Volatility Transmission between Dow Jones Stock Index and Emerging Bond Index

Amir Saadaoui[1], Younes Boujelbene[2]

Abstract: In this paper, we use a bivariate GARCH model to estimate simultaneously of the mean and the conditional variance between the Dow Jones stock index and some emerging bond indices. We used the DCC-GARCH model to graphically demonstrate the peaks of the volatility transmission. We examined this transmission using daily returns between July, 30, 2009 and January, 18, 2011 extracted from Datastream. Our results demonstrate that there is a significant transmission of shocks and volatility between the Dow Jones stock index and bond indices of the emerging countries. The results also confirm the idea that the crisis was transmitted from the United States to the emerging countries due to foreign investment made in these countries.

Keywords: volatility transmission; DJ Index; Emerging Bond Index; bivariate GARCH-BEKK

JEL Classification: C8; G1; F3

1. Introduction

The volatility transmission between markets has been the subject of several studies. This transmission can be between different types of markets, such as the stock and bond markets, or between countries, such as the developed and the emerging countries. We can the research of, Karolyi (1995); Caporale et al. (2006); Goeij and Marquering (2004); Baele et al., (2010).

The structure of the correlation between the different classes of assets in competition has a significant role in the strategies of asset allocation and the process of the portfolio diversification. The strategic allocations of limited capital resources among the different asset classes, such as the wider stocks and bonds, may be the most critical in determining investment performance, and financial success decision. The stock and bond markets have historically been substituted to balance the portfolio of assets. In addition, the emerging markets are considered among the most important markets for the allocation of international assets

[1] Faculty of Economics and Management, University of Sfax, Tunisia, Address: Airport Road Km 4 Sfax 3018, Tunisia, Corresponding author: am.saadaoui@yahoo.fr.
[2] Professor, PhD, Faculty of Economics and Management, University of Sfax, Tunisia, Address: Airport Road Km 4 Sfax 3018, Tunisia, E-mail: younes.boujelbene@gmail.com.

(Harvey, 1995). López-Mejía (1999), Bekaert and Harvey (2003) have shown that there is a large number of international capital flows from the developed countries to the emerging bond markets which were brought in to Asia and Latin America during the 1990s debt crisis. In fact, the bond markets of emerging countries have a relatively low correlation with the developed capital markets. Indeed, Bekaert and Harvey (2003) found that the emerging markets have been long marked by a high volatility, a diversification of sources of risk and higher returns than the developed markets. In addition, most of the emerging countries in Eastern Europe, Asia and Latin America have now become more financially sound because of the liberalization of their financial systems and macroeconomic stabilization.

However, several studies, such as, that of Skintzi and Refenes (2006); Cifarelli and Paladino (2006), Lin, Wang, and Gau, (2007) focused on the flow of the stock markets in the emerging countries, but rarely the bond markets. Furthermore, Cai, Jiang and Kumar (2004) showed that the volatility of returns in the bond market is not only important to expect bond yields, but also allows investors to understand the behavior, the source of inter-market volatility transmission for the international diversification, risk management, the valuation of assets and their allocation decisions.

This paper examines the dynamic interrelationships between the Dow Jones stock index and seven emerging bond Indices in terms of return and volatility transmission mechanism. We use the BEKK-GARCH (1, 1) to show the transmission of shocks and volatility asymmetry between the financial markets. We also consider the impact of the global financial crisis on the emerging bond markets and explore the relationship between the US stock market and the bond markets of the selected emerging countries.

This document is divided into five sections covering the above discussion; the first section is the introduction of the research that includes the context and the objectives of the study. The next section discusses the literature review. The data and methods of observation are discussed in Section 3, while the result and the empirical analysis are described and discussed in Section 4. Finally, we end up with a conclusion in which the results are discussed.

2. Literature Review

The correlation between the stock and bond yields has been expressed in a variety of models. Indeed, all the evidence showed that the relationship between these two assets changes over time, especially under the exogenous influence as in crisis. Volatility inducing events, such as the crash of the subprime crisis, is the cause of acute changes in the investor’s feeling and allows the transmission of the price differential between stocks and bonds through the domestic and international markets. Indeed, it is generally recognized that stocks and bonds are complementary and that investors should combine the two different asset classes into portfolios.

Indeed, Barsky (1989), in an earlier study, discussed the interaction between the stock and bond markets using a method based on asset prices. In fact, he analyzed the effects of the risk and real growth changes in economic productivity and their impact on the development of the stock and bond markets. Barsky concluded that the interaction between stocks and bonds can change everything depending on the general behavior of the economic agents. He also posted his paper with an extract of a letter from the Federal Reserve indicating that investors seek to grow and move the shares into relatively safer bonds with falling share prices and rising sovereign bond prices thereafter. In addition, Connolly, Stivers and Sun (2005) showed that instability in the stock markets is an important causal factor in the correlation between stocks and bonds. On the other hand, Baur and Lucey (2010) focused on the correlation between stocks and bonds throughout stress periods.

Alternatively based on general inter-active studies, Fleming, Kirby and Ostdiek (1998) developed a model that predicts the correlation between the stock, bond and money markets. Using a stochastic model, these authors showed that there is a volatility transmission between the various asset classes. In the same context, Lim, Gallo, and Swanson (1998) used both stock and bond indices to test the effect of the long-run causality and the interaction between these two different assets and found a significant relationship between these two markets indices. Indeed, several previous studies used a constant correlation in the context of the analysis of the relationship between stocks and bonds. In contrast, Scruggs and Glabadanidis (2003) used a dynamic approach to study the long-term correlation between a stock index and a portfolio of government bonds. Fang, Lin and Lim (2005) studied the transmission of volatility between the stock and bond markets of Japan and the United States. To measure transmission, they used the GARCH-BEKK model to test the effect of information coming on the market. In some cases, the authors found that there is a bidirectional volatility transmission between markets. Moreover, the results showed that, in domestic markets, the volatility transmission is unidirectional from the stock market to the bond one. This study also showed that transmission among the international stock markets is more important than between the bond ones. Volatility transmission between the two markets indicates that the international diversification of bonds is absent. In the same context of the volatility transmission between the stock and bond markets, Johansson (2010) analyzed this transmission in nine Asian countries. Using a stochastic volatility model with two variables, he found that there are significant effects of volatility transmission between stock and bond markets in several countries. In addition, it was found that the dynamic correlation models show that the relationship between the stock and bond markets changes significantly over time in all countries and that this correlation increases during the turmoil periods in several countries, indicating that there is a contagion effect between stocks and bonds. Similarly, he showed that the results have direct implications on the behavior of the domestic and international investors in the various asset classes. To explain the transmission of volatility between international equity and bond markets, Christiansen (2008) used a multivariate GARCH model and found that there is a significant effect between the two markets. He also showed that after the introduction of the euro on the European markets, bond markets became more integrated than equity markets. In their article, Kim et al (2006) examined the dynamic correlation between equities and government bonds of some countries during the last decade to infer the state and progress of the integration of financial markets. They found that the patterns of correlations between the stock and bond markets in European countries, Japan and the United States are declining over time. Finally, d'Addona and Kind (2006) used a method of valuation of assets to model the relationship between stocks and bonds. In addition, other studies focused on the dynamic correlation between the assets that belong to the same asset class. The majority of these studies focused on the volatility transmission between assets in time and / or contagion effects between different stock markets. Among these studies we can mention that of Bekaert and Harvey (1995), Bekaert (1995), Forbes and Rigobon (2002) and Johansson and Ljungwall (2009). A limited literature focused on the relationship between international bond markets. For example, Johansson (2008) analyzed the volatility transmission between some emerging Asian bond markets and their dynamic correlation structure. Similarly, other researchers focused on the correlation between the bonds of the developed markets, such as, Skintzi and Refenes (2006) who studied the contagion effect between the US and European markets. Indeed, the study of the interdependence between the volatility in the financial markets has become an important issue for market participants, regulators, and researchers as well as for financial market integration and globalization. This was mentioned by Kim and Rogers (1995), Reyes (2001), Hassan and Malik (2007), and Harju and Hussain (2008).

In the same context, different empirical studies argue that financial crises have a crucial role in the transmission of volatility across financial markets. For example, Schwert (1989a) Caporale et al., (2006), and Tsouma (2007) state that financial crises have an effect on the increase of the stock market volatility. Indeed, Caporale et al., (2006) and Tsouma (2007) showed that the nature of this transmission may vary from one financial market to another in terms of extent and severity of impacts resulting from the recent financial crisis.

3. Data and Methodology

3.1. Data

In this empirical research, we try to analyze the sequence data of descriptive statistics. The goal of our research is to study the volatility transmission between Dow Jones stock Index and Seven Emerging Bond Index. We used daily data extracted from the Datastream database for different indices between Jully, 30, 2009 and January 18, 2011. These indices are shown respectively as follows: the USA Stock Index, the Dow Jones Index (DJI), for Greece, Greece Bond Index (GECBI); for Hungaria, Hungaria Bond Index (HBI); for Hong Kong, Hong Kong Bond Index (HKBI); for Mexico, Mexico Bond Index (MEXBI); for Poland, Poland Bond Index (POLBI); for Spain, Spain Bond Index (SPBI); and for Turkey, Turkey Bond Index (TRBI). Descriptive statistics for daily returns on the Dow Jones Stock Index and seven Emerging Bond Index are listed in the table below.

Table 1. Descriptive Statistics

	DJI	GECBI	HBI	HKBI	MEXBI	POLBI	SPBI	TRBI
Mean	0.000388	-0.001088	3.51E-05	-0.000204	-0.001621	1.70E-05	3.69E-05	0.000144
Std. Dev	0.018870	0.001254	0.000962	0.000740	0.009162	0.001015	0.002216	0.021538
Skewness	0.242810	1.365851	1.114122	-0.229078	-0.398391	0.883170	2.846479	5.396648
Kurtosis	4.601720	12.45486	12.28409	6.874178	4.204893	14.54827	37.11711	191.3891
Jarque-Bera	43.42065 0.0000***	1497.241 0.0000***	1412.971 0.0000***	235.8970 0.0000***	32.34277 0.0000***	2115.478 0.0000***	18494.15 0.0000***	551907.4 0.0000***

Notes: Jarque–Bera corresponds to the test statistic for the null hypothesis of normality in the sample return distribution. *** indicates the rejection of the null hypothesis at 1% significance level.

4. Methodology

The first stage of the bivariate GARCH methodology is to present the mean equation. Indeed, this equation for each return series is written as follows:

$$R_{i,t} = \mu_i + \alpha R_{i,t-1} + \varepsilon_{it} \quad \textbf{(1)}$$

Where $R_{i,t}$ is the efficiency of series i between time t-1 and t, μ_i the coefficient of long-term drift, and ε_{it} is the error term of the return of series i at time t. Regarding the literature of the ARCH-class models, equation (1) was developed by Engle (1982) to estimate residues and examine the presence of ARCH effects.

We next employ a variant of the bivariate GARCH model which is capable of detecting volatility transmission among different series, as well as the persistence of the volatility within each series. For this purpose, the BEKK parameterization was used for the bivariate GARCH proposed by Engle and Kroner (1995). The model incorporates quadratic forms in such a way to ensure that the covariance matrix is positive semi-definite, a requirement that is needed so that the estimated variances are non-negative.

The BEKK parameterization for the bivariate GARCH (1,1) model is given by:

$$H_{t+1} = C'C + B'H_t B + A'\varepsilon_t \varepsilon'_t A \quad \textbf{(2)}$$

Where H_{t+1},is the conditional variance matrix. Note that for the bivariate case C is a 2×2 lower triangular matrix with three parameters and B is a 2×2 square matrix of parameters which depicts the extent to which current levels of conditional variances are related to past conditional variances. A is a 2×2 square matrix of parameters and measures the extent to which conditional variances are correlated with past squared errors (i.e., deviations from the mean). The elements of A capture the effects of shocks or events on volatility (conditional variance). For the case at hand, the total number of estimated parameters is eleven.

Expanding the conditional variance for each equation in the bivariate GARCH (1,1) model gives:

$$h_{11,t+1} = c_{11}^2 + b_{11}^2 h_{11,t} + 2b_{11}b_{12}h_{12,t} + b_{21}^2 h_{22,t} + a_{11}^2\varepsilon_{1,t}^2 + 2a_{11}a_{12}\varepsilon_{1,t}\varepsilon_{2,t} + a_{21}^2\varepsilon_{2,t}^2 \quad \textbf{(3)}$$

$$h_{22,t+1} = c_{12}^2 + c_{22}^2 + b_{12}^2 h_{11,t} + 2b_{12}b_{22}h_{12,t} + b_{22}^2 h_{22,t} + a_{12}^2\varepsilon_{1,t}^2 + 2a_{12}a_{22}\varepsilon_{1,t}\varepsilon_{2,t} + a_{22}^2\varepsilon_{2,t}^2$$
(4)

Eqs (3) and (4) reveal how shocks and volatility are transmitted over time and across the two series under investigation. The following likelihood function is maximized assuming normally distributed errors:

$$L(\theta) = -T\ln(2\pi) - 1/2\sum_{t=1}^{T}(\ln|H_t| + \varepsilon_t^{'} H_t^{-1}\varepsilon_t \quad \textbf{(5)}$$

Where, T is the number of observations and θ the parameter vector to be estimated. Numerical maximization techniques were used to maximize this non-linear log likelihood function. As recommended by Engle and Kroner (1995), several iterations were performed with the simplex algorithm to obtain the initial conditions. The BFGS algorithm was then employed to obtain the final estimate of the variance–covariance matrix and the corresponding standard errors.

5. Result and Discussion

5.1. Volatility Spillover between Dow Jones Standard Index and Emerging Bond Index

Table 2.

Volatility transmission between DJ Index and Emerging Bond Index

Volatility transmission between DJ Index and Emerging Bond Index

	GRBI	HBI	HKBI	MEXBI	POLBI	SPBI	TRBI
α (1,1)	(-0.337850) 0.000000***	(-0.1663336) 0.00185235***	(0.154924653) 0.00041726***	(0.251652) 0.000092***	(-0.256397) 0.000000***	(-0.1242634) 0.016354**	(-0.270097) 0.00000***
α (1,2)	(-0.003568) 0.000000***	(0.005305277) 0.07644084*	(-0.002554538) 0.05035175**	(-0.306604) 0.000000***	(0.0053879) 0.0001475***	(-0.0650612) 0.00000***	(-0.2373315) 0.00000***
α (2,1)	(-0.992364) 0.27150206	(0.166539156) 0.87023096	(-0.487372677) 0.60649411	(-0.079966) 0.47964372	(0.0002813) 0.99961097	(-0.681466) 0.107882	(-0.6395526) 0.000982***
α (2,2)	(1.495320) 0.000000***	(0.611728218) 0.00000000***	(0.343509707) 0.000000***	(1.3550575) 0.000000***	(0.3362423) 0.000000***	(0.7485072) 0.000000***	(4.8358586) 0.00000***
β (1,1)	(0.557494) 0.000000***	(0.970910628) 0.00000000***	(0.980404389) 0.000000***	(0.940382) 0.000000***	(0.9597433) 0.000000***	(0.9815716) 0.00000***	(0.9459626) 0.00000***
β (1,2)	(-0.054669) 0.000000***	(0.003154602) 0.00000672***	(0.001338121) 0.00001343***	(0.042131) 0.0023547***	(0.0021708) 0.00007***	(-0.013044) 0.00949***	(-0.0176133) 0.013084***
β (2,1)	(-0.520145) 0.15163164	(-1.093658414) 0.01150124*	(-0.302274320) 0.33924995	(0.093117) 0.064037*	(-0.0251717) 0.859845	(1.1826475) 0.019748**	(0.1122977) 0.001564***
β (2,2)	(0.392138) 0.000000***	(0.828751891) 0.00000000***	(0.935432743) 0.000000***	(0.473848) 0.000000***	(0.946824063) 0.000000***	(0.2468647) 0.120741	(0.052254) 0.00112***

Notes: *** indicate significance at level of 1%, ** at level of 5% and * at level of 10%.

The results reported in Table II above show the international influences between stock markets, mainly the Dow Jones and the emerging bond markets to reduce the complications of distribution. We limit our conclusions to 1 percent significance, as suggested by Karolyi (1995), to reduce the biasness that may arise. Overall, the results indicate that the GARCH (1,1) specification satisfactorily captures the continuing series of back to square. The conditional variance in each market is significantly affected both negatively and positively by its own past innovations from α_{11} with values between [-0.337850, 0.251652], while the dependence of the cross-market volatility varies according to the magnitude of the country. Indeed, the level of constancy in volatility is expressed by coefficient β_{11}. The different estimated coefficients for index β_{11} included in the range are in the interval of [0.557494, 0.9815716]. This recommendation of market volatility is a measure of persistence in both stock and bond indices.

Let's turn to the explanation of the volatility transmission between the stock index and Dow Jones of the emerging bond indices. The above table shows that the average volatility transmission between these two types of indices is significant at 1% level for most of the indices. The estimated α12 and β12 coefficients represent the average transmission of volatility and the variance of the Dow Jones to the emerging bond markets. The volatility transmission appeared significant at 1% in most of our sample. This explains well the sovereign debt crisis that some European emerging countries, such as Greece and Spain had. This explains well the negative impact of the transmission in means and in variance for both countries.

For Greece, the transmission in average and in variance is represented by α_{12} (-0.003568) and β_{12} (-0.054669). Similarly, the negative effect for Spain, which appeared in average and in variance is represented by α_{12} (-0.0650612) and β_{12} (-0.013044).

Indeed, the transmission also appeared in other countries in average and in variance, we can mention for example, Hong Kong α_{12} (-0.0650612) and β_{12} (-0.013044), Mexico α_{12} (-0.0650612) and β12 (-0.013044) Turkey and α12 (-0.0650612) and β12 (-0.013044). These results show the significant effect of the subprime crisis on all countries whether developed or emerging. Furthermore, this recommendation may be explained by the unidirectional transmission in average and in variance.

5.2. Dynamic Conditional Correlation between Dow Jones Index and Dow Jones Islamic Index

To assess the progress of the correlations between the Dow Jones standard index and the emerging bond index over time, we report in Fig.1, the dynamic conditional correlation between both types of assets. The correlation between the indices during the periods of financial stress is clearly marked. At first, the correlation is greatly volatile during the crisis period which is really seen in most of the figures below. In most cases, there is a rise in volatility during the crisis. We can say that, generally, the subprime crisis caused significant changes in the consistency of Dow Jones Standard Index and Emerging Bond indexes, as well as a higher correlation in volatility. From the results, we can conclude that the correlation tends to rise during the crisis and which increased the links between Dow Jones index and emerging bond indexes.

In general, our results show that the subprime crisis played a key role in developping the relationship between Dow Jones index and the emerging bond Indexes. Indeed, the topmost correlations between both types of indices are usually observed during the financial crisis, which represent the phenomenon of stock market financialization. The results explain the volatility transmission from Dow Jones stock index to the emerging bond index, this is noticed mainly for Greece and Spain which had a severe liquidity crisis in the mid-2010.

6. Conclusion

There are different theories about how the stock and bond markets should be related to each other. This paper examines the links between the Dow Jones Stock Index and seven emerging Bond Index. We first use the bivariate BEKK-GARCH model of Engle and Kroner (1995) to demonstrate the correlation between these indices. Then, based on the DCC-GARCH, we graphically show if the correlations between the indexes change over time, especially in the crisis period.

The great discovery can be summarized as follows: in a panel of seven Bond Indexes over the period from Jully 30, 2009 - Janury 18, 2011, we found that the correlation between the different Emerging Bond Indexes and Dow Jones Standard Index through time, was highly volatile during the 2007-2008 financial crises. While the stock market collapse has disentangled the links between the two types of Indexes on the very short run, the greatest correlations are observed during the financial crisis showing increased links between the Stock and Bond Indexes. On the whole, our detections show that the subprime crisis played a key role in showing the links between the Dow Jones stock Index and the Emerging Bond Indexes. The results show the effect of the subprime crisis which emerged in the United States, mainly on Greece and Spain which have had experienced a sovereign debt crisis since the mid-2010.

References

Baele, L, Bekaert, G and Inghelbrecht, K. (2010). The determinants of stock and bond return comovements, *The Review of Financial Studies*, 23, 2374-24 28.

Barsky, Robert B., (1989). Why Don't the Prices of Stocks and Bonds Move Together? *American Economic Review*, LXXIX (1989), 1132–45.

Baur, D.G. and Lucey, B. (2010). Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold. *Financial Review*, Vol. 45, Issue 2, pp 217-229.

Bekaert, G., (1995). Market Integration and Investment Barriers in Emerging Equity Markets, *World Bank Economic Review*, 9, 75-107.

Bekaert, G. & Harvey, C.R. (1995). Time-Varying World Market Integration, *Journal of Finance*, 50, 403-444.

Bekaert, G., Harvey, C.R., (2003). Research in emerging market finance: looking to the future. *Emerging Markets Review* (in press).

Cai, K., Jiang, X., and Kumar, P. (2004). Time-varying corporate bond volatility and corporate bond returns. *Proceedings of 2004 FMA Annual Meeting held by Financial Management Association International in New Orleans*, Louisiana.

Caporale, G. M., Pittis, N. and Spagnolo, N. (2006). Volatility transmission and financial crises. *Journal of Economics and Finance*, vol. 30, No 2, pp. 376-390.

Christiansen, C., (2008). Decomposing European Bond and Equity Volatility. *International Journal of Finance & Economics*, 15, 105-122.

Cifarelli, G. and G. Paladino (2006). Volatility co-movements between emerging sovereign bonds: Is there segmentation between geographical areas? *Global Finance Journal no.* 16.

Connolly, R, Stivers, C and Sun, L (2005). Stock market uncertainty and the stock-bond return relation. *Journal of Financial and Quantitative Analysis*, 40, 161-194.

D'Addona, S. & Kind, A.H. (2006). International Stock-Bond Correlations in a Simple Affine Asset Pricing Model. *Journal of Banking and Finance*, 30, 2747-2765.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, vol. 50, No 4, pp. 987-1007.

Engle, R. F. & Kroner, K. F. (1995). Multivariate simultaneous GARCH. *Econometric Theory*, 11:122–150.

Erb, C.B., Harvey, C.R., and Viskanta, T.E. (1999). Understanding emerging market bonds. *Emerging Markets Quarterly*, 4, 7-23.

Fleming. J, Ostdiek. B and Kirby. C, (1998). Information and volatility linkages in the stock, bond, and money markets. *Journal of Financial Economics* 49, 111-137.

Fleming, J., Kirby, C. and Ostdiek, B. (2001). The economic value of volatility timing. *Journal of Finance*, 56(1), 329-352.

Forbes, K. & Rigobon, R., (2002). No Contagion, Only Interdependence, *Journal of Finance,* 57, 2223-2261.

Goeij, P. D. & Marquering, W. (2004). Modelling the conditional covariance between stock and bond returns: A multivariate GARCH approach. *Journal of Financial Econometrics*, vol. 2**,** No 4, pp. 531-564.

Harju, K. & Hussain, S. M. (2008). Intraday return and volatility spillovers across international equity markets. *International Research Journal of Finance and Economics*, No 22, pp. 205-220.

Harvey, Campbell R. (1995). Predictable risk and returns in emerging markets. *Review of Financial Studies 8*, 773-816.

Hassan, S. A. & Malik, F. (2007). Multivariate GARCH modeling of sector volatility transmission. *The Quarterly Review of Economics and Finance*, vol. 47, pp. 470-480.

Johansson, A.C. (2010). Asian Sovereign Debt and Country Risk. *Pacific-Basin Finance Journal, forthcoming.*

Johansson, A.C. & Ljungwall, C. (2009). Spillover Effects among the Greater China Stock Markets. *World Development*, 37, 839-851.

Karolyi, G. A. (1995). A multivariate GARCH model of international transmissions of stock returns and volatility: The case of the United States and Canada. *Journal of Business and Economic Statistics*, 13, 11-25.

Kim, S-.J., Moshirian, F. & Wu, E. (2006). Evolution of International Stock and Bond Market Integration: Inference from the European Monetary Union. *Journal of Banking and Finance, 30,* 1507-1534.

Lim,E.S., Gallo J.G. & Swanson, P.E. (1998). The relationship between international bond markets and international stock markets. *International Review of Financial Analysis*, 7, pp. 181-190.

Lin, C.L., Wang, M.C., and Gau, Y.F. (2007). Expected risk and excess returns predictability in emerging bond markets. *Applied Economics*, 39, 1511-1529.

Lopez-Mejia, A. (1999). Large capital flows: Causes, consequences, and policy responses. *Finance & Development*, 36, pp. 1-7.

Reyes, M. G. (2001). Asymmetric volatility spillover in the Tokyo stock exchange. *Journal of Economics and Finance*, vol. 25, No 2, pp. 206-213.

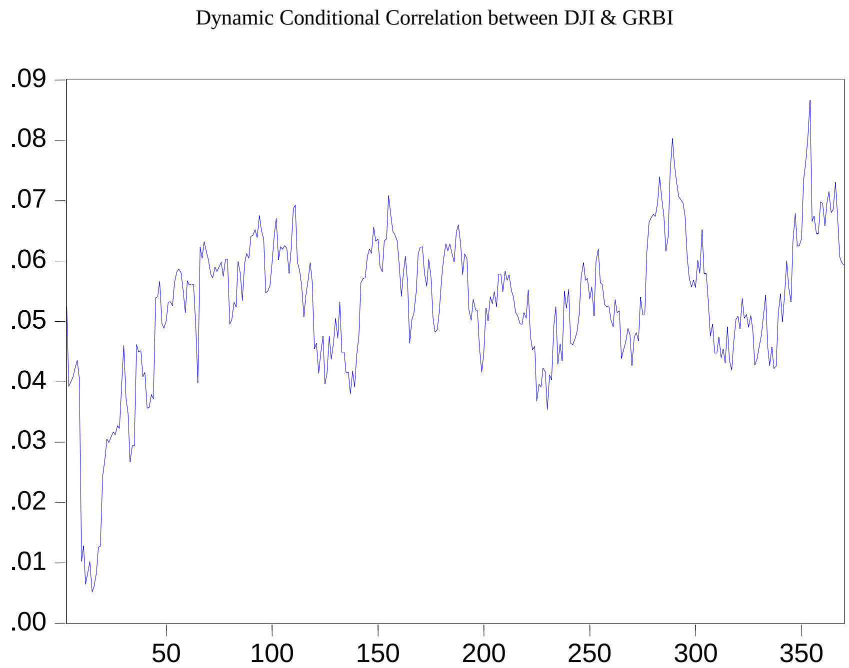
Schwert, G. W. (1989a). Business cycles, financial crises and stock volatility. *Discussion Paper No. 2957*, National Bureau of Economic Research.

Scruggs, J. & Glabadanidis, P. (2003). Risk premia and the dynamic covariance between stock and bond returns. *Journal of Financial and Quantitative Analysis*, 38 (2), 295–316.

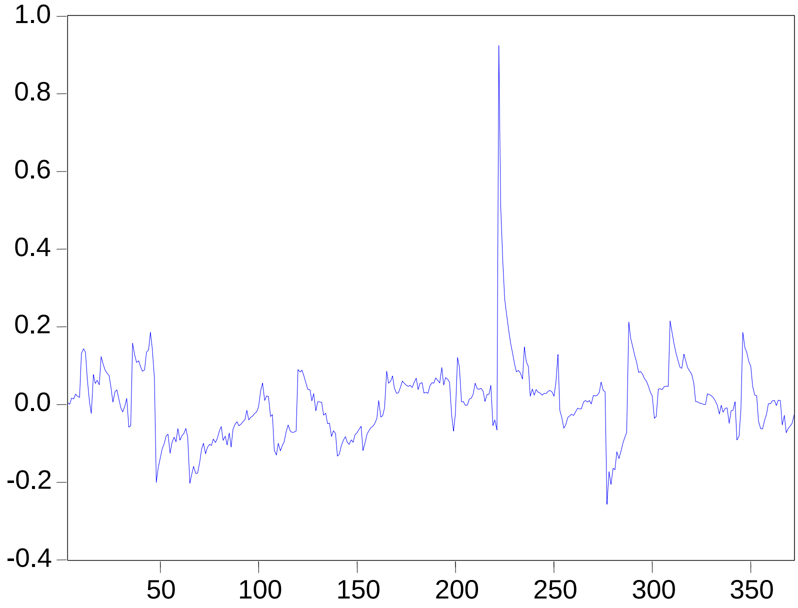
Skintzi, V. & Refenes, A. (2006). Bond volatility spillovers and dynamic correlation in European bond markets. *Journal of International Financial Markets, Institutions and Money, 16*, 23-40.

Tsouma, E. (2007). Stock return dynamics and stock market interdependencies. *Applied Financial Economics*, vol. 17, pp. 805-825.

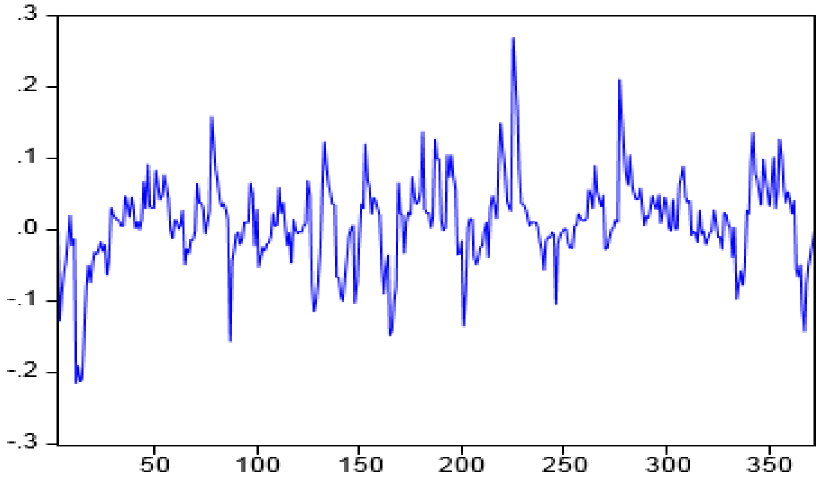
Figure 1. Conditional Correlation between DJI & EBI



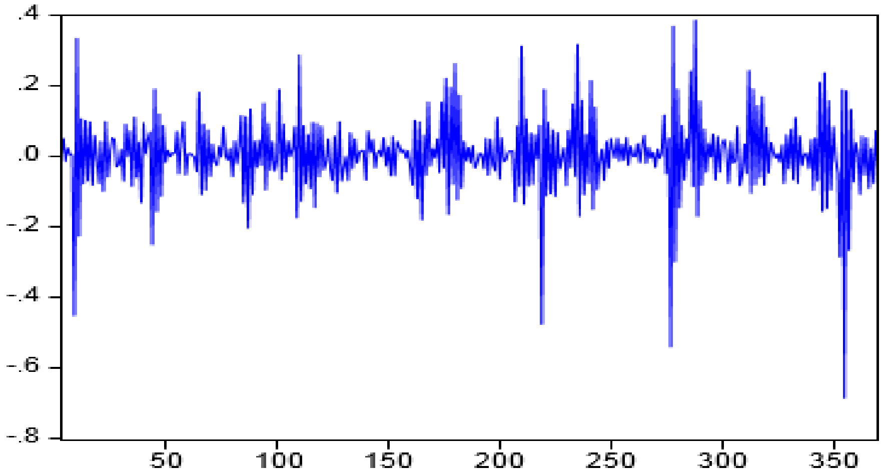
Dynamic Conditional Correlation between DJI &HBI



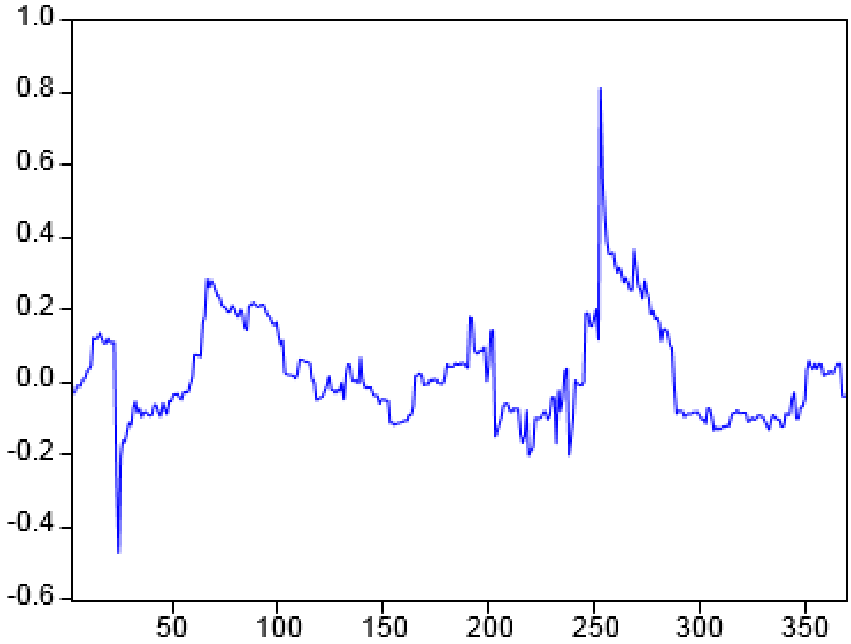
Dynamic Conditional Correlation between DJI &HKBI



Dynamic Conditional Correlation between DJI &MEXBI



Dynamic Conditional Correlation between DJI &SPBI



Dynamic Conditional Correlation between DJI &SPBI