Government Bond Yield Volatility and It's Determinants: The Case of Indonesia Government Bond

Harjum Muharam

Economics and Business Faculty Diponegoro University

harjumuharam@undip.ac.id

Abstract

This research is conducted from gaps of research findings regarding factors influencing government bond yield. The aim of this research is to develop a model of government bond yield determinants and to test hypothesis about the effect of inflation, foreign reserves, local interest rate, stock market return, exchange rate, foreign interest rate, world oil prices, real sector performance, and conditional variances on government bond yield. Time series process and multifactor models are employed. The model combines two approaches called ***Multifactor EGARCH-M Model***. The population is Indonesian government bond, denominating in IDR and has a fixed coupon rate. The sample selected is five years tenor bond. The findings are: (1) Indonesia's government bond yield has volatility clustering as measured by GARCH process; (2) based on adjusted R^2, logL, Akaike Information Criterion (AIC) and Schwarz Criterion (SC), ***Multifactor EGARCH-M Model*** is the best model among six models developed; (3) as a proxy of market risk and default risk, GARCH-M has the biggest effect on its yield followed by non gold reserve; (4) the other variables having influences on government bond yields are: local interest rate, stock market return, exchange rate, foreign interest of rate, and world oil price. Inflation and real sector performance have no effect on government bond yields.

Key Words: yield, government bonds, multifactor model, conditional variance, GARCH.

Introduction

Government bond is a simple financial product: a government as the issuer has an obligation to pay a fixed coupon earlier and pay the principal when the bond matures. Bond prices are based on the calculation of the current value of future cash flows. In the simplest approach, if the future cash flows fixed and guaranteed, the bond's value is the present values of cash flows have been discounted at a certain rate. The interest rate in financial terms is called the yield. Yields on government bonds have become a staple of the attention either by the government as the issuer or by the bond investors. The Government is very concerned with the yield on the bonds are due to the high-low yields reflect the

cost to the government in the repurchase of bonds or the issuance of new bonds. High yield and low volatility returns for investors is a reflection of the return that would be obtained and the risks that must be faced when investing in government bonds.

Movement of government bond yields as adjusted expected return should be relatively stable over time because government bonds have low default risk, Alesina, et al. (1992). Movement of the Indonesian government bond yields show phenomenon as opposed to it. Data of Indonesian government bond yields from 2002 to 2009 showed a high level of volatility and unstable. There are two periods in which volatility of Indonesian government bond yields are very high, in May 2005 the Indonesian government bond yields reached 15.69 % and in October 2008 reached 16.65%, while in May 2007 was the lowest 8.42%. The existence of this phenomenon and the lack of research on the Indonesian government bond yields to be the main reason for this research.

There are two primary theories that widely used in the valuation of financial assets, namely: Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT). CAPM emphasis on the establishment of an efficient portfolio based on mean variance analysis. APT is not emphasized in the formation of an efficient portfolio but emphasizes in determining economic and non - economic variables that affect the price of an asset.

APT has been widely applied to the study of government bond yields, such as Min (1998), Reschreiter (2003), Ericsson and Joel Reneby (2005), Artam (2006), Orlowski and Kirsten (2006), and Alexopoulou et al. (2010). The main problem in the application of APT in research on government bond yields is the determination of the variables that affect yield. According to Azeez and Yonoezawa (2003) no formal theoretical guide in the selection of variables included in the APT model

Much research has been done to analyze the movement and volatility of government bond yields or interest rate term structure. According to Artam (2006), understanding interest rate of term structure is very important both in terms of financial and macroeconomic. On the financial side, forecasting and pricing (yield) is important for the management of risk, particularly for short-term

bond yields (short term rate). Short-term bond yields are the basis in determining the long-term bond yields (long term rate), to perform risk adjustment. From the point of macroeconomic, interest rate term structure provides important information about inflation expectations and real sector activity, and vice versa.

Movement of government bond yields are influenced by many factors, both fundamental factors as well as non-fundamental factors. Fundamental factors include government liquidity, macroeconomic conditions, financial market conditions, and the condition of the real sector. Non-fundamental factors include socio-political conditions, global economic conditions such as interest rates and international oil prices, and the past behavior of the yield movement itself. In the study Min (1998) macroeconomic condition variables that influence government bond yields is inflation rate, terms of trade and the exchange rate of domestic currency against US$. The inflation rate has a positive effect on yield. High inflation suggests that macroeconomic conditions are not healthy and this will increase the risk for investors who invest their funds in government bonds, so investors demanded higher yields on government bonds. Terms of Trade significant negative effect on government bond yields. Rising terms of trade showed an increase in export earnings and make a country's ability to pay its debts for the better and this will reduce the liquidity risk of the government and bring down government bond yields. Currency exchange rates negatively affect the domestic government bond yields. The protection of domestic currency exchange rate at a competitive level will lead to high inflation. High inflation will impact on the decline of economic performance which in turn will lead to an increase in government bond yields.

Haque, et al. (1996) find that the prices of government bonds in developing countries are affected by the ratio of reserves to total imports, the ratio of the balance of payments to GDP, economic growth and inflation. According to Nakayama, et al. (2004) fluctuations in the interest rate of Japanese government bonds is influenced by: (a) Expectations of investors about the changes in the Japanese economy, (b) the movement of interest rates synchronize between Japan and the United States; (c) investors' expectations about monetary policy by the Bank of Japan; (d) hedging strategy that the financial institutions do

in Japan. According to Sachs (1985) important variables that affect risk and the price of securities in the international capital market is the performance of the trade and exchange rate.

Cappiello, et al. (2006) analyzed the behavior of international stocks and government bonds. The results showed that there was a good conditional volatility of stock return and the return on government bonds. Stocks have a higher conditional volatility compared to government bonds. The study also found empirical evidence that stocks respond more strongly to the bad news than government bonds. Ericsson and Joel Reneby (2005), evaluating the maximum - likelihood approach that applied in a structural model of bond prices. Maximum - likelihood approach has several advantages. The first gives the easy of doing derivations distribution estimators, and of the model allows for an alternative way of measuring the price of bonds, and in particular the model calculates a confidence interval about a default that can be applied in credit risk management. Second, it is easy to estimate some model parameters.

Stivers and Sun (2002), conducted a study on the movement of time variation in stock returns and bond together as well as their relationship to the uncertainty of the stock market. This study found there are two contrasting periods. In the first period stock returns and bond returns move together substantially, the average stock return is higher than the average return bonds, and the volatility of stock returns is lower than the bond return volatility. In the second period stock returns and bond returns show negative co-movements, the average bond return is higher than stock returns, and stock volatility is more volatile than bonds.

Orlowski and Kirsten (2006) conducted research on government bond yields of Polish, Hungarian and Czech. This study aimed to analyze the influence of the German government bond yields and the economic fundamentals of each country to the domestic government bond yields. This study concludes that government bond yields of Poland, Hungary and the Czech significantly influenced by the German government bond yields. Economic fundamental variables that have positive effect on government bond yields in these countries are inflation, exchange rate, GDP growth, and both domestic interest rates and

international interest rates (ECB rate). Alexopoulou , et al . (2010) conduct other research on the factors that affect bond yields Eastern European countries that recently entered the European Union. In this study it was found that the factors that influence government bond yields are inflation, exchange rate, interest rate, and stock price index. Inflation has no effect on government bond yields Bulgaria, Czech Republic, Hungary, Romania and Slovakia. Inflation has negative effect on government bond yields of Latvia and Lithuania, while the Polish government bond yields positively affected by inflation. Exchange rate has no effect on government bond yields for Bulgaria, Czech Republic, Latvia, Romania and Lithuania. The exchange rate has a positive effect on government bond yields in Hungary, Poland, and Slovakia. The interest rate has no effect on government bond yields Lithuania and Romania. The interest rate has a positive effect on government yields in Bulgaria, Czech Republic, Latvia, Hungary, Poland, and Slovakia. Stock price index does not affect the government returns in the Czech Republic, Latvia, Lithuania, and Romania, but it has negative effect on government bond yields in Bulgaria, Hungary, Poland, and Slovakia.

This research was conducted from gaps of research findings regarding factors influencing government bonds yields, namely: (1) the effect of inflation on the yields of government bonds, (2) the effect of foreign exchange reserves on the yields of government bonds, (3) the influence of local interest rates on the yields of government bonds, (4) the influence of stock market returns on the yields of government bond, (5) the influence of exchange rate on the yields of government bonds, (6) the influence of foreign interest rates on the yields of government bonds; (7) the influence of world oil prices on yields of government bonds; (8) the influence of performance of the real sector on the yields of government bonds, and (9) the effect of variance volatility on the yirlds of government bonds. Based on problems mentioned above, the aim of this research is to create a determinan model of government bond yields. The model combines time series and fundamental factors approach.

Arbitrage Pricing Theory (APT) and Government Bond Yields

In this study, the model was developed using the approach of arbitrage pricing theory (APT) developed by Ross (1976). APT does not emphasize the establishment of an efficient portfolio but determining economic and non-economic variables that affect the price of an asset. Arbitrage Pricing Theory states that the return of securities is determined by common factors and specific factors related to such securities (Solnik, 1993). Many studies have been conducted to test the APT, both for stocks and bonds, including Antoniou, et al. (1998), Reschreiter (2003), and Dhankar and Esq (2005).

APT can explain a good relationship with the yield on government bonds with the factors that influence it, especially risk factors. As expected returns, government bond yields highly influenced by risk (Gilles and Leroy, 1990). Risks faced by investors in holding government bonds can be sourced from two things, namely: macroeconomic factors and specific factors. Macroeconomic factors that affect all assets in the market and can not be diversified. Specific factors unique to each asset and can be diversified. In the efficient market specific risks can be ignored so that only the asset risk stemming from macroeconomic factors or market risk .

Reschreiter (2003) using the approach of APT (Arbitrage Pricing Theory) in his research on the UK government bond yields. In this study, general factors affecting yields from financial variables and macroeconomic. APT assumes that government bond yields are tenured T at time t (r_{Tt}) is determined by various factors f, so generally the bond return equation can be formulated in the following factors :

$$r_{Tt} = E(r_{Tt}) + \sum_{j=1}^{K} \beta_{ij} f_{jt} + u_{it} \quad \text{.....(1)}$$

where: r_{Tt} is the return of T tenor bond at time t, $E(r_{Tt})$ is the expected bond return T at time t, βij is the sensitivity of (r_{Tt}) to movements of risk factors fjt (j = 1,2 , ... , K), u_{it} is the residual return i at time t that can not be explained by risk factors K. If $E(u_{it}) = E(u_{it}*fjt) = 0$ for each factor j= 1 , 2 , ... K, then equation (1) can be reduced to the expected yield equation as follows:

$$E(r_{Tt}) = \lambda_{0t} + \sum_{j=1}^{K} \beta_{ij}\lambda_j \quad \text{.....(2)}$$

Where : λj is the risk premium associated with factor j and λ_{0t} has beta = 0 so λ_{0t} equal to the risk-free interest rate (R_f). Substituting the expected return equation (2) to factors equation (1), then we get general model of government bond yields as follows :

$$r_{Tt} = \sum_{j=1}^{K} \beta_{ij}(f_{jt} + \lambda_j) + u_{it} \quad \text{.....(3)}$$

If λ is constant for each j = 1,2 , ... K and has a beta equal to zero then the model (3) can be simplified into multifactor models as follows :

$$r_{Tt} = \lambda_0 + \sum_{j=1}^{K} \beta_{ij} f_{jt} + u_{it} \quad \text{.....(4)}$$

where: f_{jt} is a risk factor and u_{it} is the residual return T at time t that can not be explained by risk factors K.

Volatility Risk and Government Bond Yields

Volatility risk in government bonds is the risk arising from high fluctuations in yields. Fluctuations in yield resulted in the uncertainties of cash flows to be received by investors. Batten, et al. (2005) use a GARCH model to capture the differences in the volatility of returns over time and found that government bond yields following the GARCH process. De Goeij and Marquering (2004) analyze the interaction between stock returns and bond returns. They assume that stock returns and bond returns follow a multivariate GARCH process and no effect of asymmetry in the conditional variance and covariance. De Goeij and Marquering finding out that there is conditional heteroskedasticity in the covariance between stock returns and bond returns.

Tahani (2006) analyze the mean reversion and volatility across time using mean reverting GARCH models. The results show that GARCH can explain the volatility of returns well. Lucchetti and Palomba (2008) conducted research on U.S. government bond yields using VAR models by incorporating GARCH variables in the model, the results of their research indicate GARCH variables significantly influence the yields on U.S. government bonds. Other researchers

use the ARCH-GARCH models in research on the volatility of government bond yields are Glabadanidis and Scruggs (2003), Cappiello, et al. (2006).

Pérignon and Smith (2007) developed a comprehensive model for dynamic volatility in the government bond yield curve that includes the level, slope, and curvature (LSC) and the GARCH effect. In this research note that the level of the short rate volatility can be explained by either LSC, besides that there are significant GARCH effect on yields. GARCH models developed can also be used to predict volatility of returns outof sample with excellent results. Balli (2009) conducted fieldwork on the time variation between yields on government bonds European Union countries using multivariate GARCH models. Multivariate GARCH models can well explain volatility in government bond yields European Union countries.

Previous researchers have proved the existence of volatility in government bond yields. Referring to these studies, this research aims to study and examine the volatility of Indonesian government bond yields and modeling the volatility of government bond yield volatility variance approach. Based on Multifactor model in equition (4), government bond yields (r_{Tt}) is a function of risk factors (f_{jt}) and has a residual u_{it}. Engle (1982) use a simultaneous model of the mean and variance to resolve the non-compliance problem assuming constant variance. Estimation of the model (4) give the expected value of yields as follows:

$$\bar{r}_{Tt} = \lambda_0 + \beta_1 f_{1t} + \beta_2 f_{2t} + ... + \beta_{Kt} f_{Kt} \quad \text{.....(5)}$$

and expectations of the residual variance as follow:

$$E_t\left[(r_{it} - \lambda_0 + \beta_1 f_{1t} + \beta_2 f_{2t} + ... + \beta_{Kt} f_{Kt})^2\right] = E_t(\varepsilon_{it})^2 = \sigma^2 \quad \text{.....(6)}$$

This study assumes that the residual variance to follow the GARCH (p,q) developed by Bollerslev (1986), so that the unconditional variance (σ^2_t) can be formulated as follows:

$$\sigma_t^{\,2} = \omega + \sum_{i=1}^{p} \gamma_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \delta_j \sigma_{t-j}^2 \quad \text{.....(7)}$$

Where p>0, q≥0, ω>0, γi≥0 l = 1, 2, ..,q δj≥0 j = 1, 2, ...p

Equation (7) is a model of GARCH (p,q) which allows autoregressive and moving average components in the variance heteroscedasticity. If p=0 and q=1, then equition (7) is GARCH (0,1) or first order ARCH. If all δj values equal to zero, then the model GARCH (p,q) is equivalent to the model of ARCH (q). Equition (4) and (7) are the basic model in this study to estimete both the average yield (mean) and its variance. This study also aimed to examine the effect of volatility on yields, therefore the lag of residual variance (δσ2t-1) or GARCH-M will also be tested on the equition (4).

Fundamental Risks and Government Bond Yield

Yields as a risk adjusted discount rate is theoretically subject to the rules of the risk-return relationship as defined in the Arbitrage Pricing Theory and Multi- Factor Model. When the risk is high, the return demanded by investors will be high and will decrease as low risk. The main problem in the application of Arbitrage Pricing Theory (APT) in government bond yields research is the determination of risk factors that affect yields. According to Azeez and Yonoezawa (2003) no formal theoretical guide in the selection of variables in the model APT.

Default risk is the risk that the issuer can not meet its obligations to pay interest and principal of bonds that have matured (Fabozzi, 2007). Defaulted on government bonds barely breathing occurs. This is because if there are bonds that mature and the government does not have the funds to pay the interest and principal of the bonds, the government will do a rollover on such bonds or issues new bonds with more attractive coupon for replacement. Nevertheless the government bonds have default risk. Default on government bonds known as outright default (Alesina, et al., 1992). Default risk will be reflected in the yield demanded by investors to keep investing their funds in government bonds . Investors will ask for higher yields at higher risk of default and will lower yields prompted if default risk is reduced.

Factors that may increase the risk of default on government bonds is a liquidity crisis. Foreign exchange reserves is one measure of the level of government liquidity. Foreign exchange reserves will lower the risk of default, the more foreign exchange reserves held by the government will lower the risk of default, and conversely the lower the foreign exchange reserves held by the government, the greater the risks of default. Haque, et al. (1996) found that foreign exchange reserves is important factor that influence government bond yields. This study is supported by the Sun (1998), Fiess (2003), Vargas (2004), and Diebold , et al. (2006).

Other risk factors that affect government bond yields is interest rate. Diebold, et al. (2005) conducted a study on the influence of domestic interest rates on government bond yields. Diebold and his colleagues concluded that the domestic interest rate has a positive effect on government bond yields. Two others research give the same results, Nakayama, et al. (2004) and Diebold, et al. (2006). Based on the discussion in front of it can be concluded that the yields on government obligasai (r_T) is determined by the level of interest rate risk as measured by changes in market interest rates (r_m) . At the time of interest rate risk is high then the government bond yields will be higher , and vice versa when the interest rate risk is low, will also yield lower.

Inflation risk on government bonds due to variations in the value of cash flows received by investors as a result of inflation. The real value of cash flows received from fixed income investments such as government bonds will fall if there is inflation, therefore the price of government bonds will fall and the yield will rise. Research conducted by Alesina, et al. (1992) showed a positive effect of inflation on government bond yields. Other researchers gave the same conclusion is Haque, et al. (1996) , Min (1998) , Vargas (2004) , and Diebold, et al. (2006) .

A change in international interest rates will be followed by changes in domestic interest rates and these changes will affect the value of the cash flows that will be received by investors from investing in government bonds. Research conducted by Calvo, et al. (1993), Frankel (1994), Dooley, et al. (1996) and Barr and Pesaran (1997), concluded that the changes in international interest rates has a positive effect on government bond yields.

A changes in the performance of the real sector can also be a risk factor for government bonds. It can be explained that at the time of high real sector activity both businesses and individual companies experiencing shortage of funds for investment and this has resulted in high demand for funding. The high demand for funding resulted in an increase in interest rates. The expectation of the increase in interest rates will be responded by the government bond market with increased yields. Hu (1993) conducted a study on the relationship of the performance of the real sector of the government bond yields, in this study Hu found that there is a positive influence on the performance of the real sector returns . Other researchers who support the research and Zeynep Hu is Chauvet (2009) and Ahmad, et al . (2009).

Return of Substitution and Complementary Products and Government Bond Yields

According to Arbitrage Pricing Theory, financial markets are perfectly competitive and interconnected without friction (Gultekin and Richard, 1984). The implication of this interconection is the relationship between the price of the stock market, forex market and commodity markets with the bond market. It is also in accordance with the law of one price where the price of the assets that have proximity will affect each other. Relationships between financial assets can be substituted and may also complementary. If the relationship is a substitution then increase the return of an asset will result in deterioration in return on other assets . If the relationship is complementary to the increase in the return of an asset will increase another asset returns.

Stocks and government bonds are substitutes , so that an increase in the stock market return will result in a decline in government bond yields. The results of research by Alexopoulou, et al. (2010) in Bulgaria, Hungary, Poland, and Slovakia show that the stock price index has negative effect on government bond yields.

Other factors that also determine the level of government bond yields is the foreign exchange market performance, Fabozzi (2007). Foreign exchange is a

financial product that is complementary to government bonds. Incrising of forex market return as measured by the exchange rate will increase government bond yields. Decline in the exchange rate will lower government bond yields. Alexopoulou , et al . (2010) conduct other research on the factors that affect bond yields in Eastern European countries that recently entered the European Union . In this study it was found that the exchange rate has a positive effect on government bond yields. The results support previous research conducted Sachs (1985), Min (1998), Fiess (2003), and Vargas (2004).

Commodity markets is also associated with the government bond market. Commodity market has complementary relationship with government bond markets. Improved performance of the commodity markets will improve the performance of the government bond market. Decline in commodity market performance will lower government bond yields. In this study the performance of the commodities markets proxied with world oil prices. Increase in world oil prices (po) will increase government bond yields (rT), and a decline in world oil prices would lower government bond yields. Research conducted by the Sun (1998) and Min (1998) suggests a link between the world oil price with government bonds yields. Sun and Min's research support previous research conducted by Goodwin (1986) and Dotsey and Reid (1992).

Data and Sample

The populations in this research are Indonesian government bonds, denominating in IDR and having fixed coupon rate. Purposive sampling method was used in this research with the following conditions: (1) the bond has long time to maturity, (2) the bond has a long data series, and (3) the bond has high volatility yields. Under these provisions, the sample selected was five years tenor bond. The bond has the following characteristics: (1) the bond has five years time to maturity, (2) the bond has ninety six monthly data series (January 2002 to December 2009), (3) the bond has high volatility yields, where the highest value is 16.66% and the lowest is 8.42%. The average value of the yield is 11.35% with 1.73% standard deviation.

Empirical Result

There are six models developed in this study: multifactor GARCH model, multifactor GARCH-M model, multifactor TGARCH model, multifactor TGARCH-M model, multifactor EGARCH model, and multifactor EGARCH-M model. Models are evaluated using adjusted R^2, logL, Akaike Information Criterion (AIC) and Schwarz Criterion (SC), and the result shows that the multifactor EGARCH-M model is the best model. The model has biggerst value of adjusted R^2 dan logL, and has smallest value of AIC and SC.

Both In sample and out of sample prediction values from multifactor EGARCH-M model is accurate. The accuracy of model prediction showed by the values of MAE, MAPE, and RMSE. MAE values of in sample prediction are 0.7033 or 7 bps, MAPE values are 5.8% or 5.8 bps, and the RMSE values are 0.9284 or 9 bps. In sample prediction errors possibility of the model are 7 bps. MAE values for out of sample prediction are 0.4269 or 4 bps, MAPE values are 4.6% or 4 bps, and RMSE values are 0.5036 or 5 bps. Out of sample prediction error for the model are 5 bps.

The yields of government bonds have conditional variances and having greatest influence on the yields of government bonds among other variables. The results support the concept of Autoregressive Conditional Heteroscedasticity (ARCH) and GARCH (Generalized Autoregressive Conditional Heteroscedasticity) which originally rose by Engle (1982) and Borreslev (1986). Non-gold foreign exchange reserves have significantly negative effect on the yields of government bonds. These results prove the theory of "outright default" raised by Alesina *et al.* (1992). Alesina stated that government bonds have default risk. A country with good liquidity has low default risk on its bonds and otherwise a country with poor liquidity has high default risk on its bonds. The higher the risk the higher the yields.

Local interest rates have significantly positive effect on the yields of government bonds. The result proved Preferred Habitat Theory (Elton, *et al*. 2003, p. 506). Based on this Preferred Habitat Theory, local interest rate changes will affect government bond yields, this is because government bonds have a

fixed coupon until maturity and cannot be changed. Increasing in local interest rates will lower the relative cash flow received by investors from investing in government bonds. In these conditions, investors would require compensation by requiring higher yields. The results of this study also support the work of Nakayama, *et al* (2004), Diebold *et al.* (2005), and Diebold, *et al.* (2006).

The returns of the stock market have a significant negative effect on the yields of government bonds. These result proved the theory of portfolio and Arbitrage Pricing Theory (Markowitz, 1952). Markowitz stated that the investor always faced two things, namely the expected returns and risks. Bonds are the complement to the shares in an investment portfolio. At the time of good market performance, investors will increase the amount of funds invested in stocks and bonds. Increasing of the demand of the bonds will decrease the yields. At the time of the performance of the stock market declines, investors will reduce the amount of funds invested in stocks and bonds. Decreasing of the demand of the bonds will increase the yields. Arbitrage Pricing Theory states that the stock market and bond market is interconnected; if there are price changes in one market it will affect other markets. At the time of stock market performance increases, the performance of the bond market will also increase. Improved performance of the bond market is shown by the price increase or decrease in yield.

World oil prices have positive influence on yields of government bonds. The results support the work of Gisser and Goodwin (1986) and Dotsey and Reid (1992) which stated that the change of world oil price will shock the economy of a country. The change of world oil prices is a signal to the merits of future economic conditions, therefore, investors will respond if there are changes in world oil prices.

Conclusions

Foreign exchange reserves have negatively effect on the yields of government bonds. In practical terms this means that if the liquidity of a country's troubled which shown by the decrease in non-gold reserves then the yields of government bonds will rise and the values of investments will decline. For this reason, in managing the portfolio investors should pay attention to the movement

of foreign exchange reserves. Investors should also look at the movement of local interest rates and world oil prices in managing the portfolio of government bonds since the two variables are positively affected the yields of government bonds.

The results of this study indicate that stock market returns adversely affect the yields on government bonds. There are two implications of these findings; the first investor can make the stock as an investment instrument replacement in case of decrease in yields on government bonds and vice versa; secondly investors can make the stock and government bonds as constituting an investment portfolio to minimize risk at the specified portfolio expected return or maximize the return on a particular level of risk.

The results of this study indicate that the movement of government bond yields is not smooth, at certain periods the movement has high fluctuation or volatility. This finding means that government bonds are a risky investment instruments, the higher the volatility of yields, the greater the risk of the bonds. Investors should consider this risk in their investments.

A high rate of yields means the cost to be borne by the government on the issuance of bonds will be high and it is becoming a burden on state finances. For that reason the Debt Management Office (DMO) should pay attention to the foreign exchange reserves, interest rates, stock market returns, and world oil prices in determining the timing and the amount of bonds to be issued. DMO should also minimize volatility of government bond yields movements as this will increase the investment risk for investors. Investor will compensate the high risk on government bonds with high yields and this will increase the cost to be borne by the government.

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Appendix 1: Estimation Output of Multifactor-GARCH Models

	M-GARCH	**M-GARCH-M**
Mean Equition	Coefficient	Coefficient
GARCH-M		0.954048***
Foreign Reserve	-0.162457***	-0.132042***
Domestic interest of rate	0.279276***	0.304331***
Inflation rate	-0.065851	-0.123472
FED rate	-0.498442***	-0.27836***
Industry Production Index	-0.000641	0.007303
Capital market index	-0.02804***	-0.047635***
Foreign Exchange Rate	0.000696***	0.000584***
WTI	0.054115***	0.044017***
C	6.934479***	4.895687***
Variance Equation		
C	0.087922	0.026135
RESID(-1)^2	0.999136	0.537356***
RESID(-1)^2*(RESID(-1)<0)		
GARCH(-1)	0.110222	0.545773***
C(10)		
C(11)		
C(12)		
C(13)		
C(14)		

Independent Variable: government bond yield
***)significant at alfa 1%
**)significant at alfa 5%
*)significant at alfa 10%

Appendix 2: Estimation Output of Multifactor-TGARCH Models

	M-TGARCH	**M-TGARCH-M**
Mean Equition	Coefficient	Coefficient
GARCH-M		1.255498**
Foreign Reserve	-0.162431***	-0.160374***
Domestic interest of rate	0.279323***	0.297929***
Inflation rate	-0.065841	-0.1244
FED rate	-0.498432***	-0.396559***
Industry Production Index	-0.000602	0.0061
Capital market index	-0.027987***	-0.045632***
Foreign Exchange Rate	0.000696***	0.000294***
WTI	0.054109***	0.059956***
C	6.935104***	8.403858***
Variance Equation		
C	0.087593*	0.072783
RESID(-1)^2	0.994342***	0.572841**
RESID(-1)^2*(RESID(-1)<0)	0.012895	-0.097528
GARCH(-1)	0.110282	0.353271***

Independent Variable: government bond yield
***)significant at alfa 1%
**)significant at alfa 5%
*)significant at alfa 10%

Appendix 3: Estimation Output of Multifactor-EGARCH Models

	M-EGARCH	**M-EGARCH-M**
Mean Equition	Coefficient	Coefficient
GARCH-M		2.844479***
Foreign Reserve	-0.158124***	-0.119855***
Domestic interest of rate	0.281473***	0.380566***
Inflation rate	-0.0535	-0.0375
FED rate	-0.491362***	-0.47378***
Industry Production Index	0.0015	0.0130
Capital market index	-0.022451***	-0.051137***
Foreign Exchange Rate	0.000634***	0.000363**
WTI	0.052666***	0.043393***
C	7.117749***	5.118225***
Variance Equation		
C(10)	-1.747073***	
C(11)	1.799602***	-0.325017**
C(12)	-0.0827	-0.45654***
C(13)	0.691327***	0.612884***
C(14)		0.360974***

Independent Variable: government bond yield
***)significant at alfa 1%
**)significant at alfa 5%
*)significant at alfa 10%

Appendix 4: The Value of Adj. R^2, Log Likelihood, AIC, dan SC for all Models

No.	Model	Adj. R^2	LogL	AIC	SC
1.	Multifaktor-GARCH	0.714349	-104.9758	2.436996	2.757540
2.	Multifaktor-GARCH-M	0.778088	-97.10005	2.293751	2.641006
3.	Multifaktor- TGARCH	0.710871	-104.9754	2.457821	2.805077
4.	Multifaktor-TGARCH-M	0.797186	-94.14912	2.253107	2.627074
5.	Multifaktor- EGARCH	0.705858	-100.9179	2.373289	2.720545
6.	***Multifaktor-EGARCH-M***	***0.832689***	***-78.26049***	***2.050233***	***2.439092***