Relation between macro economic variables and government securities: Malaysian case

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Relation between macro economic variables and government securities: Malaysian case

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Abstract:

The focus of this paper is to study the relationship between macroeconomic variables i.e. interbank money market (IBR), Consumer Price Index (CPI), Industrial Price Index (IPI), money supply(M2) and the performance of Malaysian Government Securities (MGS) with a view to finding out which variables are the leaders and which ones are the followers. The standard time series techniques are employed for the analysis. Malaysia is taken as a case study. The findings tend to indicate that the yield of Malaysian Government Securities (MGS) is mostly driven by the inflation rate (CPI) and money supply (M2) rather than Industrial production index (IPI) or Interbank money rate (IBR).These findings are plausible and contain strong policy implications for emerging economies like Malaysia.

Keywords: Government securities , macroeconomic variables, VECM, VDC, Malaysia

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1. INTRODUCTION: OBJECTIVE AND MOTIVATION OF RESEARCH

The purpose of this paper is to study the relationship between macroeconomic variables i.e. interbank money market (IBR), Consumer Price Index (CPI), Industry Price Index (IPI), money supply and the performance of Malaysian Government Securities (MGS) with a view to finding out which variables are the leaders and which ones are the followers. Furthermore, this research will look into monetary policy instruments that have a major impact on the performance of MGS with maturity term of three years. This study has been motivated by two reasons:

(i) Firstly, there are very few studies regarding the factors influencing the yields of MGS. Cheng and Ariff (2011) studied factors correlated with MGS in an emerging capital market and another study on factors influencing yield spreads of the Malaysian bonds by Ahmad et al. (2009). However, one of the studies uses arbitrage pricing model approach to investigate the MGS yields.

(ii) Secondly, this study is conducted to examine whether macroeconomic variables have lead-lag relationship with the movement of MGS yields.

Therefore, this paper tends to fill this gap by answering the following research questions:

1. How do the monetary macroeconomic variables influence the performance of MGS?
2. Which variables drive the MGS yield movements?
3. How do the movements in yield affect investors' preferences?

This research finding would be providing insight understanding of the investors and also issuers in their investment decisions and financing. Besides that, the findings also will assist them in describing and analyzing the movement of MGS yields in secondary market.

2. THEORETICAL FRAMEWORK

Maysami and Koh (2000) indicates that various macroeconomic variables affect stock market behaviour based on the 'intuitive financial theory' while Rozeff (1974) mentioned about 'monetary portfolio model' in his paper where an increase in the interest rates raises the opportunity cost of holding cash and is likely to lead to a substitution effect between stock and other interest bearing securities.

Elton, Gruber, Agrawal and Mann (1999) defined yield spreads as the difference in yield to maturity on corporate bonds and the government bonds of equivalent maturity period. However, according to Joriah et al. (2009), there are three types of yields related to investing in bonds:

i) Coupon yield referred to interest paid to the bondholder as a percentage of bond par values, namely coupon rate of the bond;
ii) Current yield being measured by the annual coupon income divided by bond's market price; and
iii) Yield to maturity (YTM) that provides more comprehensive measure of bond returns by estimating the total amount of income for the entire period of bond holdings.

It turns out that, despite the impressive theoretical advances in the financial economics of the yield curve but the theoretical answers are still inconclusive. Thus, there is a need for an empirical answer to the issue raised.

3. LITERATURE REVIEW

Study made by Fah (2008) on the impact of several macroeconomic factors to the yield spreads between two MGS and 10-year MGS found that Growth Domestic Product (GDP) growth rates, industry production and money supply ratio are positively related to MGS yield spreads while other variables i.e. foreign exchange rates, interest rates, current account, reserves and asset return were not affecting the MGS yield spreads.

Furthermore, study done by Hordahl et al. (2006) found that changes in monetary policy have a strong relationship with the bond market where his finding shows that monetary policy shocks have stronger relationship on short-term maturities of bond yield.

Diebold et al. (2006) suggested that money supply affect the future movements in yield curve. A study by Wongbangpo and Sharma (2002) suggest a positive relationship between stock prices and IPI, which is used as a proxy for the levels of economic activity, will influence stock prices through its impact on corporate profitability.

Although there are empirical studies on the macroeconomic variables but the issue has remained unresolved since the studies are more towards corporate bonds compared to MGS. Thus, the objective of this research is to fill in the gap in the literature.

4. RESEARCH METHODOLOGY, RESULTS AND INTERPRETATION

In empirical economics, macroeconomic variables comprise of non-stationary series. Treating non stationary variables in empirical analysis is important so that the results of spurious regression can be avoided. The cointegration technique pioneered by Engle and Granger (1987) made a significant contribution towards testing Granger causality. Granger causality is a technique for determining whether one time series is useful in forecasting another.

According to the concept of cointegration, two or more non-stationary time series share a common trend, then they are said to be cointegrated. The theoretical framework highlighted is expressed as follows:

$$YTM_{i,t} = \beta_0 + \beta_1 IBR_{i,t} + \beta_2 CPI_{i,t} + \beta_3 IPI_{i,t} + \beta_5 M2_{i,t} + \varepsilon_{i,t} \quad (1)$$

where

YTM_{it} represents the yields of MGS with the term of maturity of three years.
$IBR_{i,t}$ is the monthly interbank money market.
$CPI_{i,t}$ is the monthly Consumer Price Index as a proxy for country's inflation.
$IPI_{i,t}$ is the monthly Industry Production Index.
$M2_{i,t}$ is the monthly aggregate of money supply.
$\varepsilon_{i,t}$ is the stochastic error term

Above equation explains the relationship between macroeconomic variables such IBR, CPI, IPI and money supply (M2) with bond yield spreads of MGS. I choose M2 instead of M1 and M3 as the research is on short term MGS i.e. three years maturities. Furthermore, M1 keeps changing over time in order to accommodate the new financial instruments. Besides that, MGS maturity of three years has been selected as the long term MGS resulted stationary in level form besides there are many studies on long term MGS compared to short term MGS.

In our research, only secondary data have been used. It is used to answer a different question than originally intended and its analysis in a different way. Monthly MGS yields are examined for the period of 2007 to September 2012. The source of data was Bond Info Hub, Bank Negara Malaysia (BNM) monthly statistically bulletin, Ministry of International Trade and Industry Malaysia (MITI) weekly bulletin and Malaysian Statistic Department.

4.1 TESTING STATIONARITY OF VARIABLES

We begin our empirical testing by determining the stationarity of the variables used. In order to proceed with the testing of cointegration later, ideally, our variables should be in their original level form, there are non-stationary and in their first differenced form, there are stationary. The differenced form for each variable used is created by taking the difference of their log forms. For example, DYTM = LYTM – LYTM (-1). Then, Augmented Dickey-Fuller (ADF) test has been conducted on each variable (in both level and differenced form). The table below summarizes the results.

Variables in Level Form			
Variable	**Test Statistic**	**Critical Value**	**Implication**
LIBR	-1.4525	-3.4812	Variable is non-stationary
LCPI	-2.1996	-3.4812	Variable is non-stationary
LIPI	-1.9566	-3.4812	Variable is non-stationary
LM2	-2.0220	-3.4812	Variable is non-stationary
LYTM	-2.7939 (AIC)	-3.4812	Variable is non-stationary
	-2.3035 (SBC)	-3.4812	Variable is non-stationary

Variables in Different Form			
Variable	**Test Statistic**	**Critical Value**	**Implication**
DIBR	-5.3753	-2.9084	Variable is stationary
DCPI	-7.7597	-2.9084	Variable is stationary
DIPI	-8.8759	-2.9084	Variable is stationary
DM2	-7.5613	-2.9084	Variable is stationary
DYTM	-6.4470 (AIC)	-2.9084	Variable is stationary
	-4.0987 (SBC)	-2.9084	Variable is stationary

Besides ADF Test, we also test the variable using Phillips-Peron Test (PP Test) in order to prove that variable is non-stationary at level form and stationary at different form. The table below summarizes the result:

	Variables in Level Form	
Variable	**T-Statistic**	**Implication at 10%**
IBR	0.825	Variable is stationary
CPI	0.174	Variable is stationary
IPI	0.035	Variable is non-stationary
M2	0.625	Variable is stationary
YTM	0.010	Variable is non-stationary

There is a different interpretation on the variable whether they are stationary or non-stationary between ADF Test and PP Test. Thus, we are relying primarily on ADF Test which that all the variables we are using for this analysis are non-stationary at level form and stationary at different level. Therefore the series can be said to be integrated of order 1, I (1).

Thus we may proceed with testing of cointegration. Note that in determining which test statistic to compare with the 95% critical value for the ADF statistic, we have selected the ADF regression order based on the highest computed value for AIC and SBC.

4.2 Determination of Order of the VAR Model

Before proceeding with test of cointegration, we need to first determine the order of the vector auto regression (VAR), that is, the number of lags to be used. As per the table below, results show that AIC recommends order of 1 whereas SBC favours zero lag.

	Choice Criteria	
	AIC	**SBC**
Optimal order	1	0

Given this apparent conflict between recommendation of AIC and SBC, we address this in the following manner. First we checked for serial correlation for each variable and obtained the following results.

Variable	Chi-Sq p-value	Implication (at 10%)
LIBR	0.780	There is no serial correlation
LCPI	0.972	There is no serial correlation
LIPI	0.278	There is no serial correlation
LM2	0.661	There is no serial correlation
LYTM	0.090	There is serial correlation

As evident from the above results, there is one autocorrelation in these variables. Thus, we decided to choose the higher **VAR order of 1** as if we adopted a higher order, we may encounter the effects of serial correlation.

4.3 Testing Cointegration

Once we have determined the optimal VAR order as 1, we are ready to test for cointegration. As depicted in the table below, the maximal Eigenvalue and Trace, indicate that there is one cointegrating vector whereas according to HQC; AIC and SBC; there are 2, 3 and 1 cointegrating vectors, respectively.

H_0	H_1	Statistic	95% Crit	90% Crit
Maximal Eigenvalue value Statistics				
r = 0	r = 1	67.9102	37.8600	35.0400
r<= 1	r = 2	30.6848	31.7900	29.1300
Trace Statistic				
r = 0	r>= 1	123.2487	87.1700	82.8800
r<= 1	r>= 2	55.3384	63.0000	59.1600

Statistically, the above results indicate that both trace and max-eigenvalue statistics reject the null hypothesis of zero cointegrating equation at 5% significant level. Both tests indicate the presence of a single cointegrating vector in the model, confirming the existence of a long-run stable linear equilibrium relationship among the variables.

However, cointegration cannot tell us the direction of Granger-causation as to which variable is leading and which variable is lagging (i.e. which variable is exogenous and which is endogenous). Thus, we need to run Long Run Structural Modelling.

4.4 LONG RUN STRUCTURAL MODELLING (LRSM)

Next, we attempt to quantify this apparent theoretical relationship among the variables. We do this in order to compare our statistical findings with theoretical (or intuitive) expectations. Relying on the Long Run Structural Modelling (LRSM) component of Microfit, and normalizing our variable LIPI, we initially obtained the results in the following table. Calculating the t-ratios manually, we found all the variables to be insignificant. There is a negative relationship between MGS yield with IBR, CPI, IPI and M2.

Variable	Coefficient	Standard Error	t-ratio	Implication
LIBR	-2.7444	3.2435	-0.84612	Variable is insignificant
LCPI	-5.7084	7.4044	-0.77095	Variable is insignificant
LIPI	39.8907	55.3138	0.72117	Variable is insignificant
LM2	-11.5914	18.202	-0.63682	Variable is insignificant
LYTM	-	-	-	-

There is curiosity on the result since there is no relationship between all the macroeconomic variables with the MGS yield. In turn of that, we decided to over-identifying restrictions again for all the variables (making one over-identifying restriction at a time).

Variable	Chi-Sq p-value	Implication
LIBR	0.000	Variable is significant
LCPI	0.350	Variable is insignificant
LIPI	0.000	Variable is significant
LM2	0.258	Variable is insignificant
LYTM	-	-

After over-identifying restriction test on all the variables, two variables show positive relationship with MGS yield which is IBR and IPI relationship with MGS yield. However, we reject the null of restriction of CPI and M2 as in my opinion that both of the variables have relationship with the yield in the long run.

Furthermore, study by Ahmad et al. show positives relationship between CPI and yield spread of MGS as higher CPI implies difficult economic condition and caused yield spread to increase besides higher CPI will reduce the purchasing power of consumers i.e. less cash flowing in the

country. Besides that, study by Ong et al. indicates that money supply and current account are the factors that have strong relationship with maturity spread. Thus, we proceed with following cointegrating equation for the remainder of the paper:

YTM	- 2.74IBR	- 5.71CPI	+ 39.89IPI	- 11.59LM2	→ I(0)
	(3.24)	(7.4)	(55.31)	(18.20)	

4.5 VECTOR ERROR CORRECTION MODEL (VECM)

From our analysis thus far, we have established five variables are cointegrated to a significant degree – YTM, IBR, CPI, IPI and M2. However, the cointegrating equation reveals nothing about causality i.e. which variable is the leading and which variable is the follower. Information on direction of Granger-causation can be particularly useful for investors as the investors can better forecast or predict expected results of their investment based on the variable which is exogenous and endogenous,.

In order to ascertain which variables are in fact exogenous and which are endogenous, we need to analyse the variables by using Vector Error Correction Model (VECM). By examining the error correction term, e_{t-1}, for each variable, and checking whether it is significant, we found that there three variables are exogenous i.e. CPI, M2 and YTM, as depicted in the table below. The other variables were found to be endogenous.

Variable	ECM (-1) t-ratio [Prob]	Implication
LIBR	6.7399 [0.000]	Variable is endogenous
LCPI	0.27178 [0.787]	Variable is exogenous
LIPI	-2.8782 [0.005]	Variable is endogenous
LM2	0.67431 [0.503]	Variable is exogenous
LYTM	0.53481 [0.595]	Variable is exogenous

The interpretation can be looked at from the two numbers, either t-ratio or probability. Both will give the same interpretation, but the author simply looks at the t-ratio; that is, a t-ratio higher than 2 represents endogenous variable, while a t-ratio lower than two represents exogenous variable.

This outcome seems to be a little puzzling since the initial normalization was to make A5=1, that is the LYTM as the dependent variable. Thus, we see the characteristic of the time series technique here that data will show the true movement of variables. The drawback of this method

is however, it cannot determine which of the variables are most exogenous or endogenous when there more than one of the same type. For example, in this case, there are three exogenous variables, but we do not know which one is the ultimate leader i.e. the most exogenous.

This limitation of VECM will be solved in the next step, which is the Variance Decomposition (VDCs).

4.6 VARIANCE DECOMPOSITION (VDCs)

As the VECM is not able to assist us in determining the relative endogeneity of the remaining variables which is the most laggard variable compared to others, or, the least laggard, we turn our attention to variance decomposition (VDC). The VDC has two methods in the Microfit software. One is the orthogonalized and the other is the generalized restriction. VDC decomposes the variance of forecast error of each variable into proportions attributable to shocks from each variable in the system, including its own. The least endogenous variable will be considered as exogenous. This is seen from how much the variable is explained by its own past.

Furthermore, orthogonalized VDC assumes that when a particular variable is shocked, all others are 'switched off'. In addition, the numbers presented in the output depends on the ordering of the variables in the VAR. Usually, the first written variable will have the highest percentage since it is given priority as the first. Therefore, this first variable will normally turn out to be the most exogenous.

We started out applying orthogonalized VDC and obtained the following results.

Forecast at Horizon = 25 (weeks)

TIME	IBR	CPI	IPI	M2	YTM
IBR	46.193%	0.005%	52.735%	0.574%	0.493%
CPI	0.037%	99.633%	0.324%	0.004%	0.003%
IPI	37.516%	0.568%	58.431%	1.875%	1.610%
M2	0.274%	2.490%	9.815%	87.403%	0.018%
YTM	3.581%	1.046%	14.144%	5.072%	76.157%

Table above read in the percentage of the variance of forecast error of each variable into proportions attributable to shocks from other variables (in originality), including its own. The

columns read as the percentage in which that variable contributes to other variables in explaining observed changes. The highlighted diagonal pattern is the relative exogeneity (extent to which variation is explained by its own past variations); CPI being the most exogenous, and IBR being the least exogenous, therefore most endogenous as per the table below:

No.	Variable
1	CPI
2	M2
3	YTM
4	IPI
5	IBR

Following this discovery, we decided to rely instead on Generalized VDCs, which are invariant to the ordering of variables and does not assume that when one variable is shocked, the others are 'switched off'. However, the numbers in the row for generalized version does not add up to 1 or 100% like the orthogonalized. Thus, in interpreting the numbers generated by the Generalized VDCs, we need to perform additional computations. For a given variable, at a specified horizon, we total up the numbers of the given row and we then divide the number for that variable (representing magnitude of variance explained by its own past) by the computed total. In this way, the numbers in a row will now add up to 1.0 or 100%. The tables below show the result.

Forecast at Horizon = 25 (weeks)

TIME	IBR	CPI	IPI	M2	YTM
IBR	0.3387070	0.0000078	0.6472558	0.0000779	0.0139514
CPI	0.0003527	0.9538721	0.0073923	0.0233988	0.0149841
IPI	0.2832637	0.0047166	0.6722567	0.0279368	0.0118263
M2	0.0025160	0.0229859	0.0617629	0.9005329	0.0122023
YTM	0.0317317	0.0090582	0.0629096	0.0200543	0.8762461

The two tables above (both orthogonalized and generalized) show consistent findings regarding the exogeneity of the variables. All two outcomes rank the relative exogeneity as follows.

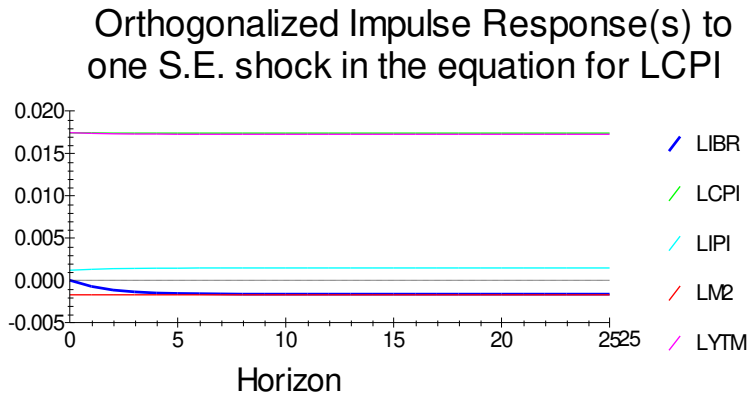
No.	Variable Relative Exogeneity
1	CPI
2	M2
3	YTM
4	IPI
5	IBR

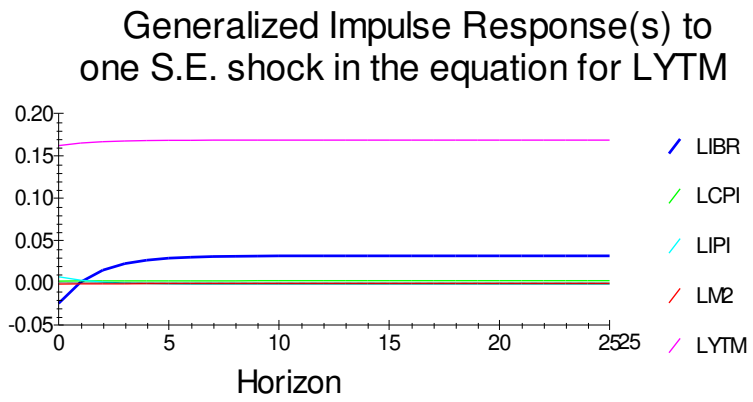
Surprisingly, after running the Generalized VDCs, the result show the ranking is same as Orthogonalized VDCs result. Thus, we can conclude order of the variable will not determine the endogeneity or exogeneity of the variable.

From here we are able to see that both steps 5 and 6 are consistent in giving out the results although initially the authors placed A5=1; that is the variable YTM as the dependent. It turns out to be that the MGS yield is not really influenced by the two other variables i.e. IPI and IBR, rather the IBR are influenced by the other variables.

4.7 IMPULSE RESPONSE FUNCTIONS (IRF)

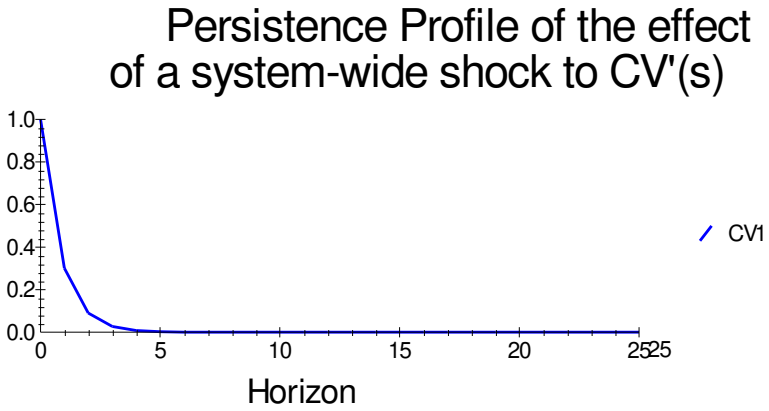
The Impulse response functions basically show the graphical representation of the VDCs in the previous step. While the VDCs prints out the numbers in the output, the IRFs uses these numbers to generate graphs. IRFs essentially map out the dynamic response path of a particular variable owing to a standard deviation shock of one period to another variable. Graph below show one example for Orthogonalized VDCs and Generalized VDCs.





4.8. PERSISTENCE PROFILE

The IRFs through VDCs illustrate a situation that depends on a shock to a single variable. But here in this step, the persistence profiles give a situation where the entire system is given a shock; that is, the whole cointegration equation is shocked and indicates the time it would take for the relationship to get back to equilibrium. Both IRFs and persistence profiles map out the dynamic response of long term relationships but differ in that the former is based on variable-specific shock and the latter, the whole system shock. As the graph below illustrates, the equilibrium time is around 5 weeks; that is to say, it would take approximately 5 weeks for the cointegrating relationship to get back to equilibrium after a system-wide shock.



5. CONCLUDING REMARKS

This study attempts to investigate the relationship between macroeconomic variables and MGS yield. The result shows several macroeconomics factors influencing MGS yield i.e. IBR and IPI.

An insight understanding on the determinants of yield spread could benefit the investors and issuers in making wise investment and financing decisions as macroeconomic factors work and affect differently on each types of bonds. The findings of over-identifying restriction show that interest rate is one of the major determinants of bond yield spread. Therefore, investors may restructure their portfolio in order to match with the movement of interest rates.

Besides that, the knowledge and information on macroeconomic factors could also assist bond issuers to make better prediction in particular in the pricing their bonds. By understanding the direction of interest rates, bond issuers are able to determine the financing costs. Cost of funds is lower when interest rates is low and vice versa. Therefore, bond issuers should consider buying back their bonds against the cost of new financing when interest rate is low.

6. LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Nonetheless, this study is not without limitations which are mainly due to the nature of the data themselves. First limitation would be the fact that the market is thinly traded and most of the bonds are held till maturity. The second limitation is the differences in maturity or issuing period which may confound some analysis though the impact is thought to be minimal. The third is data limitations restricted to the choice of macroeconomic factors since several factors for example gross domestic product and current account are not available on the monthly frequency.

Further research should aim at resolving the fact and predictions. The extension model should consider the effects of the maturity spreads on macroeconomic variables. Besides that, the relation between maturity spread and different macroeconomic variables has to be focused in terms of different maturities.

In addition, future research should also consider other factors that could affect the MGS performance such as foreign exchange rate. Besides that, the future study may incorporate the Islamic and conventional types of bonds as well as government and corporate bonds to understand the behavior of different types of bond.

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