Volatility Transmission between Bond and Stock Markets: Case of Emerging Financial Markets

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Abstract: This paper investigates the transmission of market volatility between the emerging stock and bond markets. In order to examine this relation between the bond and stock market, we use the BEKK GARCH model; a decomposition approach of the multivariate GARCH (1, 1) model. The outcome of this study displays a significant relation between bond and stock index and the incidence of the interest rate in this transmission. Besides, there is a transmission of volatility between the bond and stock index demonstrated by the DCC GARCH graph.

Keywords: Volatility transmission; Multivariate GARCH (1, 1) BEKK; Bonds; Stock Market

JEL Classification: C32; F30; G12; G15

1. Introduction

Several studies investigated the comovement between the stock index and bonds by prescribing the presence of volatility transmission. Although a consensus to causation and prediction has yet to be reached. Volatility inducing events such as the subprime crises cause an acute convergence of investors' behavior and may lead of the transmission of price variance between the bonds and stocks across the developed and emerging markets. In this context, there are several studies which focused on the volatility transmission between the stock index and bonds markets. Merton (1974) is the pioneer who studied this kind of relationship. However, Jayech et al. (2011) indicate a financial contagion presence during the crisis of 2007. Therefore, this crisis may affect the relation between the bond and stock index of the emerging markets. The study of the transmission of volatility between the bond and stock markets is considered as a central focus in many recent studies.

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A growing number of empirical studies (Johansson2010, Steeley 2007, Fang and Lim 2009) mainly explore the relation linking the stock market and bond market and suggest that volatility transmission exists. Many empirical proofs show a negative correlation between the stock index and bonds, (Shiller and Beltratti (1992), Kwan, Campbell and Ammer (1993)).

The change of the correlation amid international the stock markets over time is explained by different studies. Voronkova (2004), Bekaert and Harvey (2003); Bekaert and Harvey (2000) Errunza and Losq (1985) showed that the relationship across international stock markets index is not constant over time whether in economic, politic and market situations. On the other hand, Corhay et al. (1995) found no evidence of a correlation in their study about Australia, Japan, Hong Kong, New Zealand and Singapore markets. Nath and Verma (2003) studied the stock market of some Asian countries and initiated no correlation between these indices. Cheung and Mak (1992) and Masih and Mash (1997) established that the correlation of international stock markets is strong. They definitely instituted that the US market is a global factor moving both the developed and emerging markets.

2. Literature Review

A vast empirical literature documented a high correlation between the bond and stock markets. Indeed, recent studies have been interest in the volatility transmission across the stocks and bonds in the emerging financial markets. Johansson (2010) examined the correlation between stocks and bonds in nine Asian countries. Spending a bivariate stochastic volatility model, there is a significant effect between the stock and bond markets in most of these countries. Moreover, dynamic correlation patterns show that this relationship changes considerably over time in most of the countries.

Similarly, Connolly, Stivers and Sun (2005), Li (2004) and Jones and Wilson (2004) studied the relationship between the stock and bond indices based on their changes over time.

On the other hand, some studies explain the comovement between the stock index and bond market by using the multivariate GARCH model to study the existing interrelation between these two assets in the U.S and Europe (Christiansen (2008)), to show that the covariance of the stocks and bonds is contingent on the type of shocks (De Goeij and Marquering (2004)).

This correlation was an objective for many studies. Bekaert and Harvey (1995), Bekaert (1995), Forbes and Rigobon (2002) and Johansson and Ljungwall (2009) have converging ideas about the comouvements effects between the different stock markets. In contrast, limited literatures are concentrated on the correlation between the international bond markets. Johansson (2008), for example, studied the correlation between four emerging Asian bond markets as well as their dynamic relationship structure. Skintzi and Refenes (2006) examined the relationship between bonds in more developed markets such as the correlation between the European and the US markets and the individual European markets.

The empirical evidence presented by Shiller and Beltratti (1992), Kwan, Campbell and Ammer (1993) shows a negative interaction, albeit to varying degrees.

On the other hand, Campbell and Ammer (1993) study the correlation between the stock and bond returns and found traditional fundamental effects. Fleming et al (1998), considered two distinct effects in the evaluation of volatility linkages between the stock and bond markets. It is also well known that the stock and bond returns are positively correlated. To explain the increase in bond returns, Campbell and Taksler (2003) presented new evidence on this phenomenon by using equity volatility.

Generally, some studies proposed a correlation between the stock and bond returns on an aggregate level, while limited evidence present minor disparities. In accordance with the conventional potentials model, Shiller and Beltratti (1992) found substantial evidence on strong negative correlation variability in the real stock prices and long-term interest rates of the U.S. and U.K. financial markets. Caporale et al. (2002) used the test for the East Asian markets and found a correlation between the stock indexes and the exchange rates volatility.

Besides, Alaganar and Bhar (2003) observed causality both the mean and variance of the financial sector returns and short-term interest rates of the G7.

Hamao et al. (1990) and Koutmos and Booth (1995) and other researchers examined the interdependence of the equity market volatility, typically using mainly the framework of generalized autoregressive conditional heteroscedasticity (GARCH) time series models.

However, there are a few studies that explained the interdependence of the international bond markets. Ilmanen (1995) cast-off a linear regression model to estimate the unrestraint returns of long-term international bonds. The excess returns were highly correlated to indicate a significant integration across the transnational bond markets. In the same context, Clare and Lekkos (2000) used a VAR model to amount the interaction between the US, UK and German bond markets, and found that transnational factors are more important during times of instability. Driessen et al (2003) examined the bond markets of the US, Japan and Germany using a principal components analysis method.

The role of the interest rates in the transmission of volatility between bond and stock market has been the focus of many studies. These studies used a simultaneous analysis of the bond prices, short-term interest rates and equity markets, Rigobon and Sack (2003b) discovered that the causality of the transmission process may run in different directions, such as the correlation between the US short-term interest rates and the equity prices swing from positive to negative at which asset prices are dominant in crisis periods.

Similarly, Dungey and Martin (2001) studied the contagion across different countries and financial markets. They studied essentially the correlation between the short-term interest rates and the stock market index in different countries.

In the same context, Steely (2006) established a correlation between the stock, bond and interest rate returns in the UK. Most of these studies demonstrated that the sovereign bonds in the US interest rates affect significantly several emerging bond markets.

3. Data and Methodological Approach

3.1. Data

To determinate the relationship between the bond and stock markets, we employ daily data of the stock and bond indices for Argentina, Australia, Greek, Hong Kong, Hungary, Mexico, Peru, Spain, Turkey and Polanda, over the period of 7/30/2009 to 18/01/2011. Since this period includes the subprime crisis period, this study employs data from two sources. The closing price data of the bond market indexes and the interest rates are provided by Datastream database. The data of the stock market index are drawn from Econostats.

This sample period encapsulates volatility inducing events such as the subprime crises in which appeared in the summer of 2007 in the United States.

This period is characterized by the volatility of interest due to the subprime crisis which hit the mortgage market in the United States and subsequently became a financial crisis that affected all the financial markets worldwide.

3.2. Methodological Approach

The transmission of volatility between the bond and stock markets has become the major topic in the financial studies in recent years. Thus, at first, we inspect the relation between bond and stock markets.

A negative correlation between stocks and bonds is demonstrated in the empirical evidence presented by Shiller and Beltratti (1992), Kwan (1996) and Campbell (1993). While the methods used in their study are robust, however, they did not care about the informational role of the variance in financial time series. This motivates us to investigate the causality between both assets via temporal volatility. In addition, the variance of returns indicates the flow of information among investors. Therefore, if causality is observable in variance, these assets (and their markets) should be information-linked.

Cheung and Ng (1996), Caporale et al. (2001) and Bhar (2003) developed several variations of measuring causality-in-variance.

Instead of using the GARCH (1, 1), Bhar (2003) employed the Markov Switching process to model conditional variances (on stock returns) based on an unobserved state. The model estimation relies on a probability weighted maximum likelihood function, and allows a smooth distribution of conditional variances that are suitable for a causality-invariance test.

Caporale et al. (2001) and Cheung and Ng (1996) used the BEKK model, which parameterizes conditional variances, covariance and their cross-correlation. Properly, the model is applicable to two or more variables in two moments, while not requiring excessive parameter estimation, and reduces complications of reconfiguration (inherently VAR). However, the quadratic specification helps us treat problematic negative covariance matrices faced by other specifications (such as the VECH) without difficulty.

In order to analyze the volatility spillover effect, we used a multivariate GARCH model. More specifically, we used the BEKK model proposed by Engle and Kroner (1995).According to Wang (2009), the BEKK model can be written as:

$$H_t = A_0 A'_0 + A'_i \varepsilon_{t-i} A_i + B'_j H_{t-j} B_j \quad (1)$$

Where A_0 is a symmetric (N×N) parameter matrix, and A_i and B_j are unrestricted (N×N) parameter matrices. This specification allows the conditional variances and covariances of the time series to influence each other, and at the same time, does not require estimating a large number of parameters. For Wang (2009), based on the symmetric parameterization of the model, H_t is almost surely positive provided that A_0 A'_0 is positive (Tsay, 2010). Wang (2009) writes the variances and covariances explicitly as:

$$h_{11,t} = \alpha_{11,0} + (\alpha^2_{11,1}\varepsilon^2_{1,t-1} + 2\,\alpha_{11,1}\alpha_{21,1}\,\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \alpha^2_{21,1}\varepsilon^2_{2,t-1}) + (\beta^2_{11,1}\,h_{11,t-1} + 2\beta_{11,1}\,\beta_{21,1}\,h_{12,t-1} + \beta^2_{21,1}\,h_{22,t-1}) \quad (2)$$

$$h_{22,t} = h_{21,t} = \alpha_{12,0} + [\alpha_{11,1}\alpha_{12,1}\varepsilon^2_{1,t-1} + (\alpha_{12,1}\alpha_{21,1} + \alpha_{11,1}\alpha_{22,1})\,\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \alpha_{21,1}\alpha_{22,1}\varepsilon^2_{2,t-1}] + [\beta_{11,1}\,\beta_{21,1}\,h_{11,t-1} + (\beta_{12,1}\,\beta_{21,1} + \beta_{11,1}\,\beta_{22,1})\,h_{12,t-1} + \beta_{21,1}\,\beta_{22,1}\,h_{22,t-1}], \quad (3)$$

$$h_{22,t} = \alpha_{22,0} + (\alpha^2_{12,1}\varepsilon^2_{1,t-1} + 2\,\alpha_{12,1}\alpha_{22,1}\,\varepsilon_{1,t-1}\varepsilon_{2,t-1} + \alpha^2_{22,1}\varepsilon^2_{2,t-1}) + (\beta^2_{12,1}\,h_{11,t-1} + 2\beta_{12,1}\,\beta_{22,1}\,h_{12,t-1} + \beta^2_{22,1}\,h_{22,t-1}), \quad (4)$$

The diagonal elements of the matrix, h_{11} and h_{22}, evaluate the impact of the shock of one series on the volatility of the other. This impact could be asymmetric or only one way effective (Wang, 2009). The parameters $\alpha_{11,1}$ and $\alpha_{22,1}$ represent the effect of the shock on the future uncertainty of the same time series and $\alpha_{21,1}$ and $\alpha_{12,1}$ represent the cross effect. If $\alpha_{11,1}$ and $\alpha_{21,1}$ have different signs, then the shocks with different signs in the two time series tend to increase the future uncertainty in the first time series. In the same way, if $\alpha_{12,1}$ and $\alpha_{22,1}$ have different signs, the future uncertainty of the second time series might increase if the two shocks have different signs (Wang, 2009).

We also used the DCC GARCH to estimate the transmission of volatility between the bond and stock market. The result of this estimation is demonstrated in the graph below.

Table 1 present statistical summaries and preliminary diagnostics for the daily returns of all the stock and bond indices and the interest rate for the sample period from July 30, 2009 to January 31, 2011.

4. Empirical Results

4.1. Descriptive Statistic

Table 1 presents the basic statistical properties of the data of 10 emerging financial markets. The average returns of the stock indexes are positive but very low for most countries (except for Greece and Hungary, are negative). Peru and Argentina have the maximum average returns regarding the other countries. The same applies to the bond index (except for Greece and Mexico, are negative). Turkey and Argentina have the maximum average returns compared to the other countries.

The coefficients of skewness are different from zero for all the indexes and for all the countries, which reflects the asymmetry of returns. The high frequency of large negative returns compared with large positive returns can explain this result. Similarly, the coefficients of kurtosis are largely higher than 3 for all the bond and stock indexes, which confirms the high occurrence of extreme values. We conclude that the empirical distribution of all the returns series is leptokurtic. Therefore, the Jarque-Bera test rejects the normality of the return series.

Table 1. Descriptive Statistic

	Argentina	Australia	Greece	Hong Kong	Hungary	Mexico	Peru	Poland	Spain	Turkey
Stock Index										
Mean	0.002	0.001	-0.001	0.005	-0.001	0.001	0.045	0.002	3.47e-05	0.001
Max.	0.071	0.0298	0.091	0.032	0.198	0.026	3.859	0.098	7.50e-05	0.071
Min.	-0.060	-0.031	-0.066	-0.048	-0.104	-0.033	-4.246	-0.071	2.47e-05	-0.055
Skewness	-0.247	-0.118	0.225	-0.298	1.850	-0.492	-0.247	0.018	1.504	0.003
Kurtosis	5.471	3.455	4.428	3.244	18.283	4.276	4.383	4.054	3.263	5.150
Jarque-Bera	98.192	4.076348	34.70493	6.460	3832.755	40.267	26.184	17.20977	140.9948	71.646
p-value	0.000***	0.130*	0.000***	0.039**	0.000***	0.000***	0.000***	0.001***	0.000***	0.000***
Bond Index										
Mean	0.001	6.26e-05	-0.000576	9.18e-07	0.000176	-0.003	0.001	0.002	4.10e-05	0.002
Max.	0.234	0.015153	0.233909	0.007181	0.032255	0.018	0.021	0.020	0.007	0.243
Min.	-0.040	-0.017429	-0.053397	-0.006674	-0.023819	-0.028	0.000	-0.015	-0.005	-0.198
Skewness	12.311	0.030808	9.713373	-0.171099	0.297568	-2.023	12.687	0.274	-0.077	0.543
Kurtosis	187.940	4.184433	157.8940	4.474657	8.637368	24.444	170.149	3.744	13.075	7.620
Jarque-Bera	538093.9	21.80350	376712.4	35.52157	498.0786	7381.700	346566.3	13.239	1569.666	349.193
p-value	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.001***	0.000***	0.000***
Interest Rate										
Mean	11.238	5.324194	2.792451	0.340444	5.293690	5.771	0.341	3.153	30.003	9.614
Max.	13.125	5.7	3.3585	0.66	8.075	6.455	0.54	5.481	44.4	11.32
Min.	10.625	4.25	2.014	0.16	0.36	4.86	0.25	2.563	20.50	8.42
Skewness	1.490	-1.057490	-0.421910	0.202190	-0.091975	-0.314	0.918	3.803	0.332	0.198
Kurtosis	4.272	3.702358	1.945719	2.134807	4.516109	1.721	2.283	28.744	2.929	2.218
Jarque-Bera	162.373	76.97995	28.18890	14.13729	36.15258	31.481	47.169	11170.30	6.878	11.904
p-value	0.000***	0.000***	0.000***	0.001***	0.000***	0.000***	0.000***	0.000***	0.032**	0.002***

***indicates significance at the 1 percent level ** at 5 percent * at 10 percent

4.2. Correlation Analysis between Bond and Stock Market Index

The result reports the domestic cross-market influences between the bonds and stocks for ten emerging countries in the presence of an interest rate determinant. In order to compensate for any biasness that may arise, we restricted our inferences to 1 per cent significance, as suggested by Karolyi (1995).

The results indicate that in domestic emerging markets, the government bonds have in influence on the domestic stock market in variance. Overall, the results indicate that the GARCH (1, 1) specification captures satisfactory the persistence in the squared return series.

Table 2 shows the result of the transmission of volatility between the bonds and stocks of the emerging markets in the presence of the interest rates as a transmission channel. The result shows that there is a transmission of the volatility of the bond market to the spot markets. This transmission occurs in two stages, at the average coefficients expressed by α_{21} and α_{31} and at variance β_{21} and β_{31}.

The estimate of α_{21} in the emerging market is statistically significant at 1% level in most countries as shown in the table. This suggests that a 1 percent increase in the volatility of the bond market causes its own stock market volatility to decrease (increase) by α%.

These tables show that the transmission of volatility, on average, between domestic bond and stock markets is statistically significant. The results indicate that the coefficient α_{21} measuring the mean spillover from the bond market to stock Market is significant in the majority of the countries, as shown in the tables above.

The results also show that the correlation between two asset classes changes over time and correlation between the emerging bond and stock markets is indeed time varying in nature. This varying is explained by moves between positive and negative values. In addition, the bond-stock correlation tends to increase during periods of market turmoil for most countries. This result confirms those shown by Johansson (2009).

Most of the studies show a comovement volatility between the stock and bond markets, whereas our study shows a comovement between bond and stock domestic emerging markets.

The majority of the empirical studies (Granger and Morgenstern, 1970; Arshanapalli *et al.*, 1995; Malliaris and Urrutia, 1992; Hon, Strauss and Yong, 2006; Khalid and Rajaguru, 2007; Huyghebaert and Wang, 2010) show that the comovement patterns of national stock markets change significantly after major economic events such as crises. These results confirm our work**.**

The result also shows that the uncertainty in the bond and stock markets has a significant effect on the existing correlation between these two assets. Our study shows that the correlation structure between the bond and stock market varies over time and manly during periods of financial turmoil. This result confirms the work done by Hartmann, Straetmans and De Vries (2001), Gulko (2002), and Baur, Lucey (2009).

Moreover, the evidence shows that the volatility transmission is bidirectional between domestic cross-markets in the sense that the domestic bond market tends to exert influence over the domestic stock market and vice versa.

In our study, we used the interest rate as a transmission channel. The results showed that there is relationship between the interest rates and stock indices in average expressed by the coefficient α_{31} or in variance expressed by the coefficientβ_{31} as shown in Table 2.

The correlation between the interest rates and the stock indexes, may explain that the interest rates have an essential role in the transmission of the shock of a mortgage crisis to a financial crisis. This crisis affected almost all the financial markets and primarily the emerging markets, such as the Greece market.

Table 2. Results of transmission volatility between bond and stock index in the presence of interest rate

	Argentina	Australia	Greece	Hong Kong	Hungary	Mexico	Peru	Spain	Turkey	Poland
α_{12}	(0,0784)	(-0,0142)	(0,023)	(0,004)	(0,027)	(0,738)	(0,000)	(-0,000)	(0,001)	(0.007)
	0,000***	0,834	0,000***	0,629	0,010***	0,000***	0,000***	0,000***	0,826	0.045**
α_{13}	(-0,3951)	(-0,0391)	(-13,832)	(-0,134)	(-7,710)	(2,113)	(0,001)	(-0,083)	(-0,064)	(-0.291)
	0,000***	0,140	0,000***	0,054**	0,000***	0,053**	0,1171	0,165	0,966	0.460
α_{21}	(-3,9997)	(0,2082)	(-0,240)	(-1,420)	(-0,410)	(0,505)	(1671,930)	(-233,153)	(0,020)	(1.993)
	0,000***	0,015***	0,069	0,000***	0,339	0,000***	0,000***	0,001***	0,050**	0.124
α_{23}	(-4,9954)	(0,0248)	(-221,673)	(-0,256)	(17,617)	(-3,142)	(-10,027)	(-17,998)	(-0,218)	(29.115)
	0,036**	0,423	0,000***	0,637	0,000***	0,000***	0,000***	0,599	0,667	0.001***
α_{31}	(0,0011)	(-0,0014)	(0,000)	(-0,045)	(0,003)	(0,056)	(-0,411)	(-0,317)	(0,000)	(0.000)
	0,000***	0,000***	0,000***	0,391	0,357	0,000***	0,022**	0,000***	0,000***	0.121
α_{32}	(0,0005)	(-0,0011)	(0,000)	(-0,023)	(0,000)	(-0,038)	(0,001)	(-0,000)	(0,000)	(-0.000)
	0,000***	0,000***	0,000***	0,004***	0,678	0,014***	0,057**	0,932	0,977	0.000***
β_{12}	(-0,0012)	(0,1355)	(-0,004)	(0,059)	(0,035)	(0,672)	(0,000)	(-0,001)	(-0,010)	(-0.013)
	0,188	0,014***	0,002***	0,000***	0,076	0,000***	0,000***	0,000***	0,126	0.000***
β_{13}	(-0,8569)	(0,2029)	(-49,753)	(0,595)	(1,040)	(0,954)	(0,000)	(-0,088)	(3,189)	(4.042)
	0,000***	0,024**	0,000***	0,000***	0,525	0,342	0,799	0,417	0,125	0.000***
β_{21}	(8,6795)	(0,3781)	(0,846)	(1,701)	(0,667)	(-0,134)	(-248,921)	(510,626)	(0,047)	(14.049)
	0,000***	0,127	0,000***	0,000***	0,099	0,005***	0,026**	0,000***	0,000***	0.000***
β_{23}	(-3,9460)	(0,0249)	(-191,389)	(-2,488)	(-0,286)	(-3,100)	(-2,889)	(-309,942)	(-0,089)	(-45.530)
	0,072*	0,667	0,000***	0,000***	0,916	0,000***	0,000***	0,000***	0,743	0.000***
β_{31}	(-0,0047)	(0,0097)	(-0,001)	(0,219)	(-0,038)	(0,046)	(2,661)	(0,095)	(-0,002)	(0.002)
	0,000***	0,000***	0,000***	0,000***	0,000***	0,000***	0,000***	0,712	0,000***	0.002***
β_{32}	(0,0005)	(0,0036)	(0,000)	(0,022)	(0,000)	(-0,037)	(0,000)	(-0,001)	(-0,000)	(-0.000)
	0,000***	0,000***	0,000***	0,029**	0,709	0,000***	0,687	0,014***	0,671	0.023**

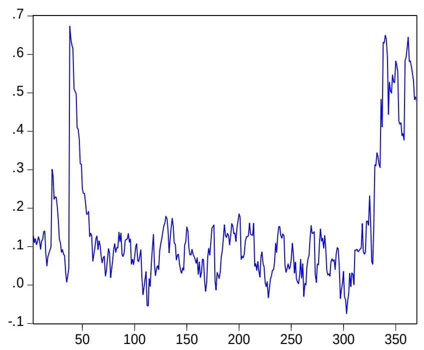
***indicates significance at the 1 percent level ** at 5 percent * at 10 percent

4.3. Dynamic Conditional Correlation between Bond and Stock Index

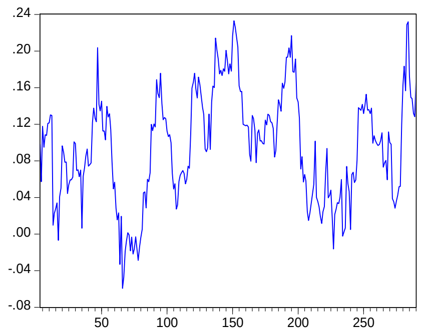
To explain the relationship between the bond and stock indexes in the emerging financial markets we use the DCC-GARCH model. The Figure plots the dynamic correlation between the bond and stock index returns during and after the subprime crisis.

We found a strong time varying evidence of negative and positive correlation between the bond and stock index. Some turmoil periods provide extremely high negative correlation, while some tranquil periods provide low correlation among these indexes. We note that the transmission of volatility varies greatly and can be positive or negative in almost all the studied countries, excepting Polanda in which there was a positive correlation.

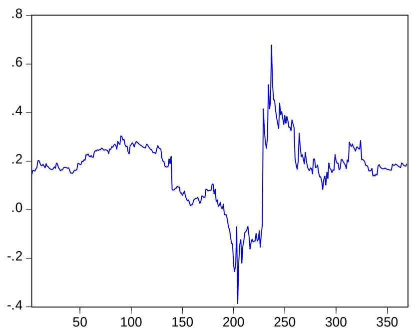
Argentina



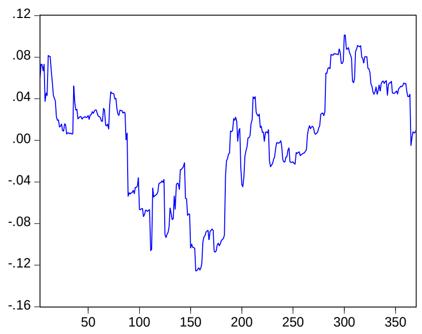
Australia



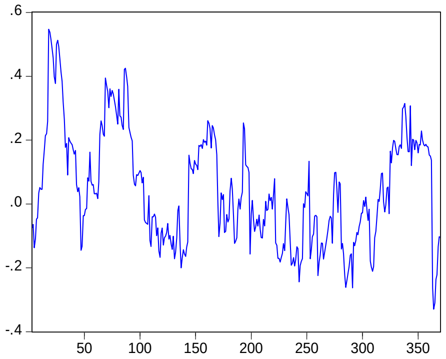
Greece



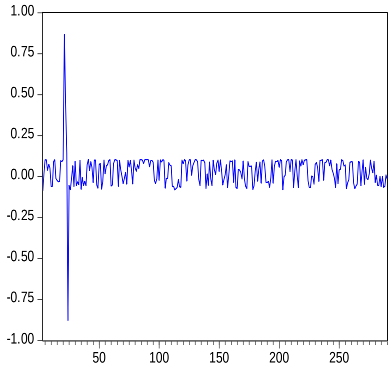
Hong Kong



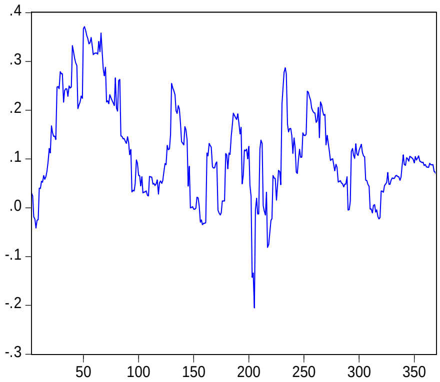
Hungary



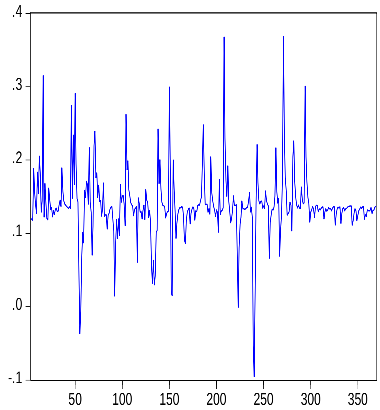
Mexico

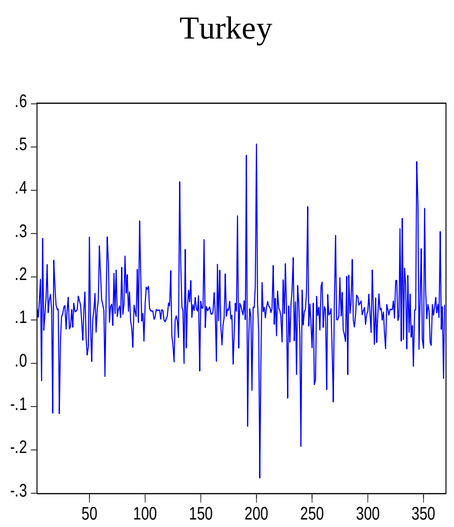


Peru



Spain





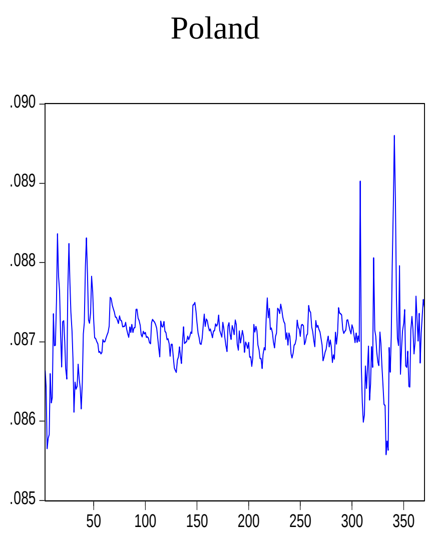


Figure 1. The Dynamic correlation between bond and stock index for emerging financial markets

5. Conclusion

This paper examines the volatility transmission between the bond and stock emerging market in the presence of the interest rates. We use the BEKK-MGARCH (1, 1) (Multivariate Garch) and the DCC-GARCH. We found a bidirectional transmission of volatility between the bond and stock market. We also found that the interest rates are the canal of transmission. This result is explained by the significant effect of the interest rates on the stock indices in mean and in variance. This result also explains the transmission of liquidity problems from the mortgage market to the financial market. This clearly explains the transmission transfer of the crisis, from a mortgage crisis to a financial crisis that hit everyone.

Our study highlights the role of the indices in the transmission of information from one market to another. The context of high interest rates (increase) is perceived resilience of the economy in the world offer us a unique opportunity to study the informational dependence between the bond and equity investors in the emerging markets. As bond yields correspond to the reference rate, it is reasonable to assume that a significant number of sophisticated investors will shape their portfolios to capitalize on the bond market countries of our sample.

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