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Stock Market Volatility Spillover in West Africa: Regional and Global Perspectives

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Abstract:

This study examines volatility spillover between stock markets in the West African region, and with the United States of America (US) and United Kingdom (UK) stock markets using the Exponential Generalized Autoregressive Conditional Heteroscedastic (E-GARCH). Daily stock market index returns from 2008-2016 were analysed considering two sub-sample periods representing periods of turbulence and tranquil. Findings from the study reveal that there is the presence of significant volatility spillover effects between stock markets in the West African region and also with major global markets of US and UK. Significant changes are also observed in the direction, magnitude and sign of impact during the period of crises and in the post crises period. The results of this study is important to local, regional and international investors, market participants and regulatory bodies as it implicates on portfolio diversification strategies, capital controls policies and efforts towards regional stock market integration.

Keyword: integration; volatility spillovers; E-GARCH; stock markets; West Africa; financial crises

JEL Classification: G15; G01; C58; F36; F37; F65; G23

Introduction

International portfolio diversification comes handy with financial globalization fostered by; the ease of funds transfers through technology, computerized securities clearing system, online trading of securities and electronic banking. International investors are able to react to market news and revise their portfolio strategy thus investing and divesting at will from markets with little or no capital flow restriction in this age of economic liberalization and technological innovation. Global financial integration has taking its toll on many stock markets leading to interdependence and co-movements between markets such that volatile prices changes in one market could have a spillover effect on others. Recent studies have shown that liberalization and internationalization of stock markets world over have come with its gains and pains (Yao, He, Chen and Ou 2018, Asaleye, Adama and Ogunjobi 2018, Bai and Chow 2017).

The Autoregressive Conditional Heteroscedasticity (ARCH) as proposed by Engle (1982) is able to model volatility. Other modifications of ARCH including the Generalized ARCH (GARCH) by Bollerslev (1986) can reveal if the volatility inherent in one market is affected by the volatility in another market. Other information available through the ARCH and GARCH models include if the mean reverts slowly or fast, and if the magnitude of the effect of a negative shock is more than that of a positive shock (known as the leverage effect) as established to be commonly exhibited in financial series. Closely integrated markets without substantial capital flow restrictions usually experience volatility spillovers, but arguments exist as to the extent of interactions that exist among stock

markets in the West African region on one hand, and the extent of such interactions between the stock markets in the region and major global stock market.

There are insufficient studies on the existence of volatility spillover within stock markets in the West African region related to major global stock markets. This study intends to fill this gap by examining volatility in major stock markets in the West African region and further examine if there are spills over among them and between them and major global stock markets. The general notion is that stock markets in the West African region are disintegrated among themselves and independent from the global stock market. Assessing the nature and extent of volatility spillovers has implication for both local and foreign investors, other market participants and regulators in the face the dynamic interdependencies of equity markets in a financial globalization era and against the background of efforts towards a higher level of regional market cooperation in West Africa. The study hereby examines volatility spillover of stock returns in the West African region from a regional and global perspective in the stock markets of Nigeria, Ghana, the West African Economic and Monetary Union (WAEMU), United Kingdom (UK) and the United States (US).

1. Empirical review

Examining the co-movement of stock market indexes has been established as a yardstick for integration in the literature. Kanas (1998) is one of the early studies on volatility spillover between stock markets. The author examined the volatility spillover between the London, Paris, and Frankfurt stock markets using Exponential Generalized Autoregressive Conditional Heteroscedasticity (E-GARCH) on daily data of whole sample period from 1984-1993 and sub-sample periods of 1984-1987 and 1987-1983. While bi-directional spillover was found between Paris and London and Paris and Frankfurt, a unidirectional spillover was found from London to Frankfurt. From the sub-period analysis, the study reveals that the intensity of volatility spillover was higher during the later (post market crash) period.

Rockinger and Urga (1999) is another early study on stock market integration. A time-varying parameter model was used to test for predictability and integration in stock markets of Czech, Poland, Hungary, and Russia. Daily data from April 1994 to July 1997 were used for the study. The Kalman's filter framework that allows for a GARCH structure for the residuals was employed. The evidence from the study revealed that the importance of Germany has changed over time for all the markets and that shocks in the UK were positively related to the Czech and Polish markets, but neither with the Russian nor Hungarian market. Findings further show that the markets exhibit significant asymmetric GARCH effects where bad news generates greater volatility, although in Hungry, good news instead generates greater volatility.

Kim, Moshirian, and Wu (2005) examined the impact of the introduction of the euro currency on the dynamic interactions and interdependencies between stock markets in the European Monetary Union (EMU) from 1989-2003. The authors employed a bivariate E-GARCH model and the seemingly unrelated regression estimations (SURE). Findings from the study reveal a striking number of significant return and volatility spillover within the region, and for the entire region with the US and Japan. More so the results revealed that market linkages have strengthened since the introduction of the euro. It further shows that the introduction of the euro has resulted to stock market integration and that the integration is an unrelenting and seasonal process being basically determined by the existing levels of integration and stock market development.

Caporale and Spagnolo (2010) estimated a trivariate Vector Autoregressive - GARCH (1,1) model to examine volatility spillovers between the stock markets of three Central and Eastern European countries (CEECs), namely the Czech Republic, Hungary, and Poland. Similar to the findings of Kim, Moshirian, and WU(2005) the author's findings suggest that following the accession of the EU, linkages between markets in the region have become even stronger, thus making intra-regional portfolio diversification a less effective investment strategy.

Hochstotter and Weskamp (2012) conducted a study on international co-movement of equity markets and foreign exchange, using a large international dataset covering the most important markets. They measured the mutual influence on the levels by correlation, linear regression, vector autoregression, and Granger causality as well as the dynamics in the co-movement behaviour by means of DCC-GARCH. Findings of the study show significant negative, as well as positive co-movements. It was observed that co-movement measured by linear dependence tends to be much more stable in developing economies than in the leading economies. On the other hand, a significant regional cluster of co-movement behaviour is not found.

Arouri, Lahiani and Nguyen (2013) examine the co-movement between Argentina, Brazil, Chile and Mexico using DCC-GARCH and BEKK-GARCH from 1988-2009. Their findings revealed evidence of time-varying market co-movement. Syriopoulos (2014) studied equity market volatility and contagion in South Eastern Europe

from 2000-2013 using the vector error correction model, the univariate GARCH and the Asymmetric Dynamic Conditional Correlation (ADCC). The stock indexes of markets in the sub-region that includes: Cyprus, Turkey, Croatia, Romania, Bulgaria, and Greece were compared with major global stock markets of Germany and USA. The ADCC analysis showed more correlations between the southeastern European stock markets than with the major world markets.

Donadelli (2014) studied 35 stock markets in both advanced and emerging countries using national and sector-based stock market indexes and examined the effect of the global integration process on international stock market returns from 1988-2011. The co-movement measures show that benefits of cross-country and cross-industry diversification have reduced, implying that index in both advanced and emerging countries tend to co-move using the DCC-GARCH. The study also revealed that emerging stock market indexes (including Nigeria) have been greatly influenced by domestic shocks. It also showed that liberalization has not affected excess returns without some delays. Furthermore, it was observed based on the analysis that there were increases both at the country and sector level indexes as *de facto* integration increased.

Stuart (2017) examined stock market returns comovement between the London Stock and Ireland Exchanges from 1869-1929 using monthly data, employing the BEKK GARCH model. The study revealed that the direction of volatility spill was unidirectional from the London stock market to Ireland stock market. The study by Yao, He, Chen and Ou (2018) investigates the impact of China's financial liberalization policies on the world within the period of 2000 – 2015. The Authors' findings reveal that the market integration has positive and negative effects on China's stock market.

Most empirical studies have focused more on markets in developed economies and other emerging markets, with little focus on emerging markets in the West African region. Few studies that have included the stock Markets in West Africa have not examined volatility spillover. The aim of the study is to examine the extent of market integration in West Africa from a regional and global perspective by investigating for the nature of volatility spillover existing within the markets in the region and between major global equity markets.

2. Data and descriptive statistics

Stock market index returns of Nigeria, Ghana, WAMEU, UK and the US were used for the study. The All-share index was selected for the Nigerian stock exchange, the Ghanaian composite index/All share index for Ghana, the BRVM composite index for the WAMEU countries, the FTSE 100 index for the UK stock market and the SP500 for the US market. The acronyms representing the index returns of Nigeria, Ghana, BRVM, US, and UK are NSE, GSE, BRVM, FT and SP respectively. All the indexes were converted to returns. Index returns were calculated using the formulae X=100*log (X/X (-1))" where X represents daily market index datum. Daily index data returns are used for the study in other to sufficiently capture the volatile movement of stock prices through their index and the spillover effect from one market to the other.

Data were obtained from different sources. The Nigerian all share index data was obtained from the African Markets and Cash Craft websites. The GSE composite index (from 2011-2016) and the GSE all share index (2008-2010) were obtained from GSE Annual Report and African Markets. The BRVM composite index was obtained from African Markets. The SP 500 index was obtained from yahoo finance while the FTSE100 from the Financial Times market data website. The GSE all share index which was the major market index for the Ghanaian stock market prior to 2011 *(i.e.* 2008-2010) was converted to 1000 base year index point which the Ghana composite index is based on for uniformity of the series.

The descriptive statistics for the crises period (*i.e.* from 2008-2010) and post-crises period (2011-2016) are presented in Table 1 and 2 respectively. The mean returns for all the series are negative for the crises period except for the GSE, compared to the mean returns in the post-crises sample period where all the returns are positive. In the crises period, the NSE had the highest negative value followed by BRVM, SP, and FTSE, indicating that investors may had made more losses from the NSE and BRVM than their global counterparts during the crises period. Meanwhile, in the post-crises period, NSE had the highest returns followed by the GSE, the FTSE, BRVM and lastly the SP. We can infer from the mean returns in the crises and post-crises period that emerging market have higher returns but also higher risk especially during periods of turbulence.

In the crises period, the highest and lowest maximum and minimum mean return values respectively were observed in the NSE. Meanwhile, in the post-crises period, the SP had the highest maximum return value, while the GSE had the lowest minimum return value. In the crises period, the SP had the highest standard deviation implying a high level of volatility followed by the FTS, NSE, GSE and the BRVM. In the post-crises period the SP also had the highest standard deviation but was followed by the BRVM, GSE, NSE, and the FTSE respectively.

In the crises period the NSE and BRVM were positively skewed while the GSE, FTSE, and SP were negatively skewed. Meanwhile, in the post-crises period the NSE, GRVM, and BRVM were all negatively skewed while the SP and FTSE were positively skewed. All the return series in both sub-sample periods exhibited excess kurtosis. The Jarque-Bera test for the index returns similarly indicates that skewness and kurtosis of the entire index return data in both sub-periods do not conform to that of a normal distribution.

Table 1. Descriptive statistics for 2008-2010 sub-sample period index returns

	NSE	GSE	BRVM	FTSE	SP
Mean	-0.112060	0.014420	-0.032181	-0.016627	-0.027086
Median	-0.019169	0.002484	0.000000	0.000000	0.053939
Maximum	11.758360	5.142638	6.230127	9.384339	10.95720
Minimum	-9.475281	-8.754035	-5.444762	-9.265572	-9.469512
Std. Dev.	1.485540	1.017351	0.924785	1.710515	1.885917
Skewness	0.360110	-0.882074	0.547868	-0.028840	-0.164798
Kurtosis	13.210760	15.969670	10.626290	8.591833	8.993523
Jarque-Bera	3,370.368000	5,510.942000	1,909.444000	1,005.914000	1,158.996000
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	772	772	772	772	772

Source: Author's computation

Table 2. Descriptive statistics for 2011 to 2016 sub-sample period index returns

	NSE	GSE	BRVM	FTAE	SP
Mean	0.038774	0.036155	0.012223	0.033516	0.004994
Median	0.000000	0.019283	0.011698	0.000000	0.000000
Maximum	3.438337	4.631738	3.942950	4.440781	7.972911
Minimum	-5.999722	-6.895833	-4.779456	-2.758154	-4.353162
Std. Dev.	0.752125	0.935008	0.981583	0.526903	0.970966
Skewness	-0.363405	-0.503794	-0.209091	0.595906	0.292340
Kurtosis	10.877190	8.048962	5.308629	10.69657	9.385788
Jarque-Bera	4,078.023000	1,727.389000	358.7193000	3952.857000	2,679.662000
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1,564	1,564	1,564	1,564	1,564

Source: Author's computation

3. Methodology

The multivariate E-GARCH (1,1) by Nelson (1991) was used for the study to model volatility in the series and examine volatility spillover between the regional market, and between the regional markets and the two selected global stock markets. The E-GARCH model is able to capture asymmetric volatility effects. The γ parameter as seen in equation 1 captures the asymmetric effect, where a negative and significant coefficient indicates that negative volatility has a greater effect on future volatility than positive volatility.

$$\log(\sigma_t^2) = \omega + \beta_t \log(\sigma_{t-1}^2) + \alpha \left\{ \left| \frac{\varepsilon t - 1}{\sigma t - 1} \right| \sqrt{\frac{2}{\pi}} \right\} - \gamma \frac{\varepsilon t - 1}{\sigma t - 1} \quad (1)$$

4. Findings

The ARCH test is first conducted as indicated in Table 3. The output indicates the presence of ARCH effect as the Chi-square and the F statistics probability values are statistically significant, implying that GARCH analysis can be further conducted.

The E-GARCH outputs for the two sub-periods considered are presented in Table 4 and Table 5. The ARCH term indicated by α which captures the effect of past innovations of a series on its current volatility is significant for all the markets returns in the study both in the crises and post period. This implies that past news of each market influences the current volatility in significantly way. On the other hand, the GARCH term coefficient indicated by β that captures the impact of the last period volatility on current volatility is significant for all the market returns in the crises period except for the BRVM, and significant for all the markets in the post-crises period.

The coefficient of the asymmetric term (γ) in the E-GARCH model with the NSE as the dependent variable is negative but insignificant, implying an insignificant leverage effect both in the period of turbulence and tranquil. From the GSE to the NSE volatility spillover is negative and significant in both the crises period periods [-0.091144(0.0028)] and the post-crises period [-0,061609(0,0213)]. From the BRVM to the NSE, volatility spillover is positive but insignificant in the crises period [0.023821(0.3234)] but positive and significant in the post-crises period [0.113999(0.0000)]. From the FTSE to the NSE volatility spillover is also positive and insignificant [0.029172(0.2016)] in the crises period, and similarly positive but significant in the post-crises period [0.091293(0.0006)]. From the SP to the NSE, volatility spillover is negative and significant [-0.048468(0.0015)] while in the post-crises period it is positive and significant [0.068762 (0.0000)].

The presence of leverage effect in the model with the GSE as the dependent variable is indicated by a negative coefficient and significant probability both in the crises period [-0.023956(0.0016)], and post-crises period [-0.164180(0.0000). From the NSE to the GSE volatility spillover is positive and significant in the crises period [0.059962(0.0000)] and positive but insignificant in the post-crises period [0.017411(0.2326,)]. Volatility spillover from the BRVM to the GSE is positive and significant in the crises period [0.062574(0.0000)], while it is negative but also significant in the post-crises period [-0.105667(0.0000)]. Volatility spillover from the FTSE to the GSE is positive and significant [0.116653(0.5037)] in the crises period but negative and insignificant in the post-crises period [-0.008618(0.5037)]. Volatility spillover from the SP to the GSE is positive and significant for both the crises and post-crises sub-sample periods respectively [0.034182(0.0000)], [0.068762 (0,0000)].

The asymmetric term for the model with the BRVM as the dependent variable in the crises period is positive and insignificant implying the absence of a leverage effect in that period [0.048642(0.2402), whereas the presence of leverage effect is found in the post-crises period [-0.084809(0.0000)]. Volatility spillover from the NSE to the BRVM is negative but insignificant in the crises period [-0.018034 (0.2746)], but positive and significant in the post-crises period [0.042642(0.0136)]. Spillover effect is positive and significant from the GSE to the BRVM in the crises period [0.129888(0.0000)], but negative and also significant in the post-crises period [-0.131292(0.0000). Volatility spillover is positive and significant from the FTSE to the BRVM in the crises period [0.061131(0.0032)], and remained positive but insignificant in the post-crises period [0.013152(0.3076)]. Spillover effect is negative and significant from the SP to the BRVM in the crises period [-0.119112(0.0000)], but became positive and significant in the post-crises period [0.017524 (0.0449)].

The asymmetric term for the model with the FTSE as dependent variable is negative and significant implying the presence of a leverage effect in the crises period [-0.128096(0.0000)], meanwhile in the post-crises period, the asymmetric term is positive and significant implying that the impact of negative news is same as or less than that positive news (*i.e*. leverage effect is absent) [00.023112(0.0161). From the NSE to the FTSE volatility spillover is negative but insignificant in both sample periods [-0.000555(0.9503)], [-0.026729(0.2028)]. From the GSE to the FTSE volatility spillover is negative but insignificant in the crises period [-0.007911(0.3933)], and was also negative but significant [-0.040155(0.0754)] in the period of tranquil. From the BRVM to the FTSE volatility spillover is negative and significant in both sub-sample periods respectively [0.062853(0.0002)], [-0.062016(0.0086)]. From the SP to the FTSE, volatility spillover is negative and significant in the crises period [-0.053730(0.0000), but became positive and significant in the post-crises period [0.035704(0.0007)].

The asymmetric term in the model with the SP as the dependent variable is negative but not significant in the crises period [-0.026276(0.3859)] implying an insignificant leverage effect, and positive and not significant implying the non-existence of leverage effect in the market for the post-crises period [0.00440(0.6234)]. From the NSE to the SP, volatility spillover is positive but insignificant in the crises period [0.001399(0.8590)], and positive but significant [0.03622(0.0265)] in the post-crises period. From the GSE to the SP volatility spillover is also positive but insignificant in the crises period [0.000203(0.9752)], and negative but also insignificant [-0.020314(0.4872)] in the post-crises period. From the BRVM to the SP, volatility spillover is negative and significant in both sub-sample periods respectively, [-0.062354(0.0004)], [-0.099993(0.0001)]. Lastly from the FTSE to the SP volatility spillover is negative and significant in the crises period [-0.103703 (0.0000)], and also negative but insignificant in the post-crises period [-0.015682(0.2032)].

Table 3. Heteroskedasticity Test-ARCH

F-statistic	104.4442	Prob. F(1,2345)	0.0000
Obs*R-squared	100.0760	Prob. Chi-Square (1)	0.0000

Source: Author's computation

Table 4. E-GARCH Output for Crises (2008-2010) Sample Period

Coefficient	NSE	GSE	BRVM	FTSE	SP
Ω	-0.304029 (0.0000)	-0.046501 (0.0000)	-0.474589 (0.0000)	-0.031293 (0.2093)	-0.030555 (0.1105)
A	0.475512 (0.0000)	0.083346 (0.0000)	0.356987 (0.0000)	0.059403 (0.0584)	0.053916 (0.0293)
B	0.910040 (0.0000)	0.960788 (0.0000)	0.073190 (0.4848)	0.963842 (0.0000)	0.976410 (0.0000)
Γ	-0.041155 (0.1206)	-0.023956 (0.0016)	0.048642 (0.2402)	-0.128096 (0.0000)	-0.026276 (0.3859)
NSE		0.059962 (0.0000)	-0.018034 (0.2746)	-0.000555 (0.9503)	0.001399 (0.8590)
GSE	-0.091144 (0.0028)		0.129888 (0.0000)	-0.007911 (0.3933)	0.000203 (0.9752)
BRVM	0.023821 (0.3234)	0.062574 (0.0000)		-0.062853 (0.0002)	-0.062354 (0.0004)
FTSE	0.029172 (0.2016)	0.116653 (0.0000)	0.061131 (0.0032)		-0.103703 (0.0000)
SP	-0.048468 (0.0015)	-0.008709 (0.3799)	-0.119112 (0.0000)	-0.053730 (0.0000)	

Source: Author's computation

Table 5. E-GARCH Output for Post Crises (2011-2016) Sample Period

Coefficient	NSE	GSE	BRVM	FTSE	SP
Ω	-0.292925 (0.0000)	-0.109267 (0.0000)	-0.087298 (0.0000)	-0.334889 (0.0000)	-0.178221 (0.0000)
A	0.185053 (0.0000)	0.123411 (0.0000)	0.107449 (0.0000)	0.273187 (0.0000)	0.228663 (0.0000)
B	0.735827 (0.0000)	0.966061 (0.0000)	0.983842 (0.0000)	0.890063 (0.0000)	0.956648 (0.0000)
Γ	-0.037545 (0.0180)	-0.164180 (0.0000)	-0.084809 (0.0000)	0.023112 (0.0161)	0.004409 (0.6234)
NSE		0.017411 (0.2326)	0.042642 (0.0136)	-0.026729 (0.2028)	0.036322 (0.0265)
GSE	-0.061609 (0.0213)		-0.131292 (0.0000)	-0.040156 (0.0754)	-0.020313 (0.4872)
BRVM	0.113999 (0.0000)	-0.105667 (0.0000)		-0.062016 (0.0086)	-0.099993 (0.0001)
FTSE	0.091293 (0.0006)	-0.008618 (0.5037)	0.013152 (0.3076)		-0.015682 (0.2032)
SP	0.068762 (0.0000)	0.034182 (0.0000)	0.017524 (0.0449)	0.035704 (0.0007)	

Source: Author's computation

Conclusion

The study set out to examine volatility spillovers among stock markets in West Africa vis a vis the markets of the US and the UK from 2008-2016 using sub-sample period representing the global crises period and the post-crises period. Findings from the study reveal the presence of leverage effect in most of the markets and volatility spillover between most of the markets in the two sub-periods.

In the crises period, negative asymmetric term indicated by *γ* is found in four of the five markets (*i.e* the NSE, GSE FTSE and SP), while only that of the GSE and the FTSE were significant implying the existence of leverage effect. Meanwhile, in the post-crises period, a significant leverage effect was found in all the markets indexes returns except for the SP. The absence of leverage effect in the SP may be due to the sample period under consideration. The presence of a leverage effect in the other indexes indicates that past negative volatility has a greater impact than past positive volatility on current volatility. Thus investors tend to divest from the respective markets either to other market or to other asset types due to negative volatility in a flight to safety response.

Furthermore, significant volatility spillovers are found both between regional markets and the global markets both in the crises and post-crises period. In the crises period bidirectional volatility spillover are observed between GSE and NSE; SP and FTSE; and BRVM and FTSE while significant unidirectional spillover effect is observed from GSE to BRVM; FTSE to GSE, and from the SP to NSE with no significant volatility spillover effect between the other pairs. In the post-crises period, more significant spillover effects are observed between market pairs. Bidirectional volatility spillovers are observed between GSE and BRVM; GSE and FTSE; NSE and BRVM SP and NSE, while unidirectional spillover effect is observed from the GSE to NSE; SP to GSE; FTSE to NSE; SP to FTSE and from the BRVM to FTSE in the post-crises period. It can be inferred that market integration is on the increase post the global crises period both at the regional and global level. This can be attributed to a number of factors including increase effort towards regional stock market cooperation and integration in the West African region, more drive towards internationalization of individual stock markets, more inter-market diversification activities by international investors and the growing level of financial globalization.

These findings have implications for international investors and policymakers at the national, regional and international levels. The leverage effect found in most of the markets in the study is of importance to international investors that employ active portfolio management strategies. Since significant interactions are observed between the markets in the study, they should be viewed as interdependent rather than as isolated. Though the magnitude of spillover effects is small in some of the cases, the implications could be far-reaching. Based on the extent of interactions, it can be inferred that some diversification opportunities still exist both within the regional market and beyond. Based on these, efforts towards regional market integration should be fostered with due considerations to interactions that exist between the stock markets in the form of volatility spillover both on a regional and global scale. Further studies can be considered using different data frequency and varying longitudinal scope at market wide, sub-sector or industry level. Also, other analytical tools can be employed including other variants of GARCH.

References

[1] Arouri, M.E., Lahiani, A. and Nguyen, K.D. 2013. Assessing the intensity of US-Latin American market co-movements and contagion effects in times of crisis. *Journal of Quantitative Economics*, Volume 11, 1-2: 130-147.

[2] Asaleye, A.J, Adama, J.I. and Ogunjobi, J.O. 2018. Financial sector and manufacturing sector performance: Evidence from Nigeria. *Investment Management and Financial Innovations,* 15(3): 35-48. Available at: http://dx.doi.org/10.21511/imfi.15(3).2018.03

[3] Bai, Y. and Chow, D.Y.P. 2017. Shanghai-Hong Kong Stock Connect: An Analysis of Chinese Partial Stock Market Liberalization impact on the Local and Foreign Markets, *Journal of International Finance Markets Institution of Money,* 50: 182 – 203.

[4] Bollerslev, T. 1986. Generalised Autoregressive conditional heteroscedasticity. *Journal of Econometrics,* 31: 307—27.

[5] Caporale, M.G. and Spagnolo, N. 2010. *Stock market integration between three CEECS*. Economics and Finance Working Paper Series Working Paper No. 10-09.

[6] Engle, R.F. 1982. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica,* 50(4): 987-1008.

[7] Hochstotter, M. and Weskamp P. 2012. *International co-movement of equity markets and foreign exchange*. School of Economics and Business Engineering, Karlsruhe Institute of Technology, Germany.

[8] Kanas, A. 1998. Volatility Spillovers across equity markets: European evidence. *Applied Financial Economics*, 8: 245-256.

[9] Kim, S., Moshirian F. and Wu, E. 2005. Dynamic stock market integration driven by the European Monetary Union: An empirical analysis. *Journal of Banking and Finance,* 29(10): 2475–2502.

[10] Nelson, D.B. 1991. Conditional Heteroscedasticity in asset returns: A new approach. *Econometrica*, 59(2): 347-370.

[11] Rockinger, M. and Urga, G. 1999. *A time varying parameter model to test for predictability and integration in stock markets of transition economies.* Cahier De Recherche Du Groupe Hec 635/1998.

[12] Syriopoulos, T. 2014. *Stock market volatility and contagion effects in the financial crisis: The Case of South Eastern Europe.* Emerging Markets and the Global Economy. Academic Press, Elsevier.

[13] Stuart, R. 2017. Co-movements in stock market returns Ireland and London 1869-1929. *Financial History Review*, 24(2): 167-184.

[14] Yao, S., He, H., Chen, S., Ou, J. 2018. Financial Liberalization and Cross-border Market Integration: Evidence from China's Stock Market. *International Review of Economics and Finance,* 58: 220-245. DOI: 10.1016/j.iref.2018.03.023

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