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Linkages Between Crude Oil and the Islamic Stock Market:
Evidence from Islamic Stock Market in Asian Countries

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ABSTRACT
In this paper, the impact of oil price shocks on the stock exchanges of Asian Countries – Saudi Arabia, Singapore, India, Pakistan, Philippines, Thailand, Indonesia, China, Taiwan, South Korea, Japan, and Turkey – was examined through the GARCH BEKK method. For the research, daily data from the stock exchanges, and the oil price were collected between December 2011–June 2020. According to the results, several countries affect the rate of return of the oil market on the daily data. The full period of daily data shows that some countries have volatility spillovers such as China, South Korea, Thailand, Philippines, Singapore, Taiwan and Turkey. For the normal period, only four countries have volatility spillovers, namely Saudi Arabia, Philippines, Taiwan and Turkey, and during the COVID-19, all countries have volatility spillovers to the oil market. Meanwhile, the Philippines, Taiwan and Turkey have volatility spillovers for all periods. During the COVID-19 period, volatility spillovers increased. In order to stabilize their stock prices, these countries should decrease their dependencies to the oil market.

Keywords: *MGARCH-BEKK, Volatility, Crude Oil, Islamic Stock, Spillover*

1. INTRODUCTION

The main aim of this work was to examine the volatility spillover of Brent oil prices shocks on the Islamic stock exchanges of Asian Countries. It is known that most Asian Countries highly depend on crude oil, both in terms of export or import. Their stock prices may be susceptible to positive or negative impacts of oil prices. The volatility or shock transmission has recently attracted considerable attention from regulators and investors. According to previous studies, high oil prices and volatility shocks could cause a downswing in stock markets and the wealth of stock market investors, which could decrease consumer spending and economic growth, especially in crisis periods, when the return and volatility transmission between markets vary intensely [1]. These challenges push investors to better risk management; they need to adjust their allocation asset and the regulator needs to take better action to maintain their financial stability. To fulfill the needs of investors, this study also computes asset allocation and hedging on stock and oil portfolios.

Major events may significantly affect stock and oil markets. Most of the previous study only focused on examining the spillover during the financial crisis and other economic crises. To address this literature gap, this study aims to explore the dependency of stock prices to oil price, particularly during COVID-19 period. Since China informed the World Health Organization (WHO) of the occurrences of flu-like symptoms on December 31st 2020 [2], this COVID-19 period starts from January 1st 2020 – June 2020. Over 64 countries' stock markets responded negatively to the growth in COVID-19 confirmed cases [3].

2. LITERATURE REVIEW

2.1. Investment

Some people are interested in investing because it can increase wealth, both in the long and short term. Besides that, investors manage their wealth effectively so as not to be affected by inflation, taxes, and other factors. There are several investment instruments, such as deposits, stocks, mutual funds, and bonds. To

minimize losses, investment managers usually diversify their portfolios. Through a book entitled "The Theory and Practice of Investment Management", Options et al., (2011) conveyed a theory presented by Markowitz that forming a good portfolio must have several selection strategies. Portfolios can be divided into two: active and passive. An active portfolio strategy is one which uses available information and estimates with the aim of finding better performance than a simple, broadly diversified portfolio, the most important thing is the factors found to affect the performance of an asset, while the passive portfolio strategy will involve minimal input expectations, and rely solely on diversification to match the performance of the index market. An efficient portfolio is a portfolio that provides the highest expected level of all portfolios with the same risk. An efficient portfolio is also referred to as a mean-variance efficient portfolio. Thus, for each level of risk there is an efficient portfolio. An efficient set of portfolios is called an efficient set. In this research, the portfolio is composed of stocks and oil.

2.2. Islamic Stock Market

As time went by, capital markets formed into Islamic stock market which was based on Islamic principles, commonly known as the Islamic capital market. The basic thing that is different with the conventional market is interest. Interest is defined as income from loans, either in kind or in money. The practice of interest is prohibited in Islam; therefore, Islam uses profit which is permissible because the party lending the money will also bear the risk. The capital market also sells Islamic stock. Islamic Stock Market is a place to buy and sell Islamic shares. According to the Indonesia Financial Services Authority (OJK), Islamic stocks are securities in the form of shares that follow sharia principles in the Capital Market. There are two types of Islamic shares that are recognized in the Indonesian capital market. Firstly, shares that are declared to meet the criteria for selection of sharia shares based on OJK Regulation Number 35 / POJK.04 / 2017 concerning Criteria and Issuance of Sharia Securities List. Secondly, shares that are listed as sharia shares by an issuer or sharia public company based on OJK regulation no. 17 / POJK.04 / 2015.

The impact of globalization is that the Islamic stock market cannot operate independently from conventional financial markets. It is because of the contagion effect. It will always occur, because there is arbitrage activity between markets, even though it may not be allowed under sharia rules. Second, the fact is that the global market is currently very distorted to interest rates, exchange rates, different tax rates, and the regime which will have an impact on the Islamic stock market.

2.3. Volatility Oil Price

According to Rossi [5], the price of commodities is correlated positively with equity prices, global demand, and interest rates that are delayed in one and two quarters. The oil market has an important role in the economy. Moreover, the increase in oil prices affects asset prices which have an impact on economic activity, corporate earnings, inflation, and monetary policy. An increase in the oil price has an impact on the wealth of the country because of the transfer of income from imported oil to oil exporting countries through trade provisions. The shifting of the trade balance can also change the expected exchange rate [6].

The volatility and uncertainty of economic variables poses a problem for decision making and economic forecasts for both companies and investors. Oil is one of the vital energy sources in many production processes [7]. Changes in crude oil prices affects the stock market price through cash flow [8]. Research reveals that there is a negative effect of oil prices on stock returns such as an increase (decrease) in oil prices decreasing (increasing) stock prices, so the volatility of oil prices has an impact on stock returns [9]. Macroeconomists believe that the relationship between oil price shocks and fluctuations in macroeconomic variables stems from a series of fundamental shocks that hit all economic sectors [10]. The increase in oil prices can be caused by oil supply shocks that will interrupt the economy and lead to a negative relationship between oil prices and stock returns [11].

3. RESEARCH METHODOLOGY

3.1. MGARCH-BEKK FULL

To measure the relationship between oil price volatility and the Islamic stock market the MGARCH-BEKK-FULL model is used by estimating the bivariate from MGARCH-BEKK-FULL for oil and stock market.

$$Var(\varepsilon_t)^2 = H_t = C'C + A_{\varepsilon_{t-1}\varepsilon'_{t-1}}A' + BH_{t-1}B' \quad (1)$$

The variance-covariance matrix H_t is symmetric. The parameter matrix A, B, Care as:

$$C = \left(c_{o,o}\ 0\ c_{o,s}\ c_{o,o}\right),\ A = \left(a_{o,o}\ a_{s,o}\ a_{o,s}\ a_{s,s}\right),$$
$$B = \left(b_{o,o}\ b_{s,o}\ b_{o,s}\ b_{s,s}\right) \quad (2)$$

C is a triangular coefficient matrix to ensure positive definiteness of H_t. A is a 2x2 matrix to see the shock effect of volatility, B is a parameter that measures volatility in the past with the present. There are 11 parameters to be estimated:

$$h_{o,t} = c_o^2 + a_o^2\varepsilon_{o,t-1}^2 + 2a_o a_{so}\varepsilon_{o,t-1}\varepsilon_{s,t-1} + a_{so}^2\varepsilon_{s,t-1} + b_o^2 h_{o,t-1}^2 + 2b_o b_{so} h_{so,t-1} + b_{so}^2 h_{s,t-1} \quad (3)$$

$$h_{s,t} = c_s^2 + a_s^2\varepsilon_{o,t-1}^2 + 2a_{os}a_o\varepsilon_{o,t-1}\varepsilon_{s,t-1} + a_o^2\varepsilon_{s,t-2}^2 + b_{os}^2 h_{o,t-1} + 2b_{o,s}b_s h_{so,t-1} + b_s^2 h_{s,t-1} \quad (4)$$

$$h_{so,t} = c_o c_{so} + a_o a_s \varepsilon_{o,t-1}^2 + (a_{so}a_{os} + a_o + a_s)\,\varepsilon_{o,t-1}\varepsilon_{s,t-1} + a_{so}a_s\varepsilon_{s,t-1}^2 + b_o b_{os} h_{o,t-1} + (b_{so}b_{os} + b_o b_s) h_{so,t-1} + b_{so}b_s h_{s,t-1} \quad (5)$$

$h_{o,t}$ and $h_{s,t}$ are the conditional variance of oil and stocks, respectively. $h_{so,t}$ is the c*onditional covariance* between stock and oil market. a_o and a_s *are shock persistence* in oil and stock markets. b_o and b_s shows the v*olatility persistence* in oil and stock markets. a_{os} are s*hock transmission* from oil to stock markets. a_{so} shows s*hock transmission* from stock to oil market. b_{os} is v*olatility transmission* from oil to stock markets. b_{so} shows v*olatility transmission* from stock market to oil market.

The function of log-likelihood is set as:

$$L\emptyset = -Tln(2\pi) - \frac{1}{2}\sum_{t-1}^{T} \quad (ln\ |H_t| + \varepsilon t' H_t^{-1} \varepsilon t) \quad (6)$$

T represents as number of observations and $\emptyset$ is the vector of the parameter.

3.2. Weighting and Hedging

The BFGS algorithm (Broyden, Fletcher, Goldfarb and Shanno) is used to calculate the maximum likelihood estimate. BEKK can also be used to calculate optimal portfolio weights and hedge ratios. The formula used follows [12]:

$$w_{so,t} = \frac{h_{O,t} - h_{SO,t}}{h_{S,t} - 2h_{SO,t} + h_{O,t}} \quad (7)$$

$$W_{SO,t} = \{0, if\ W_{SO,t} < 0\ W_{SO,t}\ if\ 0 \le W_{SO,t} \le 1\ 1, if\ W_{SO,t} > 1 \quad (8)$$

$$\beta_{so,t} = \frac{h_{SO,t}}{h_{O,t}} \quad (9)$$

Formulating portfolio weights of two equities of one dollar, $w_{so,t}$ depicts the weight of the first out of two variable (equity s, equity o) at time t, $h_{SO,t}$ represent as the conditional covariance between the two variables and $h_{O,t}$, $h_{S,t}$ are the conditional variance of variables s and o. The weight for the second variables will be calculated as 1-$w_{so,t}$.

4. RESULTS

4.1. Unit root test

Using Augmented Dicky-Fuller (ADF) and Phillip-Perron (PP) test for testing prices and returns of Asian stock exchange market under null hypothesis of unit root contrary to the stationary, the test confirms the unit root in all cases and oil market too. The return series of individuals lead to the rejection of null hypothesis at 1 percent significance level. The values are stationary for all the three returns. The Phillips-Perron Test yields similar results as the ADF test, confirming the stationary at 1% level of significance.

4.2. Statistic Descriptive

Based on Table 1, it is full period, it can be seen that not all markets in some Asian Countries have positive returns. Pakistan, Saudi Arabia, Singapore, Turkey and oil stock markets show negative average returns, while the rest of the stock markets have positive average returns. Oil has the highest return at the rate of 0.190. The oil market also has the lowest returns at -0.273. Standard deviation is used to see the volatility and the oil Market has the highest volatility 0.23 and the Saudi Stock Market has the lowest Volatility 0.11. Based on these data, when the return of oil is high, it will be higher than the rest of the stock markets and when it is low, it becomes lower than the stock markets. For skewness, the total data is on the negative side which means prices are still arguably high.

4.3. Cointegration Test

Based on the results of the cointegration test above, all periods show the same results, rejecting the null hypothesis which means it has cointegration. This proves that oil market and stock markets between countries in Asia have a long-term relationship, all of which will have a certain balance, which will reduce the opportunity for benefits for investors to get diversification. When there is a long-term relationship in a certain stock index, the benefit will be reduced over time.

Table 1. Statistic Descriptive for for full period

	DCHINA	DFIL	DINDIA	DINDO	DJEP	DKORSEL	DOIL	DPAK	DSAUDI	DSING	DTAIW	DTHAI	DTURK
Mean	0.000092	0.000018	0.000078	0.000090	0.000305	0.000267	-0.000555	-0.000006	-0.000013	-0.000068	0.000275	0.000057	-0.000039
Median	0.000120	0.000000	0.000000	0.000667	0.000673	0.000514	0.000235	0.000000	0.000000	0.000425	0.000522	0.000234	0.000289
Maximum	0.071341	0.076722	0.095880	0.086920	0.078844	0.091202	0.190774	0.076913	0.086553	0.080583	0.056879	0.096791	0.075215
Minimum	-0.065181	-0.147657	-0.143642	-0.091998	-0.075987	-0.100691	-0.272557	-0.106363	-0.081425	-0.088325	-0.085209	-0.147318	-0.141105
Std. Dev.	0.012812	0.013788	0.012730	0.011203	0.012375	0.014318	0.022539	0.014745	0.010656	0.011434	0.011685	0.013663	0.016824
Skewness	-0.183909	-0.766347	-0.858385	-0.594006	-0.266346	-0.110288	-0.876750	-0.214125	-0.980873	-0.480384	-0.263966	-0.605373	-0.579679

Table 2. Cointegration Test, for Full, Before COVID-19 and COVID-19

Johansen's cointegration test result (Periode Penuh)							
Null Hypothesis	Trace			Null Hypothesis	Max Eigen		
	Model 1	Model 2	Model 3		Model 1	Model 2	Model 3
None	334.98*	374.90*	358.71*	None	76.57*	80.87*	79.97*
At most 1	285.14*	322.06*	306.89*	At most 1	70.53*	74.83*	73.94*
At most 2	239.23*	273.18*	259.02*	At most 2	64.50*	68.81*	67.91*
At most 3	197.37*	228.29*	215.12*	At most 3	58.43*	62.75*	61.80*
At most 4	159.52*	187.47*	175.17*	At most 4	159.52*	56.70*	55.72*
Model 1	*intercept (no trend) in CE and test VAR*						
Model 2	*intercept (no trend) in CE - no intercept in VAR*						
Model 3	*intercept and trend in CE - intercept in VAR*						

Johansen's cointegration test result (Periode Sebelum COVID-19)							
Null Hypothesis	Trace			Null Hypothesis	Max Eigen		
	Model 1	Model 2	Model 3		Model 1	Model 2	Model 3
At most 1	334.98*	374.90*	358.71*	At most 1	76.57*	80.87*	79.97*
At most 2	285.14*	322.06*	306.89*	At most 2	70.53*	74.83*	73.94*
At most 3	239.23*	273.18*	259.02*	At most 3	64.50*	68.81*	67.91*
At most 4	197.37*	228.29*	215.12*	At most 4	58.43*	62.75*	61.80*
Model 1	*intercept (no trend) in CE and test VAR*						
Model 2	*intercept (no trend) in CE - no intercept in VAR*						
Model 3	*intercept and trend in CE - intercept in VAR*						

Johansen's cointegration test result (Periode COVID-19)							
Null Hypothesis	Trace			Null Hypothesis	Max Eigen		
	Model 1	Model 2	Model 3		Model 1	Model 2	Model 3
None	334.98*	374.90*	358.71*	None	76.57*	80.87*	79.97*
At most 1	285.14*	322.06*	306.89*	At most 1	70.53*	74.83*	73.94*
At most 2	239.23*	273.18*	259.02*	At most 2	64.50*	68.81*	67.91*
At most 3	197.37*	228.29*	215.12*	At most 3	58.43*	62.75*	61.81*
At most 4	159.52*	187.47*	175.17*	At most 4	52.36*	56.7	55.72*
Model 1	*intercept (no trend) in CE and test VAR*						
Model 2	*intercept (no trend) in CE - no intercept in VAR*						
Model 3	*intercept and trend in CE - intercept in VAR*						

Table 3. MGARCH-BEKK Estimation for Full Period

ESTIMASI GARCH(1,1) - BEKK																								
PAR	OIL / CHI		OIL / KORSEL		OIL/THAI		OIL/SAUDI		OIL/FIL		OIL/JEP		OIL/PAK		OIL/SING		OIL/INDO		OIL/INDIA		OIL/TAIWAN		OIL/TUR	
	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value
Co	0.002	0.000	0.869	0.000	0.002	0.000	0.002	0.000	0.002	0.000	0.002	0.000	0.002	0.000	0.001	0.000	0.002	0.000	0.002	0.000	0.001	0.697	-0.001	0.001
Cso	0.001	0.239	0.002	0.000	0.002	0.474	0.000	0.604	-0.002	0.000	0.000	0.869	-0.003	0.134	-0.002	0.000	0.000	0.867	-0.001	0.211	0.001	0.039	-0.002	0.104
Cs	0.002	0.000	0.000	1.000	0.002	0.000	0.002	0.000	0.002	0.000	0.002	0.000	0.003	0.026	0.000	1.000	0.002	0.000	0.002	0.000	0.000	1.000	0.004	0.000
ao	0.267	0.000	0.263	0.000	0.263	0.000	0.276	0.000	0.271	0.000	0.261	0.000	0.271	0.000	0.240	0.000	0.278	0.000	0.278	0.000	0.273	0.000	0.273	0.000
aos	0.005	0.640	-0.017	0.139	0.026	**0.014**	0.008	0.375	0.032	**0.008**	-0.002	0.854	-0.007	0.642	0.003	0.798	0.013	0.074	0.000	0.990	-0.017	**0.014**	0.027	**0.043**
aso	0.075	**0.023**	0.095	**0.000**	0.026	0.486	0.018	0.343	-0.062	**0.007**	-0.034	0.143	0.033	0.365	-0.135	**0.000**	-0.014	0.558	0.005	0.843	0.021	0.539	0.042	**0.031**
as	0.224	0.000	0.160	0.000	0.297	0.000	0.301	0.000	0.289	0.000	0.334	0.000	0.273	0.000	0.279	0.000	0.286	0.000	0.286	0.000	0.115	0.000	0.256	0.000
bo	0.963	0.000	0.961	0.000	0.965	0.000	0.961	0.000	0.960	0.000	0.965	0.000	0.962	0.000	0.968	0.000	0.960	0.000	0.286	0.000	0.963	0.000	0.963	0.000
bos	-0.002	0.497	0.004	0.239	-0.008	**0.010**	-0.003	0.178	-0.005	0.152	0.001	0.729	-0.001	0.783	-0.002	0.636	-0.003	0.248	0.002	0.547	0.008	**0.000**	-0.005	0.228
bso	-0.025	0.095	-0.037	**0.000**	-0.007	0.683	-0.004	0.618	0.035	**0.000**	0.009	0.306	0.025	0.384	0.062	**0.000**	0.004	0.948	0.005	0.671	-0.028	**0.000**	-0.023	**0.023**
bs	0.960	0.000	0.969	0.000	0.938	0.000	0.936	0.000	0.936	0.000	0.927	0.000	0.915	0.000	0.948	0.000	0.948	0.000	0.934	0.000	0.986	0.000	0.932	0.000

4.4. VOLATILITY SPILLOVER

The tables show volatility spillover for some Asian Countries. When a_{os} and a_{so} or b_{os} and b_{so} are significant, it means that the oil market has volatility spillover to stock markets. There are two types of the relationships: unidirectional (one way) and bidirectional (two ways). If the relationship is unidirectional with the direction only oil to stock or stock to oil, investors may get the benefit of the diversification but not as much as no relationship. When the relationship turns bidirectional from the direction from oil and to oil, investors may not get benefit of the diversification.

a_{os} and b_{os} present the conditional variance equation for stock market returns and depicts that stock market volatility is affected by shocks and volatility in the oil market. Using daily data of stock prices, China, Thailand, and Singapore does not have volatility spillover in before COVID-19 period but South Korea, Philippine, Taiwan and Turkey Islamic Stock Markets

Table 4. MGARCH-BEKK Estimation for before COVID-19 period

ESTIMASI GARCH(1,1) - BEKK																								
PAR	OIL / CHI		OIL / KORSEL		OIL/THAI		OIL/SAUDI		OIL/FIL		OIL/JEP		OIL/PAK		OIL/SING		OIL/INDO		OIL/INDIA		OIL/TAIWAN		OIL/TUR	
	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value
Co	0.001	0.000	-0.001	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	-0.001	0.000	-0.001	0.206
Cso	-0.001	0.000	0.001	0.000	0.000	0.522	0.000	0.608	-0.002	0.008	0.000	0.684	0.001	0.404	0.001	0.948	0.000	0.572	-0.001	0.276	0.002	0.000	-0.003	0.392
Cs	0.001	0.000	0.000	1.000	0.001	0.000	0.002	0.000	0.002	0.000	0.002	0.000	0.002	0.000	0.001	0.000	0.001	0.000	0.002	0.000	0.000	1.000	0.003	0.237
ao	0.222	0.000	0.218	0.000	0.220	0.000	0.210	0.218	0.870	0.000	0.202	0.000	0.226	0.000	0.225	0.000	0.218	0.000	0.224	0.000	0.214	0.000	0.210	0.000
aos	-0.004	0.729	0.012	0.223	0.015	0.188	0.004	**0.004**	0.065	**0.018**	0.004	0.761	-0.019	0.113	-0.003	0.802	0.005	0.572	-0.005	0.636	0.003	0.793	0.019	0.347
aso	-0.028	0.358	-0.028	0.193	-0.007	0.781	-0.015	**0.036**	-0.036	0.107	-0.036	**0.070**	0.019	0.486	-0.030	0.412	0.009	0.669	-0.005	0.862	0.034	0.214	0.038	**0.036**
as	0.172	0.000	-0.178	0.000	0.222	0.000	0.297	0.000	0.036	0.000	0.334	0.000	-0.241	0.000	0.211	0.000	0.261	0.000	0.257	0.000	-0.221	0.000	0.260	0.000
bo	0.973	0.000	0.974	0.000	0.974	0.000	0.976	0.000	0.974	0.000	0.978	0.000	0.972	0.000	0.973	0.000	0.974	0.000	0.973	0.000	0.975	0.000	0.977	0.000
bos	0.001	0.843	-0.009	**0.000**	-0.004	0.176	-0.001	0.578	-0.007	0.098	-0.001	0.719	0.004	0.194	0.000	0.995	-0.001	0.577	0.003	0.348	-0.009	**0.011**	0.000	0.977
bso	0.013	0.059	0.016	**0.007**	0.000	0.973	0.009	0.278	0.025	**0.011**	0.010	0.154	-0.004	0.750	0.008	0.454	-0.003	0.667	0.006	0.593	0.049	**0.000**	-0.022	**0.031**
bs	0.978	0.000	0.978	0.000	0.967	0.000	0.932	0.000	0.933	0.000	0.926	0.000	0.952	0.000	0.972	0.454	0.957	0.000	0.941	0.000	0.952	0.000	0.933	0.000

Table 5. MGARCH-BEKK Estimation for COVID-19 Period.

ESTIMASI GARCH(1,1) - BEKK																								
PAR	OIL / CHI		OIL / KORSEL		OIL/THAI		OIL/SAUDI		OIL/FIL		OIL/JEP		OIL/PAK		OIL/SING		OIL/INDO		OIL/INDIA		OIL/TAIWAN		OIL/TUR	
	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value
Co	0.020	0.000	0.024	0.000	0.031	0.000	0.011	0.013	0.018	0.001	0.022	0.000	0.032	0.000	0.019	0.019	0.003	0.589	0.031	0.000	0.019	0.025	0.026	0.000
Cso	-0.008	0.000	-0.007	0.002	-0.004	0.057	-0.003	0.028	-0.008	0.005	-0.001	0.491	-0.003	0.340	-0.008	0.001	-0.003	0.062	0.000	0.831	-0.011	0.005	-0.006	0.001
Cs	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
ao	1.013	0.000	1.062	0.000	0.913	0.000	0.789	0.000	0.870	0.000	1.039	0.000	0.994	0.000	0.961	0.000	0.355	0.003	1.021	0.000	0.985	0.000	1.024	0.000
aos	0.012	0.695	-0.017	0.847	0.145	**0.003**	0.036	0.492	0.065	0.251	-0.084	**0.014**	0.153	**0.002**	0.057	0.129	0.092	**0.014**	0.103	0.073	-0.002	0.958	0.076	**0.038**
aso	-0.354	0.134	-0.007	0.969	-0.212	0.495	-0.230	0.065	-0.885	**0.030**	1.423	**0.000**	-0.130	0.519	0.016	0.952	-1.571	**0.000**	-0.122	0.925	-0.201	0.459	-0.632	0.061
as	0.374	0.000	0.297	0.000	0.497	0.000	0.362	0.000	0.339	0.030	-0.188	0.229	0.244	0.000	0.466	0.000	0.310	0.001	0.326	0.005	0.169	0.075	0.234	0.017
bo	0.018	0.900	0.182	0.417	0.042	0.780	0.726	**0.000**	-0.234	0.170	0.106	0.265	0.033	0.839	-0.142	0.341	0.620	0.000	0.027	0.818	0.276	0.213	-0.044	0.768
bos	0.051	0.224	0.046	0.310	-0.062	0.170	-0.052	**0.000**	0.098	0.237	0.198	**0.000**	-0.053	0.294	0.130	0.222	-0.156	**0.000**	0.134	**0.015**	0.070	0.200	0.023	0.556
bso	1.320	**0.000**	0.636	**0.003**	0.466	**0.005**	0.422	**0.000**	0.878	0.152	0.704	**0.012**	0.373	0.113	1.337	**0.000**	1.314	**0.000**	0.293	0.256	1.182	**0.008**	0.887	**0.000**
bs	0.755	0.000	0.867	0.000	0.850	0.000	0.914	0.000	0.827	0.000	0.694	0.000	0.922	0.000	0.606	0.013	0.800	0.000	0.763	0.000	0.662	0.026	0.858	0.000

have volatility spillover for all periods. Japan, Pakistan, Indonesia and India only have volatility spillover on the COVID-19 Period.

The relationships in the full period are mostly unidirectional such as China, South Korea, Thailand, and Singapore. The bidirectional happens between oil and Philippine, Taiwan and Turkey. The rest has no volatility spillover. Before COVID-19, most of the countries had no volatility spillover. The bidirectional relationship occurs in South Korea, Philippines, Saudi, and Taiwan and the unidirectional occurs in Thailand, Japan, and Turkey. During the COVID-19 period, all the countries had a volatility spillover. Half of them are unidirectional such as China, South Korea, Philippine, Pakistan, Singapore and Indonesia, and some are bidirectional such as Thailand, Saudi Arabia, Japan, India, Taiwan and Turkey.

It needs to be mentioned that there are different reasons for different outcomes in full, before COVID-19 and during COVID-19 period. The uncertainty in share and commodity markets can influence the stock market in short and long run periods with different responses from investors. Due to the uncertainty the investors start to invest in different commodities such as oil, gold or currency etc. This can happen in a short term period. Meanwhile, the Chinese stock market is mostly government owned, and the government has influence to maintain stable stock market conditions in the long run [13].

Table 6. Weighting and Hedging Oil-Stock

	CHN/OIL	SAU/OIL	FIL/OIL	PAK/OIL	INDO/OIL	IND/OIL	JEP/OIL	KS/OIL	TUR/OIL	SING/OIL	TAIW/OIL	THAI/OIL
Full Period												
w	0.670	0.766	0.652	0.602	0.751	0.700	0.702	0.621	0.548	0.742	0.674	0.672
b	0.006	0.009	-0.026	0.011	0.018	0.010	-0.017	0.022	0.018	0.003	-0.014	0.024
Before Covi-19 Period												
w	0.659	0.762	0.644	0.589	0.736	0.691	0.688	0.611	0.528	0.730	0.675	0.661
b	-0.005	0.762	-0.029	-0.003	0.018	0.006	-0.018	0.007	0.013	-0.007	-0.021	0.009
Covid-19 Period												
w	0.932	0.868	0.759	0.825	0.893	0.861	0.893	0.175	0.905	0.922	0.886	0.839
b	0.096	0.013	0.149	0.132	0.022	0.127	0.076	0.460	0.074	0.092	0.037	0.144

4.5. Weighting and Hedging

Table 6 shows the optimal weights and hedge ratios for an oil-stock portfolio during the full, before COVID-19 and Covid-19 period. The average optimal weight range for full period is 0.54 for TUR/OIL to 0.76 for SAU/OIL, indicating that for a Turkey-Oil portfolio of $1, 54 cents should be invested in Turkey stocks and the remaining 47 cents in the oil market. Hedging stock with oil needs a negative correlation. The average hedge ratio range is -0.026 for FIL/OIL to 0.024 for THAI/OIL during the full sample period, indicating that a $1 long position in Philippine stocks can be hedged for 1 cent with a short position in oil assets. Before Covid-19 period, the average optimal portfolio weight ranged from 0.52 for TUR/OIL to 0.76 for SAU/OIL. Furthermore, the average hedge ratio range is -0.029 for FIL/OIL to 0.018 for IND/OIL. During the COVID-19 period, the average optimal portfolio weights vary from 0.75 for FIL/OIL to 0.93 for CHN/OIL. However, the average hedge ratio range is 0.013 for SAU/OIL to 0.14 for TUR/OIL. However, during the COVID-19 period stock market cannot be hedged with the oil market.

5. DISCUSSION

To sum up, through *volatility spillover* shows the relationship between the Islamic Stock Market in Asia and the oil market fluctuates for each period. The more data and the longer the time, the more valid the relationship between the Islamic stock markets in Asia and the oil market. For the daily data of the COVID-19 period, the Islamic stock market in the Asian region is more dependent on the stocks themselves compared to the shocks or volatility resulting from the Oil Market. Seven out of 12 countries have no spillover volatility during normal times.

During the COVID-19 period, all countries had a volatility spillover to the oil market. This finding is similar to previous research which stated that the stock market will have a relationship with the oil market when a crisis occurs or when oil prices fall for a long time, such as during COVID-19. Calculating the optimal weight is a guide for investors to reduce the expected risk without reducing the allocation of capital to certain assets. After that, the hedge ratio is used to protect the value of shares with oil. The higher conditional variance of oil will cause the hedging ratio to be smaller, while the conditional covariance that has a high value will increase the value of the hedging ratio. If the conditional covariance or conditional variance has a negative value, oil can be used to hedge stocks. Beta is used to determine how stocks move.

Based on optimal weight calculations, the allocation of capital is at least two-thirds of the investment in the Islamic stock market in the Asian region and the rest is allocated to oil assets for the optimal oil-stock portfolio. In fact, oil assets in the portfolio in the COVID-19 period decreased compared to the full portfolio and before the COVID-19 period. Comparing the hedging ratio, it was found that the lowest value is before COVID-19 period, implying that more oil was allocated compared to other periods, whereas during the COVID-19 period, the hedging value increased and became positive.

6. CONCLUSION

The results of the MGARCH-BEKK show that the full period, countries that have volatility spillovers are China, South Korea, Thailand, Philippines, Singapore, Taiwan, and Turkey. Before the COVID-19, only four countries had a volatility spillover, such as Saudi Arabia, Philippines, Taiwan and Turkey and the COVID-19 period, all countries had a volatility spillover with the oil market. The Philippines, Taiwan and Turkey had a volatility spillover for the three periods.

Based on the reaction of the stock market to the oil market during the COVID-19 period, it can be concluded that oil and stocks are positively correlated. All countries have a volatility spillover, which means that integration is increasing compared to the previous periods. So, if the investors plan to diversify their portfolio assets, investors need to consider these periods. Based on the result of the optimal weight calculation, at least two-thirds of capital is allocated to stock and one-third to oil. The results show that the lower hedge ratio, the lower the allocation of shares in the portfolio, which means increasing allocation of funds for oil.

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