Examining the Developed and Emerging Bond Market Interactions: A VAR Analysis

Kemal Eyuboglu[1], Sinem Eyuboglu[2]

Abstract: Financial markets are growing and getting more integrated. Therefore, the transmission of bond markets across countries has become an important issue for monetary policymaking and portfolio diversification. This study examines interactions among government bond markets of 3 developed (Japan, US, Germany) and 5 emerging countries (Russia, India, China, Brazil and Turkey) that cover the period of January 2006 to September 2015. A VAR analysis is carried out to monthly data in order to determine the linkages among the 10 year government bond yields. The results showed that the impact of US bond market is not dominant while the Japanese market is more influential. Furthermore, Japanese and Chinese bond markets are found less integrated.

Keywords: Developed countries; Emerging countries; Bond markets; VAR Analysis

JEL Classification: F30; G10; G15

1. Introduction

The world economy has been dominated by the dynamics of globalization over the last two decades. Capital movements in the world economy are concordantly associated with it. This process has an effect on many areas, like financial markets. Thus, the global economic conditions have become more effective on the domestic interest rates than the domestic economic conditions and monetary policy.

In the recent years, the issue of interest rates' co-movements of the different countries in the financial markets has interested plenty of researchers, especially after the growing signs of increasing international interactions between capital markets all over the world. Structural changes like regulation of financial markets, removing of capital controls, and development of new financial instruments, improvement of the communication and information technology (reduction of

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information costs) have also increased the flow of capital among the countries. In particular, after the global financial crisis in 2008, the subject of investigating the interaction among the international bond markets gained importance in terms of asset allocation management, portfolio diversification and independent monetary policy.

As stated by Barassi et al. (2001), bond yields can be regarded either in a similar manner to other asset prices or as policy instruments (Yang, 2005a, p. 599). Hence, a good understanding of the linkages among the bond yields provides important guidance for national authorities in organizing their monetary policies to sustain the macroeconomic stability. Therefore, the scope of international bond market interactions is basically a matter of empirical testing. However, most of the literature on the international bond market interactions across government bond markets have focused on the developed bond markets (e.g. DeGennaro et al., 1994; Bremnes et al., 2001; Smith, 2002; Barr & Priestley, 2004; Yang, 2005b; Kumar & Okimoto, 2011), whereas the studies on emerging bond markets are very limited (Vo, 2009; Bunda et al., 2009; Piljak, 2013).

Bond markets in emerging countries have become an important investment tool in recent years by taking the following facts into account; a) The emerging markets tend to grow rapidly; b) bonds of emerging market countries have been the second largest funding source since the early 1990s; c) liquidity and transparency of the emerging bond markets have developed over the past decades (Piljak, 2013, p. 30).

In this respect the study contributes to the literature in several aspects. First, there is a gap in the field of the interactions among the bond markets. Second, most of the previous studies on international bond markets have focused more on interactions between developed markets. Few studies that document such linkages have concentrated on emerging markets. Third, the study examines the effects of changes in emerging markets' bonds to developed markets' bonds and vice versa. Consequently, this study attempts to provide new insights into the field of interaction by examining the both developed and emerging countries' bond markets' perspective.

The purpose of this study is to examine the co-movement of the government bond yields of three developed and six emerging markets that covers the period of 2006:01-2015:9 by applying the Vector Auto Regression (VAR) framework. The rest of this paper is organized as follows. Section 2 explains the literature review. Section 3 describes the data and the methodology. Section 4 presents empirical result and Section 5 presents conclusion.

2. Literature Review

Lots of studies have concentrated on linkages among international equity markets. However, few studies have examined the interactions among international bond

markets. Besides, the literature on the examining the interactions among international bond markets have mainly focused on developed bond markets. In these studies; Fukao and Okubo (1984) examined the co-movement between the interest rates of Japan and US and they concluded that US's interest rate had an important impact in the determination of Japan's long-term interest rates. Kirchgassner and Wolters (1987) tested the linkages of the interest rates among the US, West Germany and Switzerland. They found that there was no linkage before the 1980 but there were strong linkages between US and two European government bond markets after 1980. Karfakis and Moschos (1990); Edison and Kole (1995); Borio and McCauley (1996) investigated interactions between the short-term domestic interest rates of the European Monetary System (EMS). Findings showed that interest rate of Germany had a dominant role in the EMS. Goodwin and Grennes (1994) analyzed the long-term relations between the interest rates of US and Canada and found two rates were cointegrated. DeGennaro et al. (1994) searched the interactions among the long-term interest rates of the five industrialized countries (Canada, Japan, Germany, UK and US). Findings showed that there was no evidence of the cointegration among the interest rates. Clare et al. (1995) examined the correlation among the four bond markets (Germany, Japan, UK and US). Findings show that there was a weak correlation between the bond markets. Hence, there was an opportunity for the portfolio diversification. Barkoulas et al. (1997) examined the dynamics of the US, Canada, Germany, UK and Japan's long term interest rates. They found a strong interaction between the Canadian and US interest rates. Phylaktis (1999) investigated the long run linkages between the real interest rates of Singapore, Korea, Taiwan, Malaysia, US and Japan. Findings showed that Japan interest rates had more effect than US interest rates on these countries.

Barassi et al. (2001) investigated the cointegration among the long-term interest rates of the G7 countries. They indicated that long-term rates of Italy and Germany were non-cointegrated and their rates were isolated from the others. Bremnes et al. (2001) tested the long run linkages between interest rates of US, Germany and Norway. Results showed that US's interest rates had an important effect on both interest rates of Germany and Norway. Also, Germany had an important impact on Norway. Smith (2002) analysed the linkages among government bond markets of the six countries (US, Canada, UK, Germany, France, and Japan). In the short term, findings indicated some opportunities for the portfolio diversification due to the low correlations. Vuyyuri (2004) tested the influence of Japanese and US short term interest rates on India's interest rates. The results indicated that there was a long-term relationship among the interest rates of India, US and Japan.

Yang (2005a) analysed the co-movements on the European government bond markets of Germany, France, Italy, UK, Belgium and Netherlands. Result showed a little evidence on the long-term relationship among the six markets. Furthermore, Yang found UK and Italy were less cointegrated with other markets. Chinn and

Frankel (2005) investigated the interactions among the international interest rates. They found that US interest rates influenced European rates, but German rates did not have a similar effect like the US interest rates. Yang (2005b) searched the linkages among government bond markets of five industrialized countries (US, Japan, Germany, UK and Canada). The findings indicated that there was no long-run relationship which exists among the five major bond markets. Also, dynamic linkage pattern showed that UK and Germany had some noticeable impact on the US and Japan, which was the most unaffected market. Hunter and Simon (2005) analysed the relationships among the US, UK, Germany and Japan government bonds. They concluded that integration increased for the last ten year of the sample period. Kim et al. (2006a) investigated the co-movement of the European government bond markets (Czech Republic, Hungary, Poland, Belgium, France, Ireland, Italy, Netherlands, UK and Germany). He concluded that there were linkages among the Belgium, Italy and Netherland bond markets. Ciner (2007) examined the dynamic relationships among the bond markets of the US, Japan and Germany. Results indicated that those bond markets were not cointegrated for the whole sample period. Georgoutsos and Migiakis (2007) examined the relationship between the European bond markets and the US bond market. He concluded that Greece, Ireland, Portugal, Spain, France and Netherlands were more integrated with US bonds than the European bond markets.

Abad et al. (2010) tested the relationship between US and European government bond markets. Results showed that Belgium and Germany were the most integrated bond markets with US. Kumar and Okimoto (2011) analysed the dynamics among the six of the G7 countries' (Canada, France, Germany, Italy, UK and US) government bond markets. They found correlations for the long-term yields of Canada-UK, UK-US and Canada-US had increased in the sample period. Jeon et al. (2012) analysed the Japanese bond yields' linkages with US, UK and Germany bonds. Results showed that Japanese bond yields are only affected by itself and US bond yield.

The studies have focused on the emerging bond markets; Bunda et al. (2009) investigated the co-movement among the eighteen emerging bond markets. Results showed that there were a co-movement in Hong Kong SAR market crash of October 1997, the Russian crisis and the collapse of LTCM in 1998 and the Argentinean crisis of 2001 among the bond markets. Vo (2009) examined the linkages among the Asian bond markets (Thailand, Hong Kong, Japan, Malaysia, Korea, Singapore and Philippine) to US, Australia and New Zealand. He found that Australia government bond was integrated with the yields of US, Japan and New Zealand bonds. Also, he indicated that Asian government bond yields' linkages were high except Korea. Piljak (2013) analysed the linkages among the fourteen government bond markets. He found that US bond market has a positive impact on all markets (except Ecuador). He also indicated that the linkages among the emerging markets are relatively high.

3. Data and Methodology

Our empirical analysis consists of 5 emerging (Brazil, China, India, Russia and Turkey) and 3 developed government bond markets (US, Japan and Germany). The selection of countries is dictated by data availability. The empirical analysis is based on VAR analysis. Using an eight-variable VAR model, this study examines whether there is an interaction among the eight countries' 10 year government bond yields.

Long-term bonds are selected because of their comparability across countries. They not only have an impact on long-term saving and investment strategies, but also on business cycle and forming of macroeconomic policies (Orr et al., 1995, p. 76). The bond yields are obtained from the website of Eurostat, investing.com and the ieconomics.com. The sample period extends from January 2006 to September 2015, leading to a sample size of 117 observations. The starting point of the sample period is determined by data availability.

The VAR analysis, which is developed by Sims (1980) is used for examining the linkages among the 10-year government bond yields. The VAR is an efficient model for analysing the dynamic linkages among economic variables. This model provides a multivariate framework related with changes in a variable and its own lags and also changes in other variables. No limitations are enforced on the structure of system and the VAR assumes all variables as jointly endogenous (Maghyereh, 2004, p. 31; Acikalin et al., 2008, p. 12). In this study, after estimating the VAR model, impulse-response functions and variance decompositions are also derived from the estimates.

4. Findings

Table 1 shows descriptive statistics of 10-year government bond yields in logarithm form. As can be seen from Table 1 during the sample period, all emerging markets have higher average bond yields than the developed markets. The highest yields are recorded for Brazil and Turkey. The lowest yields are found for Japan and Germany. Also, the volatilities of the developed bond markets are lower than the volatilities of the emerging bond markets. The lowest volatile market is US and the highest volatile market is Turkey. The distributions of bond market yields are statistically non-normal and show negative skewness (except China, Turkey and Russia).

Table 1. Descriptive statistics of the 10-year government bond yields

	LUS	LJAP	LGER	LBRE	LCHI	LTUR	LIND	LSAF	LRUS
Mean	1.073	0.006	0.785	2.507	1.295	2.427	2.070	2.088	2.089
Maximum	1.638	0.662	1.532	2.852	1.532	3.100	2.231	2.370	2.645
Minimum	0.385	-1.251	-1.687	2.217	1.011	1.819	1.660	1.793	1.836
Std. Dev.	0.062	0.075	0.085	0.126	0.123	0.328	0.089	0.095	0.206
Skewness	0.096	-0.757	-1.291	-0.041	0.152	0.400	-1.553	-0.548	0.894
Kurtosis	1.946	2.623	3.520	3.459	2.189	1.953	6.163	3.954	2.938
Observation	117	117	117	117	117	117	117	117	117

Before estimating the model, series are analysed in terms of stationarity with using Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests in order to avoid the possibility of spurious relationships.

Table 2 shows unit root results of the eight government bond yields. We determine that there is not unit root in bond yields at level in Japan, China and India. We find that there are unit roots in the bond yields of Germany, Turkey, US, Russia and Brazil at level, but no unit root in their first differences in significance at the 5% level. These results are important for VAR analysis, given the importance of using stationary variables.

Table 2. Unit root results of the government bond yields

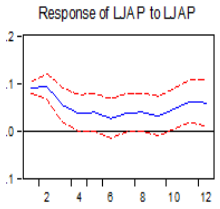
	I (0)				I (1)			
Variables	**ADF**		**PP**		**ADF**		**PP**	
	Intercept	**Trend and Intercept**	**Intercept**	**Trend and Intercept**	**Intercept**	**Trend and Intercept**	**Intercept**	**Trend and Intercept**
LUS	-1.627	-2.617	-1.607	-2.775	-10.465[a]	-10.423[a]	-10.465[a]	-10.423[a]
LJAP	-0.008	-3.312[c]	1.168	-3.217[c]				
LGER	-0.535	-3.374[b]	-0.481	-2.908	-5.872[a]	-5.886[a]	-11.201[a]	-11.224[a]
LBRE	-2.303	-1.923	-2.134	-1.739	-11.078[a]	-11.209[a]	-11.105[a]	-11.310[a]
LCHI	-3.653[a]	-3.534[b]	-2.676[c]	-2.571				
LTUR	-1.216	-2.077	-1.292	-2.365	-9.531[a]	-9.487[a]	-9.499[a]	-9.454[a]
LIND	-3.227[b]	-3.882[b]	-3.390[b]	-3.517[b]				
LSAF	-2.806[c]	-3.014	-2.754[c]	-2.971	-12.075[a]	-12.022[a]	-12.163[a]	-12.108[a]
LRUS	-1.565	-2.051	-1.671	-2.137	-10.113[a]	-10.078[a]	-10.114[a]	-10.077[a]

[a] denotes significance at the 1% level. [b] denotes significance at the 5% level. [c] denotes significance at the 10% level.

Using the Akaike Information Criteria (AIC) the appropriate lag length is determined to be seven or one. However, in the VAR (1,1) model, autocorrelation has occurred. Therefore, appropriate lag length is selected seven.

4.1. Impulse Response Functions

Impulse response functions are used to analyse dynamics of the variables. The goal of the investigation is to find out how each of bond markets responds to shocks by other bond markets. It is also important for investors who want to make portfolio diversification. If the shocks are not transmitted to other markets, there is an opportunity to make diversification.



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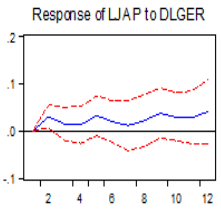

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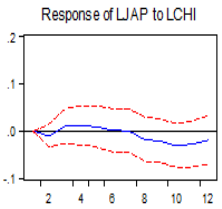

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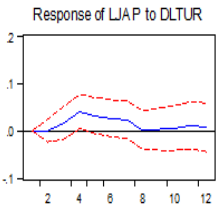

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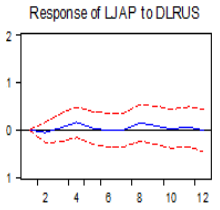

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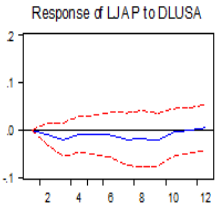

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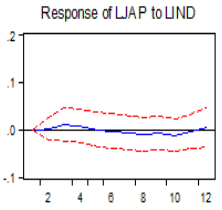

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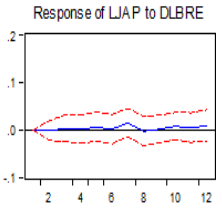
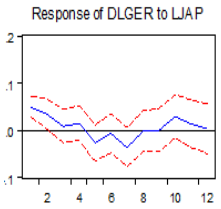


Figure 1(h)

In the case of Japan[1] Fig. 1a shows that the Japanese bond yield responds significantly only to its own shocks. Fig. 1b plots the response of bond yields in Japan to a German bond yield shock and the response is insignificant. Fig. 1c, d, e, f, g, h plot the responses of yields in Japan to China, Turkey, Russia, US, India and Brazil respectively. All these bond markets are insignificant in explaining the movement of bond yields like Germany.

[1] Fig. 1(a) Japan to Japan 10 year government bond yield Fig. 1(b) Japan to Germany 10 year government bond yield. Fig. 1(c) Japan to China 10 year government bond yield. Fig. 1(d) Japan to Turkey 10 year government bond yield Fig. 1(e) Japan to Russia 10 year government bond yield. Fig. 1(f) Japan to US 10 year government bond yield. Fig. 1(g) Japan to India 10 year government bond yield. Fig. 1(h) Japan to Brazil 10 year government bond yield.



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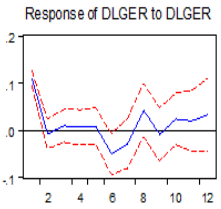

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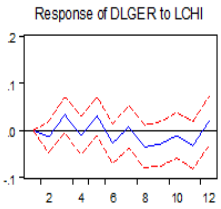

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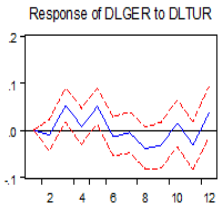

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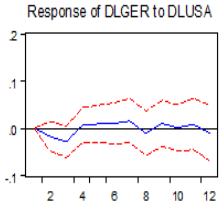

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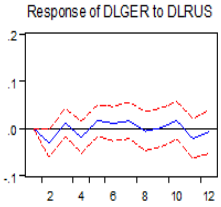

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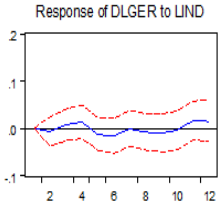

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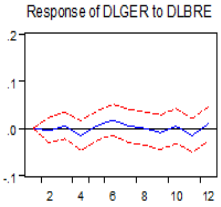
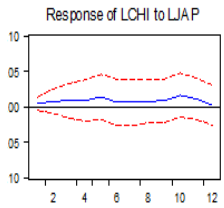


Figure 2(h)

Figure 2[1] shows that Germany bond yield responds significantly to shocks from Japan, Turkey and its own shocks. Fig. 2a plots the response of German bond yield to Japan bond yield and shows that it is significant and positive around the first month. Fig. 2b plots the German bond yields' response to own shocks. There is a short but positive and significant response in the first month. Fig. 2d plots the effect of the Turkish bond yield on the German yield and shows that the response is positive and significant in the third month and the fifth month. Fig. 2c, e, f, g and h plot the response of yields in Germany to China, US, Russia, India and Brazil respectively. There are no evidences of significant exposure of yield of Germany to bond yields of five markets.



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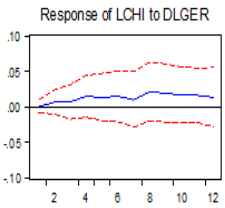

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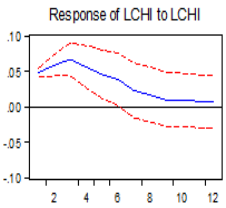

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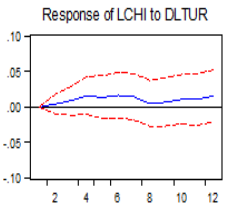
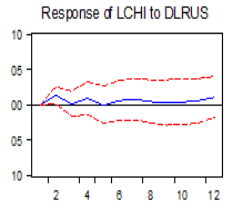


Figure 3(d)

[1] Fig. 2(a) Germany to Japan 10 year government bond yield Fig. 2(b) Germany to Germany 10 year government bond yield. Fig. 2(c) Germany to China 10 year government bond yield. Fig. 2(d) Germany to Turkey 10 year government bond yield. Fig. 2(e) Germany to US 10 year government bond yield. Fig. 2(f) Germany to Russia 10 year government bond yield. Fig. 2(g) Germany to India 10 year government bond yield. Fig. 2(h) Germany to Brazil 10 year government bond yield.



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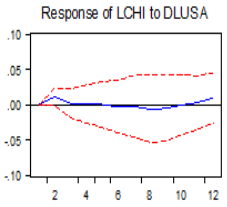

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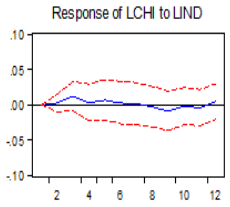

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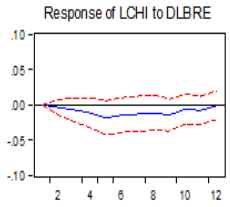


Figure 3(h)

In the case of China[1], bond yield responds only its own shocks. The response functions in Fig. 3a, b, d, e, f, g, h indicate that Chinese bond yield does not respond significantly to Japanese, German, Turkish, Russian, US, Indian and Brazilian bond yields in the sample period.

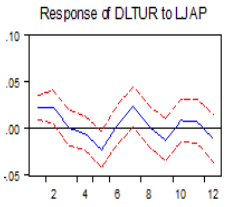


Figure 4(a)

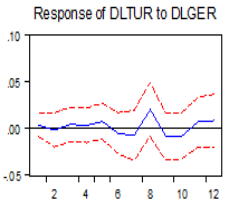
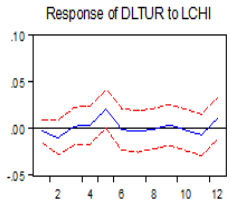


Figure 4(b)



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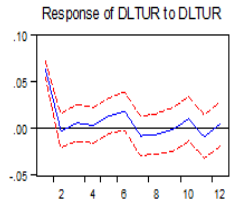
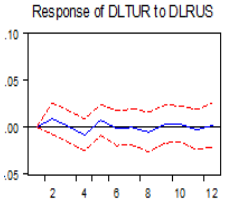


Figure 4(d)



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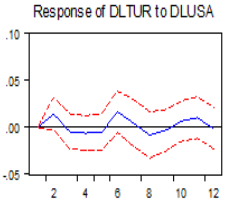

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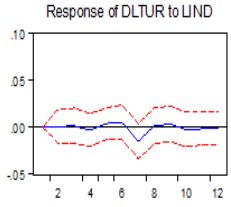

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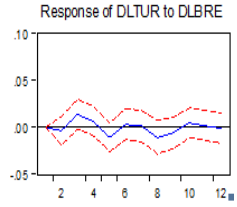


Figure 4(h)

The impulse response functions for Turkey[2] indicate that Turkey bond yield responds significantly to shocks from Japan, China and its own shocks. Fig. 4a plots the response of Turkish bond yield to Japan bond yield and shows that it is significant and positive at about first two months. Fig. 4c plots the effect of the Chinese bond yield on the Turkish yield and indicates that the response is positive and significant

[1] Fig. 3(a) China to Japan 10 year government bond yield Fig. 3(b) China to Germany 10 year government bond yield. Fig. 3(c) China to China 10 year government bond yield. Fig. 3(d) China to Turkey 10 year government bond yield Fig. 3(e) China to Russia 10 year government bond yield. Fig. 3(f) China to US 10 year government bond yield. Fig. 3(g) China to India 10 year government bond yield. Fig. 3(h) China to Brazil 10 year government bond yield.

[2] Fig. 4(a) Turkey to Japan 10 year government bond yield Fig. 4(b) Turkey to Germany 10 year government bond yield. Fig. 4(c) Turkey to China 10 year government bond yield. Fig. 4(d) Turkey to Turkey 10 year government bond yield Fig. 4(e) Turkey to Russia 10 year government bond yield. Fig. 4(f) Turkey to US 10 year government bond yield. Fig. 4(g) Turkey to India 10 year government bond yield. Fig. 4(h) Turkey to Brazil 10 year government bond yield.

in the fifth month. Fig. 4d plots the Turkish bond yields responds to its own shocks. There is a short, positive and significant response around the first month. Fig. 4b, e, f, g and h plot the response of yields in Turkey to Germany, Russia, US, India and Brazil respectively. There are no evidences in explaining the movement of Turkish bond to five markets.

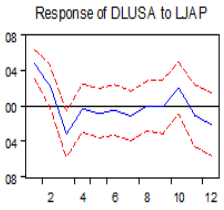


Figure 5(a)

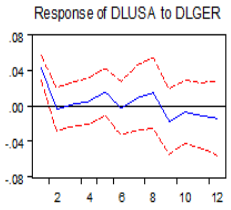


Figure 5(b)

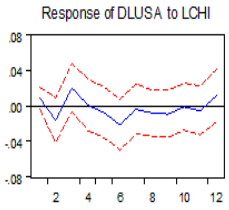


Figure 5(c)

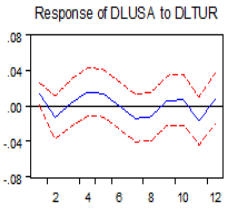
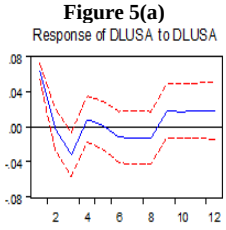


Figure 5(d)



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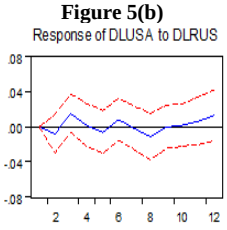

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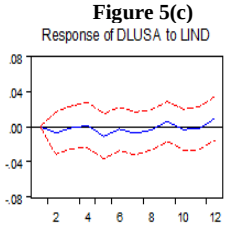


Figure 5(g)

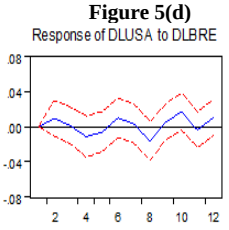


Figure 5(h)

In the case of US[1], bond yields respond significantly to shocks from Japan, Germany, and in addition to its own shocks. Fig. 5a plots the response of US yields to Japan. The response is positive and significant in the first two months and negative by the third month. Fig. 5b plots the response of US bond yield to German bond yield and shows that bond yield increase leads to a positive movement in bond yield of US. Response is short and significant in the first two months. Fig. 5c, d, f, g and h plot the response of yields in US to China, Turkey, Russia, India and Brazil, respectively. All these bond yields are insignificant in explaining the movement of bond yields in US. Also Fig. 5e shows that US bond yield responds significantly to its own shocks.

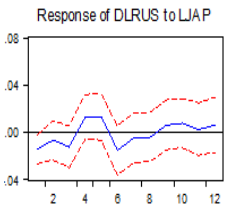


Figure 6(a)

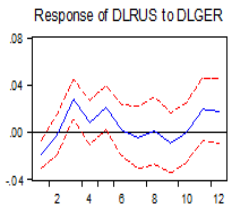


Figure 6(b)

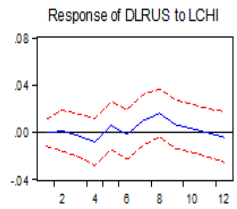


Figure 6(c)

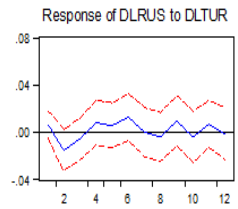
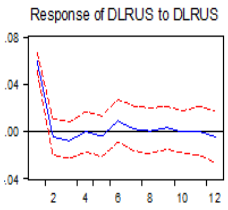


Figure 6(d)

[1] Fig. 5(a) US to Japan 10 year government bond yield Fig. 5(b) US to Germany 10 year government bond yield. Fig. 5(c) US to China 10 year government bond yield. Fig. 5(d) US to Turkey 10 year government bond yield Fig. 5(e) US to Russia 10 year government bond yield. Fig. 5(f) US to US 10 year government bond yield. Fig. 5(g) US to India 10 year government bond yield. Fig. 5(h) US to Brazil 10 year government bond yield.



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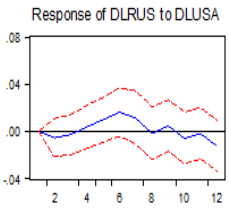

Figure 6(f)

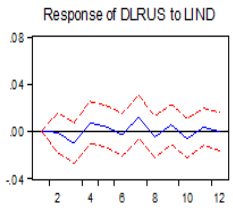

Figure 6(g)

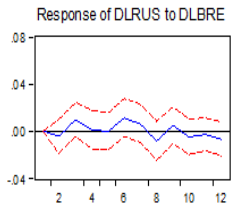

Figure 6(h)

Figure 6 shows the impulse response function for Russia[1] Fig. 6a, c, d, f, g, and h indicate that shocks to Japan, China, Turkey, US, India and Brazil have no significant responses in the Russian market. The significant yields are Germany and its own. Fig. 6b plots the response of yields to the German yield and shows that it is significant and positive around the third month. Fig. 6e plots the Russian bond yields responds to own shocks. There is a positive and significant response in the first two months.

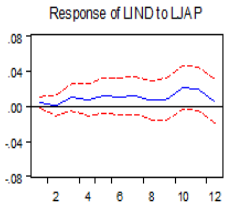

Figure 7(a)

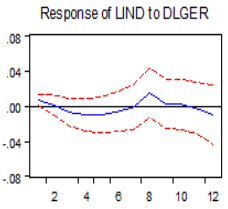

Figure 7(b)

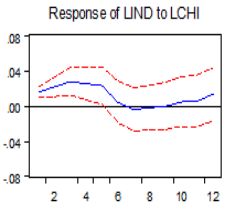

Figure 7(c)

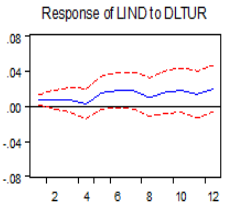

Figure 7(d)

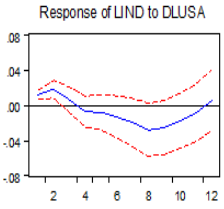

Figure 7(e)

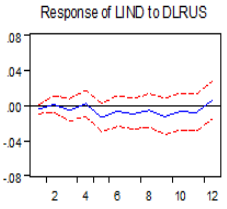

Figure 7(f)

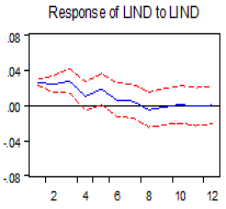

Figure 7(g)

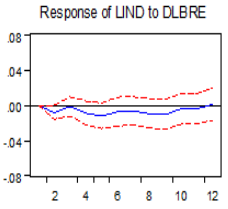

Figure 7(h)

In case of India[2], bond yield responds significantly to shocks from China, US, and in addition to its own shocks. Fig. 7c plots the response of Indian bond yield to China

[1] Fig. 6(a) Russia to Japan 10 year government bond yield Fig. 6(b) Russia to Germany 10 year government bond yield. Fig. 6(c) Russia to China 10 year government bond yield. Fig. 6(d) Russia to Turkey 10 year government bond yield Fig. 6(e) Russia to Russia 10 year government bond yield. Fig. 6(f) Russia to US 10 year government bond yield. Fig. 6(g) Russia to India 10 year government bond yield. Fig. 6(h) Russia to Brazil 10 year government bond yield.

[2] Fig. 7(a) India to Japan 10 year government bond yield Fig. 7(b) India to Germany 10 year government bond yield. Fig. 7(c) India to China 10 year government bond yield. Fig. 7(d) India to Turkey 10 year government bond yield Fig. 7(e) India to US 10 year government bond yield. Fig. 7(f) India to Russia 10 year government bond yield. Fig. 7(g) India to India 10 year government bond yield. Fig. 7(h) India to Brazil 10 year government bond yield.

bond yield and shows that it is significant and positive in about five months. Fig. 7e plots the effect of the US bond yield on the Indian market and indicates that the response is positive and significant in first three months. Fig. 7g plots the Indian bond yields responds to its own shocks. The effect is positive and significant in the first four months. Fig. 7a, b, d, f and h indicate that Indian bond market do not respond significantly to Japanese, German, Turkish, Russian, and Brazilian bond markets in the sample period.

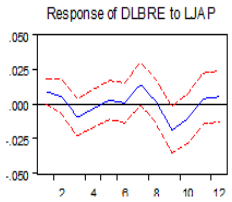

Figure 8(a)

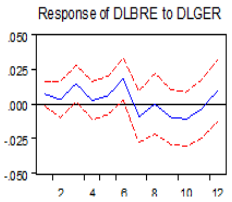

Figure 8(b)

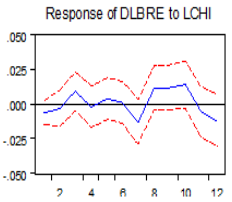

Figure 8(c)

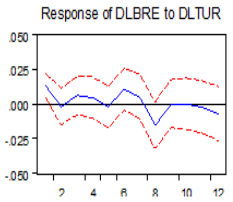

Figure 8(d)

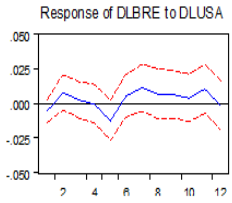

Figure 8(e)

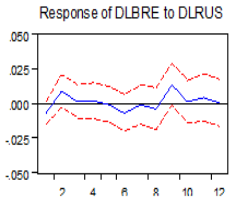

Figure 8(f)

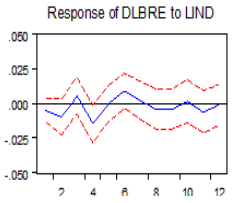

Figure 8(g)

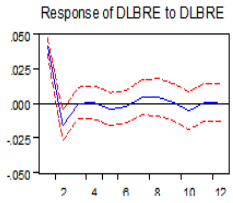

Figure 8(h)

In case of Brazil[1], the significant bond yields are Germany and its own shocks. Fig. 8b plots the response of bond yields in Brazil to a German bond yield shock and the response is significant and positive in the sixth month. Fig. 8a, c, d, e, f and plot the responses of yields in Brazil to Japan, China, Turkey, US, Russia and India, respectively. All these bond yields are insignificant in explaining the movement of bond yields of Brazil. Fig. 8h plots the Brazilian bond yields' response to its own shocks. The impact is positive and significant in the first two months.

4.2. Forecast Error Variance Decompositions

We also present the forecast error variance decompositions in Table 2 to indicate how variance of bond yield in a country is explained in percentage points by shocks to eight countries listed in the first row.

[1] Fig. 8(a) Brazil to Japan 10 year government bond yield Fig. 8(b) Brazil to Germany 10 year government bond yield. Fig. 8(c) Brazil to China 10 year government bond yield. Fig. 8(d) Brazil to Turkey 10 year government bond yield Fig. 8(e) Brazil to US 10 year government bond yield. Fig. 8(f) Brazil to Russia 10 year government bond yield. Fig. 8(g) Brazil to India 10 year government bond yield. Fig. 8(h) Brazil to Brazil 10 year government bond yield.

As can be seen from the Table 2, bond yield of the US is the most affected by other bonds in contemporaneous time. For instance, foreign bond yields explains over 52.2% of US price variations at the 1-month interval, compared with 0% for Japan, 16.2% for Germany, 1% for China, 11.1% for Turkey, 16.2% for Russia, 43.7% for India and 20.3% for Brazil in contemporaneous time.

Chinese and Japanese bond markets are relatively independent as each explains a larger percentage of their own error variance relative to other bond markets. The effect of foreign shocks on Chinese and Japanese bond markets increase only moderately over forecast intervals unlike in all the other countries. Thus, China and Japan are the least influenced countries by others at the 12-month interval. Gains from diversification are less when foreign markets account for a greater percentage of the forecast error variance than the shocked market accounts for. Hence, investors have some opportunities to make portfolio diversification in these two markets. Foreign bond markets account for 29.4% of total China price variations. The Germany, Turkey and Brazil, respectively, account for 9.18 %, 5.8% and 5.4% of price variations in the China at the 12-month interval.

For Japan, foreign bond markets account for 35.2% of total Japan price variations. The Germany, Turkey and China, respectively, account for 14.6%, 7.9% and 5.9% of price variations in the Japan. Also, Japanese bond market plays a very important role in the international linkages of yields at the longer interval. For instance, at the 12-month interval, Japanese bond market on average accounts for 14% of price variations in the other countries.

Interestingly, US bond market is not a dominant international factor for other seven countries' bond markets, except India. Also, US bond market is relatively dependent because the bond market explains only 33.5% of its own error variance at the 12-month interval. The Japanese bond market explains 24% of the US bond market, while the German and Chinese government bond markets explain 15.7% and 7.9%, respectively.

Germany, Turkey, Russia and Brazil are slightly influenced by other countries at the 1-month 16.2%, 11.1%, 16.2% and 20.3%, respectively. However, they become highly vulnerable to foreign influence at the longer interval. Foreign bond markets explain 62%, 55%, 64.6% and 71.2% of price variations respectively at the 12-month interval in the four countries. For instance, the German bond market explains only 38% of its own shocks. The Turkish bond market explains 21% of the German bond market, while the Japanese and Chinese bond markets explain 13.3% and 12.9%, respectively.

Table 2. Forecast error variance decompositions (percentage)

Month	Japan	Germany	China	Turkey	US	Russia	India	Brazil
Variance of United States Explained by Shocks to the Eight Countries								
1	26.49	22.69	0.85	2.17	47.77	0.00	0.00	0.00
3	30.19	15.75	6.24	2.99	41.24	2.40	0.44	0.71
6	26.54	15.47	8.97	5.58	36.71	2.82	1.31	2.48
12	24.05	15.70	7.94	7.78	33.51	3.63	1.97	5.33
Variance of Japan Explained by Shocks to the Eight Countries								
1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	89.27	5.18	0.94	1.19	2.42	0.36	0.55	0.04
6	73.62	8.69	1.38	11.69	2.57	1.24	0.61	0.17
12	64.79	14.61	5.92	7.92	3.40	1.55	0.95	0.81
Variance of Germany Explained by Shocks to the Eight Countries								
1	16.14	83.85	0.00	0.00	0.00	0.00	0.00	0.00
3	15.87	55.06	5.69	12.54	4.97	5.13	0.47	0.24
6	13.85	45.64	9.33	17.16	4.09	5.77	2.20	1.91
12	13.39	38.07	12.94	21.05	3.89	5.81	2.73	2.08
Variance of China Explained by Shocks to the Eight Countries								
1	0.79	0.017	99.18	0.00	0.00	0.00	0.00	0.00
3	1.35	0.85	92.34	0.72	1.45	1.25	1.39	0.61
6	2.28	3.49	83.45	3.83	0.84	1.28	1.04	3.75
12	4.08	9.18	70.65	5.83	1.44	1.96	1.34	5.48
Variance of Turkey Explained by Shocks to the Eight Countries								
1	10.67	0.21	0.20	88.90	0.00	0.00	0.00	0.00
3	17.52	0.52	1.92	71.54	4.17	0.86	0.03	3.40
6	19.43	1.54	6.94	57.59	7.01	2.30	0.62	4.53
12	22.86	7.84	6.92	45.04	7.38	2.19	2.79	4.94
Variance of Russia Explained by Shocks to the Eight Countries								
1	5.29	8.526	0.01	1.05	1.27	83.82	0.00	0.00
3	7.48	19.71	0.19	5.52	1.80	61.45	1.85	1.95
6	12.64	20.85	1.51	7.25	6.20	46.13	2.32	3.08
12	11.33	23.67	5.21	7.25	8.28	35.48	4.29	4.45
Variance of Brazil Explained by Shocks to the Eight Countries								
1	3.48	2.28	1.93	7.63	1.29	2.43	1.18	79.73
3	6.06	8.59	4.27	6.48	2.99	4.09	4.79	62.68
6	4.93	14.94	3.63	8.00	6.51	4.27	10.54	47.14
12	12.64	14.51	13.50	9.05	8.48	5.52	7.42	28.85
Variance of India Explained by Shocks to the Eight Countries								
1	1.26	3.98	20.47	4.4	11.68	1.86	56.32	0.00
3	2.57	2.33	32.90	3.33	11.32	1.18	44.76	1.56
6	5.14	4.41	33.33	8.66	9.922	3.68	30.52	4.30
12	10.37	4.91	20.56	15.53	21.28	5.34	17.57	4.39

Russia and Brazil are also barely influenced by other countries at the 1-month interval (16.2%-20.3%). However, Russian and Brazilian bond markets become one of the most vulnerable countries to the influence of foreign bond markets at the 12-

month interval. Only 35.4% and 28.8% of the price variations are explained by their own shocks. For Russia; Germany and Japan account for about 23% and 11%, and for Brazil; Germany and China explain 14.5% and 13.3% of the price variations, respectively.

Interestingly, Turkish bond markets account for a significant portion of price differentials in many other countries. For instance, it is 21% for the Germany, 15.5% for India and 9% for Brazil at the 12-month interval. Also, Japan explains about 22.8% of the price variations in Turkey.

Lastly, India is similar to US, being among the most influenced countries by the others at the 1-month interval (43.7%) as well as the 3-month interval (55.3%). Indian markets account for a smaller percentage of its own error variance than any other markets. At the 12-month interval, a shock to the Indian market indicates that the US bond yield explains 21.2%, while the Indian bond market explains only 17.5% of its own forecast error variance. Also, India is fragile to shocks originating from China (20.5%) and Turkey (15.5%).

5. Conclusion

The co-movement of international markets has been increased since the structural changes like regulation of financial markets and removing of capital controls etc. are put into practice in the last two decades. This paper contributes to the knowledge of the dynamic relationships among the developed and emerging bond markets perspective. Interactions among government bond markets (Japan, US, Germany, Russia, India, South Africa, China, Brazil and Turkey) are examined with VAR analysis. Before estimating the model, series are analyzed in terms of stationary using the ADF and PP tests in order to avoid possibility of spurious relationships. ADF and PP tests indicate that bond yields of Japan, China and India are stationary at level; bond yields of Germany, Turkey, US, Russia and Brazil are stationary in their first differences. Appropriate lag length is determined by using the AIC. Afterwards, impulse response functions are used to analyze the dynamics of the variables. Findings show that foreign bond yield generally appears to have a positive effect.

Japanese and Chinese bond yields respond only significantly to own shocks. In terms of Germany, market responds to shocks from Japan and Turkey. For US, Japanese and German are the significant markets. In case of Turkey, the significant bond markets are Japan and China. In case of Russia, the significant market is Germany and in case of India, market responds to shocks from China and US.

The forecast error variance decompositions indicate that Japan bond yield is not influenced by any other bonds, but generally explains the movement on all the other markets except China (13.3% on Germany, 22.8% on Turkey, 24% on US, 11.3%

on Russia, 10.3% on India, 12.6% on Brazil) at the 12-month interval. It is also interesting to note that the Chinese and Japanese markets seem to be less integrated with the other six markets. Specifically, their market exogeneity is showed by the percentage of self-explained variation as 70% and 64%, respectively. Hence, investors have some opportunities to make portfolio diversification in these two markets. In addition, Japan (13.3%), China (12.9%), Turkey (21%), and to a lesser extent, Russia (5.8%) can noticeably influence Germany.

It is interesting to note that US bond yield is not dominant for other seven countries' bond yields except India. Japan bond yield has more effect than US bond yields on these countries. In addition, US bond market is relatively dependent because the bond yield explains only 33.5% of its own error variance at the 12-month interval. The Japanese bond yield explains 24% of the US bond yield, while the German and Chinese government bond yields explain 15.7% and 7.9%, respectively. Turkey, Russia and Brazil are slightly influenced by other countries in 1-month 16.2%, 11.1%, 16.2% and 20.3%, respectively. However, they become highly vulnerable to foreign influence at the longer interval. Foreign bond yields explain 62%, 55%, 64.6% and 71.2% of price variations respectively at the 12-month interval.

Lastly, India is like US, being the most influenced country by the others at the 1-month interval (43.7%) as well as the 3-month interval (56%). Indian yield accounts for a smaller percentage of its own error variance than any other markets. Also, at the 12-month interval, a shock to the Indian yield indicates that the US bond yield explains 21.2%, while the Indian bond yield explains only 17.5% of its own forecast error variance. Moreover, India can be fragile to shocks originating from China (20.5%) and Turkey (15.5%).

The findings may have important implications for international investors and policy makers. For instance, the low level of dynamic linkages of markets may help international investors to choose target countries with the maximum diversification potential, creating some opportunities to make diversification that the shocks are not transmitted to other markets like China, Japan and Russia markets. In addition, developed market shocks have been found to be consistently important in all emerging markets (except China) for policy-makers. Therefore, they need to concentrate to shocks from developed markets.

6. References

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