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AUTHORS

Khaled Bataineh 

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Khaled Bataineh, Assistant Professor of Finance, Economics and Administrative Sciences Faculty, Finance and Banking Sciences Department, Yarmouk University, Jordan.



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Khaled Bataineh (Jordan)

RETURN AND VOLATILITY SPILLOVERS BETWEEN FTSE ALL-SHARE INDEX AND S&P 500 INDEX

Abstract

This paper explores the effect of the return and volatility spillover between the Standard and Poor's 500 index and FTSE All-Share index using the AG-DCC_ Dynamic Conditional Correlation model over the sample period from April 1995 to April 2019. It demonstrates that the Standard and Poor's 500 return and volatility are crucial in forecasting the market's future dynamics of the FTSE All Shares where it finds a significant spillover effect for both return and volatility from the Standard and Poor's 500 to FTSE All Shares, while weak evidence has been found in the opposite direction, that is, an insignificant spillover effect for both return and volatility from FTSE All Shares to the Standard and Poor's 500. In addition, the paper also finds high Dynamic Conditional Correlation (DCC) between both the Standard and Poor's 500 and FTSE All Shares. Therefore, it finds asymmetric correlation and transmission mechanisms between the Standard and Poor's 500 and FTSE All Shares, which means there is an asymmetric interconnectedness between two markets, so allocating assets between two markets will not benefit investor portfolios as investing in high-yielding shares do.

Keywords

volatility spillover, AG-DCC model, asymmetric interconnectedness, asset allocation, diversification, investor portfolios

JEL Classification

G10, G11, G15

INTRODUCTION

There are many reasons for the importance of return spillover and volatility between stock markets. Firstly, it disseminates information regarding the market's efficiency. Return prediction in an efficient market with no risk premium is difficult using the conditional lagged return in another similar marketplace. And then, the existence of a significant transmission means that there is a global trading chance that could be taken advantage of to earn abnormal returns. This is proof that the markets are inefficient. Second, the impact of spillover effects on returns and volatilities might assist with managing portfolios, especially in the areas of strategic investment allocation and market positioning. Thirdly, considering volatility interconnectedness might ameliorate the calculating of conditional volatility that is important for specific financial applications like options pricing, risk valuation, optimizing portfolios, and hedging against several kinds of risk. In addition, many papers investigate returns and volatility using the popular time series models. Recent studies cover most aspects of this transmission. Umar et al. (2013) handle the relation between return and the spillover of volatility and oil prices. Malik (2021) links this relation with exchange rates, while Geng et al. (2021) measure it across global energy firms. Most studies try to measure the return and spillovers? between developed stock exchanges (efficient) and developing stock exchanges (inefficient) and vice versa to capture the transmission of global shocks. This study tries to capture the traded transmission among the developed stock exchanges.

1. LITERATURE REVIEW AND HYPOTHESIS

Many researchers have studied the volatility and return spillovers and the interconnectedness between global markets. Diebold and Yilmaz (2009) examine the interconnectedness between 9 global equity markets; they measure spillovers in terms of return and volatility across these stock exchanges and find strong evidence of divergence in the dynamics of return spillovers versus volatility spillovers (asymmetric) where the return spillovers show a gradual increasing pattern, while volatility spillovers show a strong effect but with no clear pattern. With regard to the U.S. market, Diebold and Yilmaz (2012) estimate the directional and the total volatility spillovers between different US markets using a generalized vector autoregression. They employ a daily observation from 1999 to 2010 of foreign exchange, stock, commodities, and bond markets. They find a significant spillover of volatility in all 4 markets. But the strongest spillover of volatility was seen from equity exchange towards other financial markets in September 2008, just after the Lehman Brothers bankruptcy.

Regarding the South American countries, Cardona et al. (2017) use MGARCH-BEKK models to explore the transmission of volatility between the US stock market and six big South American stock markets from 1993 to 2013. The investigation demonstrates the existence of volatility, which is transmitted by the USA equity exchanges to its peer's markets in South America, the relationship is weak in the opposite direction. Moreover, Gamba-Santamaria et al. (2017) study the USA market and 4 South-American countries. They extended Diebold and Yilmaz (2009, 2012) by constructing volatility spillover indices using a DCC-GARCH model. They use a series of asset returns to compute spillover indices. Findings reveal that Brazil is the main volatility transition country to Colombia, Mexico, and Chile. The volatility spillover is very higher during the 2008 financial crisis, especially after the Lehman Brothers collapse.

In connection with exchange rates, oil markets, and sovereign CDS, Antonakakis (2012) tests spillovers of volatility and profitability joint movements between a number of exchange rates pre- and post-presenting the Euro. Findings show strong spillovers and return joint movements among the exchange rates of

currencies. More importantly, this effect is stronger during the before-euro period and mitigates gradually during the post-euro period. Many researchers discover that the return and volatility transmission across stock marketplaces and oil prices are bi-directional (Awartani & Maghyereh, 2013; Awartani et al., 2013; Maghyereh et al., 2016). Wen et al. (2019) investigate the impact of the relation of spillover risk between the equity exchanges and the oil sector using IRFs. The spillover is asymmetric, and it is only significant at the positive quantiles, while it is minor at the negative quantiles. According to the results established on the findings of the analyses of a subsample, they conclude that the spillover of risk gets more powerful beyond the 2008 international crisis, while pre this time the effect of spillover is highly ineffective. Furthermore, Maghyereh and Al-Kandari (2007) investigate a potential link across the equity exchange in Gulf Cooperation Council countries and the price of oil. Findings conclude that in the Gulf Cooperation Council countries, oil prices have a non-linear impact on the stock market. Arouri et al. (2011) show a strong spillover of volatility between equity stock return and oil prices. The findings reveal that in Europe there is a one-way directional spillover from oil markets to equity stock markets, while in the U.S markets the relationship is mutually directional. Moreover, Asteriou and Bashmakova (2013) investigate the link across oil prices and stock markets in Central and Eastern Europe. Findings reveal that oil prices are key factors in deciding stock return, where there is significant evidence of volatility spillover between oil prices and equity stock markets. Sun et al. (2019) find that developed countries experience lower spillovers compared with developing countries in relation to sovereign CD to the spillovers of stock return; at the same time, the developing countries channel fewer spillovers than the developing countries in the other direction.

With reference to the Bitcoin market and options pricing, Yaya et al. (2019) find that the Bitcoin market could be efficient. In addition, they find that volatility is high, especially in the post-market crash sample. These volatility levels will therefore last for a shorter time than they did before the catastrophe. Goncalves-Pinto et al. (2019) confirm that stock price pressure is found to be the key to stock return forecasting and is the main driver of pricing options. Additionally, Berisha et al. (2018) find that income disparity is exacerbated by rises in the stock market

and individual debt. Moreover, the interest rate and income disparity have a negative and statistically significant association.

Many old and recent studies cover the developed and emerging markets (Ehrmann et al., 2005; Forbes & Rigobon, 2002; Zhou et al., 2012; Awartani et al., 2013; Corsetti et al., 2005; Jin & An, 2016; Gamba-Santamaria et al., 2017; Belcaid & El Ghini, 2019; Atenga & Mougoué, 2021) try to shed light on the issue that the transmission and volatility and return spillovers have become stronger throughout the financial crisis. Jin and An (2016) also tested the effect on South Africa, Russia, Brazil, India, and China, those are emerging economies. They use the (VIRF) approach to the consequences of contagion between the stock markets of the BRICS and those of the United States. More importantly, how the stock markets in the BRICS countries reacted to the global financial crisis of 2008. The results show that there was significant contagion influence of the USA equity market exchanges on the equity markets of the BRICS countries. Moreover, Darrat et al. (2000) aim to test the degree of integration of three Middle Eastern markets (emerging markets). They find a stable integration between the three markets. Maghyereh and Awartani (2012) test spillover of both return and volatility impacts among Abu Dhabi Stock Exchange and Dubai Financial Market are both located in the United Arab Emirates. Findings affirm that return and volatility transmission mechanisms among the two markets are asymmetric. Kuttu's (2014) results show a mutual return spillover among Kenya and Ghana equity markets as well as among Nigeria and South Africa. Conversely, Humavindu and Floros (2006) use daily closing indices to look at spillovers of the volatilities and return across the South Africa and Namibian equities markets from January 1999 to March 2003. Findings show that the correlation is weak between the two equity markets. Therefore, there are no spillover effects. Yilmaz (2010) and Lee (2009) explore an interconnectedness among East-Asian stock markets and find a great deal of evidence there is a tremendous spillover between marketplaces. Finally, Sugimoto et al. (2014) conclude that the interconnectedness and spillovers between African countries are not as strong as the interconnectedness and spillovers with global financial markets.

African equity markets have grown increasingly integrated on a global scale. For example, Blackman et

al. (1994) and Jeon and Chiang (1991) improve the integration by increasing the efficiency of African equity markets and reducing the transaction costs. In addition, the new technology has increased the interconnectedness among African equity markets and global markets. According to Eun and Shim (1989), the USA stock market is an important volatility spillovers transmitter to other equity markets, but the opposite is not true. Hence, no equity market can explain the US equity market dynamics. More recent studies, such as Giovannetti and Velucchi (2013), investigate equity markets' volatility (dynamics and interactions with other markets) between the UK, China, and US markets and some African emerging markets like Botswana, Egypt, Kenya, South Africa, Nigeria, and the state of Tunisia from the year of 2005 to 2012. Findings affirm that China has become more interconnected and both UK and the US markets transmit spillovers of volatility to African stock markets. According to Belcaid and El Ghini (2019), the Moroccan and other stock markets have varied financial and asymmetric connectivity, according to the aftermath of the global financial findings. There was a large increase in spillover in the aftermath of the global financial, which affirms that the European and American stock markets have been the most impacted markets during the global financial crisis of 2008. Atenga and Mougoué (2021) find that regional and international market shocks are time-varying shocks and have diverse (heterogeneous) effects on equity markets in Africa, the share to the world trade, and the degree of financial exposure can explain the immensity of these effects. On the other hand, equity markets receive both volatility spillovers and returns from other international and regional equity markets. Moreover, volatility shocks effects are stronger than return shocks to Africa's stock markets. Sugimoto et al. (2014) find that Africa's stock markets are strongly receiving spillovers from international markets. On the contrary, regional spillovers between African equity markets are weak. By contrast, concerning MENA countries, Graham et al. (2013) used the wavelet squared coherency test for the joint movements of the index Standard and Poor's 500 with some MENA region equity markets and the regional joint movements between MENA region equity markets from 2002 to 2010. Results suggest that there is a moderate joint movement among the Standard and Poor's 500 index and MENA region equity markets and a high joint movement between MENA region equity markets.

Concerning the non-financial markets (food and energy markets), Śmiech et al. (2019) investigate the sources of food prices volatility. The results show that volatility spillover measures vary over time; volatility spillovers are mostly observed in two categories of markets: the food markets and 'non-food' markets. Moreover, Chuliá et al. (2019) investigate the extent and evolution of the links between energy markets using broad data, they find that in the energy markets within and across sectors effects of the volatility spillover do exist, and the nature of those markets that are exporters of volatility to other markets.

With regard to the USA, UK, and Japan, Hamao et al. (1990) show a volatility spillover from NYSE and London stock exchange to the Tokyo stock exchange. More importantly, Lin et al. (1994) try to prove that spillovers often change over time between the Tokyo stock exchange and NYSE, they find a relationship in the two directions between daytime returns and overnight returns. This paper tries to fill up an important gap in the literature by testing the volatility and return spillovers between the two biggest markets in the world, the Standard and Poor's 500 and the FTSE All Shares, because those markets are considered the main sources of transmitting the volatility and return spillovers to other global markets. To the best of the author's knowledge, nobody tried to examine the bidirectional relationship of transmitting the volatility and return spillovers between the two markets. To that end, this paper tests the return and volatility spillover effects between two markets using the Dynamic Conditional Correlation (DCC) model proposed by Engle (2002).

Following the literature, the paper expects the following hypothesis:

H1: The mechanics of return and volatility transfer among the index of Standard and Poor's 500 and the index of FTSE All Shares is asymmetric (return and volatility from the Standard and Poor's 500 index to the FTSE all-shares index have considerable spillover effects).

2. METHODOLOGY

2.1. Data and variables

This paper uses two stock indices, the FTSE All Shares (FTSE) index and the Standard and Poor 500 index. For monthly data over the time period from April 1995 to April 2019, because spillovers are transient and may only last a few days, short-horizon returns were chosen. It could make returns with a long-time horizon inappropriate, particularly for spillovers of volatility, which are often weaker when analyzed over longer timeframes (Kim et al., 2005).

The price indices are presented in Figure 1 and Figure 2 for S&P 500 Index and FTSE All-Shares Index respectively. The two indices, as seen in the graphs, move in comparable directions and have similar long-term associations. It also indicates a significant increase at the start of 2005. The rise in oil prices aided this boom,

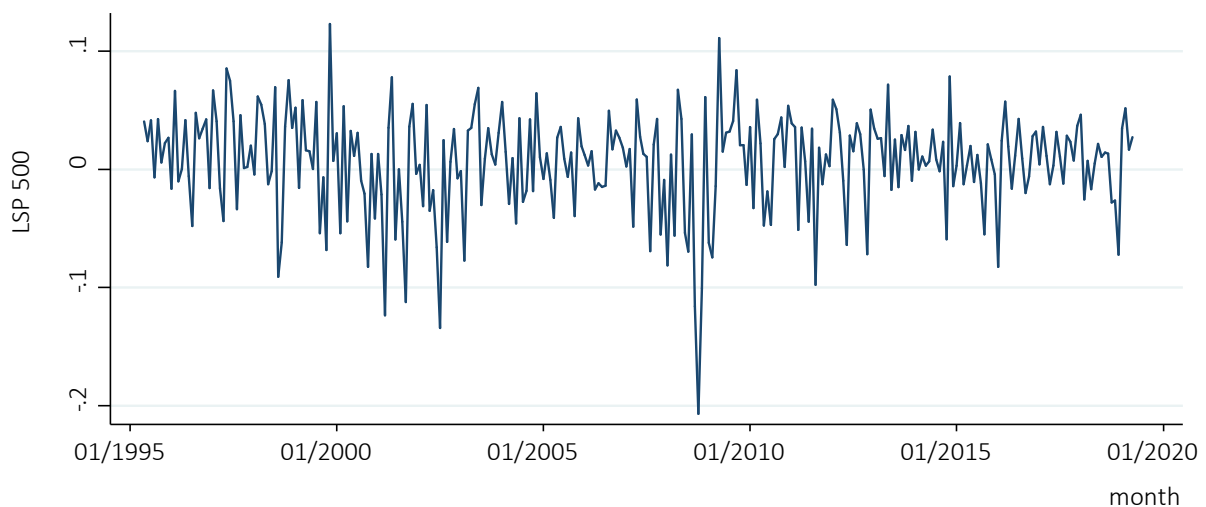


Figure 1. S&P 500 Index

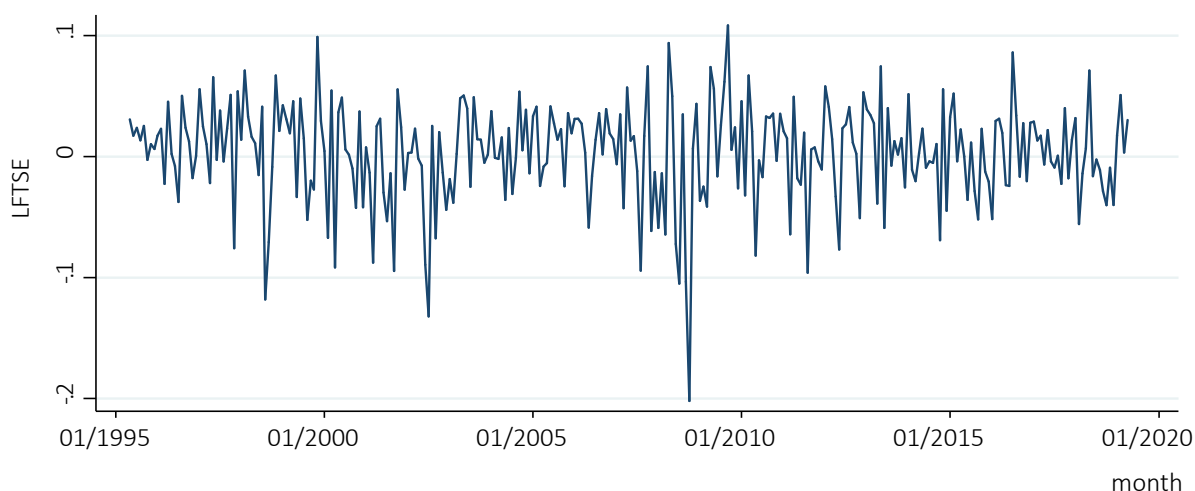


Figure 2. FTSE All-Share Index

positive firm profits and continuous structural reforms. The sentiment started changing in mid of 2005, and in early 2006 declined sharply in both markets. Oil and the global financial crisis, which began in August 2008, are the main forces behind both markets. Then, by October 2008, the indices had fallen by more than 40%. Price volatility in both markets remained strong from the end of 2009 through February 2010. Because of the growing American mortgage crisis, the increasing trend during this time period was short-lived.

2.2. Methods

2.2.1. Regression models

To study the return and volatility spillovers between indices, this paper employs the other index's lagged returns and volatilities in the mean and variance formula of every index, the index of Standard and Poor's 500 and the index of FTSE All Shares. The methodology included the first lag of results from the Standard and Poor's 500 to highlight spillover effects in the FTSE All-share index. As a result, the following conditional mean model with spillovers from a specific market will be as follows:

Monthly results using the Vector Autoregressive (VAR) process:

$$r_{1,t} = \mu_{1,0} + \mu_{1,1}r_{1,t-1} + \mu_{1,2}r_{2,t-1} + \varepsilon_{1,t} \quad (1)$$

for the Standard and Poor's 500 index

$$r_{2,t} = \mu_{2,0} + \mu_{2,1}r_{1,t-1} + \mu_{2,2}r_{2,t-1} + \varepsilon_{2,t} \quad (2)$$

for FTSE All Shares index

Equation (1) estimates the return for the Standard and Poor's 500 index; where, the $r_{1,t}$ is the current return of the Standard and Poor's 500 index, $\mu_{1,0}$ is the constant term for the Standard and Poor's 500 index return, $\mu_{1,1}$ is the coefficient of the lag return portion that comes from the Standard and Poor's 500 index, $r_{1,t-1}$ is the lag return of the Standard and Poor's 500 index, $\mu_{1,2}$ is the coefficient of the lag return portion that comes from the other market (the FTSE All-shares index), $r_{2,t-1}$ is the lag return portion that comes from the other market (the FTSE All-shares index), $\varepsilon_{1,t}$ is the error term of the Standard and Poor's 500 index. While Equation (2) estimates the return for the FTSE All-share index; where $r_{2,t}$ is the current return of the FTSE All-shares index, $\mu_{2,0}$ is the constant term for the FTSE All-shares index return, $\mu_{2,1}$ is the coefficient of the lag return portion that comes from the other market (the Standard and Poor's 500 index), $r_{1,t-1}$ is the lag return that comes from the other market (the Standard and Poor's 500 index), $\mu_{2,2}$ is the coefficient of the lag return portion that comes from the FTSE All-share index, $r_{2,t-1}$ is the lag return portion that comes from the FTSE All-share index, and $\varepsilon_{2,t}$ is the error term of the FTSE All-share index.

In the above equations, the lag values of conditional return, as well as the lag values of other indices affect the conditional mean. The partial effect of previous innovations of return of other indices on

the market performance can be measured by a parameter. In other words, a significant parameter means that the return spillover impact from index j to index i is confirmed.

2.3. Dynamic Conditional Correlation (DCC) model

The AG-DCC model, first introduced by Engle (2002), is a multivariate GARCH model that resolves computing problems and permits asymmetry. The dynamics of correlation between various investment classifications and markets can be described using this model. It additionally tests the fact that there are disparities in the case of correlations and conditional volatilities because of negative shocks of return. Following Cappiello et al. (2006), this study's AG-DCC model will be as follows:

$$H_t = D_t R_t D_t,$$

where $D_t = \text{Diag} \left(h_{1,t}^2, \dots, h_{N,t}^2 \right)$

and $h_{it} = c_i + a_i \varepsilon_{i,t}^2 + b_i h_{i,t-1}$, for $I = 1, 2$ (3)

$$R_t = \text{diag} (Q_t)^{-\frac{1}{2}} (Q_t) \text{diag} (Q_t)^{-\frac{1}{2}},$$
 (4)

$$(Q_t) = (Q^- - \varphi_1 Q^- - \varphi_2 Q^- - gN^-) + \varphi_1 \varepsilon_{t-1} \varepsilon_{t-1}' + \varphi_2 \varepsilon_{t-1} \varepsilon_{t-1}' + g\eta_{t-1} \eta_{t-1}'$$
 (5)

where R_t is a conditional correlation matrix that changes over time. Here $Q_t = \{q_{i,t}\}_t$ is the standardized error' variance-covariance matrix. Additionally, keep in mind that φ_1, φ_2 .

3. RESULTS AND DISCUSSION

3.1. Descriptive statistics

Table 1 provides descriptive statistics of both the S&P 500 index and FTSE All Shares index. As shown in the table, the number of observations is 288 for both indices, the log difference of both indices was calculated to get stationarity. It is notable that the Standard and Poor's 500 index's mean value is (.0060619), which is double the FTSE all shares index's mean value (.0033218).

Consequently, the Standard and Poor's 500 index's volume is much bigger than FTSE All Shares which leads to expecting a significant return spillover from the US market to the UK market. Moreover, the standard deviation for the Standard and Poor's 500 index is (.0428233) and (.041539) for FTSE All Shares which means that the US market is a bit more volatile than the UK market with expectations of significant volatility spillover from the US to the UK market as well. Finally, the Standard and Poor's 500 index scored a lower minimum value (-.2065935) than the FTSE all shares index minimum value (-.2018061). Oppositely, the Standard and Poor's 500 index scored a greater maximum value with (.1230235) versus (.1084957) for FTSE All Shares, which supports what was previously said about higher volatility in the Standard and Poor's 500 index, which could lead to volatility spillover from the US side to the UK side.

Table 1. Descriptive statistics of the log difference of the Standard and Poor's 500 index and FTSE All-Share index

Descriptive statistics	LSP500	LFTSE
Obs	288	288
Mean	.0060619	.0033218
Std. Dev.	.0428233	.041539
Min	-.2065935	-.2018061
Max	.1230235	.1084957

3.2. Unit root test

This paper covers the time period from April 1995 to April 2019, which leads to a series of 289 observations. First, a Dickey-Fuller test was run to test for unit root; the null hypothesis of this test says that there is a unit root, meaning that the two series of both indices are not stationary. The alternative hypothesis says that there is no unit root, meaning that the two series of both indices are stationary. The test statistics of the two series were insignificant, and the null hypothesis of the Dickey-Fuller test cannot be rejected, meaning that the two series are not stationary. After that, the first log difference of the two series (S&P 500 index and FTSE all shares index) was taken to be the length of both series 288 and again a Dickey-Fuller test was retested as shown in Table 2. The Dickey-Fuller test statistics for S&P 500 index and FTSE all shares index is (-16.267) and (-17.008), re-

spectively, with a P-value of zero for both indices. Therefore, the null hypothesis of the Dickey-Fuller test can be rejected, which affirms that both series are now stationary and the problem of unit root is resolved. This finding is consistent with Gamba-Santamaria et al. (2017) and Kuttu (2014).

Table 2. Dickey-Fuller test for unit root

Variable	Dickey-Fuller test Test statistics	p-value	Variable status
LSP500	-16.267	0.0000	Stationary
LFTSE	-17.008	0.0000	Stationary

3.3. Skewness and kurtoses

Bono et al. (2019) elucidate that skewness is a way of measuring symmetry, or rather, the absence of it. A distribution is considered to be symmetric if it appears identical to the left and right of the midpoint. In relation to normally distributed data, kurtosis is a statistical technique that determines how huge or light-tailed a set of data is. Data with a high kurtosis are more likely to contain big tails. Small tails are common in data sets with low kurtosis.

Table 3 reports the two return series of both indices skewness and kurtosis with its P-value, Standard and Poor's 500's return series is skewed to the left (-0.081) with zero P-value. In addition, FTSE All Shares' return series is more skewed to the left (-0.178) with zero P-value as well. This could lead us to conclude that the return of both standard and poor's 500 and FTSE all shares indices are asymmetric. Moreover, the two series are experiencing kurtosis, it is obvious with zero P-value for both series and with a coefficient of 2.651 for Standard and Poor's 500's and 3.897 for FTSE All Shares that the two return series (indices) are too peaked. This result is in line with Śmiech et al. (2019), Maghyreh and Awartani (2012), and Diebold and Yilmaz (2009).

Table 3. Skewness and kurtoses

Skewness and kurtoses statistics	LSP500	LFTSE
Obs	288	288
Coef	-0.081	-0.178
Pr(Skewness)	0.0000	0.0000
Coef	2.651	3.897
Pr(Kurtosis)	0.0000	0.0000

3.4. Return normality

The Jarque-Bera test, which has acquired widespread acceptability among econometricians, is one of the most well-known tests for normalcy. The Jarque-Bera test statistic is a function of the sample's calculated skewness and kurtosis values. The theoretical values of skewness and kurtosis under normalcy are 0 and 3, respectively. This examination assumes that the null hypothesis ensures the distribution of returns is normal, the alternative hypothesis assumes that the returns are not normally distributed. Thus, Table 4 shows that the adjusted Chi-square test statistic values for Standard Poor's 500 and FTSE all shares indices are 40.67 and 36.74, respectively, with zero P-value for the two indices' Chi-square test statistic; the Jarque-Bera test can reject the null hypothesis of normality of the two indices, indicating that both indices are not normally distributed. This finding is in line with Arouri et al. (2011) and Cardona et al. (2017).

Table 4. Jarque-Bera test for normality

Joint	LSP500	LFTSE
adj chi2(2)	40.67	36.74
Prob>chi2	0.0000	0.0000

3.5. Ljung-Box Q examination of the serial correlation (Autocorrelation)

In time series analysis, autocorrelation is a popular way to assess serial dependency. Researchers construct sample autocorrelations and use Ljung and Box (1978) to examine the combined importance of these statistics to better understand the dependency structure of time series data. The volatility clustering effect is a term used in financial time series analysis to describe the need of checking serial correlations of series. The null hypothesis of this test assumes that the series of the returns are serially correlated, while the alternative hypothesis affirms the nonexistence of autocorrelation. Table 5 shows the LB Q test of 10 lags test statistics for both Standard and Poor's 500 and FTSE All Shares are 7.6975 and 2.9765, respectively, with P-values 0.6584 and 0.9820, respectively. Therefore, the null hypothesis about autocorrelation for both indices with P-values of 0.6584 and 0.9820 respec-

tively could not be rejected. Returns have autocorrelation for both indices. The effects of ARCH and clustering in volatility are also shown by the significant serial correlation of returns. This result is consistent with Maghyereh and Awartani (2012), Awartani et al. (2013), and Maghyereh et al. (2016).

Table 5. Ten lag return series – serial correlation's Ljung–Box Q examination

Variable	LB Q Test (10) statistics	p-value	Variable Status
LSP500	7.6975	0.6584	serially correlated
LFTSE	2.9765	0.9820	serially correlated

3.6. Appropriate number of lags

This paper utilizes a number of criteria to select the optimal number of lags for the model such as the Akaike Information Criteria for lag selection (AIC), final prediction error (FPE), and Hannan–Quinn information criterion (HQIC). Table 6 shows that the test statistics values at one lag for FPE, AIC, and HQIC are $1.0e-04$, -8.13223 , and -8.10082 , respectively, with a P-value of 0.001 for all of them. This paper adopts the first lag as the appropriate number of lags for its model. Most of the previous studies that examined the developed markets spillover went with one lag model such as Hamao et al. (1990), Diebold and Yilmaz (2012), Cardona et al. (2017), and Antonakakis (2012).

3.7. AG model estimation

Table 7 demonstrates the model of AG-DCC estimated parameters. It is clear from the table that there is a significant dynamic correlation between

the Standard and Poor's 500 and the FTSE All Shares indices. Coefficients are significant and positive. Panel 1 and Panel 2 show that there are both positive return and volatility spillovers from the Standard and Poor's 500 index to the FTSE All Shares index. This result is in line with Maghyereh and Awartani (2012), they also document positive return and volatility spillovers. Conversely, the evidence in the opposite way (from the FTSE All Shares index to the Standard and Poor's 500 index) is weak, which means that the level of spillover from the Standard and Poor's 500 index to the FTSE All Shares index is greater and more important than the opposite direction, as seen in the panels. This is due to the larger and more accessible Standard and Poor's 500 index transmitting more information to the lesser and less accessible FTSE All Shares index. Further, this result is consistent with Maghyereh and Al-Kandari (2007) who indicated that magnitude and access are crucial variables in influencing the form of transfer techniques between the Gulf Cooperation Council countries, and Maghyereh and Awartani (2012) who investigated the relationship between UAE markets. Furthermore, findings show that spillovers are asymmetric. This result is in line with Diebold and Yilmaz (2009), Awartani and Maghyereh (2013), Awartani et al. (2013), Maghyereh et al. (2016), Cardona et al. (2017), and Wen et al. (2019). Return and volatility spillovers are a topic that is intensively researched and widely discussed amongst stock markets. In addition, the relationship between stock markets and exchange rates, oil prices, cryptocurrency, and bond markets was investigated. The amount of information available on the connectedness in term of returns and volatility spillovers between bond markets and cryptocurrency is

Table 6. Appropriate number of lags

Lags	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	1127.08				$1.0e-04$	-8.09413	-8.08366	-8.06803^*
1	1136.38	18.591*	4	0.001	$1.0e-04^*$	-8.13223^*	-8.10082^*	-8.05393
2	1138.21	3.6524	4	0.445	$1.0e-04$	-8.11659	-8.06424	-7.9861
3	1138.38	.33978	4	0.987	$1.1e-04$	-8.08903	-8.01574	-7.90635
4	1141.16	5.5714	4	0.234	$1.1e-04$	-8.0803	-7.98606	-7.84542
5	1142.53	2.7278	4	0.604	$1.1e-04$	-8.06133	-7.94616	-7.77425
6	1144.78	4.5073	4	0.342	$1.1e-04$	-8.04877	-7.91266	-7.7095
7	1146.08	2.5962	4	0.627	$1.1e-04$	-8.02933	-7.87228	-7.63786
8	1148.57	4.984	4	0.289	$1.1e-04$	-8.01848	-7.84049	-7.57482
9	1149.14	1.1503	4	0.886	$1.2e-04$	-7.99384	-7.79491	-7.49798
10	1151.39	4.4918	4	0.344	$1.2e-04$	-7.98122	-7.76135	-7.43317

Note: ** indicates the appropriate number of lags.

Table 7. AG model estimation

Panel 1: Conditional mean						
The Standard and Poor's 500 Index				The FTSE All Shares Index		
Coeff Symbols	Coeff Value	Standard Error	p-value	Coeff Value	Standard Error	p-value
$\mu_{i,0}$	.0061383**	.0025255	.015	.0033647	.0024788	.175
$\mu_{i,1}$	.1778711***	.1035526	.086	.0228607	.1048122	.827
$\mu_{i,2}$	.2690913**	.1067876	.012	-.035545	.1016371	.727
v	.0005788*	.0000482	.000	.0005446*	.0000454	.000
Panel 2: Conditional variance						
The Standard and Poor's 500 Index				FTSE all shares index		
Coeff Symbols	Coeff Value	Standard Error	p-value	Coeff Value	Standard Error	p-value
c_i	.0030309***	.0016056	.060	-.0006012	.0016095	.709
a_i	5.285658*	1.412975	.000	1.08798	1.5749	.490
b_i	.1812688*	1.412975	.000	-.1935868*	.0582061	.001

Note: *, ** and *** indicate test statistically significant at 1 percent, 5 percent, and 10 percent, respectively.

currently limited, and future research projects examining these connections might be fruitful.

Table 7 reports positive and highly significant estimated coefficients, which means positive and highly significant spillovers from the S&P 500 index to the FTSE All-Share index in terms of conditional mean in Panel 1 and conditional variance in Panel 2, meaning that the mechanics of return and volatility transfer among the index of

Standard and Poor's 500 and the index of FTSE All-Share is asymmetric (return and volatility from the Standard and Poor's 500 index to the FTSE All-Share index have considerable spillover effects, which affirms the hypothesis that suggests the asymmetry and strong volatility and return spillovers from the Standard and Poor's 500 index to the FTSE All-Share index); this result is consistent with Maghyereh and Awartani (2012), Awartani et al. (2013), and Vortelinos et al. (2018).

CONCLUSION

The positive and asymmetric spillovers of both return and volatility between the Standard & Poor's 500 index and the FTSE All-Share index are explored in this paper. Positive and asymmetric spillovers from the US market to the UK market are reported in the paper, as predicted. In addition, because the US market dominates the UK markets, the US return stock index sends conditional mean and volatility spillovers to the UK markets. These findings have significant implications for investors and portfolio managers who are investing in both markets at the same time, where diversification is of limited value. Investing in high-yielding equities, on the other hand, is given greater credit. Furthermore, the findings of this paper are important for policymakers in both markets, because market asymmetry raises the risk of insider trading and arbitrage, particularly in the UK market. Future study might offer insight on the spillovers between different asset classes inside the same market, rather than across markets. Moreover, studying connectedness is dependent on risk level, i.e. comparing low-risk and high-risk instruments.

AUTHOR CONTRIBUTIONS

Conceptualization: Khaled Bataineh.

Data curation: Khaled Bataineh.

Formal analysis: Khaled Bataineh.

Visualization: Khaled Bataineh.

Writing – original draft: Khaled Bataineh.

Writing – review & editing: Khaled Bataineh.

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