The effect of inflation, US bond yield, and exchange rate on Indonesia bond yield

Achlanudin Yusuf*; Ahmad Danu Prasetyo

School of Business and Management, Institut Teknologi Bandung, Indonesia

**To whom correspondence should be addressed. Email: achlanudin_yusuf@sbm-itb.ac.id*

Abstract
Indonesia sovereign bonds are investment graded bonds, therefore, it will have global exposure and it will be more interlinked with global market condition. The purpose of this research is to examine the impacts of US bond yield, exchange rate, and inflation on Indonesian bond yield. Our result conclude that based on Vector Error Correction Model there are long run causality from inflation, US 10 year bond yield, and USD/IDR exchange rate to Indonesia 10 year bond yield. There are also short-run causality from inflation and US 10 year bond yield to Indonesia 10 year bond yield. Based on impulse response function, Indonesia 10 year bond yield respond permanently to changes in US 10 year bond yield. Based on Granger causality we also reveal that inflation and US 10 year bond yield can cause Indonesia 10 year bond yield. US 10 year bond yield has a larger impact than inflation when it comes to affecting Indonesia 10 year bond yield.

***Keywords**: Inflation, Bond yield, Exchange rate, Government bonds*

JEL classification: E44, G23

INTRODUCTION

Indonesian government requires a lot of funds to fulfill public services. The gap between government revenue that derived from tax and government expenditures will leads to budget deficit. This deficit on government budget resulted in the needs to seek financing by issuing government bonds.

Since May 2017, for the first time since the Asian financial crisis 1998, Indonesia's government bonds are rated investment grade by all three major credit rating agencies, S&P, Moody's, and Fitch. It means global fund managers will watch Indonesian market closely, especially its sovereign bond market. Investment grade also means Indonesian financial market condition will be more interlinked with global market condition.

Spillover from US financial markets to domestic sovereign market has been studied by various researchers. Hsing (2015) in Spain revealed that the Spanish government bond yield is positively associated with the US 10 year government bond yield. By using impulse response function to measure shock effects from the US government bonds term premium to Latin American government bonds term premia, Espinosa-Torres et al. (2016) found that the responses are larger for Brazil and Colombia whereas Mexico shows the lowest responses.

Impact of The Fed tapering from its quantitative easing on emerging markets also has been emphasized by some researchers. Fong, Li, & Sze (2016) revealed that there are spillovers between the US and emerging markets because of US monetary tightening such as tapering off quantitative easing by The Fed. Belke, Dubova, & Volz (2016) found that government bond yields in emerging Asia affected significantly by changes in the United States and Eurozone bond yields. Various global external shocks such as volatility index, fuels, 3 month treasury bills, credit default swap, gold price, and Brent oil are very significant in determining bond yield in emerging market (Akinsola, 2018).

Inflation rate affect how much real interest will be received from the coupon as Fisher (1930) argued that the real interest rate equals the nominal interest rate minus the expected inflation rate. Hsing (2015) revealed that the Spanish government bond yield is positively associated with the expected inflation rate. Schaeffer & Ramirez (2016) examined co-movement of European sovereign bond yields and they concluded that the yields move together over time and inflationary shocks are transmitted quickly from country to country in Europe. Ouadghiri, Mignon, & Boitout (2015) found that by using intraday data as an event study, the main bond market mover is based on inflation indicators.

Exchange rate is suspected to be the main catalyst in determining bond yield. Arshad, Muda, & Osman (2017) found that in the long run, there is a strong relationship between oil prices and exchange rate on the yield of sovereign bond and sukuk in Malaysia. Gadanecz, Miyajima, & Shu (2014) found that yield as compensation for holding emerging market local currency government bonds depend on the exchange rate volatility. The impact of exchange rate volatility become higher since 2013 when Federal Reserve started to taper its quantitative easing.

Based on the literature review as we stated before, there are various research about how inflation, US bonds market, and exchange rate will affect bond yield in emerging market. However, in Indonesia research about that topics are very limited. Yuliawati & Suarjaya (2017) revealed that by using linear regression, inflation have an insignificant effect on bond yields. Manurung et al. (2017) found that Indonesia government bonds yield curve is determined by liquidity factors, macroeconomic factors, external factors, and market risk factors.

The aim of this research is to examine the impacts of US bond yield, exchange rate, and inflation on Indonesian bond yield. We do this research with the newest available data by using monthly data start from January 2009 to December 2018. We have novelty and scientific contributions from this research. First, there are no academic research about how US bond yield can affect Indonesia bond yield. Second, we use Vector Error Correction Model (VECM) as econometric tools that are the best model for these variables and go further with impulse response function and Granger causality under VECM environment.

METHOD

Vector error correction model (VECM)

In this research, a Vector Error Correction Model (VECM) is employed to investigate the complexities of the dynamic connections from US 10 year bond yield, inflation, and exchange rate to Indonesia 10 year bond yield. The regression equations of the VECM z_t for an $m \times 1$ vector of I(1) variables is as follows:

$$\Delta z_t = -\Pi z_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \, \Delta z_{t-1} + d + \epsilon_t \quad \text{.......................................(1)}$$

Where *k* is the number of lags in the unrestricted Vector Auto Regression (VAR) representation of z_t , *d* is an *m* vector of deterministic terms, Π is restrictions on the rank of the long-run matrix, and Γ_i is restrictions on the short-run dynamic coefficients. A negative and significant coefficient of the VECM ($-\Pi z_{t-1}$) shows that long run relationship exists between independent and dependent variables.

Variables

All variables are monthly data from Januari 2009 to December 2018. The variables explanations are as follows:

Table 1 . Variables descriptions

Variable code	Description	Source
ID10	Indonesia 10 year bond yield	Investing.com
CPI	Consumer Price Index as a proxy of inflation	Bank Indonesia
US10	US 10 year bond yield	Investing.com
USDIDR	Exchange rate USD/IDR	Investing.com

From VECM, we analyze impulse response function and Granger Causality under VECM environment. Based on impulse response functions, we examine the interactive response between shock from CPI, US10, and USDIDR to ID10. In Granger Causality, we examine not only correlation among variables but also the causality among variables.

RESULTS AND DISCUSSION

Descriptive statistics

Before we conduct deeper analysis, we can gather some information based on descriptive statistics in Table 2. Besides we compute minimum, maximum, and average value of the variables, we also compute standard deviation of the variables based on its monthly return. We found that US10 is the most volatile variable with standard deviation 9.3% and CPI is the least volatile variable with standard deviation 0.5%.

Table 2. Descriptive statistics

Variables	Min	Max	Average	Std.Dev.
ID10	5.17	14.17	7.82	6.4%
CPI	71.09	112.09	91.44	0.5%
US10	1.45	3.84	2.48	9.3%
USDIDR	8508.00	15227.00	11452.63	2.4%

Source: Bank Indonesia, Investing.com (author's calculation)

Stationarity test & lag selection

Stationarity test is a very important technique in time series analysis as time series data tend to have a unit root (its mean and variance are not constant). This phenomenon occurs because a trend in time series data is very common. We conducted the stationarity test based on Augmented Dickey-Fuller/ADF test. If the data has a unit root, it means the data has a trend or non-stationary. On the other hand, if the data does not have a unit root, it means the data does not have a trend or stationary. Null hypothesis of ADF test is the data has a unit root. Precondition of the VECM are variables must be non-stationary at level but when we convert all the variables into first differenced then they will become stationary. Or in other words, the variables must integrated of the same order.

Table 3 . Stationarity test

Level			First Differenced		
Variables	Probability	Stationarity	Variables	Probability	Stationarity
ID10	0.0544	Non-stationary	ID10	0.0000	Stationary
CPI	0.9531	Non-stationary	CPI	0.0000	Stationary
US10	0.2682	Non-stationary	US10	0.0000	Stationary
USDIDR	0.9537	Non-stationary	USDIDR	0.0000	Stationary

Based on the ADF test in Table 3, the variables are non-stationary at level and stationary at first differenced or the variables are integrated of the same order.

Table 4 . Lag selection

Lag	SC	HQ	Lag	SC	HQ
0	26.56663	26.50894	5	17.53318	16.32154
1	16.01990*	15.73142*	6	17.93542	16.49299
2	16.35566	15.83639	7	18.25628	16.58307
3	16.70557	15.95551	8	18.75815	16.85414
4	17.21645	16.23560			

For lag selection, we use Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) in Table 4. Based on SC and HQ, the most optimum lag for the model is lag 1. Therefore, we use lag 1 for this model development.

Johansen cointegration test

As a long-term relationship was expected from the variables, we conduct Johansen cointegration test. Rejection of the hypothesis at the 0.05 level.

Table 5 . Unrestricted cointegration rank test (trace)

Hypothesized No.of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.225955	60.31321	47.85613	0.0022
At most 1*	0.176776	30.09040	29.79707	0.0463
At most 2	0.053795	7.136185	15.49471	0.5619
At most 3	0.005167	0.611256	3.841466	0.4343

Table 6 . Unrestricted cointegration rank test (Maximum eigenvalue)

Hypothesized No.of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.
None*	0.225955	30.22282	27.58434	0.0224
At most 1*	0.176776	22.95421	21.13162	0.0274
At most 2	0.053795	6.524930	14.26460	0.5468
At most 3	0.005167	0.611256	3.841466	0.4343

Based on trace test and maximum-eigenvalue, there are two cointegrating equations for this model development. Therefore, we conclude that there is suspected long-term relationship between those variables.

VECM analysis

As there are two cointegrating equations, therefore, we use Vector Error Correction Model (VECM). The model for ID10 as a dependent variable is as follow:

$$D(ID10) = C(1)*(ID10(-1) - 1.08875747496*US10(-1) - 0.0001426538576107*USDIDR(-1) - 3.4510797025) + C(2)*(CPI(-1) + 0.445066273945*US10(-1) - 0.00579108467585*USDIDR(-1) - 26.3629659749) + C(3)*D(ID10(-1)) + C(4)*D(CPI(-1)) + C(5)*D(US10(-1)) + C(6)*D(USDIDR(-1)) + C(7)$$

Overall, the model is reliable as R-squared is quite high at 28.75% and probability of F-statistics is very significant (below 5%). We can see that in C(1) or coefficient of cointegrating model, the coefficient is negative (-0.295118) and its corresponding probability is significant at 0.0014 which is below 0.05 significant level. We also call C(1) as error correction term or speed of adjustment towards equilibrium. Because C(1) is negative and significant, then we can say that there is a long run causality from CPI, US10, and USDIDR to ID10.

Table 7 . Model characteristics

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.295118	0.090082	-3.276096	0.0014
C(2)	-0.030655	0.020245	-1.514215	0.1328
C(3)	-0.122968	0.108481	-1.133550	0.2594
C(4)	0.189417	0.093135	2.033781	0.0444
C(5)	0.443136	0.198435	2.233152	0.0275
C(6)	-8.74E-06	0.000192	-0.045527	0.9638
C(7)	-0.122033	0.051232	-2.381986	0.0189
R-squared	0.287469			
Adjusted R-squared	0.248954			
S.E. of regression	0.424319			
Sum squared resid	19.98514			
Log likelihood	-62.66871			
F-statistic	7.463796			
Prob (F-statistic)	0.000001			

Because there is only one lag, therefore, there is no need to do Wald test. We can see short-run causality directly from table x. Probability of C(4) or coefficient of CPI is 0.0444 and below 0.05 significant level. Therefore there is a short-run causality from CPI to ID10. Probability of C(5) or coefficient of US10 is 0.0275 and below 0.05 significant level. Therefore there is also a short-run causality from US10 to ID10.

Residual diagnostic

After having the model, the model is good enough if it passes residual diagnostic tests. There are three main residual diagnostic tests, namely serial correlation test, heteroskedasticity test, and normality test. The residual must have no serial correlation, no heteroscedasticity, and normally distributed.

Table 8 . Breusch-Godfrey serial correlation LM test

F-statistic	0.412550	Prob. F(1,110)	0.5220
Obs*R-squared	0.440901	Prob. Chi-Square(1)	0.5067

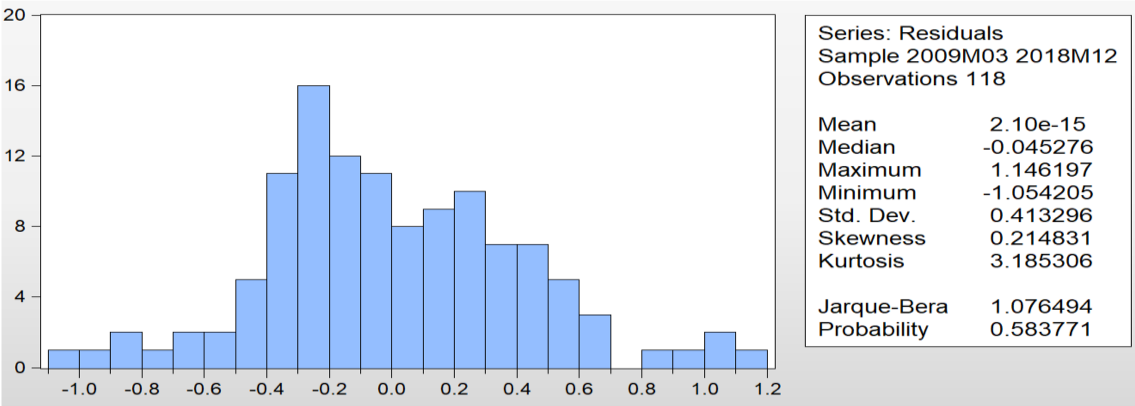
Null hypothesis of Breusch-Godfrey serial correlation LM test is there is no serial correlation. Based on the probability of Chi-Square we can see that the probability (0.5067) far beyond 0.05 level. Therefore, we accept null hypothesis, or there is no serial correlation.

Table 9 . Breusch-Pagan-Godfrey heteroskedasticity test

F-statistic	1.201161	Prob. F(8,109)	0.3051
Obs*R-squared	9.559927	Prob. Chi-Square(8)	0.2973
Scaled explained SS	9.243124	Prob. Chi-Square(8)	0.3222

Null hypothesis of Breusch-Pagan-Godfrey heteroskedasticity test is there is no heteroskedasticity. Based on the probability of Chi-Square we can see that the probability (0.2973) far beyond 0.05 level. Therefore, we accept null hypothesis, or there is no heteroskedasticity.

Null hypothesis of Jarque-Bera normality test is the residuals are normally distributed. Based on the probability we can see that the probability (0.583771) far beyond 0.05 level. Therefore, we accept null hypothesis, or the residuals are normally distributed.

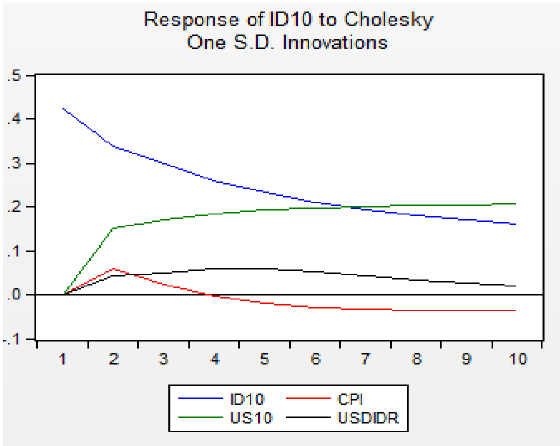


Graph 1. Jarque-Bera normality test

Because of the model passes all three residual diagnostic tests (serial correlation test, heteroskedasticity test, and normality test), we can say that the model is very robust. From the robust model, we can expand further into deeper analysis such as impulse response function and Granger causality test.

Impulse response function

One of the advantages of VECM is the capability to conduct impulse response function analysis. Impulse response function is a technique that can be used to determine the response of an endogenous variable from a shock from other variables. It also determine the length of the shock from one variable to the other variable.



Graph 2. Impulse response function

In impulse response function graph above, it is showed how if one standard deviation of shock of a variable will affect another variable and how it is developed over time. The interpretations are as follows:

a) 1 standard deviation change of CPI increase 0.06 standard deviation of ID10 at 2nd period and then gradually decreasing until 0.035 standard deviation of ID at 10th period.
b) 1 standard deviation change of US10 increase 0.15 standard deviation of ID10 at 2nd period and then gradually increasing until 0.21 standard deviation of ID at 10th period. In other words, ID10 respond permanently to changes in US10.
c) 1 standard deviation change of USDIDR increase 0.06 standard deviation of ID10 at 4th period and then gradually decreasing until 0.02 standard deviation of ID at 10th period.

Granger causality test

From Granger causality perspective, if X Granger causes Y, it does not mean that X causes Y. It only means that X improves Y predictability. On the other words, Y can be better forcasted using the both X and Y than it can by using the Y alone.

Table 1 0 . VEC Granger causality (Dependent variable: D(ID10))

Excluded	Chi-sq	df	Prob.
D(CPI)	4.136264	1	0.0420
D(US10)	4.986969	1	0.0255
D(USDIDR)	0.002073	1	0.9637
All	9.130611	3	0.0276

We use Granger causality test under VECM environment. The interpretations are as follows:

a) Null hypothesis of the test is D(CPI) cannot cause D(ID10) and alternative hypothesis of the test is D(CPI) can cause D(ID10). The probability value is 0.0420 which is less than 0.05 therefore we reject null hypothesis and accept alternative hypothesis that D(CPI) can cause D(ID10).
b) Null hypothesis of the test is D(US10) cannot cause D(ID10) and alternative hypothesis of the test is D(US10) can cause D(ID10). The probability value is 0.0255 which is less than 0.05 therefore we reject null hypothesis and accept alternative hypothesis that D(CPI) can cause D(ID10).
c) Null hypothesis of the test is D(USDIDR) cannot cause D(ID10) and alternative hypothesis of the test is D(USDIDR) can cause D(ID10). The probability value is 0.9637 which is more than 0.05 therefore we accept null hypothesis that D(USDIDR) cannot cause D(ID10).

Based on Granger causality we can see that CPI and US10 can cause ID10. However, US10 is more significant than CPI because based on the test, it has less probability value. On the other side, USDIDR cannot cause ID10.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The aim of this research is to examine the impacts of US bond yield, exchange rate, and inflation on Indonesian bond yield. We examine the variables by using Vector Error Correction Model (VECM), impulse response function, and Granger causality. By using monthly data from January 2009 to December 2018, our result concludes that based on VECM there are long run causality from inflation, US 10 year bond yield, and USD/IDR exchange rate to Indonesia 10 year bond yield. There are also short-run causality from inflation and US 10 year bond yield to Indonesia 10 year bond yield. Based on impulse response function, Indonesia 10 year bond yield respond permanently to changes in US 10 year bond yield. Based on Granger causality we also reveal that inflation and US 10 year bond yield can cause Indonesia 10 year bond yield. US 10 year bond yield has a larger impact than inflation when it comes on affecting Indonesia 10 year bond yield.

This research shows that as an external factor, US 10 year bond yield has significant impact on Indonesia 10 year bond yield. This phenomenon occurs as Indonesia sovereign bonds are investment graded bonds. Therefore, global fund managers will closely watch and invest in Indonesian bond market. Fluctuation of the US bond market affects Indonesian bond market directly. The result of this research shows that Indonesian sovereign bonds market is more interlinked with global market condition.

Recommendations

Practical implications of this research are very useful not only for the investors but also for Ministry of Finance Republic of Indonesia as debt manager of the government. For investors, inflation and US 10 year bond yield will affect its return on investment. Whereas for Ministry of Finance, it will affect cost of debt in term of interest payment that has to be paid to bond holders and also cost of refinancing the debts. The stakeholders must emphasize at the fluctuation of US bond yield as an external factor and inflation as an internal factor.

Further research can be conducted to examine volatility spillover from advanced bond markets such as US, Japan, and Europe into emerging bond markets such as Indonesia. The method to examine volatility spillover is generalized autoregressive conditional heteroskedasticity (GARCH) model (Christiansen, 2007). From this method, we can find volatility transmission mechanism from advanced markets to emerging markets.

REFERENCES

Akinsola, F. A. (2018). Essay on spillovers from advanced economics (AE) to emerging economics (EM) during the global financial crisis. *Journal of Financial Economic Policy, 10*(1), 38-54.

Arshad, H., Muda, R., & Osman, I. (2017). Impact of exchange rate and oil price on the yield of sovereign bond and sukuk: Evidence from Malaysian capital market. *Journal of Emerging Economies & Islamic Research, 5*.

Belke, A., Dubova, I., & Volz, U. (2016). Long-term interest rate spillovers from major advanced economies to emerging Asia. ADBI Working Paper, No. 705.

Christiansen, C. (2007). Volatility- spillover effects in European bond markets. *European Financial Management, 13*(5), 923-948.

El Ouadghiri, I., Mignon, V., & Boitout, N. (2016). On the impact of macroeconomic news surprises on Treasury-bond returns. *Annals of Finance, 12*(1), 29-53.

Espinosa-Torres, J. A., Gomez-Gonzalez, J. E., Melo-Velandia, L. F., & Moreno-Gutiérrez, J. F. (2016). The international transmission of risk: Causal relations among developed and emerging countries' term premia. *Research in International Business and Finance, 37*, 646-654.

Fisher, I. (1930). *Theory of interest: as determined by impatience to spend income and opportunity to invest it.* Augustusm Kelly Publishers, Clifton.

Fong, T., Li, K. F., & Sze, A. (2016). Measuring Spillovers between the US and Emerging Markets. HKIMR Working Paper No.08.

Gadanecz, B., Miyajima, K., & Shu, C. (2014). Exchange rate risk and local currency sovereign bond yields in emerging markets. BIS Working Paper 474.

Hsing, Y. (2015). Determinants of the government bond yield in Spain: a loanable funds model. *International Journal of Financial Studies, 3*(3), 342-350.

Manurung, A. H., Sihombing, P., Siregar, H., & Santosa, P. W. (2017). Determinan Yield Curve Surat Utang Negara. *Jurnal Keuangan dan Perbankan, 15*(1).

Schaeffer, I., & Ramirez, M. D. (2017). Is there a Long-Term Relationship among European Sovereign Bond Yields? *Business and Economic Research, 7*(1), 68-86.

Yuliawati, D., & Suarjaya, A. G. (2017). Pengaruh Umur Obligasi, Tingkat Suku Bunga, Dan Inflasi Pada Imbal Hasil Obligasi Pemerintah Di BEI. *E-Jurnal Manajemen Universitas Udayana, 6*(11), 6187-6215.