VOLATILITY SPILLOVERS BETWEEN EQUITY AND BOND MARKETS: EVIDENCE FROM G7 AND BRICS[1]

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Abstract

This study implies the causality-in-variance test newlydeveloped by Hafner and Herwartz (2006) to investigate the volatility spillovers between domestic equity and bond markets in G7 and BRICS countries. The empirical result shows thatthere is ethier unidirectional or bidirectional spillover effect in every developed market and weak evidence for the existence of the spillover effect in two countries (i.e. China and Russia) of BRICS in both directions.In details, there is bidirectional volatility spillovers between the equity and bond markets in France, Japan, Italy, Canada, Brazil, and South Africa, and shows unidirectional spillovers from the bond to the equity in US, UK, Germany and India at 1% level of significance. Meanwhile in the case of Russia and China, there is nostrong evidence of spillover in ethier direction.This has important implications for domesticcross-market portfolio allocationand risk management in both developed and emerging markets.

Keyword:volatility spillover, equitymarket, bond market, causality-in-varince, LM-GARCH

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[1]*This study is supported by (a)the Fundamental Research Funds for the Central Universities0f China and (b)the Ministry of Education Research of key projects of philosophy and Social Sciences(12JZD029)*

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JEL Classification:C12, C32, G12, G15

Ⅰ. Introduction

Stocks and bonds are two basic asset classes that are crucial in asset allocation and risk management.Since the 1970s, the relationship between the equity and the bond markets has been attracting a great deal of interest from policy makers and scholars.The motivation is more than obvious. On one hand,we intend toprofit by forecasting the trend of the prices of equities according to that of the bonds,or in the reverse way; on the other hand, we need toevaluate whether there is volatility spillover between two markets or not, which can help the supervisory authorities stabilize the financial system upon impact of financial market risk.

Dean (2010) noted several explanations that can be advanced for the existence of spillover effects in return and volatility within the equity and bond markets.(a)The asset substitution hypothesis regards equities and bonds as competing assets so that it predicts negative correlation of the two assets. (b)The financial contagion hypothesis refers to the propagation of return shocks across markets as an over-reaction to news disclosures or noise. (c)News specificity hypothesis holds that the news conveyed by price changes in stock and bond differ in terms of the degree to which they provide information of a specific nature about the respective asset classes. (d)The news decomposition hypothesis breaks down news into two distinct components — news about future cash flows and news about discount rates, which equity and bond prices react differently to. Therefore, different kinds of news can bring about different kinds of spillover between the two markets. (e)The hypothesis of asymmetric price adjustment considers that the asymmetric transaction costs result in different rates of news impoundment into market prices and then the asymmetric price adjustment occurs.

Numerous studies (e.g. Campbell and John,1993;Kwan and Simon,1996;Ilmanen, 2003;Baele, Bekaert and Inghelbrecht, 2010; Chui and Yang,2012) have been advocating a connection between the returns and volatility of stock and bond markets sinceMerton (1974), who posited that the negative relation of the two assets during periods of higher volatility were based on their different levels of risk. These literatures mainly focus attention on the statistical correlationbetween the returns and volatility of the two markets.

The spillovers in return and volatility, which take the lead-lag effect into account,are generally consideredas causality-in-mean and causality-in-variance, respectively. Some researchers explore the causality-in-mean between different financial markets, e.g. equity markets of different counties or regions (Hiemstra, Jonathan, 1994; Huang, Yang, Hu, 2000; Bhar, Ramaprasad and Hamori, 2003), the equity market and the exchange market (IssamAbdalla, Victor Murinde, 1997) and international exchange markets (Engle, 1990) .As for causality-in-volatility, which is usually called volatility spillover, Lin (1994) found that volatility spillover existed between American and Japan stock markets. Baele(2005)investigated how American stock market and the aggregate European stock market affected the European national stock market.

In contrast, comparatively little attention has been paid to the spillover between the returns and volatility of equities and bonds.Steeley (2006)found the past bond market volatility affected both equity and bond markets and fed back into short-term yield volatility in UK. Victor Fang (2006)examined the volatility transmission of stock and bond markets of the USA and Japanand found that there was unidirectional volatility transmission from the stock market to the bond market in both domestic cross markets, but showed weak evidence for the spillover effects between international stock and bond markets. Victor Fang (2007) investigated the transmission of market-wide volatility between the equity markets and bond markets of Japan, Germany, the U.K., and the U.S., finding that within the domestic cross markets, the volatility transmission was unidirectional from the stock market to the bond market. Dean(2010) found there was only volatility spillover from bond market to stock market by taking example of the stock and bond market of Australia from 1992 to 2006.Christiansen(2010)examined volatility spillover from US and aggregate European asset markets into European national asset markets,finding that the national bond volatilities were mainly influenced by bond effectsandthe national stock volatilities were mainly influenced by stock effects.

Earlier analysis mainly concentrates on the equity-bond volatility spillover in developed financial markets (e.g., US, Japan, UK and other European counties). In this paper we further explore the spillover in emerging markets, to be specific the BRICS, as well as the developed countries, in which we selectthe G7.

For testing causality in variance, two approaches have been followed in the literature. On one hand, a two-step methodology has been introduced by Cheung and Ng (1996) and Hong (2001) that concentrates on the cross correlation function (CCF) of squared univariate GARCH residual estimates.On the other hand the MVGARCH models rely on a dynamic specification, like BEKK-GARCH (Engle and Kroner, 1995; the acronym comes from synthesized work on multivariate models by Baba, Engle, Kraft and Kroner), the GO-GARCH (Alexander and Chibumba, 1997), and the DCC-GARCH (Engle and Sheppard, 2001). While the latterpromises substantial gains in power, likelihood based tests within multivariate dynamic models typicallysuffer from a curse of dimensionality.In this study we adopt the modeldeveloped by Hafner and Herwartz (2006)—we call LM-GARCH[1]—to assess the volatility spillover between the equity and bond markets of the G7 and BRICKS countries.

Compared with the existing literature, our study has two mainly contributions. (a) We are among the few to explore the volatility spillover effects in emerging markets which play more and more important role in worldwide financial market, and compare the different effects between the two groups of countries. (b) We adoptthe new developed LM-GARCHto test the causality in variance, which can overcome the problems MVGARCH model faced, and provide a new tool for further study about volatility spillover effect.

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[1]Up to now, the two-step-GARCH model by Hafner and Herwartz(2006)doesn't have a formal name. The reason we call it LM-GARCH is that the key of model is a LM test based on univirable GARCH, which we will explain in Section Ⅱ of this paper.

Ⅱ. Methodology

The causality-in-variance test of Hafner and Herwartz(2006) based on Lagrange multiplier (LM) principle overcomes the shortfalls of Cheung and Ng'smethod and is very practical for empirical illustrations. Furthermore, the Monte Carlo experiment carried out inLM-GARCH indicates that the LMapproachismore robust against leptokurtic innovations in small samples and the gain from carrying the LM test increases with sample size. The results furthershowthat an inappropriate lead and lad order choice in the CCF test distorts its performance and thereby leads to the risk of selecting a wrong order of the CCF statistic. In what follows, we briefly explain the details of causality in variance test.

In this approach, testing for causality in variance is based on estimating univariate GARCH models. The null hypothesis of non-causality in variance between two return series is described as follows:

Consider a stochastic process on a probabilityspace. For simplicity we assume stationarity of and. We want to test the following null hypothesis for given i, j=1… N,:

, (1)

where. To test consider the model

(2)

where.

In Eq. (2), a sufficient condition for Eq. (1) is, so that the null and alternative hypothesis of the LM test is. An LM statistic can be constructed by means of estimated univariate GARCH processes.

The score of the Gaussian log-likelihood function of is given by,

where .

We propose the following test statistic:

Where

Ⅲ.Data and Variables

We use daily data of equity indices and bond indices of G7 (i.e. US, UK, Japan, France, Germany, Italy, Canada) and BRICS countries (i.e. Brazil, Russia, India, China, South Africa). Considering the different history of the development of the equity and bond market in different countries, the dataset for G7 countries consist of daily data between Dec. 30, 1988 to Dec. 7, 2012 for equity and bond indices: S&P 500andUS DS Gov. Index(US), FTSE 100andUK DS Gov. Index (UK), CAC 40andFRDS Gov. Index (France), DAX 30andBDDS Gov. Index (Germany), TOPIXandJPDS Gov. Index (Japan), FTSE ITALYandItaly DS Gov. Index (Italy), S&P/TSX and Canada DS Gov. Index (Canada).

As for BRICS countries, equity and bond indices andtheirtimespans are as follows: BrazilBovespa Index and JPM EMBI+ Brazil Index (Brazil, Jan. 1, 1994-Dec. 7, 2012),

RussianMicex Index and Micex CBI Index (Russia, Jan. 01, 2003-Dec. 7, 2012), India BSE Index and JPM ELMI+ India Index (India, Jan. 1, 1997-Dec. 7, 2012); Shanghai SE Composite Index and FTSE Global Gov. CH Index (China, Oct. 13, 2004-Dec. 7, 2012).FTSE/JSE All Share Index and SA DS Gov. Index (South Africa, Aug. 31, 2000-Dec. 7, 2012).

The source of the raw data is Thomson Reuters DataStream and the econometric tests are completedinEViews 6.0.

Each data series is then converted into daily logarithmic returns, as follows:

Where:

is the return for each equity index at time t for country i;

is the return for each bond index at time t for country i;

is the equity index at time t for country i;

is the equity index at time t-1 for country i;

is the bond index at time t for country i;

is the bond index at time t-1 for country i;

Table 1 represents the descriptive statistic and ADF P-value for the Re and Rb series. It shows that, as expected, the SD of the equity indices is higher than that of the bond indices in all countries. In terms of Re, Brazil is the highest while Japan is the lowest. As for the mean of Rb, Brazil is the highest while Russia is the lowest.

Table 1

Descriptive statistic and ADF P-value

Country		Mean	SD	Skewness	Kurtosis	JB	ADF-P
US	Re	2.61E-04	0.01141	-0.25909	12.03	21280.8	0.0001
	Rb	4.48E-05	0.00288	-0.18521	5.39	1525.0	0.0001
UK	Re	1.91E-04	0.01119	-0.12980	9.28	10287.0	0.0000
	Rb	5.08E-05	0.00346	0.08190	6.50	3193.4	0.0001
France	Re	1.33E-04	0.01393	-0.04105	7.83	6061.2	0.0000
	Rb	3.99E-05	0.00241	-0.16448	5.45	1586.9	0.0001
Germany	Re	2.77E-04	0.01449	-0.25685	9.13	9854.5	0.0001
	Rb	3.34E-05	0.00220	-0.34009	5.87	2267.9	0.0001
Japan	Re	-1.75E-04	0.01298	-0.13099	9.60	11345.7	0.0001
	Rb	1.79E-05	0.00171	-0.41118	7.64	5766.0	0.0001
Italy	Re	3.49E-05	0.01446	-0.09622	7.19	4567.9	0.0000
	Rb	4.79E-05	0.00285	0.64731	25.69	134336.6	0.0001
Canada	Re	2.05E-04	0.01006	-0.74683	14.37	34225.1	0.0000
	Rb	5.03E-05	0.00303	-0.23962	5.91	2266.3	0.0001

Brazil	Re	1.02E-03	0.02333	0.49862	14.29	26425.6	0.0001
	Rb	4.76E-04	0.01060	-0.96828	22.73	80914.2	0.0000
Russia	Re	5.82E-04	0.02297	-0.23746	19.21	28411.8	0.0001
	Rb	-3.03E-05	0.00195	-0.11888	40.55	152248.8	0.0000
India	Re	4.72E-04	0.01670	-0.25701	8.62	5522.2	0.0001
	Rb	2.43E-04	0.00443	-0.29970	14.05	21194.8	0.0001
China	Re	1.86E-04	0.01713	-0.31231	6.65	1216.7	0.0001
	Rb	3.40E-05	0.00197	0.19205	32.94	79439.3	0.0000
South Africa	Re	4.75E-04	0.01268	-0.10182	6.40	1546.3	0.0001
	Rb	6.99E-05	0.00420	-1.67978	55.45	368359.8	0.0000

Ⅳ. Empirical Findings

To investigate volatility transmission between equity prices and bond prices, we first estimate the univariate GARCH (1, 1) processes. The estimations are shown in **Table 2**andgraphs of conditional variance (GARCH) of the return series estimated by GARCH (1, 1) are given in **Appendix**.

Table 2

Estimations of the univariate GARCH (1, 1) model

			p-value		p-value		p-value
US	Re	1.03E-06	0.0000	0.0656	0.0000	0.9259	0.0000
	Rb	6.90E-08	0.0000	0.0326	0.0000	0.9592	0.0000
UK	Re	1.28E-06	0.0000	0.0842	0.0000	0.9055	0.0000
	Rb	1.39E-07	0.0000	0.0430	0.0000	0.9454	0.0000
France	Re	3.02E-06	0.0000	0.0852	0.0000	0.8991	0.0000
	Rb	1.13E-07	0.0000	0.0622	0.0000	0.9180	0.0000
Germany	Re	3.96E-06	0.0000	0.1012	0.0000	0.8811	0.0000
	Rb	4.42E-08	0.0000	0.0531	0.0000	0.9385	0.0000
Japan	Re	3.21E-06	0.0000	0.1098	0.0000	0.8748	0.0000
	Rb	2.15E-08	0.0000	0.0736	0.0000	0.9220	0.0000
Italy	Re	2.37E-06	0.0000	0.0841	0.0000	0.9064	0.0000
	Rb	8.02E-09	0.0000	0.1071	0.0000	0.9037	0.0000
Canada	Re	6.95E-07	0.0000	0.0739	0.0000	0.9191	0.0000
	Rb	1.08E-07	0.0000	0.0511	0.0000	0.9377	0.0000
Brazil	Re	8.03E-06	0.0000	0.0988	0.0000	0.8850	0.0000

	Rb	3.56E-07	0.0000	0.1599	0.0000	0.8548	0.0000
Russia	Re	1.10E-05	0.0000	0.1055	0.0000	0.8697	0.0000
	Rb	3.51E-08	0.0000	0.3537	0.0000	0.7523	0.0000
India	Re	5.35E-06	0.0000	0.1174	0.0000	0.8685	0.0000
	Rb	4.92E-08	0.0000	0.0544	0.0000	0.9474	0.0000
China	Re	2.18E-06	0.0000	0.0468	0.0000	0.9461	0.0000
	Rb	1.12E-08	0.0000	0.0453	0.0000	0.9530	0.0000
South Africa	Re	2.45E-06	0.0000	0.0915	0.0000	0.8935	0.0000
	Rb	2.87E-07	0.0000	0.0863	0.0000	0.8957	0.0000

Note: variance equation: in the table are obtained from GARCH (1, 1).

Table 3

Result for Test of Causality-in-Variance

		p-value		p-value
US	8.33	0.0155	17.16	0.0002
UK	8.34	0.0154	17.28	0.0002
France	15.27	0.0005	18.28	0.0001
Germany	8.55	0.0139	13.71	0.0011
Japan	29.76	0.0000	33.73	0.0000
Italy	20.97	0.0000	13.14	0.0014
Canada	20.89	0.0000	19.53	0.0001
Brazil	19.95	0.0000	64.61	0.0000
Russia	5.35	0.0690	6.64	0.0361
India	7.42	0.0245	0.00	0.0000
China	4.86	0.0879	2.65	0.2659
South Africa	28.35	0.0000	13.63	0.0011

We first check whether the stability conditions of the GARCH model hold which impose the constraints. All of the estimated GARCH models satisfy the stability condition. And it shows that all estimated coefficients are statistically meaningful at 1%level of significance. The positive coefficients in the GARCH equation show that the conditional variance process of the equity and bond returns are convergent. We observe that the GARCH parameter () which indicates long-run volatility is much higher than the ARCH parameter () which indicates the short-run volatility in all data series. The result therefore clearly shows that the volatility processes of both equity and bond returns are dominated by the GARCH effect.

After determining the volatility processes of the return series, we now start to examine the volatility spillover effect between equities and bonds. To this end, the causality in variance test by LM-GARCH is carried out and the results are illustrated in **Table 3**

Table 3 indicates bidirectional volatility spillover between the equity and bond markets in France, Japan, Italy, Canada, Brazil, and South Africa, unidirectional spillover from the bond to the equity in US, UK, Germany and India at 1% level of significance. While in the case of Russia and China, there is not enough evidence of spillover of nethier direction.

Ⅴ. Conclusions

In this study, a theoretical model newly developed by Hafner and Herwartz (2006) was used to examine the volatility spillover between the equity and the bond markets in G7 and BRICS counties.The findings of this paper can be concluded as follows.

Ⅴ.1 Idiosyncratic volatility spillover effect in individual country

The empirical result indicates bidirectional volatility spillover between the equity and bond markets in France, Japan, Italy, Canada, Brazil, and South Africa, unidirectional spillover from the bond to the equity in US, UK, Germany and India at the significance of 1%. While in the case of Russia and China, there is not enough evidence of spillover in ethier direction.The result suggests that the equity-bond volatility spillover effect may appear idiosyncratic in different countries.

Ⅴ.2 Comparisions between developed and emerging markets

We are among the few researchers that investigate the volatility spillover in emerging markets and the first to examine the spillover effect in both develeped and emerging markets.In our paper, among the G7,there is ethier unidirectional or bidirectional equity-bond volatility spillover effect in every country. In contrast, in the BRICS, there are two countries (i.e. China and Russia) that show weak evidence for the existence of the spillover effect in both directions. According to the theories described in the introduction, spillover effect can be regarded as the consequence of transimission of information among different markets. That is to say spillover effect shows evidence of efficiency of cross market information transmission and the integration of financial markets, which should be improved in China an Russia.

After further study the development and characteristics of the financial markets of China and Russia, we think the following factors may be advanced for the low efficiency of cross market information transmission in the two countries. Firstly, the T+1 trading system and lack of short sales mechanism in the financial market of China , to some extent, would limit the intra-day price adjustment, which weaken the spillover effects between markets. What's more, the equity market of China mainly consist of large mount of individual investors and the major part of the bond market is the inter-bank bond market, in which only institutional Investorsare eligible to trade. The difference in investment skills and stradegy and the ability to access timely news of them drives the two market price trend in different way. As for the Russia, due to the high openness and small size of the financial market, the equity market is vulnerable to fluctuations in international financial markets. As a result, the interaction of the domestic market prices is not so closely linked.

Taking the 2008 financial crisis and sovereign debt crisis into account,our emperical result has important implication.This paper may contribute to better domestic cross-markets portfolio and risk management for investors and policy makers in both developed and emerging markets.

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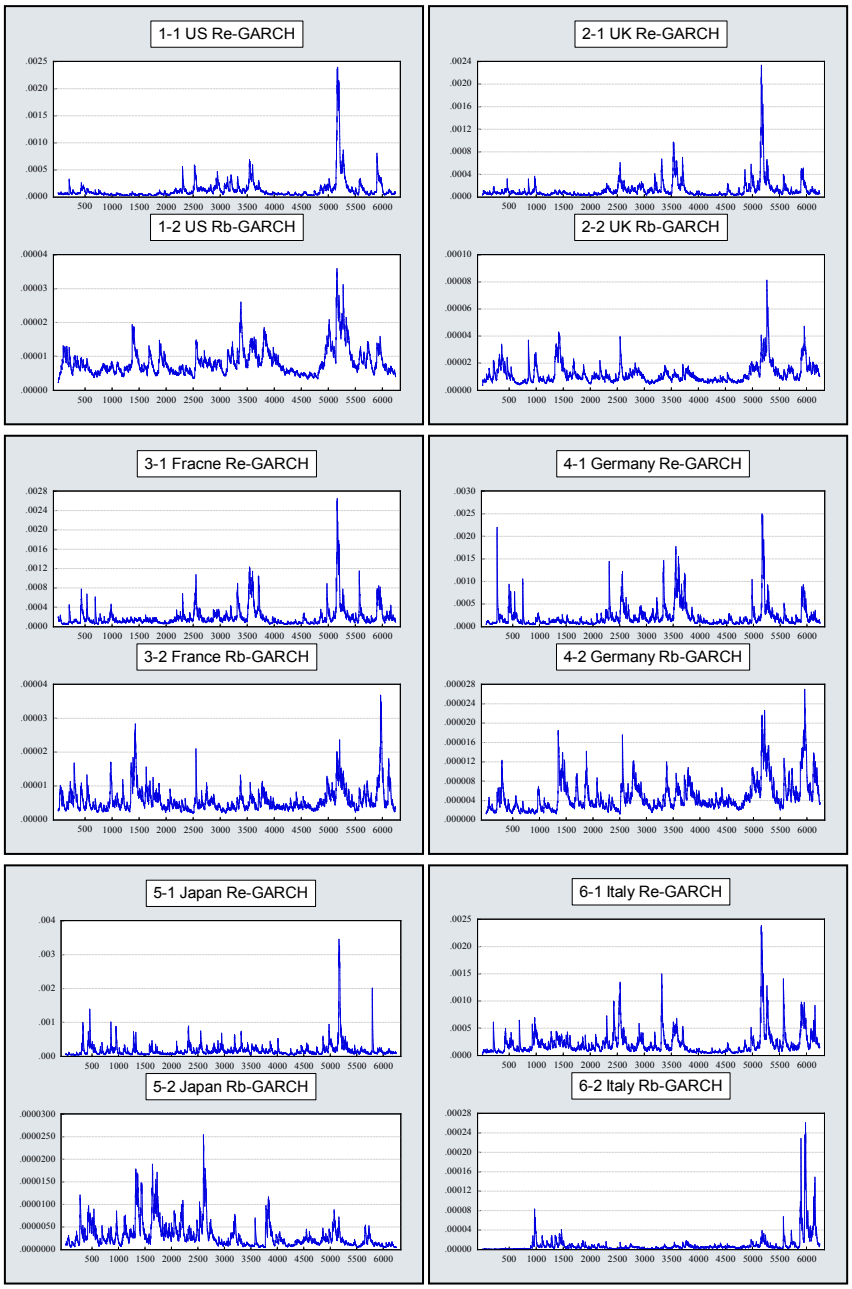
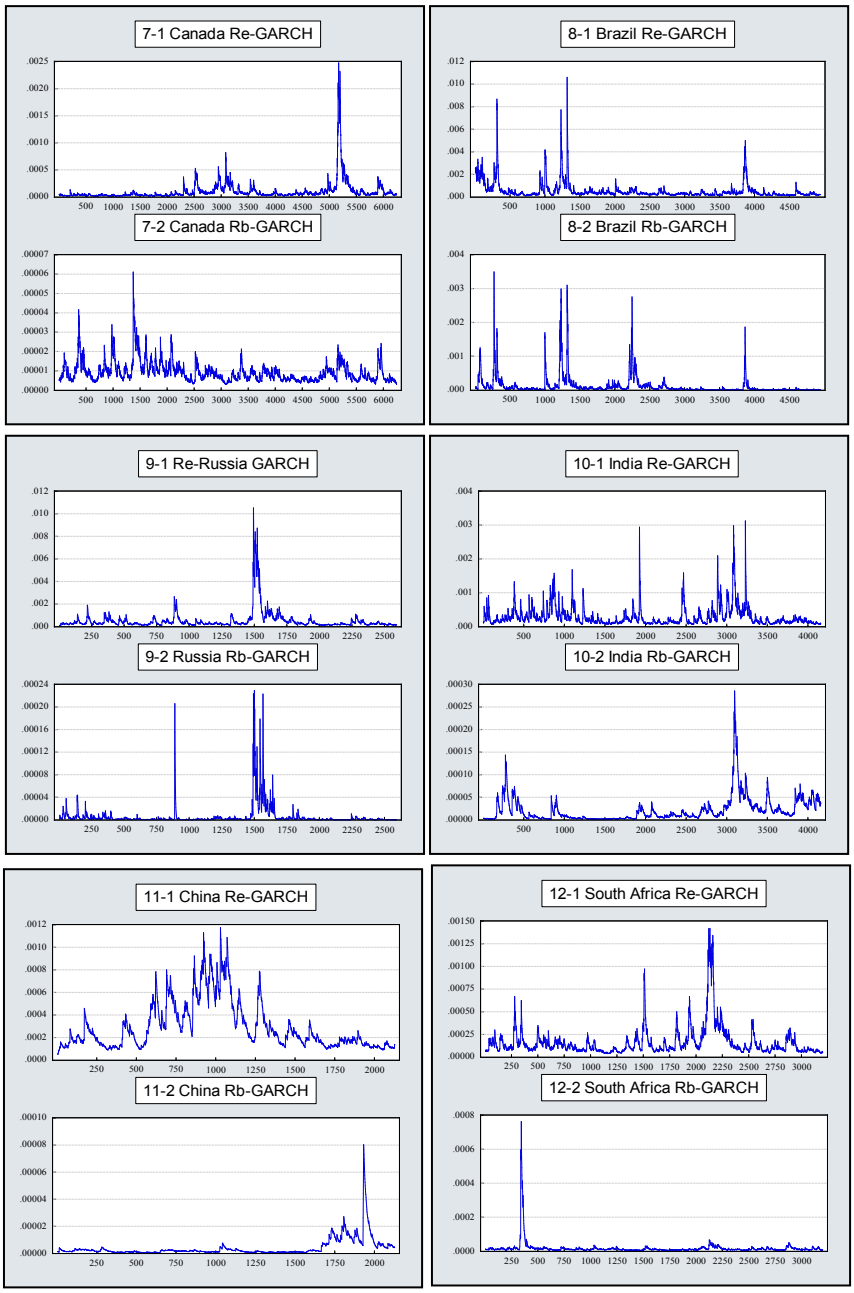
Appendix

Conditional Variance of Returns by GARCH (1, 1)


1-1 US Re-GARCH
1-2 US Rb-GARCH
2-1 UK Re-GARCH
2-2 UK Rb-GARCH
3-1 Fracne Re-GARCH
3-2 France Rb-GARCH
4-1 Germany Re-GARCH
4-2 Germany Rb-GARCH
5-1 Japan Re-GARCH
5-2 Japan Rb-GARCH
6-1 Italy Re-GARCH
6-2 Italy Rb-GARCH


7-1 Canada Re-GARCH
7-2 Canada Rb-GARCH
8-1 Brazil Re-GARCH
8-2 Brazil Rb-GARCH
9-1 Re-Russia GARCH
9-2 Russia Rb-GARCH
10-1 India Re-GARCH
10-2 India Rb-GARCH
11-1 China Re-GARCH
11-2 China Rb-GARCH
12-1 South Africa Re-GARCH
12-2 South Africa Rb-GARCH