affected than Islamic bond series traded internationally.

**TABLE 2: E-GARCH OUTPUT FOR INDONESIA GOVERNMENT BOND OBSERVED**

| Variable | (p,q) | ARCH Effect | Asymmetric Parameter | |
|---|---|---|---|---|
| | | | Coefficient | Probability |
| **Conventional bond compared to Islamic bond in Rupiah denomination** | | | | |
| FR0042 | (3,1) | None | -0.141666 | 0.0001 |
| IFR0006 | (3,3) | None | 0.134245 | 0.1515 |
| **Conventional bond compared based on maturities** | | | | |
| FR0055 | (1,3) | None | -0.118892 | 0.0225 |
| FR0031 | (1,3) | None | -0.132803 | 0.0112 |
| FR0057 | (3,3) | None | -0.018820 | 0.4202 |
| **Conventional bond compared to Islamic bond in US Dollar denomination** | | | | |
| RI0521 | (2,1) | None | -0.106669 | 0.0625 |
| SNI22 | (3,2) | None | -0.185245 | 0.0032 |
| **Islamic bond compared based on maturities** | | | | |
| IFR0005 | (1,1) | None | 0.040775 | 0.3975 |
| IFR0002 | (1,1) | None | -0.088498 | 0.3186 |
| IFR0006 | (3,3) | None | 0.134245 | 0.1515 |
| **Islamic bond compared based on market and denomination** | | | | |
| IFR0002 | (1,1) | None | -0.088498 | 0.3186 |
| SNI22 | (3,2) | None | -0.185245 | 0.0032 |

In terms of asymmetric volatility, Table 2 shows that significance negative asymmetric volatility was found in conventional bond return with probability less than 1%. While, in Islamic bond return, statistically did not show asymmetric volatility. Therefore, conventional bond series is more risky than Islamic bond series in Rupiah denomination which traded domestically as it more sensitive to negative information. We presume the causality is series Islamic bond characteristic where in issuing Islamic bond series, underlying asset is needed. While the purposes of issuing conventional bond is for covering deficit state budget. Besides, we also presume that emotional behavior domestic investor with Islamic bond series, makes these securities less traded for capital gain purposes.

Moreover, Table 2 shows the longer maturities conventional bond series will be less asymmetric. Negative asymmetric volatility found on bond return FR0055 for short term bond also on bond return FR0031 for medium term bond with probability significance less than 5%. The findings for comparison which shown by Table 2 are consistent with researches conducted by Evans and Marshall (1998), Goeij and Marqueering (2006) also Huang and Lu (2009) who found significant negative asymmetric volatility in short term bond and in medium term bond where the sensitivity to macroeconomics causing it.

Meanwhile, significance negative asymmetric volatility found both in conventional bond return and Islamic bond return in US Dollar denomination which traded internationally. We presume foreign investor characteristic which probably highly focused on capital gain rather than the long-term investment, therefore no different treatment in both bond types.

As mentioned previously, were caused by the behind reason of issuing Islamic bond series and investor emotional behavior, no asymmetric found in any Islamic bond maturities in Rupiah denomination which traded domestically. Overall, this make Islamic bond series less risky than conventional bond series. The last comparison to reconfirm domestic and foreign investor characteristic to Islamic government bond with different denomination and market.

**TABLE 3: CALCULATION RETURN AND RISK ON INDONESIA GOVERNMENT BOND OBSERVED**

| Bond Series | Mean % | Std. Dev | Skewness | Excess Kurtosis | Normality (p-value) |
|---|---|---|---|---|---|
| **Conventional bond compared to Islamic bond in Rupiah denomination** | | | | | |
| FR0042 | -0.000334 | 161.66 | 0.317555 | 14.03653 | 0.0000 |
| IFR0006 | -0.000312 | 56.13 | 1.337058 | 36.28547 | 0.0000 |
| **Conventional bond compared based on maturities** | | | | | |
| FR0055 | -0.000119 | 671.98 | -1.653893 | 16.84942 | 0.0000 |
| FR0031 | -0.000305 | 193.54 | -0.219681 | 8.990015 | 0.0000 |
| FR0057 | -0.000384 | 59.37 | 0.520502 | 99.72160 | 0.0000 |
| **Conventional bond compared to Islamic bond in US Dollar denomination** | | | | | |
| RI0521 | -0.000135 | 235.12 | -1.336219 | 19.5708 | 0.0000 |
| SNI22 | -0.000142 | 63.38 | -0.995506 | 21.20364 | 0.0000 |
| **Islamic bond compared based on maturities** | | | | | |
| IFR0005 | -0.000144 | 529.24 | -0.74616 | 12.0957 | 0.0000 |
| IFR0002 | -0.000236 | 323.06 | 0.276567 | 16.56821 | 0.0000 |
| IFR0006 | -0.000312 | 56.13 | 1.337058 | 36.28547 | 0.0000 |
| **Islamic bond compared based on market and denomination** | | | | | |
| IFR0002 | -0.000236 | 323.06 | 0.276567 | 16.56821 | 0.0000 |
| SNI22 | -0.000142 | 63.38 | -0.995506 | 21.20364 | 0.0000 |

Return of all bond series over the period observed is negative as the effect of global economic slowdown. Table 3 shows high risk yet low return applies on comparison between conventional and Islamic bond series in Rupiah denomination which traded domestically, where the return higher as -0.000312 for IFR0006 compared to FR0042 as -0.000334, followed by higher risk. Meanwhile, Table 3 also shows that high risk high return applies on comparison based on maturities in conventional bond series. The risk follows its return since the highest risk and return found on short term conventional bond series, and less risky and return received on medium and long-term conventional bond series.

The same return and risk condition applied on the third comparison on conventional bond compared to Islamic bond in US Dollar denomination which traded internationally where higher return as much -0.000135 with higher risk as much 235.12 for RI0521 and lower return as much -0.000142 with lower risk as much 63.38 for SNI22. It also applies on comparison Islamic bond series based on maturities where the short-term Islamic bond represented by IFR0005 has the highest return as much -0.000144, the second higher found on middle term Islamic bond represented by IFR0002 as much -0.000236 and the smallest found on IFR0006 which represent long term Islamic bond. As on returns, on the risk also of having the same sequence, where the shorter bond term followed by higher risk. It could be said that the risk linear with its return. The last comparison shows that Islamic government bond traded internationally has higher return yet lower risk than Islamic government bond traded domestically.

Visual interpretations of asymmetric volatility in Indonesia government bond are presented by figures 1 respectively.

FIGURE 1: REPRESENTATION OF ASYMMETRIC VOLATILITY IN CONVENTIONAL INDONESIA GOVERNMENT BOND

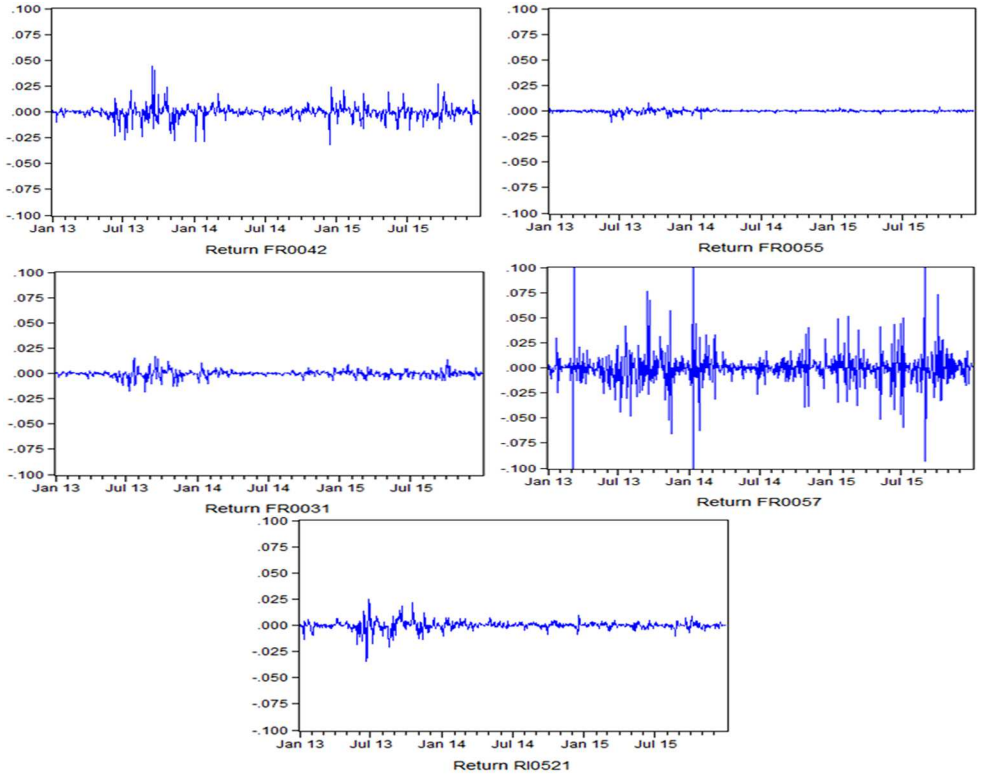
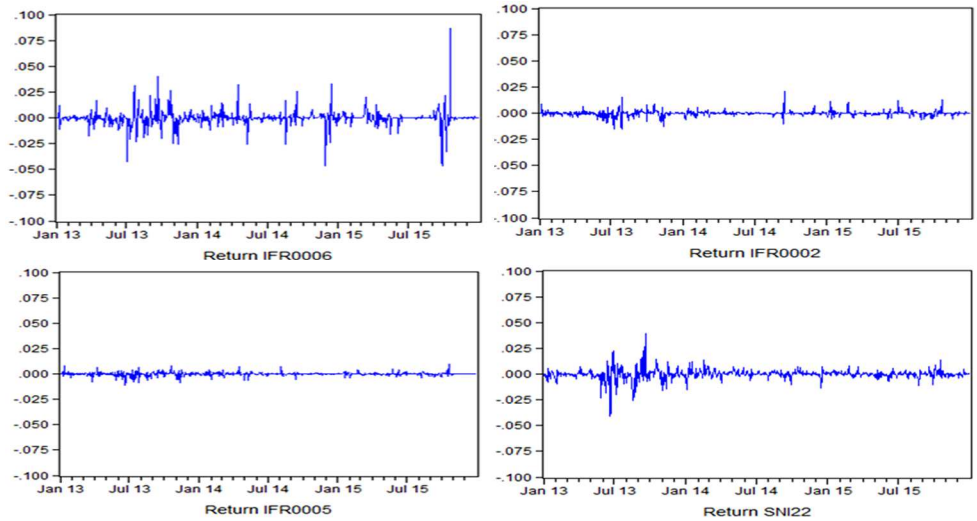



FIGURE 2: REPRESENTATION OF ASYMMETRIC VOLATILITY IN ISLAMIC INDONESIA GOVERNMENT BOND




## 4. CONCLUDING REMARKS

According to explanation above, this study concludes that the E-GARCH asymmetric volatility model for the Indonesian Government Bond in Rupiah denomination which traded domestically shows the longer bond term, the higher ordo it has which makes this current volatility series more sensitive to less recent previous return volatilities and variance. Compared to Indonesia government bond traded domestically, for current volatility series traded internationally is less sensitive to more recent previous return volatilities and variance. Result also shows that significance negative asymmetric volatility returns increasingly found with shorter conventional bond period while there is no asymmetric volatility in any Islamic bond maturities. Therefore, the shorter conventional bond maturities, negative shocks will have a greater impact than positive shocks in the same magnitude. This may explain the majority of foreign ownership in the long-term bond series, namely minimizing risk while getting higher return that emerging market could give. Meanwhile, significance negative asymmetric volatility found both in the Indonesia government bond series in US Dollar denomination which traded internationally.

Interesting findings on Indonesia government bond that high return associated with low risk is shown on comparison between conventional bond and Islamic bond which traded domestically. Contrary condition on comparison between conventional bond and Islamic bond which traded internationally, where high risk high return applies. The same condition of high-risk high return applies on comparison conventional bond as well as Islamic bond based on maturities which traded domestically, where the shorter maturities of bond series, receive the higher risk and return. But, when comparing between Islamic bond series in Rupiah denomination which traded domestically and Dollar denomination which traded internationally, high risk low return applies where Islamic bond series in Rupiah denomination which traded domestically has higher risk yet, lower return. Besides, either in domestic market or international market, Islamic bond is less risky than conventional bond. Therefore, whether in domestic market or international market, either investor or fund manager could combine conventional and Islamic bond series in order to minimize portfolio risk.

Policy implication that could be made based on this research is for government discretion in choosing type, denomination, maturities and market in bond issuance, as stated the purpose of bond issuance in international market for diversify and hedging foreign exchange reserve, yet high speculative also need to be considered.

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