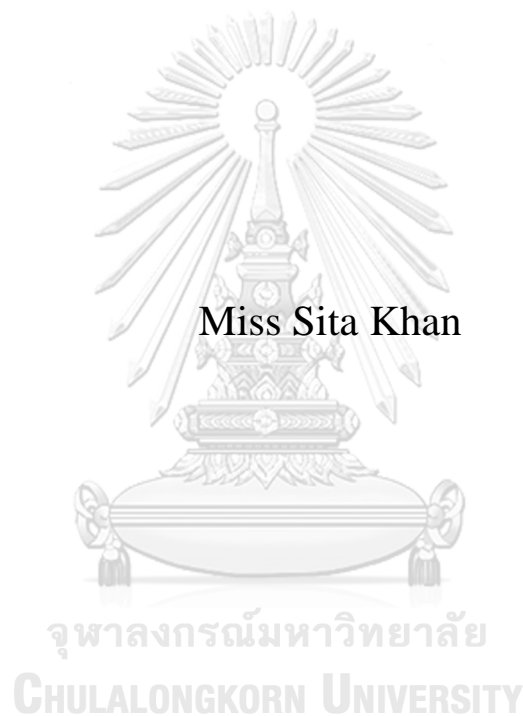


Diversification Benefits of Commodity Indices versus Islamic Stock Indices



A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Finance
Department of Banking and Finance
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ประโยชน์ของการกระจายความเสี่ยงด้วยดัชนีสินค้าโภคภัณฑ์และดัชนีหุ้นอิสลาม



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สาขาวิชาการเงิน ภาควิชาการธนาคารและการเงิน

คณะพาณิชยศาสตร์และการบัญชี จุฬาลงกรณ์มหาวิทยาลัย

ปีการศึกษา 2564

ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

Thesis Title Diversification Benefits of Commodity Indices versus
Islamic Stock Indices
By Miss Sita Khan
Field of Study Finance
Thesis Advisor Associate Professor BOONLERT JITMANEEROJ,
Ph.D.

Accepted by the FACULTY OF COMMERCE AND ACCOUNTANCY,
Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of
Science

..... Dean of the FACULTY OF
COMMERCE AND
ACCOUNTANCY
(Associate Professor WILERT PURIWAT, D.Phil.)

THESIS COMMITTEE

..... Chairman
(Assistant Professor ANIRUT PISED TASALASAI,
Ph.D.)

..... Thesis Advisor
(Associate Professor BOONLERT JITMANEEROJ,
Ph.D.)

..... Examiner
(Assistant Professor JANANYA STHIENCHOAK,
Ph.D.)

..... External Examiner
(Assistant Professor Nattawut Jenwittayaroje, Ph.D.)

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

ชิตาร์ คาน : ประโยชน์ของการกระจายความเสี่ยงด้วยดัชนีสินค้าโภคภัณฑ์และดัชนีหุ้นอิสลาม. (Diversification Benefits of Commodity Indices versus Islamic Stock Indices) อ.ที่ปรึกษาหลัก : รศ. ดร.บุญเลิศ จิตรมณีโรจน์

การศึกษานี้มีจุดประสงค์เพื่อค้นคว้าค่าสหสัมพันธ์แบบมีเงื่อนไขระหว่างดัชนี Dow Jones Emerging Market และดัชนีสินค้าโภคภัณฑ์ (เช่นกลุ่มการเกษตร กลุ่มพลังงาน กลุ่มโลหะอุตสาหกรรม กลุ่มปศุสัตว์ และกลุ่มโลหะมีค่า) และดัชนีหุ้นอิสลาม (เช่น JKII KLFTEMSI MSCI Bahrain MSCI Kuwait และ MSCI Qatar) นอกจากนี้วิทยานิพนธ์ฉบับนี้มีการจัดประเภทคุณสมบัติของสินทรัพย์ว่าเป็นสินทรัพย์เพื่อกระจายความเสี่ยง (a diversifier) สินทรัพย์ในการป้องกันความเสี่ยง (a hedge) หรือสินทรัพย์ปลอดภัย (a safe haven) ค่อดัชนี Dow Jones Emerging Market วิธีการประมาณค่าแบบจำลองจะใช้วิธี dynamic conditional correlation generalized autoregressive conditional heteroskedasticity (DCC-GARCH) เพื่อประเมินค่าสหสัมพันธ์แบบมีเงื่อนไขในช่วงปี ค.ศ. 2007 ถึงปี ค.ศ. 2021 ซึ่งครอบคลุมช่วงวิกฤตการเงินโลกและวิกฤตโควิด-19 ผลการศึกษาในภาพรวมพบว่าดัชนีสินค้าโภคภัณฑ์และดัชนีหุ้นอิสลามมีบทบาทเป็นสินทรัพย์เพื่อกระจายความเสี่ยง อย่างไรก็ตาม MSCI Bahrain MSCI Kuwait และกลุ่มโลหะมีค่ามีบทบาทเป็นสินทรัพย์ปลอดภัยในช่วงเวลาหนึ่งของวิกฤตการเงินโลกและวิกฤตโควิด-19 และประเด็นที่น่าสนใจพบว่า KLFTEMSI และ JKII มีประสิทธิภาพสูงสุดในการป้องกันความเสี่ยงตลอดช่วงการศึกษา



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ปีการศึกษา 2564

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The objective of this study is to investigate conditional correlations between the Dow Jones Emerging Market index and commodity indices (i.e., agriculture, energy, industrial metals, livestock, precious metals) and Islamic stock indices (i.e., JKII, KLFTEMSI, MSCI Bahrain, MSCI Kuwait, and MSCI Qatar). Additionally, this paper classifies the properties of assets whether it is a diversifier, a hedger, or a safe-haven assets to the Dow Jones Emerging Market index. The estimation method is the dynamic conditional correlation generalized autoregressive conditional heteroskedasticity (DCC-GARCH) model to estimate the conditional correlations during the period of 2007-2021 which covers the Global financial crisis (GFC) and Covid-19 pandemic. The finding indicates that all commodity and Islamic stock indices serve as a diversifier in general. However, MSCI Bahrain, MSCI Kuwait, and precious metals act as a safe-haven asset during certain periods of the GFC and Covid-19 crises. Interestingly, KLFTEMSI and JKII present the highest hedging effectiveness over the study period.



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CHULALONGKORN UNIVERSITY

Sita Khan

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CHAPTER 1: INTRODUCTION

Background of study

Unpredictable crises have significantly increased instability in overall financial markets. Most of crises in the past severely impacted stock markets around the world. It also resulted negatively to investors and market participants across the markets without being prepared. Besides, investing in conventional stock markets has significantly high volatility. Investors, especially those who are risk-averse, would seek an alternative way to maintain their level of satisfaction from investment. For example, risk-aversers may be willing to invest in risky securities only if they could gain higher risk premium in return to compensate on the risk they hold. However, it is not the only way to maintain maximum satisfaction. Interestingly, investors would essentially gain benefits from the investment by diversifying their portfolios across various industries and asset classes.

Portfolio diversification plays a significant role in security management. This method has been practiced across investment sectors, particularly by portfolio managers, financial advisors as well as investors both individuals and institutions. The main objective of the diversification as suggested by modern portfolio theory is to reduce portfolio risk. While some investors may argue that they can also enhance expected return relative to risk. Besides, it is considered as a free-lunch for investors under diversification concept. This implies that investors enable to reduce unsystematic risks in their portfolios without having to scarify expected returns. Therefore, this alternative method is applied extensively on security and risk managements.

Moreover, by having portfolio diversification, it is to allocate funds to alternative assets that are low or negatively correlated to assets in portfolios (Bekiros et al., 2017). The lower the correlation between assets implies the more risk reduction in portfolio (Saiti & Noordin, 2018). Remarkably, those alternative assets which will be determined as a diversifier, a hedger, or a safe haven for a portfolio would depend on the correlation between each alternative asset and proxy asset in portfolio during investment periods. Thus, with high volatility in the markets, investors opt to diversify away risk by including other alternative securities from different industries and asset classes into portfolio such as commodity indices and Islamic stocks.

Historically, commodities traded physically or used as a means of exchange in markets. However, in recent times, commodities are also used as investment vehicles in financial markets such as commodity futures. Commodity futures play a crucial role by being part of asset allocation rather than investing solely in traditional portfolios such as equities and fixed income securities. They provide a low or even negative correlation to stocks portfolios (Anson, 1999; Conover et al., 2010; Georgiev, 2001). Significantly, the portfolio consists of commodities would shift the efficient frontier upward, inferring that commodity futures reduce risk at given level of return or increase return at given level of risk (Satyanarayan & Varangis, 1996).

Among all the commodity indices, precious metals (gold, silver, and platinum) are one of the most widely used commodity in portfolio management. They are employed to reduce the total risk of the portfolio without sacrificing portfolio's expected return (Chua et al., 1990). This is because they have a low correlation of return with stocks and can also be applied as a hedging instrument against inflation (Conover

et al., 2010). Therefore, when the stock markets are volatile or there is global economic uncertainty, many investors consider these precious metals to be safe-haven assets since their value are more stable than other commodities and stocks (Sensoy, 2013).

As reported by Statista Research Department (2022), gold had the third highest average daily trading volume at 145.5 billion U.S. dollars in December 2019. Similarly, the market capitalization of investable silver is worth around 108 billion U.S. dollar as of February 3, 2021 (Profits, 2021). Gold price movement is largely influenced by changes in nonindustrial demand such as the actions from central banks around the world (Ciner, 2001). Also, it has become more appealing after the global financial crisis in 2008-2009 because of its low perceived risk in a world of high systematic risk, heightened financial uncertainty, sustained low demand, and deflationary pressures (Bekiros et al., 2017). Particularly, this is due to its price incremental while there were losses in stock prices during the subprime crisis (M.Alkhalazal & A.Zoubi, 2020).

Industrial metals are the major commodity market that significantly impact global economy. The price of industrial metals is largely fluctuated with macroeconomic shocks where demand and supply fundamentals are the main determinant of price volatility (Brunetti & Gilbert, 1995). Besides, international trades of industrial metals are widely applicable in financial markets where investors can easily perform trading transactions internationally through the financial platforms (Shyy & Butcher, 1994). According to suggestion of metals market participants, non-ferrous metals prices such as copper, aluminum, nickel, lead, tin, and zinc, have become more volatile over time due to the increment of market participants and speculators

from investment sectors (Watkins & McAleer, 2008). Thus, they are the popular commodity for speculation and hedge trading against the risks (Peng et al., 2014).

Energy sectors grow significantly around the world and becomes the world's largest commodity market afterwards. Energy sectors are not only trading on physical energy products, but they are also being part of financial products in financial markets. For example, oil serves as a pricing benchmark for a variety of financial instruments and is an important component of international asset hedging for economic agents (Arouri et al., 2011). Thus, well-diversified energy sector investment can operate as an effective hedging to reduce unpredictable energy price and attracting international investment (Rehman, 2020).

Besides, positive shocks to option-implied oil volatility certainly predict negative market returns and increased market volatility in the future (Christoffersen & Pan, 2018). While the stock market changes, may be useful in predicting oil price shocks, particularly in large oil-producing and exporting countries (Jouini, 2013). As such, it may allow a wide range of participants to hedge oil price risks which from both demand and supply sides (i.e., unexpected jump in oil demand, decrease in crude oil production capacity, global economic crises, and petroleum reserve policy) (Chang et al., 2011). As a result, by having energy futures contracts in portfolio, it allows investors to reduce their overall risk exposure by holding position in particular energy stocks (Galvani & Plourde, 2010).

Agriculture and livestock physically and internationally trade among traders either for consuming or industrial use purposes. They are main resources of food consumption around the world. However, these commodities are now being used in

financial transactions, as commodity futures particularly. Hence, they are being applied widely in asset management. Accordingly, agriculture and livestock futures contracts are possible to reduce overall risk in the portfolio without having to sacrifice expected return (Mattos & Ferreira Filho, 2003).

Islamic stock markets are growing rapidly as compared to conventional markets. It is a faith-based investment and has features in accordance with religious belief. Islamic financial principles are based on Islamic law (Shari'ah) which prohibit interest (Riba), uncertainty or ambiguity (Gharar), and pure speculation (Maisir) (Miglietta & Forte, 2011), result in having inconsistency with conventional stocks markets. Moreover, firms under Shari'ah compliance must not engage in activities of conventional financial services (banking, insurance, etc.), liquor, tobacco, pork-related products, weapons and defense, and entertainment (hotels, casinos/gambling, cinema, pornography, music, etc.) (Ali et al., 2021). Besides, total debt, account receivable balance, and cash and interest-bearing securities are limited to not exceed 33% of total assets.

With distinctions between Islamic and conventional stocks, the former is considered as a mean to fix interest-based instability in the latter (Ibrahim & Mirakhor, 2014). Additionally, investment transactions such as short-selling strategies and derivative contracts are also prohibited, which is anticipated to reduce the riskiness of equity portfolio during times of financial turbulences (Ali et al., 2021). With new and less risky elements under Islamic finance, it is interesting to consider this asset as an alternative resource to secure investors' financial conditions.

Noteworthy, Global financial crisis (GFC) began in the U.S. started from late 2007 until mid-2009 and it was originated from financial issues. Thus, it had dramatically affected financial sectors, while other industries in the economy faced less impact accordingly. On the other hand, Novel Coronavirus (Covid-19) pandemic, the spreading virus was started in Wuhan, China in December 2019 (WHO, 2020). Covid-19 is a respiratory disease's origin which related to health of individual. The disease affects majority of industries severely as it requires to lock down to control transmission of covid-19. Moreover, GFC differs from Covid-19 in the sense that the latter is extremely uncertainty and truly global impact while the former may not crucially hit on Asia markets (Borio, 2020). Also, Covid-19 tend to have more negative impact on market return than GFC did (Shehzad et al., 2020).

Motivation

With current situations that cause stock markets to be more volatile, it is interesting to look for alternative investment schemes to overcome high volatility in portfolios. There are several methods to solve volatility problems and one way is to well diversify portfolios. Hence, this research paper opts to study on diversification benefits by comparing the diversification potentials between commodity indexes and Islamic stock indexes during normal periods and financial turbulences, e.g., GFC and Covid-19. Even though there are several research papers completed on diversification benefits of several securities (e.g., Chkili, 2016; Flavin et al., 2014; Georgiev, 2001; Peng et al., 2014), however, comparing diversification efficacy of these securities during the mentioned periods has not yet been widen studied among scholars. Therefore, this paper sees gaps on these related topics since there is an opportunity to

research and find evidence to further advocate on diversification efficiency of each asset during these periods.

Moreover, commodity indexes are popular element to include in portfolio. In this study, five core commodity businesses namely precious metal, industrial metals, energy, agriculture, and livestock are chosen to be examined. This is because all these commodity sectors are significantly related to country's economy either in monetary sectors or industrial sectors. Their price fluctuation impacts the price of stocks in financial markets. Having said that it is worth to figure out whether these commodity sectors can always provide potential benefits to the portfolio, in case where there is an unexpected event occurred and impacts whole economy. Thus, it is a challenging to observe their conditional correlations and analyze diversification potential of each security at time-varying basis.

Furthermore, Islamic stock indexes applied in this study are from selected Organization of Islamic Cooperation (OIC) countries namely Indonesia, Malaysia, Bahrain, Qatar, and Kuwait where they are from Asian and Middle East and North Africa (MENA) region. These countries are chosen as they are in upper-middle income and high-income groups. They are also among those who have the highest countries' shares in global Islamic finance sector recently (COMCEC, 2020). Besides, with some distinctions from conventional markets, Islamic stocks offer alternative investment choice to conventional investors where they can achieve benefits from portfolio diversification. Hence, it gives a notion to this study to investigate diversification ability of these indices whether they can diversify portfolio efficiently throughout periods. Also, for more efficient outcomes, to make a comparison with commodity indices

during normal periods and financial crises would offer a great opportunity for investors and portfolio managers to select the best choice to their portfolio accordingly.

In addition, past GFC and recent Covid-19 crisis impact the stock markets similarly. However, these two periods have different characteristics and causes. Thus, observing data during these periods simultaneously could gain an idea whether each alternative asset class have any similarity on diversification potential when including in portfolio during these periods. Referring to Li et al. (2021), they conclude that Covid-19 shows more severity in term of economic activity, however, the impact of recession probabilities is lower than the time of subprime crisis.

Next, this study focuses on Emerging markets region and applies as a benchmark portfolio. It is interesting to discover that emerging markets are expanding from time to time over the decades. However, as compared to developed markets, emerging market is still much smaller which may severely be impacted by crises. In addition, when compared to developed markets, emerging markets have higher average returns, but also show greater volatility respectively. Besides, emerging markets present low correlations with the developed market and among themselves which mean that a portfolio's risk can actually be reduced by including an emerging market index while still benefiting from higher average returns (Bekaert & Urias, 1999). Moreover, a number of scholars have been researching on the related topics broadly in those developed markets. Thus, it is a chance for this study to observe the outcomes of this market as the related topic is not outspread.

Research Questions

In the light of discussion above, research questions are constructed. The main research question of this study is whether there is different diversification benefit between commodity indexes and Islamic stock indexes. To be noted, there will be a comparison between diversification potentials under four sub-periods namely, pre GFC, during GFC, post GFC and pre Covid-19 outbreak, and during Covid-19 outbreak. By testing the main question, available data can also be examined on additional questions related to this area which would be beneficial to financial market participants in the future. Therefore, the research question can be broken down into three-sub questions as follows:

1. Do commodity indices and Islamic stock indices provide different diversification benefits to benchmark portfolio?
2. Is each alternative asset (i.e., commodity indices and Islamic stock indices) a diversifier, a hedge, or a safe have to benchmark portfolio?
3. What is an optimal hedge ratio and hedging effectiveness of diversified portfolio?

Research Objectives

The primary objective of this research is to examine the diversification potential of commodity and Islamic stock indexes on traditional portfolio during the periods, especially financial turbulences. Thus, the research objective can be broken down into three objectives as follows:

1. To examine whether commodity indices and Islamic stock indices provide different diversification benefits to benchmark portfolio.

2. To analyze whether each alternative asset (i.e., commodity indices and Islamic stock indices) is a diversifier, a hedge, or a safe haven to benchmark portfolio.
3. To estimate optimal hedge ratio and hedging effectiveness of diversified portfolio.

Scope of the Study

This paper employs daily price return of Dow Jones Emerging Markets Index (W5DOW), OIC countries Islamic stock indices which are Jakarta Islamic Index (JKII) for Indonesia, The FTSE Bursa Malaysia EMAS Shari'ah Index (KLFTEMSI) for Malaysia, MSCI Bahrain Price Index for Bahrain, MSCI Qatar Price Index for Qatar, and MSCI Kuwait Price Index for Kuwait, and five core commodities under Bloomberg Commodity indices namely precious metals (BCOMPR), industrial metals (BCOMIN), energy (BCOMEN), agriculture (BCOMAG) and livestock (BCOMLI) for analysis. The data sets cover period from January 23, 2007, to December 31, 2021, which can be divided into four sub-periods as pre GFC, during GFC, post GFC/pre Covid-19 outbreak, and during Covid-19 outbreak. These data are retrieved from Refinitiv Eikon, Thomson Reuters database. The use of daily return is mainly to examine time-series of conditional variance of each security.

Contributions

This paper can be advantageous in many ways. The finding of diversification potentials between commodity indices and Islamic stock indices offers great opportunities to literature extensions, researchers, and academicians. The paper expects to extent existing literatures where authors examine diversification benefits purely either on commodity or Islamic stock indices and those with comparison in any crisis

particularly. It believes that this paper will deliver more clarification whether the commodity indices provide similar diversification efficiency to Islamic stock indices, especially during two major financial turbulences, GFC and Covid-19 outbreak. Thus, this paper contributes to the literature in a number of ways.

Firstly, this study focuses on time-series property of conditional volatility. It fulfills gaps of portfolio diversification benefits and alternative investment assets that have been studying by several scholars (among others, Booth & Fama, 1992; Gatfaoui, 2019; Georgiev, 2001; Hillier et al., 2006; Hkiri et al., 2017; Paltrinieri et al., 2018; Shyy & Butcher, 1994). It is still lacked an idea on a comparison of portfolio diversification benefits between each selected Islamic stock indices and commodity indices on Dow Jones Emerging Markets Index portfolio on time-series basis. Hence, this study would highlight their similarities and differences in the role of portfolio diversifier, hedger, or safe haven asset. It is believed that this study would be a great fit to estimate on diversification efficiency of these alternative investments throughout the specific periods.

Secondly, this study provides more comprehensive study by further investigating hedge ratio and hedging effectiveness for subperiods and a whole period across commodity indices and Islamic stock indices and make a comparison between each subperiod accordingly. Thus, it is expecting to have estimated results that can further advocate on related studies in the future.

Lastly, this study covers period from year 2007 until year 2021 and employs daily data in the estimation. With the long period of time estimation, it allows the paper to observe results both from normal periods and crisis periods. As such, the paper will

be covered on Global Financial Crisis 2008-2009 and novel Coronavirus outbreak which are two major crises in decades. Besides, the number of studies on these related topics are still less. Thus, by studying long periods with the inclusion of two major crises would give researchers, scholars, and academicians an idea whether there is major shift of diversification benefits occurred on time-varying basis, particularly during different market turbulences.

Research Hypotheses

Hypothesis 1: *There is differences of diversification benefits either to include commodity indexes or Islamic stock indexes in portfolio.*

Portfolio diversification is one of the most important strategies in asset management. Market participants would apply this strategy to reduce portfolio risk and enhance portfolio returns by including alternative securities into benchmark portfolio. It is believed that different alternative securities provide different diversification benefits at different times (e.g., Geman & Kharoubi, 2008; Hassan et al., 2021; Hkiri et al., 2017). Thus, market participants can vary their choices of security into portfolio based on its performance.

Hypothesis 2: *Commodity indices offer greater diversification performance during Global Financial Crisis than during Covid-19 Crisis.*

As the GFC and Covid-19 have directly impacted financial markets which cause the investors losing their investment return and facing higher volatility in portfolio. To reduce risk and enhance return, the investors should diversify their portfolio by inclusion of other alternative assets. However, these two crises have different characteristics and cause of crash. Thus, the performance of alternative assets may vary

accordingly. According to Hassan et al. (2021), they conclude that precious metal provides potential diversifications to Islamic portfolio during 2008 Global financial crisis but have been less during COVID-19 outbreak. Kinatader et al. (2021) also provide the evidence of degrading in the co-movement between asset classes in covid-19 period.

Hypothesis 3: Islamic stock indices offer less diversification performance during Global Financial Crisis than during Covid-19 Crisis.

The GFC and Covid-19 have had a direct impact on financial markets, causing investors to lose investment returns and face higher volatility in their portfolios. Investors should diversify their portfolio by including other alternative assets to reduce volatility and enhance return. However, the characteristics and cause of these two crises are not the same. As a result, the performance of alternative assets may differ accordingly. According to Arif et al. (2021), they observe that Islamic stock indices provide some diversification benefits during GFC, while they are a strong safe haven during Covid-19 crisis.

CHAPTER 2: LITERATURE REVIEW

Diversification Benefits

In general, portfolio diversification has been practiced generously by investors in the last decades. In the context of portfolio diversification, many scholars have studied and revealed investors' financial behaviors, and benefits of diversification by applying different methods. According to Reinholtz et al. (2021), they survey two groups of participants who are people with low and high financial literacy, on their believe of portfolio diversification. The result shows that people with low financial literacy see no benefit from diversification as they believe that the more securities they invest, the more volatility will increase. Whereas those with high level of financial background believe that diversification increases portfolio expected return. Additionally, those investors with knowledge of finance tend to allocate their investment efficiently and they are more likely to have better diversified portfolio as they may choose to invest in foreign stocks to reduce portfolio risk (Hibbert et al., 2012).

Furthermore, diversification benefits can be seen from several research papers which specifically study on this context. Conforming to Evans and Archer (1968), they examine the rate of variation returns whether it would be reduced when the number of securities in the portfolio increases. They select 470 securities listed on the Standard and Poor's Index starting from January 1958-July 1967 and randomly segregate into 40 portfolios to calculate ex post returns and standard deviation of logarithms of the value relatives. The authors, then do a regression analysis to test the hypothesized relationship on decreasing standard deviation as diversification increases. The result shows that

there is a relationship between the reduction in variation relative to returns and the extent of portfolio diversification.

Co-authored paper which is written by Booth and Fama (1992), also discusses about diversification benefit from investing in different asset classes. The result from this paper indicates that there is an incremental return from diversification especially in small-cap stocks. This is because small-cap stocks have higher return variance, and they are not highly correlated with other assets. Likewise, the study shows the benefit of investing in international stocks since there is a large incremental of return contributions over compound returns. They also conclude that the return increment in S&P 500 is greater than Treasury bonds because its risk is more diversified away.

Different asset classes are invested in portfolio to serve as a diversification instrument. Out of several investing assets, commodity is one of the most used for diversification. Benefits of diversified commodity have been extensively studied among researchers. Other than increment of return and volatility reduction in portfolio, commodity is also applied as a hedging instrument for inflation. As summarized by Georgiev (2001), direct commodity investment provides advantages by hedging unexpected inflation. It also provides positive roll-return during high spot price volatility of future-based commodity investment. Next, Conover et al. (2010) examine, subject to shifts in Federal Reserve policy rates, the benefits of a tactical allocation to commodity futures relative to a strategic allocation. The authors find that by adding modest commodity exposure when Fed rates increase, it results in having a remarkable increment in portfolio return, while risk reduces significantly. Besides, Chong and

Miffre (2008) realize that commodity futures are a good instrument to hedge against risk when short-term interest rate arises.

In addition, alternative investment in stocks such as socially responsible investing (SRI) and Islamic stock indices also become popular choices recently. Balcilar et al. (2017); Miralles-Quirós and Miralles-Quirós (2015) examine diversification benefit by adding SRI to portfolio; the results imply that sustainable investment improves return and reduces the risk of the portfolio, hence it can be considered as an alternative investment to diversify conventional portfolio worldwide. Moreover, SRI and Islamic stocks can be used for diversification especially during postcrisis period as they react negatively to equity markets (Paltrinieri et al., 2018). Significantly, Muslim and SRI investors can invest in Islamic finance and SRI without sacrificing performance or having higher systematic risk exposure in portfolio since they have no impact on these variables as compared to traditional finance (BinMahfouz & Kabir Hassan, 2013).

Precious Metals

Precious metals such as gold, silver, platinum, and palladium are subset of commodity that frequently applied in portfolio diversification. Gold is considered as one of the most popular and common precious metals that is being used as a diversifier. There are many papers that are documented on the role of gold and silver to serve as a diversifier, a hedge, or a safe haven especially during financial turmoil (e.g., Adekoya et al., 2021; Baur & Lucey, 2010; Chkili, 2016; Hillier et al., 2006; Kumar, 2014; Li & Lucey, 2017). For example, Li and Lucey (2017) examine save-haven properties across time varying of gold, silver, platinum, and palladium towards stock and bond markets.

They conclude that these precious metals can hedge the risk and become a safe haven when markets decline. Similarly, Hillier et al. (2006) realize that gold, silver, and platinum have low correlations with stock index returns. This implies that these assets provide diversification to portfolio and provide hedging capacities during abnormal stock market volatility.

Moreover, gold also provide diversification benefit not only to traditional portfolio but also to Islamic stock portfolio. As purposed by Maghyreh et al. (2019), they investigate the dynamic connectedness between gold, sukuk (Islamic bond), and Islamic equities at time-varying environment. They reach the conclusion that gold only hedges sukuk's risk during short and medium term. Whereas it can be used as diversifier and hedge the risk of Islamic equities across investment horizons. Recently, M.Alkhalaf and A.Zoubi (2020) also examine the role of gold in diversification Islamic stock index portfolios. The result shows Islamic index portfolio with gold stochastically dominates portfolio without gold at first, second and third orders. This implies that risk averter can be better off by diversifying gold with Islamic portfolio to maximize expected utilities, especially during financial crises.

In contrary, few other studies discover limitation of precious metals diversification potential. Recently, Ali et al. (2021) state that there is capacity limitation of silver and platinum when both pairs with Dow Jones Islamic equity investment. From their point of view, diversify by using platinum would increase downside risk and silver can only be applicable in European region. Likewise, Talbi et al. (2021) point out the same conclusion where silver and platinum may be a weak hedging instrument but provide strong potential in Italy's and Germany's stock markets. While gold remains

as a strong hedging and save-haven instruments for both research papers. Hassan et al. (2021) also conclude that gold and silver provide potential diversifications to Islamic portfolio during 2008 Global financial crisis but have been less during COVID-19 outbreak.

Several academicians shed some light on return enhancement and risk reduction from including precious metals in portfolios (Al-Yahyaee et al., 2019; Conover et al., 2009; Flavin et al., 2014; Hillier et al., 2006; Jaffe, 1989). For further illustration, Jaffe (1989) examine hypothetical portfolios by investing in gold during period from September 1971- June 1987. The results indicates that additional gold in portfolio provides an incremental average return whereas standard deviation reduces accordingly. Besides, investing in precious metals by using tactical approach and guidance from monetary policy will certainly increase higher return during periods of Federal Reserve tightening than during expansive policy periods (Conover et al., 2009). In short, with the potential in diversifying portfolio, investing in precious metals would consider as alternative investment during financial turbulences. This is suitable for individual and institutional investors, especially those who are risk-averse investors.

Industrial Metals

Industrial metals are ones of significant component to measure the economic growth of the country. The price of industrial metals could reflect volatility in stock markets. This would be resulted from demand and supply of the materials. Scholars point out several opinions on relationship between metal prices, copper particularly, and stock market performance (e.g., Guo, 2018; Liu et al., 2008; Peng et al., 2014; Shyy & Butcher, 1994). According to Liu et al. (2008), effects of spillover between the

copper spot and futures markets in China were explored. They run a linear Granger causality test by using GARCH and TGARCH models on daily data from July 10, 2000, to June 30, 2006. Their finding reveals strong bi-directional volatility spillovers between copper spot and futures markets.

Paper written by Shyy and Butcher (1994) investigates the relationship between copper prices on the London Metal Exchange (LME) and the Shanghai Metal Exchange (SME) using data from June 1, 1992, to October 14, 1993. The finding indicates that SME coppers price are conform to the LME prices. Also, the LME spot copper prices cause the SME spot copper prices unidirectionally. Likewise, Yousaf et al. (2020) summarize that including any metal to emerging Asian stock portfolio enhances its risk-adjusted return and hedges risk exposure of stock during both crisis and non-crisis periods.

Additionally, there is a negative dynamic correlation between copper and China's stock return, in consequence, during high and extreme volatility, copper can be used as a hedging instrument to hedge against the risks (Guo, 2018). Likewise, there is a diversification opportunity when combine copper with gas futures into portfolio (Rehman et al., 2019). Similarly, combination of industrial metals with stocks-bonds would provide the highest performance enhancement into portfolio in asset allocation strategies (Bessler & Wolff, 2015). Therefore, as long as there are diversification benefits from investing in industrial metals, the investors should consider including this asset into portfolio for return enhancement and risk management purposes.

Energy

As energy sectors become the largest commodity market in the world and also have significant role in financial markets, having to invest in alternative assets such as crude oil, natural gas, and unleaded gasoline could provide advantages to investors. Several scholars have been studied on benefits of diversification by having energy products in portfolio which is also applicable to real world investment. According to Geman and Kharoubi (2008), the authors apply copula functions to analyze the effect of diversification by including crude oil futures into equity portfolios. They find that crude oil provides phenomenal diversification during both boom-and-bust periods in the equity market. Furthermore, Gatfaoui (2019) examines the joint dependence structure of U.S. crude oil, natural gas, and stocks to determine the effectiveness of diversification. The result concludes that the power of energy provides the most effective diversification especially when it comes to mid-cap stock portfolios.

Co-authors, Basher and Sadorsky (2016) investigate DCC, ADCC, and GO-GARCH models on data sets consist of 23 emerging market stock returns, oils prices, gold prices, bond prices, and VIX to make a comparison on hedge ratio of each model. The daily data is employed and cover the period from January 4, 2000, to July 31, 2014. From the comparison, different multivariate GARCH models provide different results as each of the model captures data differently. With the result of investing in oil, it implies that oil is the best hedging instrument in emerging market. This is because it exhibits the highest hedging effectiveness in most cases. Besides, the oil prices that are examined by ADCC-GARCH provide superior result among all other models.

Another co-authored paper documented by Galvani and Plourde (2010) analyze portfolio performance by including energy commodity market into North American energy stocks portfolio. Daily data from January 1990 to February 2008 are being observed in this study. The authors apply mean-variance test to test the diversification benefits of WTI and Brent crudes, natural gas, and gasoline. The analysis suggests that these energy futures do not enhance risk-bearing return when they are complied with energy stocks held by investors who use buy-and-hold strategy. While these futures commodities decrease overall portfolio risk for passive investors.

In addition, there are numbers of researchers voice the similar opinion that portfolio consists of stocks and oil commodity can improve risk-adjusted return as well as effectiveness in risk reduction under time-varying conditions (see, among others, Antonakakis et al., 2018; Antonakakis & Filis, 2013; Arouri et al., 2011; Jouini, 2013; Malik & Hammoudeh, 2007). To subscribe that believe, Antonakakis and Filis (2013) examine time-varying correlation of stock market by the influence of oil prices from oil-exporting and oil-importing countries during period 1998-2011. The time-varying correlation is studied by adopting DCC-GARCH model. The finding suggests that aggregate demand shock of oil prices during financial turmoil offers negative correlation to the stock markets. Thus, it is suitable to apply for portfolio diversification and risk management. While Arouri et al. (2011) employ VAR-GARCH with the data set during period 2005-2010 to investigate the return links and volatility transmission between stock market and oil prices. The authors find that adding oil commodity into well-diversified portfolio can improve overall risk-adjusted return and oil price volatility can be hedged effectively.

Agriculture & Livestock

Agriculture and livestock products are mostly related to consumption products. However, there are few studies observe on ability of diversification of these commodity futures. According to Fortenbery and Hauser (1990) benefits of trading live cattle, hog, corn, and soybean futures contracts are determined relatively to a highly diversified stock portfolio. The authors use a mean-variance approach to observe the optimization of the portfolio that includes these commodity futures. The result of the study indicates that there is a reduction of portfolio's nonsystematic risk by adding these commodity futures into stock portfolio.

Moreover, Smimou (2010) studies on how U.S. investors could apply agricultural commodity futures to domestic and foreign stocks to reduce portfolio risk. The authors employ Markowitz's mean-variance framework to find optimal portfolio of the constructed commodity futures and selected stock indices. Monthly data from year 2001 to 2007 is observed in this study. The result of the study supports that Agriculture commodity futures help investors to diversify their portfolio. Also, the benefits of international diversification are much greater when non-US stocks are included.

Another paper by Mattos and Ferreira Filho (2003) investigates on asset combination of crops and livestock futures and stocks whether there is literally beneficial to stock portfolio in the Brazilian market. The analysis constructed by applying portfolio theory introduced by Markowitz. The finding concludes that the combining portfolio of crop and livestock with Ibovespa stocks can decrease risk in the

portfolio effectively. It is also having more efficient portfolio than having Ibovespa stock alone.

Islamic Stocks

With a speedy expansion of Islamic equities during last decades, it is believed that investors or market participants would pay more attention to Islamic asset performances and seek investment opportunity in the assets. Islamic equities have properties in accordance with Islamic law (Shari'ah). Some of those properties do not correspond with conventional market. Thus, it provides great opportunities for investors in conventional markets to consider Islamic stocks as their alternative investment or for portfolio diversification purposes.

There are extensive studies on Islamic stocks indicate that investors can gain diversification benefits by investing in this particular security (see, among other, Hkiri et al., 2017; Hussein & Omran, 2005; Saiti & Noordin, 2018; Sakti et al., 2018). For example, Hkiri et al. (2017) examine the status of Islamic indexes whether it can be a safe haven for investors through investigating total, directional and net volatility spillover. The data covers the period 1999-2014 which includes period of financial crises and employ decoupling and contagion hypothesis for testing. The finding suggests that Islamic financial indexes are the safe haven for investors during financial turbulence. Likewise, Hussein and Omran (2005) observe return between Islamic and conventional indexes under two subperiods, January 1996-March 2000 and April 2000-July 2003. They denote that Islamic index provide positives abnormal returns throughout periods and during bull market periods. However, their performance will drop and underperform conventional indices during bear market periods.

Moreover, research paper by Saiti et al. (2019) performs correlation analysis by using the DCC-GARCH model; find that Islamic stock indices would have diversification benefit for Chinese conventional equity investors as they are less volatile than conventional stock indices. Besides, Abbas and Trichilli (2015) investigate whether dynamic integration across a large set of developed and emerging market allows potential diversification benefit during financial turmoil by adopting Vector Error correction model. Overall result from the study denotes that Islamic asset provides potential diversification during financial turbulence by separately considering each market such as developed and emerging market.

Various studies have investigated the characteristics of Islamic equity performance by examine on their returns and risks (see, among others, Arouri et al., 2013; Balçılar et al., 2015; Cummings, 2000; Dewandaru et al., 2017; Gad & Andrikopoulos, 2019; Jawadi et al., 2014; Saiti & Noordin, 2018). For example, Jawadi et al. (2014) study the financial performance of Islamic and conventional indexes from Europe, USA, and World. Period of study covers 2008 financial crisis. The result indicates that Islamic stocks outperform conventional stocks during the period and implies the better performance. Contrastingly, financial performance of ethical investment in Australia has been examined by Cummings (2000). The author underlines that ethical investment does not outperform market benchmarks, rather it is the industry average. Also, it tends to underperform the market benchmark as new ethical investment is developed.

GFC and Covid-19 outbreak with stock markets

Global financial crisis (GFC) began in late 2007 in the U.S. It had direct and negative impacts on financial markets around the world, no matter in developed or emerging markets. Several scholars examine impacts of this crisis and document processes and results accordingly. For instant, Abd Majid and Hj Kassim (2009); Kang and Yoon (2011) underline that the degree of integration and co-movement between emerging markets in Asia is greater during crisis period. Besides, Bartram and Bodnar (2009) demonstrate that during financial crisis, overall performance of stock markets worldwide drops approximately 40% as compared to pre-crisis period. It also impacts severely to all industries especially in financial sectors. Therefore, overall results imply lesser diversification opportunity among countries and industries.

Covid-19 pandemic, the spreading virus was started in Wuhan, China in December 2019 and later spread around global until current time. It is an unpredictable crisis that shocks the financial markets another time after Global financial crisis. According to Zhang et al. (2020), Covid-19 has significantly increase level of volatility in stock markets. Thus, it is considered as very unpredictable event and investors would face with significant loss from investment. Increasing instability and crashes of stock markets outspread from China to various countries. Hence, it causes stock market distress and collapse afterwards (Contessi & De Pace, 2021). It also offers harmful impact to the return of S&P 500, particularly (Shehzad et al., 2020).

There are several studies make a comparison between GFC and Covid-19 outbreak. For example, Shehzad et al. (2020) report that conditional variance of U.S. and European markets is considerably higher during Covid-19, while conditional

variance in Asian markets is higher in the period of GFC. Therefore, Covid-19 has more impact towards U.S. and European markets, while the opposite is true. Even though the impact of these crises makes performance of stock markets turns down dramatically, stock performance during these crises shows recovery result after the governments' announcement of implementing QE. This is because the investors' level of confidence increases respectively (Chen & Yeh, 2021).

Theoretical Framework

This paper applies modern portfolio theory by Harry Markowitz as documented in Journal of Finance, 1952. The foundation of this theory is that the investors “should diversify their investments among all those securities which give maximum expected return”. According to the theory, the return from securities is intercorrelated and diversification cannot eliminate all variance. This implies that the portfolio with maximum return would not have minimum variance. Moreover, investors should diversify portfolio by include securities from different industries because companies in different industries would offer lower covariance than the firm within the same industry (Markowitz, 1952).

CHAPTER 3: DATA

This paper employs daily data of Dow Jones Emerging Markets Index (W5DOW), OIC countries Islamic indices are Jakarta Islamic Index (JKII) for Indonesia, The FTSE Bursa Malaysia EMAS Shari'ah Index (KLFTEMSI) for Malaysia, MSCI Bahrain Price Index for Bahrain, MSCI Qatar Price Index for Qatar, and MSCI Kuwait Price Index for Kuwait, and five core commodities under Bloomberg Commodity indexes namely precious metals (BCOMPR), industrial metals (BCOMIN), energy (BCOMEN), agriculture (BCOMAG) and livestock (BCOMLI) for analysis. These data are priced in US dollars, and they are retrieved from Refinitiv Eikon, Thomson Reuters database. The use of daily data is to examine conditional volatility of a time-series. For each data series, continuously compounded percentage daily returns are calculated as follows:

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \times 100 \quad (1)$$

Where P_t and P_{t-1} represent closing price at time t and closing price at time $t - 1$, respectively.

Data Overview

The data sets cover period from January 23, 2007, to December 31, 2021. The choice of January 23, 2007 is selected by data availability. This study covers the full period for global financial crisis 2007/2009 and the ongoing Covid-19 crisis. From this long period, it allows the paper to investigate conditional correlation and compare diversification potentials of each Bloomberg commodity indices with Islamic stock indices of selected OIC countries during both normal and crisis periods by having Dow Jones Emerging Markets Index as a benchmark in portfolio.

Precisely, this study segregates the period into 4 sub-periods for further elaboration on diversification benefits from conditional correlations on time-series basis, during both normal and crisis periods. The subperiods are divided as in table 1.¹

Table 1: The subperiods of the study

Sub-Periods	Date
Pre-Subprime Crisis	January 23, 2007 – November 30, 2007
During Subprime Crisis	December 1, 2007 - June 30, 2009
Post Subprime and Pre Covid-19 Crisis	July 1, 2009 – December 30, 2019
During Covid-19 Crisis	December 31, 2019 – December 31, 2021

Dow Jones Emerging Markets Index

In general, according to Dow Jones Indices (2021), the Dow Jones Emerging Markets Index is constructed to measure 95% of the market capitalization coverage of stocks traded in emerging markets. It was launched on September 12, 2000 and regulated by European Union. It consists of 3,652 firms within 25 emerging market countries including Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Kuwait, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Qatar, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey, and UAE.

The index is float-adjusted market capitalization weighted, where China contains the highest weight at 37.7% with the market capitalization of 13,483,432.3 million US dollars. While Pakistan has the lowest weight and market capitalization of 0.1% and 23,386.06 million US dollars, respectively. Besides, Technology, Financial,

¹ US Business Cycle Expansions and Contractions, <https://www.nber.org/research/data/us-business-cycle-expansions-and-contractions>. Also, according to the World Health Organization website (WHO), Wuhan Municipal Health Commission of China reported the first few COVID-19 cases on December 31, 2019: <https://www.who.int/news/item/29-06-2020-covidtimeline>

and Consumer Goods are the top-three largest sectors in the index. The composition is recalculated every September and changes are implemented on the Monday following the third Friday in September. In addition, share changes and IPO updates are implemented in quarterly basis, March, June, and December and effective on Monday following the third Friday of March, June, and December respectively.

Islamic Stock Indices

This study uses Islamic stock indices from selected OIC countries namely Jakarta Islamic Index (JKII) for Indonesia, The FTSE Bursa Malaysia EMAS Shari'ah Index (KLFTEMSI) for Malaysia, MSCI Bahrain Price Index for Bahrain, MSCI Kuwait Price Index for Kuwait, and MSCI Qatar Price Index for Qatar.

Jakarta Islamic Index (JKII)²

Jakarta Islamic Index (JKII) was launched in Indonesia stock market on July 3, 2000. This index consists of the 30 most liquid Islamic stocks that listed in Indonesia stock exchange (IDX). The index is reviewed on semi-annual basis which is in May and November. The liquidity screenings under this index are as follows:

- 1) the Islamic stocks must exist in Indonesia Sharia Stocks Index (ISSI) at least 6 months
- 2) Selected the 60 highest average order of market capitalization over the past 1 year
- 3) Out of 60 stocks, then select 30 stocks based on the highest daily transaction value in regular trading market to include in JII.

² Jakarta Islamic Index (JKII) (2021). Retrieved 10 November 2021, from <https://idx.co.id/en-us/idx-islamic/islamic-stock-index/>.

Moreover, there are screening criteria for selection of Islamic stocks which introduced and regulated by Financial Services Authority (OJK) as follows:³

- 1) The company must not conduct any business activities related to Gambling, Conventional financial services, Buying and selling of risks that involve speculation and gambling, Producing, distributing, trading, and providing harmful and forbidden contents, Transactions that contain elements of bribery, and Trading that is forbidden according to Islam such as fake offer or demand.
- 2) Company that fulfills the financial ratios where the total debt is not more than 45% of total assets, and interest income and other non-Islamic income must not exceed 10% of total revenue.

The FTSE Bursa Malaysia EMAS Shari'ah Index (KLFTEMSI)⁴

The index was launched to public on January 26, 2007. It is designed to use as a Shari'ah compliant investment products and an investment benchmark. Stocks in this index are selected and weighted to assure that the index is investable. Simultaneously, stocks also have liquidity screening to ensure that the index is tradable. The index is screened in accordance with the Malaysian Securities Commission's Shari'ah Advisory Council (SAC) with screening methodology as follows:

- 1) Revenue before taxation from business activities related to Conventional financial services, Gambling, Liquor-related products, Pork-related products, non-halal foods and beverages, Shari'ah non-compliant entertainment. Tobacco-related products, interest income from conventional accounts and

³ Islamic Product Screening (2021). ISLAMIC STOCKS. Retrieved 10 November 2021, from <https://idx.co.id/en-us/idx-islamic/islamic-product/>.

⁴ Russell (2021), FTSE Bursa Malaysia EMAS Shariah Index - FTSE Russell Factsheet, FTSE Russell.

instruments, and dividend from Shari'ah non-compliant investment must be less than 5%.

- 2) Revenue before taxation from businesses on share trading, stockbroking business, rental received from Shari'ah non-compliant activities, and other activities which are non-compliant according to Shari'ah principles as determined by SAC must not exceed 20%.
- 3) In term of financial ratio benchmark, cash deposits in conventional accounts and instruments and interest-bearing debt transactions must be less than 33% of total assets.

Moreover, The FTSE Bursa Malaysia EMAS Shari'ah Index is free-float adjusted and liquidity screened. It is calculated real-time in every 60 seconds where the calculation is based on price and total return methodologies. Besides, it is reviewed and rebalanced semi-annually in June and December.

MSCI Bahrain Price Index⁵

The index was implemented on January 23, 2006, by having a back-tested data for the prior date data availability. It is constructed to measure large and mid-capitalized segments performance traded in Bahrain market with the market capitalization of 6,728.72 million US dollars. It consists of top four constituents which are under financials, communication services and materials sector with weight of approximately 86.26%, 9.26% and 4.48% respectively. Weighting methodology of the index is determined by using free float-adjusted market capitalization weighting scheme.

⁵ MSCI Bahrain Index (USD) (2021). Retrieved 6 January 2022, from <https://www.msci.com/documents/10199/ea226443-e28a-4757-b984-2ce271c76d01>

Besides, the index composition is reviewed and rebalanced quarterly in February, May, August, and November.

MSCI Kuwait Price Index⁶

The index was implemented on January 23, 2006, by having a back-tested data for the prior date data availability. It is designed to measure performance of large and mid-capitalized segments in Kuwait with the market capitalization of 46,490 million US dollars. This index has a free float-adjusted market capitalization weighted scheme. It is rebalanced every quarter in February, May, August, and November. This index consists of top 6 constituents of Kuwait equity universe where the largest weight of constituent has approximately 47.81% under financial sector and the smallest weight at 3.25% under real estate segment. Besides, financials hold the highest weight portion at up to 79.96% while real estates have only 3.25% of weight portion.

MSCI Qatar Price Index⁷

The index was implemented on January 23, 2006, by having a back-tested data for the prior date data availability. It is designed to measure performance of large and mid-capitalized segments traded in Qatar with the market capitalization of 58,278 million US dollars. This index is a free float-adjusted market capitalization weighted. It is reviewed and rebalanced quarterly in February, May, August, and November. This index consists of 12 constituents where the largest weight of constituent has approximately 41.36% under financial sectors. Besides, there are segregated into seven business sectors which are financials, industrials, energy, materials, utilities, real estate,

⁶ MSCI Kuwait Index (USD) (2021). Retrieved 6 January 2022, from <https://www.msci.com/documents/10199/9a90cd00-872d-4ec7-a9f1-b2a3334c2c5f>

⁷ MSCI Qatar Index (USD) (2021). Retrieved 6 January 2022, from <https://www.msci.com/documents/10199/cd4c3955-b178-4ff5-9d08-a8f73229328f>

and communication services where financials sectors hold the highest sector weight and communication services hold the least sector weight accordingly.

As MSCI Bahrain Price Index, MSCI Kuwait Price Index, and MSCI Qatar Price Index are all under MSCI Islamic Index Series, they, therefore, share the same screening criteria which is restricted and approved by MSCI's Sharia advisors' committee of Sharia scholars. The Islamic indexes of MSCI excludes non-Shariah-compliant securities through business activity and financial screening. The screening criteria of Islamic stocks to be included in the index are as follows:⁸

- 1) For business activity screening, revenue from business activities related to Alcohol, Tobacco, Cannabis, Pork-related products, Conventional financial services, Defense and Weapons, Gambling, Music, Hotels, Cinema, Adult Entertainment, and Online Dating business must be accounted for less than 5% of their cumulative revenue.
- 2) For financial screening, company's total debt, company's cash and interest-bearing securities and company's accounts receivables and cash, using total asset as a denominator, must be less than 33%. Simultaneously, company's accounts receivables and cash using, the average market capitalization as a denominator, must not be more than 49%, while company's total debt, company's cash and interest-bearing securities remain unchanged.

This is to ensure that the companies with unacceptable level of debt and impure interest income are screened out from the index.

⁸ MSCI Islamic Index Series Methodology (2021) Retrieved 6 January 2022, from https://www.msci.com/eqb/methodology/meth_docs/MSCI_Islamic_Indexes_Methodology_Oct2021.pdf

Bloomberg Commodity Indices

This study uses Bloomberg commodity index family because it is broadly diversified and reflects global economy and market liquidity. According to Bloomberg (2021), the details on the indices can be elaborated accordingly. The Bloomberg Commodity Index (BCOM) originally known as the Dow Jones-UBS Commodity Index. It is a widely diversified index that measures commodity futures contracts to track the commodities markets. It was launched on July 14, 1998 and become a leading commodity market benchmark until current time. BCOM offers broad commodity exposure, with no single commodity or industry dominating the Index. Its goal is to give investors a diverse view of commodities as an asset class. To determine the relative amounts of included commodities, BCOM analyzes both liquidity data and U.S. dollar-weighted production data. Thus, it would have the capacity to handle large investment flows.

Specifically, this paper concentrates on index of precious metal (BCOMPR), industrial metal (BCOMIN), energy (BCOMEN), agriculture (BCOMAG), and livestock (BCOMLI). They are considered as individual subindex under Bloomberg Commodity index family. Weightings of these commodities are determined by production and liquidity and are subject to yearly weighting limitations such that no related group of commodities accounts for more than 33% of index. As of January 2021, target weights of commodity index for BCOMPR, BCOMIN, BCOMEN, BCOMAG, BCOMLI are 19%, 15.56%, 29.97%, 29.88% and 5.57% respectively. Besides, the index is subject to relancing annually.

CHAPTER 4: METHODOLOGY

The primary methodology employed by this study is Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroscedasticity (DCC-GARCH) model introduced by Engle (2002) to estimate time-series of conditional volatility and correlation of returns from the selected indices. Besides, the estimated conditional correlations are observed and discussed whether alternative indices are a diversifier, a hedge, or a safe haven. Additionally, Hedge ratio (HR) is determined to optimize portfolio allocation by having to minimizing risks and reducing the cost risk. All these estimations are applied by using percentage daily return data of W5DOW, JKII, KLFTEMSI, MSCI Bahrain Price Index, MSCI Qatar Price Index, MSCI Kuwait Price Index, BCOMPR, BCOMIN, BCOMEN, BCOMAG, and BCOMLI.

Dynamic Conditional Correlation GARCH (DCC-GARCH)

This study uses the DCC-GARCH model introduced by Engle (2002) to estimate time-varying correlations and volatilities of asset returns. It is estimated in two steps, a series of univariate GARCH estimates and the correlation estimate. This model suggests on the correlations and volatilities of asset returns change across periods, including its direction (positive or negative) and size (stronger or weaker) (Saiti & Noordin, 2018). Thus, the DCC allows for the determination of whether assets return shocks are substitutes or complements in term of risk taking (Najeeb et al., 2015). To be specified, this paper employs bivariate DCC-GARCH to estimate time series of conditional variance on the selected alternative securities as a pairwise comparison.

There are several advantages of applying DCC model in estimation process. The number of parameters which would be estimated in the correlation process is unrelated

to the number of correlated series (Engle, 2002). It enables us to detect changes in the dependency between financial variables (both when and how they occur) (Najeeb et al., 2015). Besides, it is a convenient approach to represent the process of estimating dynamic conditional volatilities and dynamic conditional correlation at the same time (Lee, 2006). Following Hassan et al. (2021), the paper defines the DCC model as follows.

$$y_t = \mu_t + \Sigma_t^{0.5} Z_t \quad (2)$$

y_t indicates the return of financial series at time t

μ_t is the conditional mean which equates to $(\mu_{1t}, \dots, \mu_{kt})'$

Z_t indicates the independent and identically distributed random vector in 2×1 form.

Σ_t is the conditional covariance explained by

$$\Sigma_t = D_t R_t D_t \quad (3)$$

R_t represents the conditional correlation of asset, which is given by

$$R_t = (\text{diag} Q_t)^{-0.5} Q_t (\text{diag} Q_t)^{-0.5} \quad (4)$$

D_t represents diagonal matrix having time-varying standard deviation. It can be expressed by

$$D_t = \text{diag} (\sigma_{11,t}^{0.5}, \sigma_{22,t}^{0.5}) \quad (5)$$

$\sigma_{ii,t}$ is estimated through univariate model, where GARCH (1,1) equation is represented by

$$\sigma_{ii,t} = \omega_{0i} + \omega_{1i} \varepsilon_{i,t-1}^2 + \omega_{2i} \sigma_{ii,t-1} \quad (6)$$

Q_t in Equation (4) is a 2×2 symmetric positive matrix, is given by

$$Q_t = (1 - \alpha - \beta)R + \alpha u_{t-1} u'_{t-1} + \beta Q_{t-1} \quad (7)$$

R is the unconditional correlation matrix

u_t represents standardized innovations.

α and β are non-negative scalar parameters.

The sum of α and β is conditionally less than 1 ($\alpha + \beta < 1$). The conditional correlation can be written as

$$\rho_{ij,t} = \frac{q_{ij,t}}{(q_{ii,t} q_{jj,t})^{0.5}} \quad (8)$$

The equation (8) has been obtained from the elements $q_{i,t}$ for the matrix Q_t .

The estimated result from this model is to be interpreted whether there is a dynamic conditional correlation between asset i and asset j . In case if there is no dynamic conditional correlation, it implies that the parameters have constant conditional correlation across the time periods. Furthermore, if the dynamic correlation exists, it will be able to determine the ability of diversification between each alternative assets and benchmark portfolios whether which one is better off than the others. Thus, it provides channel for market participants to minimize risk and maximize expected return in portfolio during both normal periods and market turmoil.

Properties of assets

This study conducts further analysis based on estimated conditional correlations to observe the ability and property of each security whether it can be used as a diversifier, a hedger, or a safe haven to the portfolio in different time periods by

performing t-test statistic to observe that the dynamic conditional correlation of each index is not significantly equal to zero. Then, it is further analyzed in accordance with the definition given by Baur and Lucey (2010). Accordingly, the authors provide definition of each term to distinguish diversification potential as follows:

1) Diversifier

The asset is defined as a diversifier in case it is positively, but not perfectly correlated, with another asset class in the portfolio on average. As a diversifier, it cannot be used to reduce losses during extreme situations such as financial turmoil or market distress.

2) Hedge

The asset is defined as a hedger when it is uncorrelated or negatively correlated with another asset in portfolio on average. It provides a similar role to a diversifier where it cannot be applied to reduce losses in extreme market conditions. This is because the asset could have a positive correlation in some periods and negative correlation in another period.

3) Safe haven

The asset is defined as a safe haven when it is uncorrelated or negatively correlated with another asset in portfolio during particular periods such as financial turbulences or market distress. This safe-haven asset is considered as a compensation of losses for asset in portfolio during extreme market conditions. It is because safe-haven asset price is increasing, while price of another asset in portfolio decreases.

As this paper examines ten alternative securities that can be diversified in the portfolio, each security may have different diversification property and different strength and weakness of diversification benefit across time periods. Also, from the observation, it grants an idea that volatility of each security may not be the same throughout the periods, especially during financial turbulences. Thus, it is better to distinguish the property of assets as it can be clearly and is broadly applied by investors in an accurate manner.

Hedge Ratio

Hedge ratio is being used as a tool for risk management. It helps market participants to understand level of risk exposure of investing assets that they would invest. In general, market participants seek to minimize risks of the portfolio, hence, it is significant to look for optimum hedge ratio for optimizing portfolio allocation (See, Chkili, 2016; Maghyereh et al., 2019). As this paper earlier estimates conditional variance and conditional covariance from Bi-variate DCC GARCH model, the optimal hedge ratio between benchmark index and alternative asset returns can be computed based on these results as follow Jitmaneeroj (2018); Kroner and Sultan (1993); Kumar (2014):

$$\delta_{i,j,t} = \frac{h_{i,j,t}}{h_{j,j,t}} \quad (9)$$

$h_{i,j,t}$ is the conditional covariance between benchmark index and alternative index at time t

$h_{j,j,t}$ is the conditional variance of alternative index at time t

According to the above formula, it is noted that a long position in one dollar of benchmark index can be hedged by a short position in $\delta_{i,j,t}$ dollars of alternative index.

Hedging Effectiveness

The objective of minimum variance hedging in earlier method is for risk minimization rather than for return maximization. Therefore, the criteria used to determine which indices are the most advantageous for a portfolio are determined in percentage by calculating hedging effectiveness (*HE*), as follow Kumar (2014):

$$HE = \frac{Var_U - Var_H}{Var_U} \quad (10)$$

Var_U indicates the variance of the returns of the unhedged portfolio

Var_H indicates the variance of the returns of the hedged portfolio

To proceed with the computation of hedging effectiveness, the returns and variances of hedge and unhedged portfolio need to be calculated as follows:

$$R_{unhedged} = i_{t+1} - i_t \quad (11)$$

$$R_{hedged} = (i_{t+1} - i_t) - h^*(j_{t+1} - j_t) \quad (12)$$

$$Var(U) = \sigma^2 \quad (13)$$

$$Var(H) = \sigma_i^2 + \delta^2 \sigma_j^2 - 2\delta \sigma_{i,j} \quad (14)$$

$R_{unhedged}$ and R_{hedged} are the return of unhedged and hedged portfolio

i_t and j_t are the logarithmic returns at time t of asset i and asset j

i_{t+1} and j_{t+1} are the logarithmic returns at time $t+1$ of asset i and asset j

h^* is the dynamic hedge ratio

$Var(U)$ and $Var(H)$ are variance of unhedged and hedge portfolio

σ_i^2 and σ_j^2 are variances of returns of the asset i and asset j

$\sigma_{i,j}$ is the covariance between the returns of asset i and asset j

By estimating hedge ratio from DCC GARCH model, it is to say that the higher the hedge ratio, the higher the hedging effectiveness for the portfolio. The higher the HE of the portfolio, the lower the portfolio risk, implying that the underlying investing strategy is determined as a better hedging strategy (Kumar, 2014). Besides, this study also compares degree of hedging effectiveness for subperiods and a whole period to determine the investment strategy whether to long asset i to hedge asset j strategy is always applicable and effective on time-series basis or it shifts to another direction when it comes to during different periods especially during financial turmoil.

CHAPTER 5: RESULTS

This section presents analysis of returns properties of all indices, lag selection criterion, the results from analysis that examine the dynamic conditional correlation from DCC-GARCH model, properties of assets, hedge ratio, and hedging effectiveness from January 23, 2007, to December 31, 2021. The estimated results are various across time horizon and market conditions. To be precise, the results are analyzed both in whole period and subperiod including pre-subprime crisis period, during subprime crisis period, post subprime and pre covid-19 crisis period, and during covid-19 crisis period.

Descriptive Statistic

Table 2 presents the descriptive statistics of all indices, including minimum, maximum, mean, standard deviation, skewness, and kurtosis of daily return during sample period. From the table, MSCI Kuwait, BCOMPR, and MSCI Qatar provides higher daily average return than the benchmark index, W5DOW (0.0102%), where MSCI Kuwait has the highest average daily return of 0.0251%, followed by BCOMPR and MSCI Qatar of 0.0222% and 0.0203% respectively. Simultaneously, KLFTEMSI and JKII also provide a positive mean return of 0.0076% and 0.0037% but they are still less than the benchmark index returns of 0.0102%. In contrary, BCOMAG, BCOMIN, BCOMLI, MSCI Bahrain and BCOMEN provide negative average daily return of -0.0017%, -0.0055%, -0.0283%, -0.0473% and -0.0501% sequentially.

In term of risk measures, most of the selected indices have higher standard deviations than W5DOW, implying that most of the selected indices have higher volatility than proxy index. MSCI Bahrain exhibits the highest volatility at 2.1297 as

compared to other indices, followed by BCOMEN, MSCI Kuwait and JKII of 1.8702, 1.8483 and 1.7792 as measured by standard deviation. Regarding the asymmetry of daily return, most of the indices under consideration yield lower negative skewness than W5DOW. This infers that it is likely to see fewer negative returns from these indices than the proxy index. Besides, MSCI Bahrain exhibits the highest kurtosis of 1014.9220, indicating that the MSCI Bahrain has the highest fat tailed than all other indices.

As noticed, percentage returns of MSCI Bahrain, MSCI Kuwait, and MSCI Qatar in panel C essentially show wide range between the minimum and maximum values. Noteworthily, the minimum value of these three indices occurred on January 2nd, 2008, while they show significant increment on the next day which was on January 3rd, 2008. These two days are in the duration of the Global Financial Crisis 2008-2009 that is defined in this study. According to Bursa Kuwait, the circuit breakers is implemented as a regulatory to measure temporarily halt trading on an exchange in order to prevent panic selling by stop trading when prices decline to reach certain levels such as 5%, 7%, and 10%. In contrary, with limited information on circuit breaker regulations of Bahrain Stock Exchange and Qatar Stock Exchange, circuit breaker regulations of these two markets are not presented in this study.

Moreover, unconditional correlations of the return series for all indices are reported in Table 3. The results show that all indices have positively low but not perfectly correlated with each other, except for the unconditional correlation between MSCI Bahrain and precious metal (BCOMPR) that presents the negative unconditional correlation against each other. Precisely, each commodity index offers diversification

benefits to stock portfolios variously. Therefore, it is believed that studying several commodity indices can benefit investors and create value for the research. Besides, different diversification benefits to the portfolios are also reflected in hedging effectiveness values that vary among selected indices accordingly. Hedging effectiveness will be presented in the next section.

Table 2: Descriptive statistic for study period

Indices	Obs.	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
Panel A Dow Jones Emerging Market Index							
W5DOW	3956	0.0102	1.1896	-12.8646	9.4589	-0.8731	14.3359
Panel B Commodity Indices							
BCOMAG	3764	-0.0017	1.2066	-6.7538	6.5653	-0.1820	5.8465
BCOMEN	3764	-0.0501	1.8702	-14.5467	10.0109	-0.3752	7.4911
BCOMIN	3764	-0.0055	1.4174	-7.5704	7.0246	-0.1837	5.1053
BCOMLI	3764	-0.0283	1.0146	-6.2694	5.5904	-0.2279	5.3477
BCOMPR	3764	0.0222	1.3039	-10.3770	9.0002	-0.4363	8.4607
Panel C Islamic Stock Indices							
JKII	3625	0.0037	1.7792	-15.3314	13.3977	-0.4400	11.0337
KLFTEMSI	3661	0.0076	1.0215	-12.3419	5.4983	-0.7076	12.1577
MSCI Bahrain	3919	-0.0473	2.1297	-79.7866	79.9624	-0.2837	1014.9220
MSCI Kuwait	3920	0.0251	1.8483	-65.4805	67.3576	0.9547	854.8987
MSCI Qatar	3920	0.0203	1.3808	-33.2553	34.1403	-0.1555	190.5639

Notes: W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. The figures of mean, standard deviation, min, and max are presented in percentage term.

Table 3: Unconditional Correlations matrix of the return series analysis for study period.

	W5DOW	BCOMAG	BCOMEN	BCOMIN	BCOMLI	BCOMPR	JKII	KLFTMSI	MSCI Bahrain	MSCI Kuwait	MSCI Qatar
W5DOW	1										
BCOMAG	0.316	1									
BCOMEN	0.348	0.374	1								
BCOMIN	0.482	0.385	0.389	1							
BCOMLI	0.171	0.208	0.170	0.159	1						
BCOMPR	0.208	0.276	0.215	0.358	0.066	1					
JKII	0.605	0.132	0.150	0.224	0.062	0.120	1				
KLFTMSI	0.628	0.152	0.171	0.263	0.096	0.143	0.584	1			
MSCI Bahrain	0.086	0.025	0.030	0.053	0.025	-0.008	0.060	0.074	1		
MSCI Kuwait	0.091	0.023	0.025	0.053	0.020	0.012	0.062	0.085	0.816	1	
MSCI Qatar	0.241	0.026	0.065	0.088	0.027	0.017	0.231	0.229	0.587	0.582	1

Notes: W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index.

Data Inspections

Before proceeding with DCC-GARCH model of time-series information, it is essential to perform time-series data analysis on uncertainty data to make a good model and result in good decision making from data itself. This study performs data inspections by examining four statistic tests including Jarque-Bera test, Ljung-Box test, Unit root test, and ARCH-LM test, on time-series of logarithmic returns of all indices under consideration. The detail of each testing is discussed as followed.

Jarque-Bera test of Normality

Jarque-Bera test is to determine whether logarithmic returns are normally distributed. Also, the test determines whether there is any skewness or kurtosis that is significantly different from zero (Cryer & Chan, 2008). The null hypothesis for the test is that the data is normally distributed, while the alternative hypothesis is that the data is not normally distributed.

Ljung-Box test

Ljung-Box (Q) test is to determine whether there is an autocorrelation left in residual of return series of all indices. The null hypothesis for the test is that the time-series data is not autocorrelation, while the alternative hypothesis is that the time-series data is autocorrelation.

Unit root test

Augmented Dickey-Fuller test is employed to test unit root on each variable to determine whether the time-series data is stationary or non-stationary. The null hypothesis for the test is that unit root exists in time-varying data, while the alternative

hypothesis is that unit root does not exist in time-varying data. Besides, the ADF test in this study does not take drift and trend term specification into analysis.

ARCH-LM Test

ARCH-LM Test is a test to check autoregressive conditional heteroskedasticity (ARCH) effect of all return series. It is to determine the correlation between volatility among all indices. The null hypothesis for the test is that there is no existing of ARCH effect in return series up to q order, while the alternative hypothesis is that there is an existing of ARCH effect is return series up to q order.

Examining results on the return series using Jarque-Bera test, Ljung-Box (Q) test, unit root test, and ARCH-LM test are exhibited in Table 4. As noticed from significant Jarque-Bera statistics, it represents deviation of distribution from the normal distribution of all daily returns at the 1% significant level. The Ljung-Box test which employs the Q (5) statistics reveals the evidence of autocorrelation up to 5 lags of all daily returns at the 1% significant level. Besides, the Augmented Dickey-Fuller (ADF) and Lagrange Multiplier (LM) statistics are used to perform unit root and ARCH effect test and to confirm stationary and heteroskedasticity of all return series before estimating the DCC-GARCH model. The ADF statistic results reveal that unit root is not present and the returns series are stationary for all indices at the 1% significant level. The ARCH effect results indicate that all daily returns have time-varying variation at the 1% significant level, except for MSCI Kuwait and MSCI Qatar. By having the ARCH effect, it implies that GARCH model might be appropriate, and it is likely to have an effective hedging strategy from the dynamic hedge ratios.

Table 4: Data Inspection results of the return series analysis for study period.

Indices	Jarque-Bera Test	Ljung-Box (Q) test	ADF Test	ARCH-LM Test
Panel A Dow Jones Emerging Market Index				
W5DOW	34378.66***	89.19***	-16.87***	267.06***
Panel B Commodity Indices				
BCOMAG	5381.68***	63.64***	-11.86***	83.94***
BCOMEN	8889.14***	54.85***	-12.52***	23.52***
BCOMIN	4108.88***	34.02***	-14.82***	71.00***
BCOMLI	4517.72***	77.38***	-9.15***	125.18***
BCOMPR	11346.06***	65.16***	-14.85***	24.72***
Panel C Islamic Stock Indices				
JKII	18505.03***	34.85***	-13.72***	117.24***
KLFTEMSI	22852.44***	29.61***	-11.70***	77.46***
MSCI Bahrain	168201355.27***	88.99***	-40.39***	28.05***
MSCI Kuwait	119373054.06***	86.31***	-56.97***	7.55
MSCI Qatar	5931400.46***	69.39***	-50.75***	4.91

Notes: W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. Uncond. Corr. presents Unconditional Correlation. The Jarque-Bera test reports the JB statistic under the null hypothesis of normality. Ljung-Box test reports the Q (5) statistic under the null hypothesis of no autocorrelation for up to 5th order serial correlation. The unit root test reports the ADF statistic using with the null hypothesis is that a unit root presents. The ARCH-LM reports the LM-statistic, with 4th order ARCH effects. ***, ** and * denote statistical significance at the 1%, 5% and 10%, respectively.

Lag selection criterion

The optimal lag of the explanatory variables is an essential aspect to determine before running DCC-GARCH model. The most frequent used criterions among researchers are Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC) which will mostly identify based on the size of observations. In this paper, the number of lags to include in the DCC-GARCH model is determined by considering the two common information criterions among AIC, HQIC, and SBIC. However, in case where there is uncommon lag among three criterions, the criterion with the least information criterion value is chosen. Thus, the optimal lags applied in this study are vary across all indices under consideration as illustrated in Table 5.

Table 5: Lag selection criterion for Bivariate DCC-GARCH model

Pairing	Information Criterions	Lags
Panel A Commodity Indices		
W5DOW & BCOMAG	AIC, HQIC & SBIC	2
W5DOW & BCOMEN	AIC, HQIC & SBIC	1
W5DOW & BCOMIN	AIC, HQIC & SBIC	1
W5DOW & BCOMLI	AIC, HQIC & SBIC	4
W5DOW & BCOMPR	HQIC & SBIC	1
Panel B Islamic Stock Indices		
W5DOW & JKII	AIC, HQIC & SBIC	3
W5DOW & KLFTEMSI	AIC	3
W5DOW & MSCI Bahrain	AIC, HQIC & SBIC	1
W5DOW & MSCI Kuwait	AIC & HQIC	3
W5DOW & MSCI Qatar	AIC, HQIC & SBIC	1

Notes: W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. AIC represents Akaike Information Criterion, HQIC represents Hannan-Quinn Information Criterion, and SBIC represents Schwarz Bayesian Information Criterion.

DCC-GARCH Model Estimation Results

Table 6 reports the estimated results of a bivariate DCC-GARCH (1,1) model for daily percentage return of each commodity index and Islamic stock index against the Dow Jones Emerging market index (W5DOW) to identify portfolio diversification benefits. The model estimation follows equation (2) to equation (8) by using whole period estimation analysis.

As for the mean equation, there are not all significant on own dynamic for daily return of W5DOW and all indices under consideration. However, BCOMEN, BEOMIN, BCOMPR, JKII, KLFTEMSI, MSCI Bahrain, MSCI Kuwait, and MSCI Qatar are statistically significant in some lagged returns at conventional levels of significance, implying that it presents positive significant return from all indices to W5DOW, and the current returns of these indices have short-term predictability in their own next-day returns. Besides, the current return of W5DOW is impacted by several days lagged return of each particular index with the maximum up to four lagged returns.

Referring to the variance equations, the parameters ω_0 , ω_1 , ω_2 of all indices are statistically significant at the 1% level excepts the coefficient ω_0 for MSCI Qatar that has the 10% significant level. The parameter ω_1 refers to the ARCH effects which measure short-term persistence, while the parameter ω_2 indicates the GARCH effects that measure long-term persistence, and both are significantly explained the conditional volatility. Overall, the estimated value of ω_1 is smaller than the estimated value of ω_2 , indicating that its own volatility long-run persistence is larger than its short-run persistence (Sadorsky, 2012). This also implies that because of the significant effect of

past volatility, estimated conditional volatility series tend to evolve more rapidly than return innovations (Kumar, 2014).

For DCC equations, the estimated coefficient of α and β determine the dynamic conditional correlation of the index against benchmark portfolio. The parameters are statistically significant at the 1% level for all cases except for MSCI Qatar price index that has the 10% statistically significant level. The highest DCC equation result is between W5DOW and BCOMIN which equals to 0.9942, following by KLFTEMSI at 0.9880, BCOMAG at 0.9878 and BCOMEN at 0.9868, implying that the impact of current returns volatility tends to decay slowly over time (the corresponding indicators are close to one), while the portfolio comprising MSCI Qatar (0.5673) promptly decreases the impact of current returns volatility (Chen & Tongurai, 2021). Moreover, the estimated coefficients (α , β) obtained from DCC equations are sum and the value is less than one, ($\alpha + \beta < 1$), inferring that dynamic conditional correlations are mean reverting and all indices confirm there is a dynamic conditional correlation with W5DOW on time-varying basis rather than having constant conditional correlation among them.

Table 6: DCC-GARCH model Estimation results

	BCOMAG		W5DOW	
L1.W5DOW	-0.0043	(0.0175)	0.1750***	(0.0185)
L1.BCOMAG	0.0136	(0.0183)	0.0418***	(0.0143)
L2.W5DOW	0.0174	(0.0174)	0.0259	(0.0182)
L2.BCOMAG	-0.0278	(0.0183)	-0.0036	(0.0141)
ARCH (ω_1)	0.0633***	(0.0081)	0.1140***	(0.0118)
GARCH (ω_2)	0.9260***	(0.0091)	0.8630***	(0.0140)
Cons (ω_0)	0.0155***	(0.0039)	0.0287***	(0.0057)
Log likelihood	-9791.47***			
ALPHA (α)	0.0108***		(0.0030)	
BETA (β)	0.9770***		(0.0049)	
	BCOMEN		W5DOW	
L1.W5DOW	0.0886***	(0.0271)	0.1770***	(0.0182)
L1.BCOMEN	-0.0576***	(0.0186)	0.0283***	(0.0096)
ARCH (ω_1)	0.0683***	(0.0079)	0.1070***	(0.0111)
GARCH (ω_2)	0.9200***	(0.0091)	0.8720***	(0.0130)
Cons (ω_0)	0.0417***	-0.0097	0.0254***	(0.0052)
Log likelihood	-11186.23***			
ALPHA (α)	0.0188***		(0.0054)	
BETA (β)	0.9680***		(0.0125)	
	BCOMIN		W5DOW	
L1.W5DOW	0.0662***	(0.0225)	0.1540***	(0.0193)
L1.BCOMEN	-0.0594***	(0.0192)	0.0551***	(0.0136)
ARCH (ω_1)	0.0426***	(0.0069)	0.1120***	(0.0116)
GARCH (ω_2)	0.9480***	(0.0089)	0.8590***	(0.0142)
Cons (ω_0)	0.0167***	(0.0053)	0.0328***	(0.0060)
Log likelihood	-10080.11***			
ALPHA (α)	0.0122***		(0.0034)	
BETA (β)	0.9820***		(0.0058)	
	BCOMLI		W5DOW	
L1.W5DOW	-0.00293	(0.0141)	0.1850***	(0.0182)
L1.BCOMLI	0.0269	(0.0178)	0.0226	(0.0154)
L2.W5DOW	0.0038	(0.0143)	0.0358*	(0.0183)
L2.BCOMLI	-0.0185	(0.0178)	-0.0353**	(0.0151)
L3.W5DOW	0.0015	(0.0142)	-0.0270	(0.0182)
L3.BCOMLI	0.0006	(0.0177)	0.0266*	(0.0152)
L4.W5DOW	-0.0187	(0.0140)	-0.0291	(0.0179)
L4.BCOMLI	0.0028	(0.0177)	-0.0179	(0.0152)
ARCH (ω_1)	0.0603***	(0.0073)	0.1120***	(0.0118)
GARCH (ω_2)	0.9250***	(0.0099)	0.8680***	(0.0136)
Cons (ω_0)	0.0145***	(0.0046)	0.0252***	(0.0053)
Log likelihood	-9369.46***			
ALPHA (α)	0.0076		(0.0072)	
BETA (β)	0.9280***		(0.1190)	

	BCOMPR		W5DOW	
L1.W5DOW	0.0467**	(0.0194)	0.1820***	(0.0180)
L1.BCOMPR	-0.0264	(0.0184)	0.0514***	(0.0133)
ARCH (ω_1)	0.0453***	(0.0062)	0.1210***	(0.0123)
GARCH (ω_2)	0.9470***	(0.0074)	0.8560***	(0.0142)
Cons (ω_0)	0.0143***	(0.0042)	0.0291***	(0.0057)
Log likelihood	-10168.16***			
ALPHA (α)	0.0310***		(0.0064)	
BETA (β)	0.9170***		(0.0172)	
	JKII		W5DOW	
L1.W5DOW	0.2830***	(0.0292)	0.2230***	(0.0206)
L1.JKII	-0.0729***	(0.0210)	-0.0601***	(0.0125)
L2.W5DOW	0.0438	(0.0293)	0.0302	(0.0208)
L2.JKII	-0.0597***	(0.0206)	0.0067	(0.0124)
L3.W5DOW	0.0649**	(0.0299)	-0.0217	(0.0208)
L3.JKII	-0.0620***	(0.0208)	-0.0241*	(0.0208)
ARCH (ω_1)	0.1020***	(0.0113)	0.0988***	(0.0095)
GARCH (ω_2)	0.8740***	(0.0138)	0.8750***	(0.0117)
Cons (ω_0)	0.0660***	(0.0129)	0.0286***	(0.0050)
Log likelihood	-10331.07***			
ALPHA (α)	0.0369***		(0.0059)	
BETA (β)	0.9310***		(0.0102)	
	KLFTEMSI		W5DOW	
L1.W5DOW	0.2110***	(0.0179)	0.2380***	(0.0213)
L1.KLFTEMSI	-0.0645***	(0.0218)	-0.1220***	(0.0221)
L2.W5DOW	0.0017	(0.0178)	0.0563***	(0.0216)
L2.KLFTEMSI	0.0638***	(0.0215)	-0.00952	(0.0219)
L3.W5DOW	0.0241	(0.0185)	-0.0236	(0.0217)
L3.KLFTEMSI	-0.0130	(0.0218)	-0.0071	(0.0220)
ARCH (ω_1)	0.0753***	(0.00865)	0.0924***	(0.0088)
GARCH (ω_2)	0.9140***	(0.00992)	0.8860***	(0.0109)
Cons (ω_0)	0.0123***	(0.00280)	0.0243***	(0.0045)
Log likelihood	-8373.32***			
ALPHA (α)	0.0290***		(0.0053)	
BETA (β)	0.9590***		(0.0088)	
	MSCI BAHRAIN		W5DOW	
L1.W5DOW	-0.0625***	(0.0196)	0.1780***	(0.0181)
L1.MSCI BAHRAIN	-0.3580***	(0.0229)	-0.0129	(0.0108)
ARCH (ω_1)	0.3640***	(0.0209)	0.1180***	(0.0121)
GARCH (ω_2)	0.8470***	(0.0067)	0.8630***	(0.0136)
Cons (ω_0)	0.0145***	(0.0039)	0.0263***	(0.0054)
Log likelihood	-10856.19***			
ALPHA (α)	0.0245***		(0.0095)	
BETA (β)	0.9450***		(0.0221)	

	MSCI KUWAIT		W5DOW	
L1.W5DOW	0.0050	(0.0168)	0.1840***	(0.0182)
L1.MSCI KUWAIT	0.0088	(0.0331)	-0.0160	(0.0121)
L2.W5DOW	-0.0528***	(0.0184)	0.0319*	(0.0183)
L2.MSCI KUWAIT	0.2210***	(0.0283)	0.0093	(0.0137)
L3.W5DOW	-0.2380***	(0.0148)	-0.0613***	(0.0184)
L3.MSCI KUWAIT	0.2120***	(0.0216)	0.0377***	(0.0139)
ARCH (ω_1)	0.8900***	(0.0489)	0.1160***	(0.0120)
GARCH (ω_2)	0.6390***	(0.0139)	0.8650***	(0.0136)
Cons (ω_0)	0.0497***	(0.0100)	0.0262***	(0.0054)
Log likelihood	-10456.43***			
ALPHA (α)	0.0256**		(0.0102)	
BETA (β)	0.9080***		(0.0410)	
	MSCI QATAR		W5DOW	
L1.W5DOW	0.0150	(0.0138)	0.1790***	(0.0181)
L1.MSCI QATAR	0.0079	(0.0222)	-0.0251*	(0.0141)
ARCH (ω_1)	0.0619***	(0.0039)	0.1090***	(0.0114)
GARCH (ω_2)	0.9570***	(0.0020)	0.8700***	(0.0133)
Cons (ω_0)	-0.0005	(0.0004)	0.0262***	(0.0053)
Log likelihood	-9842.80***			
ALPHA (α)	0.0253		(0.0179)	
BETA (β)	0.5420*		(0.3130)	

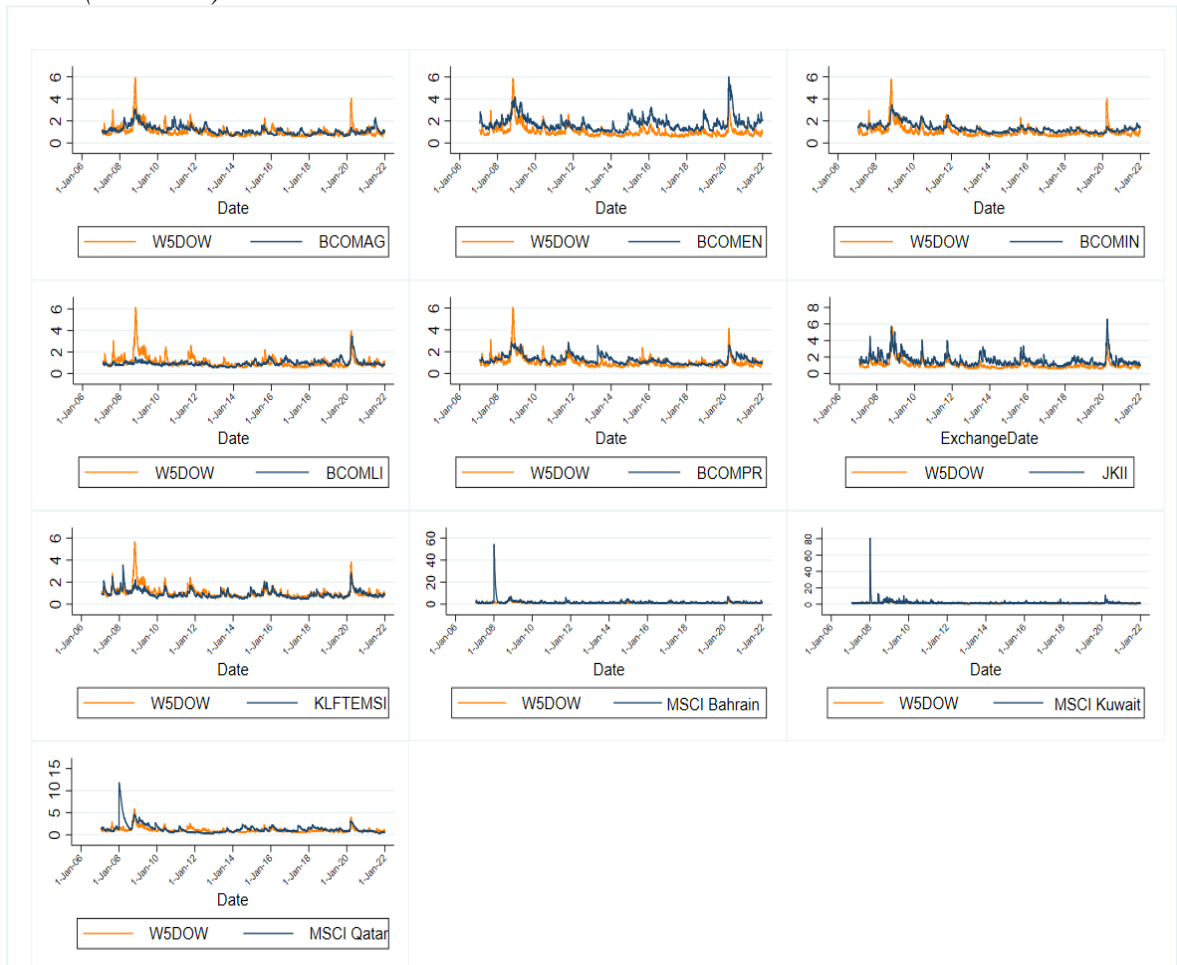
Notes: W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. L1, L2, L3, and L4 represent lag 1, lag 2, lag 3, and lag 4 which are determined by two common information criterions among Akaike Information Criterion, Hannan-Quinn Information Criterion and Schwarz Bayesian Information Criterion. ***, **, and * denote statistical significance levels at the 1%, 5% and 10%, respectively. Standard errors are reported in parentheses.

Conditional Volatilities

Referring to DCC-GARCH estimation result, this paper analyses further on the conditional volatility between each index and Dow Jones Emerging Market Index (W5DOW). As illustrated in figure 1, the volatility of all indices had significant jump during the GFC and during Covid-19 crisis, especially MSCI Bahrain and MSCI Kuwait that spike to almost 60 and 80 points during the GFC. Then, this paper applies conditional variance and conditional covariance of each index to calculate conditional correlation accordingly. The results of conditional correlations are presented in the following section.



Figure 1: Whole period Conditional Volatility between Dow Jones Emerging Market Index (W5DOW) and selected indices.



Notes: The conditional volatility computed from the bivariate DCC-GARCH (1,1) between each index and Dow Jones Emerging Market Index (W5DOW). BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, and MSCI Qatar represents MSCI Qatar Price Index.

Conditional Correlation

Whole period Conditional Correlations

The descriptive statistic results of pairwise whole period conditional correlations are reported in Table 7. Notice that the time-varying conditional correlations of all indices is fluctuated which indicate various properties in different time horizon (Fig.2). However, the average correlation values are all positive, suggesting that most of the time all indices are positively correlated with W5DOW. The results are segregated to two panels which are commodity indices under panel A and Islamic stock indices under panel B.

As noticed from panel A, on average BCOMLI provides the highest diversification with the mean of conditional correlation of 0.169, followed by BCOMPR with an average time-varying conditional correlation of 0.204. While the BCOMIN offers the least diversification benefits by having the average value of 0.457. BCOMAG and BCOMEN are relatively comparable in term of the conditional correlation against W5DOW portfolio during the whole period. Besides, among all commodity indices, BCOMPR have the highest negative value of 150 or approximately 4.58% of total observations. Also, BCOMEN had around 0.12% of negative value for the whole time-series data. This implies that BCOMPR and BCOMEN serve as a hedging instrument in a few days across the time, but majority of property are a diversifier.

Furthermore, on panel B, the average conditional correlation of JKII and KLFTEMSI are larger than 0.5, 0.558 and 0.593, which indicate that they offer the lowest diversification benefits to the portfolio. MSCI Kuwait and MSCI Bahrain on

average offer the highest diversification benefits to portfolio among all Islamic stock indices with the lowest correlation of 0.086 and 0.087 comparatively. While MSCI Qatar has the correlation of 0.222 on average. In term of negative value of conditional correlations, MSCI Bahrain (MSCI Qatar) has the highest (lowest) negative value of 388 (2) or 9.86% (0.06%) of total observations. MSCI Kuwait also provide relatively high value of negative figures of 194 days with the percentage of 5.66%.

As compared between two panels, it is noticed that Islamic stock indices namely MSCI Bahrain and MSCI Kuwait offer the greatest diversification benefits on average. It is then followed by BCOMLI and BCOMPR of commodity indices. Simultaneously, Islamic stock indices such as JKII and KLFTEMSI also have the least diversification benefits among all indices. Besides, following the definition given by Baur and Lucey (2010), among all selected indices, BCOMPR has the minimum conditional correlation for W5DOW portfolio when the correlations of return fall below zero and it reaches the bottom at approximately -0.23 at some points where the correlations range between -0.228 and 0.524. Following by MSCI Kuwait with the conditional correlations between -0.207 and 0.410 comparatively. Additionally, MSCI Bahrain, MSCI Qatar and BCOMEN also serve as hedging interment to lower portfolio volatility in some periods with minimum correlation of -0.127, -0.049 and -0.017 respectively. Whereas most of the time, all indices are considered a diversifier to the portfolio during study period.

According to a t-test, it is to test whether the conditional correlations are statistical significance with the null hypothesis stated that the correlation is equal to zero. From the t-test analysis, the null hypothesis is rejected at the 1% statistically significant level, implying that there is a relationship between selected indices and

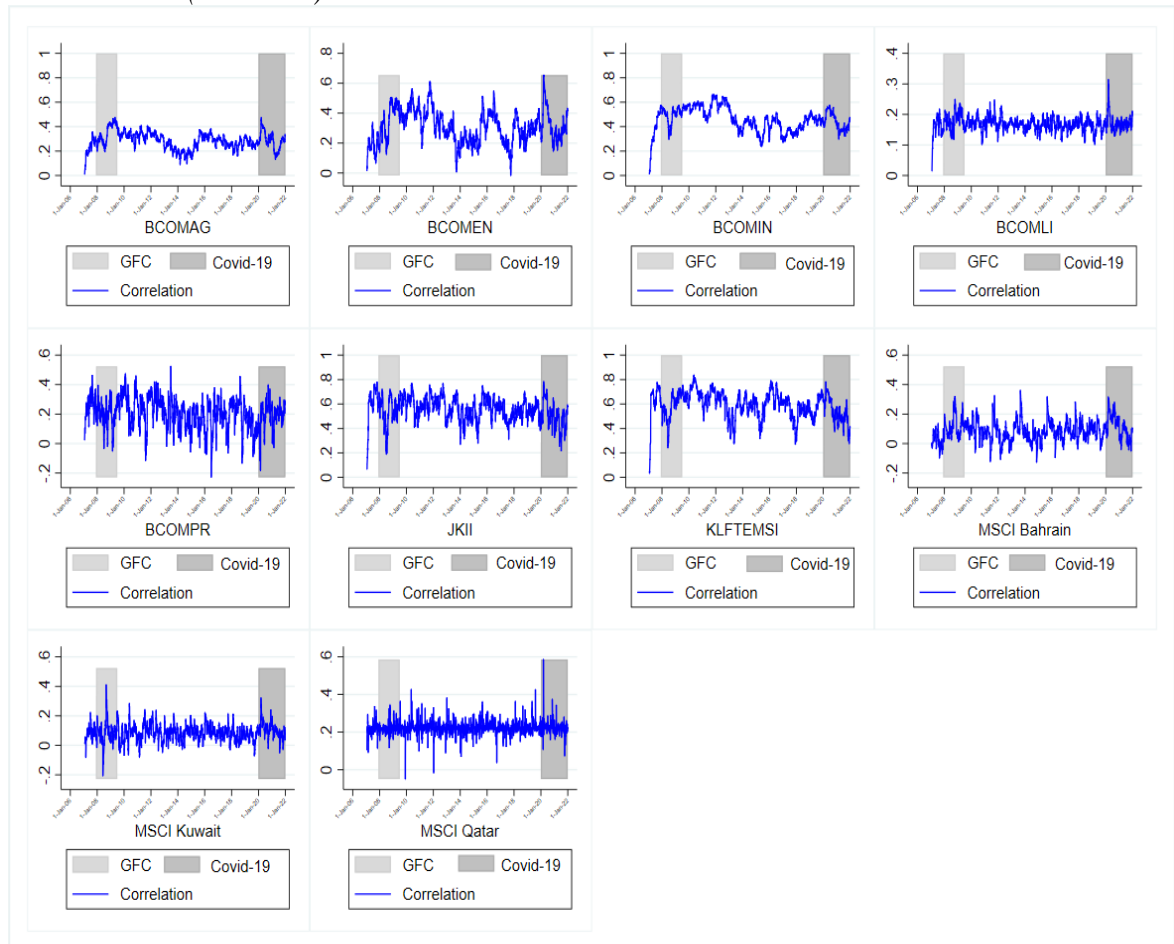
W5DOW in the study period. Besides, the Augmented Dickey-Fuller (ADF) on conditional correlations is also examined. The results show that all indices reject the null hypothesis that unit root is present, and it is highly statistically significant. It is said that the conditional correlation is stationary.

Table 7: Descriptive statistic of Conditional Correlations for whole period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	t-test	ADF	No. of Neg. (%)	No. of Pos. (%)
Panel A Commodity Indices										
BCOMAG	3,426	0.284	0.070	0.286	0.009	0.476	236.24***	-4.12***	0 (0%)	3,426 (100%)
BCOMEN	3,427	0.310	0.112	0.304	-0.017	0.655	162.40***	-3.53***	4 (0.12%)	3,423 (99.88%)
BCOMIN	3,427	0.457	0.098	0.461	0.013	0.664	273.01***	-3.58***	0 (0%)	3,427 (100%)
BCOMLI	3,424	0.169	0.024	0.169	0.013	0.315	420.26***	-8.35***	0 (0%)	3,424 (100%)
BCOMPR	3,427	0.204	0.105	0.216	-0.228	0.524	114.20***	-7.12***	150 (4.58%)	3,277 (95.42%)
Panel B Islamic Stock Indices										
JKII	3,425	0.558	0.099	0.565	0.062	0.783	143.93***	-5.28***	0 (0%)	3,425 (100%)
KLFTEMSI	3,425	0.593	0.111	0.609	0.028	0.837	313.90***	-6.12***	0 (0%)	3,425 (100%)
MSCI Bahrain	3,427	0.087	0.073	0.081	-0.127	0.361	69.50***	-5.78***	338 (9.86%)	3,089 (90.14%)
MSCI Kuwait	3,425	0.086	0.056	0.086	-0.207	0.410	90.28***	-9.05***	194 (5.66%)	3,231 (94.34%)
MSCI Qatar	3,427	0.222	0.029	0.221	-0.049	0.586	453.53***	-18.61***	2 (0.06%)	3,425 (99.94%)

Notes: This table reports Descriptive Statistic of whole period Dynamic Conditional Correlation. Std. Dev. Represents Standard Deviation. Med. Represent Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. Test for dynamic conditional correlation reports t-statistic, the null hypothesis is that dynamic conditional correlation equals to zero. The unit root test reports the ADF statistic which based on the number of lags that offer two common information criterions among Akaike Information Criterion, Hannan-Quinn Information Criterion and Schwarz Bayesian Information Criterion, the null hypothesis is that a unit root presents. No. of Neg. and No. of Pos. represent number of negative and positive value from time-series data. % is computed as the number of negative and positive dynamic conditional correlations divided by the total number of observations over this sub sample period. ***, **, * denotes statistical significance at the 1%, 5%, and 10%, respectively.

Figure 2: Whole period Conditional Correlations between Dow Jones Emerging Market Index (W5DOW) and selected indices.



Notes: The dynamic conditional correlations computed from the bivariate DCC-GARCH (1,1) model with pairwise computation over the full sample period is presented in this figure. BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, and MSCI Qatar represents MSCI Qatar Price Index, GFC represents Global Financial Crisis 2008-2009, Covid-19 represents Novel Coronavirus.

Subperiod Conditional Correlations

Table 8 reports descriptive statistics of conditional correlations during pre-subprime crisis period, the date ranges from January 23, 2007, to November 30, 2007. From panel A, surprisingly, BCOMLI on average has the lowest conditional correlation value among all commodity indices with the average of 0.159, followed by BCOMEN at the mean of 0.185, implying that they have the highest diversification benefits to the portfolio. While BCOMAG (0.227) and BCOMPR (0.262), and BCOMIN (0.359) do not provide comparative performance as a diversifier. As noticed, BCOMIN offers the lowest diversification benefits (0.359) among all commodity indices. In this period, there is no negative value of commodity indices, implying that these commodity indices can be served as the diversifier to the portfolio not as the hedging instrument through the time horizon.

In addition, the average correlation results of panel B present that MSCI Bahrain provides the highest diversification benefits by having average conditional correlation close to zero at 0.016, followed by MSCI Kuwait with average correlation of 0.085. Both indices also consider as a hedger for the portfolio for risk reduction at small points during the period with the negative value of 78 days (39%) and 4 days (2.02%) of total observations, respectively. MSCI Qatar, at the same time has the conditional correlation of 0.217 and serve as a diversifier to the portfolio. While the worst performances during the period are JKII and KLFTEMSI which is consistent with the whole period result as shown in table 6. In short, selected Islamic stocks indices offer both the highest and the lowest advantages by including in W5DOW portfolio.

Among all indices under consideration, MSCI Bahrain offers the lowest correlation of return at 0.016 and average correlation of 0.085 for MSCI Kuwait. Followed by BCOMLI and BCOMEN that outperform other selected indices. While the lowest benefits of diversification provided by JKII and KLFTEMSI. The observed conditional correlations are all statistically significant at the 1% level. This can be interpreted that the correlation between benchmark portfolio and all selected indices exist. Nevertheless, the ADF results are mostly fails to reject the null hypothesis that the unit root is present except two indices including KLFTEMSI and MSCI Qatar that present the stationary of correlation at the 10% and 1% significant level respectively. This implies that rebalancing the portfolio with non-stationary would provide less positive impact on portfolio performance, any improvement in portfolio performance during the period may be due to luck (Chen & Tongurai, 2021; Olson et al., 2017).

Table 8: Descriptive statistic of Conditional Correlations during Pre-Subprime crisis period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	t-test	ADF	No. of Neg. (%)	No. of Pos. (%)
Panel A Commodity Indices										
BCOMAG	199	0.227	0.076	0.241	0.009	0.355	41.96***	-1.94	0 (0%)	199 (100%)
BCOMEN	200	0.185	0.068	0.182	0.019	0.339	38.25***	-1.78	0 (0%)	200 (100%)
BCOMIN	200	0.359	0.145	0.387	0.013	0.575	35.02***	-1.63	0 (0%)	200 (100%)
BCOMLI	197	0.159	0.034	0.168	0.013	0.218	65.16***	-3.18	0 (0%)	197 (100%)
BCOMPR	200	0.262	0.084	0.271	0.020	0.463	43.94***	-1.68	0 (0%)	200 (100%)
Panel B Islamic Stock Indices										
JKII	198	0.606	0.154	0.632	0.062	0.779	55.29***	-2.13	0 (0%)	198 (100%)
KLFTEMSI	198	0.623	0.165	0.681	0.028	0.775	53.06***	-3.79*	0 (0%)	198 (100%)
MSCI Bahrain	200	0.016	0.051	0.014	-0.098	0.137	4.56***	-1.07	78 (39%)	122 (61%)
MSCI Kuwait	198	0.085	0.047	0.081	-0.082	0.222	25.09***	-2.14	4 (2.02%)	194 (97.98%)
MSCI Qatar	200	0.217	0.031	0.217	0.093	0.337	99.03***	-4.82***	0 (0%)	200 (100%)

Notes: This table reports Descriptive Statistic of subperiod Dynamic Conditional Correlation. Std. Dev. Represents Standard Deviation. Med. Represent Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. Test for dynamic conditional correlation reports t-statistic, the null hypothesis is that dynamic conditional correlation equals to zero. The unit root test reports the ADF statistic which based on the number of lags that offer two common information criterions among Akaike Information Criterion, Hannan-Quinn Information Criterion and Schwarz Bayesian Information Criterion, the null hypothesis is that a unit root presents. No. of Neg. and No. of Pos. represent number of negative and positive value from time-series data. % is computed as the number of negative and positive dynamic conditional correlations divided by the total number of observations over this sub sample period. ***, **, * denotes statistical significance at the 1%, 5%, and 10%, respectively.

Table 9 depicts descriptive statistics of conditional correlations during subprime crisis period, the date covers between December 1, 2007, and June 30, 2009. Panel A shows that BCOMLI has an average of 0.181 which is the lowest conditional correlation of return. Comparatively, BCOMPR offer the second highest diversification benefits with the mean of 0.192 in this subprime crisis period. While the remaining indices, BCOMAG, BCOMEN, and BCOMIN do not perform very well as compared to the other two indices by having conditional correlation on average of 0.347, 0.356, and 0.494, sequentially. In the panel A, only BCOMPR present the negative value for 8 days correlation of return or 2.25% of total time-series data during GFC period.

In panel B, the average time-varying conditional correlation of MSCI Kuwait offers the highest diversification benefits by having correlation at 0.083 and 30 days of negative value of conditional correlations. Then followed by MSCI Bahrain with the mean conditional correlation of 0.118. MSCI Qatar tends to provide comparative benefits as a diversifier by having conditional correlation of 0.220. In contrary, the worst performed indices are from Islamic stock indices including JKII and KLFTEMSI where they reach their peak of conditional correlation at 0.721 and 0.730 during the crisis period.

Nevertheless, MSCI Kuwait and BCOMPR offer some negative correlations to the portfolio during this crisis period with the least correlation at -0.207 and -0.051 respectively, implying these two indices are a safe-haven instrument in a few days but most of the time are a diversifier, however, MSCI Kuwait provides the longer days as safe haven instrument than BCOMPR in the portfolio during financial market turbulence. While the other indices serve as a diversifier to W5DOW throughout the period. The t-test shows the conditional correlation are statistically significant at the 1% level. Besides, ADF are examined to determine whether the DCC is stationary. The ADF results depict that only MSCI Kuwait, MSCI Qatar, BCOMPR, and BCOMLI reject the null hypothesis that unit root is present at the 1%, 5%, and 10% significant level sequentially.

Table 9: Descriptive statistic of Conditional Correlations during Subprime crisis period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	t-test	ADF	No. of Neg. (%)	No. of Pos. (%)
Panel A Commodity Indices										
BCOMAG	355	0.347	0.080	0.342	0.197	0.476	81.17***	-0.20	0 (0%)	355 (100%)
BCOMEN	355	0.356	0.111	0.377	0.124	0.507	60.74***	-0.27	0 (0%)	355 (100%)
BCOMIN	355	0.494	0.065	0.515	0.295	0.576	143.93***	-0.93	0 (0%)	355 (100%)
BCOMLI	355	0.181	0.028	0.181	0.118	0.250	121.78***	-2.77*	0 (0%)	355 (100%)
BCOMPR	355	0.192	0.087	0.197	-0.051	0.396	41.35***	-2.99**	8 (2.25%)	347 (97.75%)
Panel B Islamic Stock Indices										
JKII	355	0.541	0.114	0.565	0.188	0.721	89.60***	-0.63	0 (0%)	355 (100%)
KLFTEMSI	355	0.579	0.106	0.587	0.242	0.730	103.31***	-1.69	0 (0%)	355 (100%)
MSCI Bahrain	355	0.118	0.073	0.099	0.013	0.320	30.49***	-2.53	0 (0%)	355 (100%)
MSCI Kuwait	355	0.083	0.080	0.083	-0.207	0.410	19.65***	-5.02***	30 (8.45%)	325 (91.55%)
MSCI Qatar	355	0.220	0.025	0.219	0.118	0.344	168.04***	-7.69***	0 (0%)	355 (100%)

Notes: This table reports Descriptive Statistic of subperiod Dynamic Conditional Correlation. Std. Dev. Represents Standard Deviation. Med. Represent Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. Test for dynamic conditional correlation reports t-statistic, the null hypothesis is that dynamic conditional correlation equals to zero. The unit root test reports the ADF statistic which based on the number of lags that offer two common information criterions among Akaike Information Criterion, Hannan-Quinn Information Criterion and Schwarz Bayesian Information Criterion, the null hypothesis is that a unit root presents. No. of Neg. and No. of Pos. represent number of negative and positive value from time-series data. % is computed as the number of negative and positive dynamic conditional correlations divided by the total number of observations over this sub sample period. ***, **, * denotes statistical significance at the 1%, 5%, and 10%, respectively.

Table 10 summarizes descriptive statistics of conditional correlations during Post Subprime and Pre Covid-19 Crisis Period, the date covers between July 1, 2009, and December 30, 2019. Surprisingly, most of the conditional correlations of all indices tend to decrease substantially as compared to the time-varying conditional correlations during global financial crisis. In panel A under commodity indices, BCOMLI still offers the least correlation value among all commodity indices with the average of 0.167. Followed by BCOMPR, which has average time-varying conditional correlation of 0.204. At the same time, BCOMAG, BCOMEN, and BCOMIN shows comparatively high conditional correlations of 0.279, 0.311, and 0.463 as compared to the other two indices. During the period, BCOMEN and BCOMPR act as a hedging instrument in

few days by having negative conditional correlation of 0.17% and 4.85% of time-varying data, respectively.

Simultaneously, for Islamic stock indices, on average, MSCI Bahrain and MSCI Kuwait provide the best diversification performances to the portfolio among all indices with correlation near zero at 0.082 and 0.083 respectively. Followed by MSCI Qatar that offers the time-varying conditional correlation of 0.222 which serves as a diversifier to W5DOW portfolio. While the average values of JKII and KLFTEMSI is greater than 0.5 with their peak at 0.768 and 0.837 showing highly positive correlation with W5DOW. Besides, the number of negative figures of conditional correlation for MSCI Bahrain (233), MSCI Kuwait (141), and MSCI Qatar (2) imply that these indices are served as hedging instrument in some days across period.

Among all indices, MSCI Bahrain offers the highest benefits of diversification and MSCI Kuwait is the second-best index that offers diversification benefits to the portfolio, and they are considered as the top performance that act as hedging instrument with the longest periods among all indices. While BCOMLI and BCOMPR also well-performed as compared to the remaining indices. BCOMPR also has relatively high value of negative figures as compared to the former indices, indicating that having a good performance to serve as hedging instrument in few days of this period. BCOMEN and MSCI Qatar serve as a hedging instrument in small periods while they serve as a diversifier for most of the time. In parallel, the remaining indices namely BCOMAG, BCOMIN, BCOMLI, JKII, and KLFTEMSI are purely acted as a diversifier to the portfolio during this period.

In addition, t-test shows the conditional correlations of all indices are statistically significant at the 1% level. While ADF are examined to determine whether the DCC is stationary. The ADF results presents that BCOMIN fails to reject the null hypothesis that unit root is present, whereas the other indices reject the null hypothesis that unit root is present at the 1% significant level, except BCOMAG and JKII reject the null hypothesis at the 5% significant level and BCOMEN rejects the null hypothesis at the 10% significant level.

Table 10: Descriptive statistic of Conditional Correlations during Post Subprime and Pre Covid-19 crisis period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	t-test	ADF	No. of Neg. (%)	No. of Pos. (%)
Panel A Commodity Indices										
BCOMAG	2,413	0.279	0.061	0.286	0.089	0.410	223.61***	-3.10**	0 (0%)	2,413 (100%)
BCOMEN	2,413	0.311	0.107	0.310	-0.017	0.611	142.32***	-2.74*	4 (0.17%)	2,409 (99.83%)
BCOMIN	2,413	0.463	0.096	0.459	0.237	0.664	236.29***	-1.50	0 (0%)	2,413 (100%)
BCOMLI	2,413	0.167	0.020	0.168	0.101	0.248	413.34***	-6.84***	0 (0%)	2,413 (100%)
BCOMPR	2,413	0.204	0.110	0.216	-0.228	0.524	91.46***	-5.83***	117 (4.85%)	2,296 (95.15%)
Panel B Islamic Stock Indices										
JKII	2,413	0.567	0.085	0.571	0.269	0.768	329.71***	-4.05**	0 (0%)	2,413 (100%)
KLFTEMSI	2,413	0.605	0.103	0.616	0.269	0.837	289.44***	-4.46***	0 (0%)	2,413 (100%)
MSCI Bahrain	2,413	0.082	0.068	0.080	-0.127	0.361	59.68***	-5.10***	233 (9.66%)	2,180 (90.34%)
MSCI Kuwait	2,413	0.083	0.052	0.084	-0.081	0.284	79.01***	-6.62***	141 (5.84%)	2,272 (94.16%)
MSCI Qatar	2,413	0.222	0.028	0.221	-0.049	0.427	393.75***	-8.96***	2 (0.08%)	2,411 (99.92%)

Notes: This table reports Descriptive Statistic of subperiod Dynamic Conditional Correlation. Std. Dev. Represents Standard Deviation. Med. Represent Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. Test for dynamic conditional correlation reports t-statistic, the null hypothesis is that dynamic conditional correlation equals to zero. The unit root test reports the ADF statistic which based on the number of lags that offer two common information criterions among Akaike Information Criterion, Hannan-Quinn Information Criterion and Schwarz Bayesian Information Criterion, the null hypothesis is that a unit root presents. No. of Neg. and No. of Pos. represent number of negative and positive value from time-series data. % is computed as the number of negative and positive dynamic conditional correlations divided by the total number of observations over this sub sample period. ***, **, * denotes statistical significance at the 1%, 5%, and 10%, respectively.

Table 11 demonstrates descriptive statistics of conditional correlations during Covid-19 Crisis Period, the date covers between December 31, 2019 – December 31, 2021. Notice from commodity stock indices that BCOMLI, and BCOMPR still outperform other indices in term of having the greatest diversification benefits among them, by having the conditional correlations on average of 0.173 and 0.188 respectively. BCOMAG, BCOMEN, and BCOMIN shows comparatively high conditional correlation of 0.286, 0.322, and 0.440, implying lower diversification benefits to W5DOW portfolio. During the period, only BCOMPR depicts the negative correlation value of 5.45% of time-varying data, showing a safe-haven property on the portfolio in a few days during the crisis.

Moreover, as noticed from Islamic stock indices, MSCI Kuwait continuously provide the best performance in diversifying the portfolio of W5DOW by providing the least correlation on average of 0.102 during the crisis. Followed by the MSCI Bahrain and MSCI Qatar which have the conditional correlations of 0.116 and 0.224 sequentially. Also, they present the negative value showing a safe-haven property during this period for around 5.88% and 4.14% of total days, while they are a diversifier for most of the times. Not surprisingly, JKII and KLFTEMSI on average still offer the least performance as a diversifier during this crisis period. However, their average conditional correlations are comparatively and relatively lower than the other periods in this study.

During this rough period, it is noticed that MSCI Kuwait, MSCI Bahrain, and BCOMPR can become a flight to quality to the portfolio as they show the negative conditional correlations in some periods. BCOMPR provides some negative

correlations between W5DOW and itself, implying that it is a safe-haven instrument to the portfolio at small days during crisis. However, the periods of being the safe-haven instrument between MSCI Bahrain and BCOMPR are comparable, while MSCI Kuwait become safe haven to portfolio with shorter time period. Even though they serve as a safe haven in few days, but they mostly serve as a diversifier to portfolio, while the other indices are served as diversifier to the portfolio across the crisis. All the conditional correlations are statistically significant at the 1% level as examined by the t-test. Meanwhile, ADF is examined to determine whether the unit root is present in conditional correlations. The ADF results present that all indices fail to reject the null hypothesis that unit root exists, except MSCI Kuwait and MSCI Qatar that reject the null hypothesis that unit root is present at the 1% significant level.

Table 12 presents the analysis of unpaired t-test for the differences between average conditional correlations in contiguous subperiods. As notice in the period of pre-global financial crisis and during global financial crisis, there are significant difference of average conditional correlations between two periods for majority indices which has statistically significance at the 1% level. While MSCI Kuwait and MSCI Qatar fail to reject the null hypothesis of the differences between average conditional correlations between pre GFC and during GFC. The average dynamic conditional correlations of indices in panel A during GFC increase substantially, except for BCOMPR that provide less average conditional correlations during GFC period from 0.262 to 0.192. The incremental of conditional correlations against stock portfolio during GFC from the precrisis period is concurrent with commodity financialization (Tang & Xiong, 2018) where large number of investors started to invest and incorporate in the commodity index. While in panel B, MSCI Kuwait, JKII, and KLFTEMSI offer

less average time-varying conditional correlations than pre GFC period, from 0.085, 0.606 and 0.623 to 0.083, 0.541, and 0.579 respectively, implying that they offer better performance in diversifying portfolio during crisis period.

In comparison of average conditional correlations between during global financial crisis period and post global financial crisis period in table 12, it depicts that the difference of average conditional correlations of these two periods are mostly statistically significance at the 1% level, except for BCOMPR which is statistically significant at the 5% level, while MSCI Kuwait and MSCI Qatar fail to reject the null hypothesis showing that there is no different between average conditional correlations between two periods. The overall results surprisingly depict the decreasing of conditional correlations during post GFC, except for BCOMPR in panel A that increase its correlation from 0.192 during GFC to 0.204 during post GFC. Similarly, MSCI Qatar also presents the higher correlations against W5DOW during post GFC from 0.220 to 0.222, while the other indices in panel B show the less conditional correlations between W5DOW and themselves during the post GFC as compared to GFC period. As notice, overall average conditional correlations tend to be less in the normal period after the burst in GFC.

Furthermore, the comparison results of post GFC period and during Covid-19 period are also reported in table 12. As shown, the difference of average conditional correlations between these two periods for majority indices are statistically significance at the 1% level, while BCOMAG and BCOMEN depict the significant level of the 10% and MSCI Qatar fail to reject the null hypothesis showing that there is no different between average conditional correlations between two periods. The conditional

correlations of commodity indices show the same pattern as the comparison between pre-crisis and during the GFC. In this regard, during Covid-19 crisis, the commodity indices in panel A have greater time-varying conditional correlations than during post GFC period, except for BCOMPR that show less correlation from 0.204 to 0.188. In panel B, MSCI Bahrain, MSCI Kuwait and MSCI Qatar shows the greater conditional correlations during the Covid-19 than then post GFC from 0.082, 0.083, and 0.222 to 0.116, 0.102, and 0.224, respectively. The higher correlations during crisis period are considered as a correlation breakdown which comove with the benchmark index. Whereas JKII and KLFTEMSI show the less correlation comparatively. As observed, during this crisis period, the conditional correlations between index and cross market indices against conventional stock market increase substantially (Alqaralleh & Canepa, 2021; Wang et al., 2020).

Moreover, this study also compares the average conditional correlations between two major crises namely GFC and Covid-19 and it is summarized in table 12. The results of sample t-test explain that the difference of average conditional correlations between the two periods are statistically significance at the 1% level, except MSCI Qatar which is statistically significant at the 5% level. In contrary, BCOMPR and MSCI Bahrain do not present the difference on average conditional correlations between the periods. As notice in panel A, all commodity indices present significantly less average time-varying conditional correlation during Covid-19, indicating that they perform comparatively better in term of portfolio diversification in Covid-19 crisis. Simultaneously, in panel B, JKII, KLFTEMSI, and MSCI Bahrain also show relatively fewer average correlations during Covid-19 which reduce from 0.541, 0.579, and 0.118 to 0.503, 0.533, and 0.116 sequentially, indicating stronger

diversification benefits. Whereas MSCI Kuwait and MSCI Qatar shows greater average correlation during covid-19 period.

Table 11: Descriptive statistic of Conditional Correlations during Covid-19 crisis period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	t-test	ADF	No. of Neg. (%)	No. of Pos. (%)
Panel A Commodity Indices										
BCOMAG	459	0.286	0.072	0.288	0.132	0.476	85.59***	-1.55	0 (0%)	459 (100%)
BCOMEN	459	0.322	0.112	0.297	0.145	0.655	61.62***	-0.54	0 (0%)	459 (100%)
BCOMIN	459	0.440	0.070	0.429	0.298	0.573	134.35***	-0.95	0 (0%)	459 (100%)
BCOMLI	459	0.173	0.028	0.169	0.128	0.315	134.48***	-2.37	0 (0%)	459 (100%)
BCOMPR	459	0.188	0.088	0.207	-0.183	0.398	45.92***	-1.97	25 (5.45%)	434 (94.55%)
Panel B Islamic Stock Indices										
JKII	459	0.503	0.107	0.505	0.217	0.783	100.79***	-1.91	0 (0%)	459 (100%)
KLFTEMSI	459	0.533	0.104	0.526	0.276	0.781	109.80***	-2.39	0 (0%)	459 (100%)
MSCI Bahrain	459	0.116	0.081	0.114	-0.051	0.316	30.64***	-2.27	27 (5.88%)	432 (94.12%)
MSCI Kuwait	459	0.102	0.053	0.099	-0.051	0.323	41.23***	-4.06***	19 (4.14%)	440 (95.86%)
MSCI Qatar	459	0.224	0.034	0.222	0.074	0.586	139.54***	-3.62***	0 (0%)	459 (100%)

Notes: This table reports Descriptive Statistic of subperiod Dynamic Conditional Correlation. Std. Dev. Represents Standard Deviation. Med. Represent Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. Test for dynamic conditional correlation reports t-statistic, the null hypothesis is that dynamic conditional correlation equals to zero. The unit root test reports the ADF statistic which based on the number of lags that offer two common information criterions among Akaike Information Criterion, Hannan-Quinn Information Criterion and Schwarz Bayesian Information Criterion, the null hypothesis is that a unit root presents. No. of Neg. and No. of Pos. represent number of negative and positive value from time-series data. % is computed as the number of negative and positive dynamic conditional correlations divided by the total number of observations over this sub sample period. ***, **, * denotes statistical significance at the 1%, 5%, and 10%, respectively.

Table 12: Comparison of Conditional Correlations between subperiods.

Indices	Pre GFC		During GFC			During GFC		Post GFC		
	23/01/2007-30/11/2007		01/12/2007-30/06/2009			01/12/2007-30/06/2009		01/07/2009-30/12/2019		
	Mean	Std. Dev.	Mean	Std. Dev.	t-test	Mean	Std. Dev.	Mean	Std. Dev.	t-test
Panel A Commodity Indices										
BCOMAG	0.227	0.076	0.347	0.080	-17.38***	0.347	0.080	0.279	0.061	15.16***
BCOMEN	0.185	0.068	0.356	0.111	-22.50***	0.356	0.111	0.311	0.107	7.21***
BCOMIN	0.359	0.145	0.494	0.065	-12.54***	0.494	0.065	0.463	0.096	7.71***
BCOMLI	0.159	0.034	0.181	0.028	-7.73***	0.181	0.028	0.167	0.020	8.98***
BCOMPR	0.262	0.084	0.192	0.087	9.36***	0.192	0.087	0.204	0.110	-2.50**
Panel B Islamic Stock Indices										
JKII	0.606	0.154	0.541	0.114	5.15***	0.541	0.114	0.567	0.085	-4.11***
KLFTEMSI	0.623	0.165	0.579	0.106	3.39***	0.579	0.106	0.605	0.103	-4.36***
MSCI Bahrain	0.016	0.051	0.118	0.073	-19.25***	0.118	0.073	0.082	0.068	8.77***
MSCI Kuwait	0.085	0.047	0.083	0.080	0.23	0.083	0.080	0.083	0.052	0.09
MSCI Qatar	0.217	0.031	0.220	0.025	-1.28	0.220	0.025	0.222	0.028	-1.09

Table 12: Continue

Indices	Post GFC		During Covid-19			During GFC		During Covid-19		
	01/07/2009-30/12/2019		31/12/2009-31/12/2021			01/12/2007-30/06/2009		31/12/2009-31/12/2021		
	Mean	Std. Dev.	Mean	Std. Dev.	t-test	Mean	Std. Dev.	Mean	Std. Dev.	t-test
Panel A Commodity Indices										
BCOMAG	0.279	0.061	0.286	0.072	2.11**	0.347	0.080	0.286	0.072	11.36***
BCOMEN	0.311	0.107	0.322	0.112	1.95*	0.356	0.111	0.322	0.112	4.37***
BCOMIN	0.463	0.096	0.440	0.070	4.92***	0.494	0.065	0.440	0.070	11.20***
BCOMLI	0.167	0.020	0.173	0.028	5.29***	0.181	0.028	0.173	0.028	4.13***
BCOMPR	0.204	0.110	0.188	0.088	2.99***	0.192	0.087	0.188	0.088	0.54
Panel B Islamic Stock Indices										
JKII	0.567	0.085	0.503	0.107	14.27***	0.541	0.114	0.503	0.107	4.95***
KLFTEMSI	0.605	0.103	0.533	0.104	13.73***	0.579	0.106	0.533	0.104	6.20***
MSCI Bahrain	0.082	0.068	0.116	0.081	9.43***	0.118	0.073	0.116	0.081	0.45
MSCI Kuwait	0.083	0.052	0.102	0.053	7.37***	0.083	0.080	0.102	0.053	4.07***
MSCI Qatar	0.222	0.028	0.224	0.034	1.72*	0.220	0.025	0.224	0.034	1.89*

Notes: Std. Dev. represent Standard Deviation. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. Test for conditional correlations result comparison reports unpaired t-statistic where the former period minus the later period, the null hypothesis is that there is no different between average conditional correlations of two periods. ***, **, * denotes statistical significance at the 1%, 5%, and 10%, respectively.

Time-varying Hedge Ratio and Hedging Effectiveness

This study uses the estimated conditional covariance and conditional variance from the DCC-GARCH model to estimate the hedge ratio (Kroner & Sultan, 1993; Kumar, 2014) between benchmark index (W5DOW) and selected commodities indices and Islamic stock indices as pairwise calculation by using equation (9). Besides, return and variance of hedge portfolios are constructed to estimate hedging effectiveness (HE) by using equation (12) and equation (14) respectively. Then, to compute the hedging effectiveness of each index, the paper applies equation (10) in the calculation. The hedge ratio and hedging effectiveness are estimated under different market conditions.

In this study, the computations are reported by using descriptive statistic of hedge ratios for each period. As observed, the results of both hedge ratio and hedging effectiveness are wild range variations among all indices. Besides, Augmented Dickey-Fuller (ADF) test is determined whether a unit root is present in the time-varying hedge ratios. The number of lag length uses in ADF test is determined by following two common Information Criteria among AIC, HQIC, and SBIC.

Whole period Time-varying Hedge Ratio and Hedging Effectiveness

Table 13 summarizes the whole sample period descriptive statistics of the time-varying hedge ratios and hedging effectiveness on average. The results show the dynamic hedge ratio varies considerably across all indices (Fig. 3). In panel A for commodity indices, BCOMAG, the time varying hedge ratio ranges from 0.009 to 1.396 with an average ratio of 0.274, or -0.011 to 0.886 units of BCOMEN with an average ratio of 0.195 to hedge one unit of W5DOW. While the time-varying hedge ratio for BCOMIN has an average hedge ratio of 0.359, BCOMLI requires

approximately 0.015 to 1.013 units and BOMPR needs 0.170 units on average for hedging W5DOW. For panel B of Islamic stock indices, hedge ratio for JKII ranges between 0.043 to 1.073 with 0.378 on average hedge ratio, whereas the hedge ratios of MSCI Kuwait is ranged between -0.136 and 0.499 with an average value of 0.074, and MSCI Qatar is between -0.029 and 1.121 with a mean average of 0.232.

Eventually, KLFTEMSI provides the most expensive hedge (the highest value) on average. The finding indicates that a long position in one dollar of W5DOW can be hedged by a short position in 68.22 cent of KLFTEMSI. While the cheapest (the lowest value) average hedge is reported as 0.067 from MSCI Bahrain price index, implying that if the investors long one dollar of W5DOW, they should short only 6.70 cent in MSCI Bahrain price index for portfolio risk minimization. Additionally, there are five indices namely BCOMEN, BCOMPR, MSCI Bahrain, MSCI Kuwait and MSCI Qatar, present negative values of dynamic hedge ratio for 4 days, 150 days, 338 days, 194 days, and 2 days, respectively. The negative value of hedge ratios can be interpreted that investors are required to take long position in these indices to hedging long position in Dow Jones Emerging market index in certain period.

According to ADF test on hedge ratios, the results reveal that BCOMIN, BCOMLI and KLFTEMSI fail to reject null hypothesis that a unit root is present in hedge ratio. It is said that hedge ratios with unit root is considered as random hedge ratio. Therefore, rebalancing the portfolio which has random walk hedge ratio would provide less positive impact on portfolio performance, any enhancement in portfolio performance may be due to luck (Chen & Tongurai, 2021; Olson et al., 2017). In contrary, the rest of the index rejects the null hypothesis of unit root at 1% significant

level, denoted that the impact of shocks on the hedge ratio eventually becomes negligible (Jitmaneeroj, 2018).

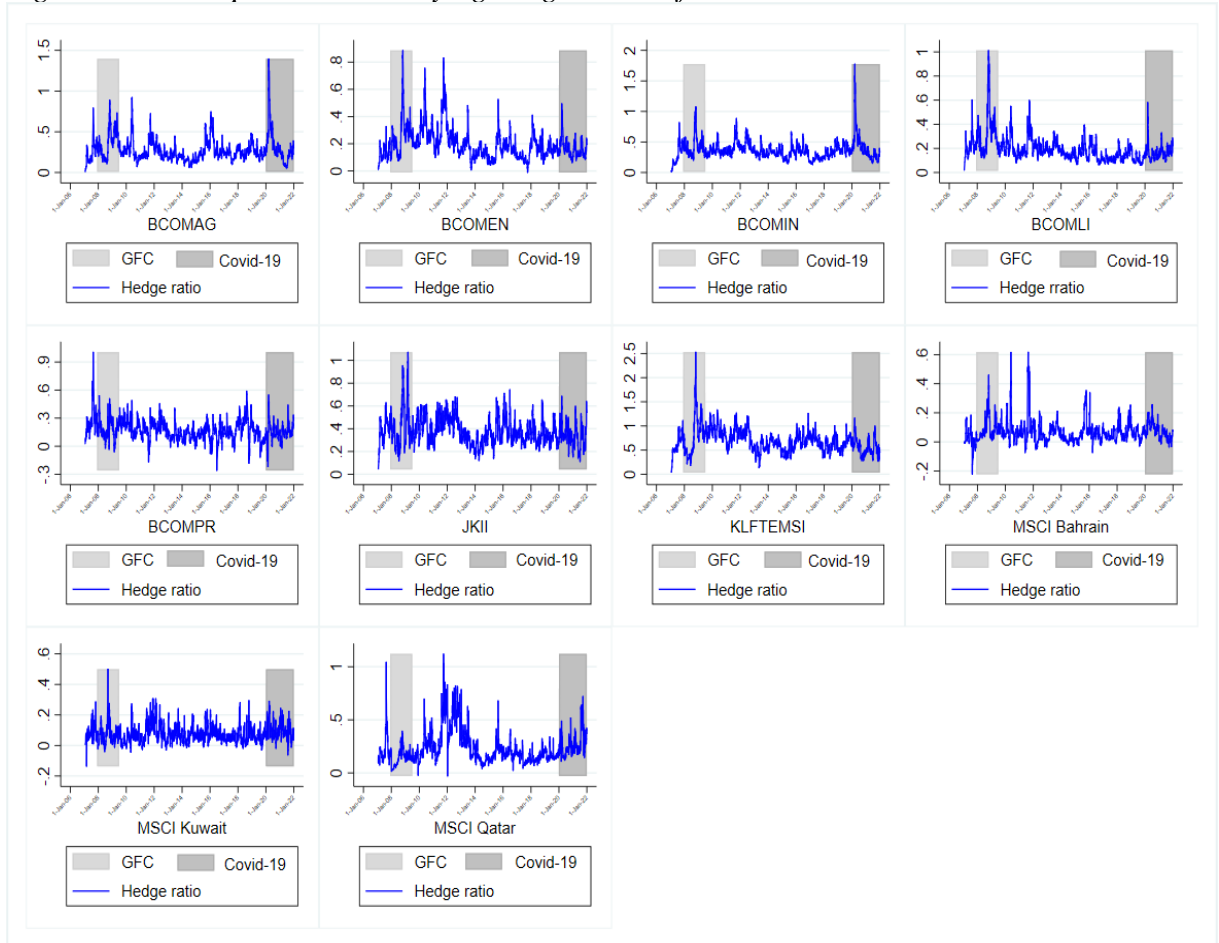
Moreover, hedging effectiveness is calculated. The result shows that the HE varies widely among selected indices and ranges between a maximum of 42.58% for KLFTEMSI and minimum of 1.77% for MSCI Kuwait. It is noted that KLFTEMSI provides the highest hedging effectiveness by including as a part of hedging strategy in the portfolio with the reduction of variance at 42.58%. While including JKII also reduces the overall risk of holding W5DOW by 38.64%. For BCOMEN, the HE is at 26.11%, whereas BCOMEN and BCOMAG have HE of 16.35% and 14.17% respectively. On the other hand, BCOMLI, BCOMPR, MSCI Bahrain, MSCI Kuwait, MSCI Qatar are not effectively hedged the portfolio as the results show small amount of risk reduction in the portfolio just by under 10%.

Table 13: Descriptive statistic of time-varying Hedge Ratio and Hedging Effectiveness for whole period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	ADF	No. of Neg (%)	Var. Hedge	Var. Unh.	Hedging Eff.
Panel A Commodity Indices											
BCOMAG	3426	0.274	0.145	0.242	0.009	1.396	-5.28***	0 (0%)	1.283	1.495	14.17%
BCOMEN	3427	0.195	0.112	0.174	-0.011	0.886	-4.58***	4 (0.12%)	1.248	1.495	16.53%
BCOMIN	3427	0.359	0.145	0.340	0.011	1.777	-2.28	0 (0%)	1.105	1.495	26.11%
BCOMLI	3424	0.191	0.103	0.169	0.015	1.013	-1.90	0 (0%)	1.413	1.496	5.51%
BCOMPR	3427	0.170	0.110	0.160	-0.260	1.006	-6.24***	150 (4.38%)	1.432	1.495	4.22%
Panel B Islamic Stock Indices											
JKII	3425	0.378	0.123	0.355	0.043	1.073	-6.52***	0 (0%)	0.918	1.496	38.64%
KLFTEMSI	3425	0.682	0.237	0.669	0.034	2.528	-1.29	0 (0%)	0.859	1.496	42.58%
MSCI Bahrain	3427	0.067	0.076	0.054	-0.222	0.617	-7.23***	338 (9.86%)	1.453	1.495	2.84%
MSCI Kuwait	3425	0.074	0.056	0.066	-0.136	0.499	-12.37***	194 (5.66%)	1.469	1.496	1.77%
MSCI Qatar	3427	0.232	0.150	0.184	-0.029	1.121	-5.73***	2 (0.06%)	1.365	1.495	8.71%

Notes: Std. Dev. represent Standard Deviation. Med. represents Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. No. of Neg represent number of negative values from time-series data. % is computed as the number of negative dynamic hedge ratio divided by the total number of observations over this subsample period. Var. Hedge and Var. Unh. represent variance of hedge portfolio and variance of unhedged portfolio respectively. Hedging Eff. represents Hedging Effectiveness. ***, **, * denotes rejecting of null hypothesis that a unit root is present in a time series sample at the 1%, 5%, and 10% statistically significant level respectively.

Figure 3: Whole period time-varying hedge ratios of all indices.



Notes: The daily dynamic hedge ratio is presented in this figure. BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, and MSCI Qatar represents MSCI Qatar Price Index, GFC represents Global Financial Crisis 2008-2009, Covid-19 represents Novel Coronavirus.

Subperiod Time-varying Hedge Ratios and Hedging Effectiveness

Table 14 presents the descriptive statistics of Pre-Subprime Crisis Period of average hedge ratios and hedging effectiveness. During this period, hedge ratio varies across all indies. In panel A, the average hedge ratio for BCOMAG, BCOMIN, BCOMLI, and BCOMPR are relatively comparable with the average hedge ratio value of 0.246, 0.283, 0.216, 0.2812, and 0.227 respectively. While BCOMEN provide the lowest hedge ratio among all commodity indices at 0.131. For panel B, the highest hedge ratio value is 0.607 for the KLFTEMSI. While MSCI Bahrain has the lowest hedge ratio at 0.0125. The hedge ratio of MSCI Bahrain swung between -0.222 and 0.185 with an average value of 0.012, and MSCI Kuwait is between -0.136 and 0.286 with a mean average of 0.081. JKII provides the average hedge ratio of 0.382 and MSCI Qatar has the hedge ratio of 0.227. In this period, MSCI Bahrain and MSCI Kuwait consist of the negative values of hedge ratio for 39% and 2.02% of total observations which can be interpreted that the investors need to take long position in these indices to hedging long position in the portfolio at some point.

According to ADF test on hedge ratios, the results reveal that BCOMAG, BCOMIN, BCOMPR, KLFTEMSI and MSCI Bahrain fail to reject null hypothesis that a unit root is present in dynamic hedge ratio. It is said that hedge ratios with unit root is considered as random hedge ratio. In contrary, BCOMEN and JKII reject the null hypothesis of unit root is present at the 5% statistically significant level, whereas BCOMLI, MSCI Kuwait and MSCI Qatar reject the null hypothesis of unit root is present at the 1% statistically significant level, denoted that the impact of shocks on the hedge ratio eventually becomes negligible (Jitmaneroj, 2018).

Furthermore, hedging effectiveness is determined in this period. The result shows that the HE values vary widely among selected indices and ranges between a maximum of 58.22% for KLFTEMSI and minimum of -4.43% for BCOMEN for portfolio variance reduction. The negative HE of BCOMEN (-4.43%) and MSCI Kuwait (-0.60%) refers to the hedging inefficient for the portfolio risk reduction. Besides, among all commodity indices, BCOMIN offers the highest HE at 30.12% during this period. While BCOMAG, BCOMLI, MSCI Bahrain, and MSCI Qatar are considerably ineffective hedge as the HE is lower than 10% (Jitmaneroj, 2018).

Table 14: Descriptive statistic of time-varying Hedge Ratio and Hedging Effectiveness during Pre-Subprime crisis period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	ADF	No. of Neg (%)	Var. Hedge	Var. Unh.	Hedging Eff.
Panel A Commodity Indices											
BCOMAG	199	0.246	0.149	0.204	0.009	0.794	-2.37	0 (0%)	1.449	1.608	9.92%
BCOMEN	200	0.131	0.056	0.134	0.012	0.328	-2.87**	0 (0%)	1.678	1.607	-4.43%
BCOMIN	200	0.283	0.179	0.226	0.011	0.819	-1.82	0 (0%)	1.123	1.607	30.12%
BCOMLI	107	0.216	0.086	0.208	0.015	0.603	-3.83***	0 (0%)	1.566	1.616	3.09%
BCOMPR	200	0.281	0.175	0.249	0.019	1.006	-2.36	0 (0%)	1.405	1.607	12.60%
Panel B Islamic Stock Indices											
JKII	198	0.382	0.113	0.396	0.043	0.630	-3.35**	0 (0%)	0.737	1.615	54.37%
KLFTEMSI	198	0.607	0.210	0.591	0.034	1.112	-0.91	0 (0%)	0.675	1.615	58.22%
MSCI Bahrain	200	0.012	0.069	0.010	-0.222	0.185	-1.73	78 (39%)	1.606	1.607	0.08%
MSCI Kuwait	198	0.081	0.055	0.073	-0.136	0.286	-3.67***	4 (2.02%)	1.624	1.615	-0.60%
MSCI Qatar	200	0.227	0.152	0.174	0.074	1.043	-5.08***	0 (0%)	1.491	1.607	7.26%

Notes: Std. Dev. represent Standard Deviation. Med. represents Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. No. of Neg represent number of negative values from time-series data. % is computed as the number of negative dynamic hedge ratio divided by the total number of observations over this subsample period. Var. Hedge and Var. Unh. represent variance of hedge portfolio and variance of unhedged portfolio respectively. Hedging Eff. represents Hedging Effectiveness. ***, **, * denotes rejecting of null hypothesis that a unit root is present in a time series sample at the 1%, 5%, and 10% statistically significant level respectively.

Table 15 depicts average hedge ratios and hedging effectiveness during Global Financial Crisis. As notice in panel A, for BCOMAG, the hedge ratio swung from 0.107 to 0.891 with an average ratio of 0.365, or 0.073 to 0.886 units of BCOMEN with an average ratio of 0.265 to hedge one unit of W5DOW. While the time-varying hedge ratio for BCOMIN has an average hedge ratio of 0.426, BCOMLI requires approximately 0.119 to 1.013 units and BCOMPR needs 0.181 units on average for hedging W5DOW. Simultaneously, in panel A, on average, MSCI Kuwait is the cheapest hedge ratio among all indices with the hedge ratio of 0.069 per unit, whereas the KLFTEMSI is the most expensive hedge at 0.790 per unit. Additionally, time-varying hedge ratio for JKII ranges between 0.116 to 1.073 with 0.424 on average hedge ratio, whereas the hedge ratios of MSCI Bahrain is ranged between 0.004 and 0.461 with an average value of 0.088, and MSCI Qatar is between 0.016 and 0.394 with a mean average of 0.143.

The negative values depict in BCOMPR and MSCI Kuwait at 8 days and 30 days respectively, implying that the investors should take long position in these indices to hedge long position in W5DOW portfolio in some periods. Besides, ADF is determined in this period. The results depict that only MSCI Kuwait rejects the null hypothesis that unit root is present at the 1% statically significant level. Whereas the remaining selected indices fail to reject the null hypothesis that unit root is exist. This implies that rebalancing the portfolio which has random walk hedge ratio would provide less positive impact on portfolio performance, any improvement in portfolio performance during the period may be due to luck (Chen & Tongurai, 2021; Olson et al., 2017).

Hedging Effectiveness is analyzed to determine the variance reduction in the portfolio. Overall results present that hedging effectiveness ratios during this period are varies in risk reduction ability between 1.52% and 39.82%. MSCI Kuwait is the least effective among all indices with the HE of 1.52%, followed by BCOMPR with HE of 2.47%. At the same time, JKII yields the highest hedging effectiveness during the period. Some of the commodity indices namely BCOMAG, BCOMEN and BCOMIN can also hedge the portfolio volatility effectively with the hedging effectiveness of 24.20%, 23.47% and 25.87% sequentially. While BCOMLI, MSCI Bahrain, and MSCI Kuwait are ineffective hedge with less than 10% reduction of variance in the portfolio.

Table 15: Descriptive statistic of time-varying Hedge Ratio and Hedging Effectiveness during Subprime crisis period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	ADF	No. of Neg (%)	Var. Hedge	Var. Unh.	Hedging Eff.
Panel A Commodity Indices											
BCOMAG	355	0.365	0.172	0.349	0.107	0.891	-1.97	0 (0%)	4.068	5.367	24.20%
BCOMEN	355	0.265	0.146	0.250	0.073	0.886	-1.64	0 (0%)	4.108	5.367	23.47%
BCOMIN	355	0.426	0.162	0.380	0.197	1.074	1.31	0 (0%)	3.979	5.367	25.87%
BCOMLI	355	0.333	0.185	0.293	0.119	1.013	-0.31	0 (0%)	4.836	5.367	9.90%
BCOMPR	355	0.181	0.107	0.163	-0.061	0.542	-2.03	8 (2.25%)	5.234	5.367	2.47%
Panel B Islamic Stock Indices											
JKII	355	0.424	0.208	0.363	0.116	1.073	-0.25	0 (0%)	3.230	5.367	39.82%
KLFTEMSI	355	0.790	0.433	0.745	0.179	2.528	-0.26	0 (0%)	3.263	5.367	39.20%
MSCI Bahrain	355	0.088	0.078	0.062	0.004	0.461	-1.61	0 (0%)	5.114	5.367	4.71%
MSCI Kuwait	355	0.069	0.066	0.060	-0.040	0.499	-4.81***	30 (8.45%)	5.285	5.367	1.52%
MSCI Qatar	355	0.143	0.073	0.140	0.017	0.394	-1.138	0 (0%)	4.909	5.367	8.54%

Notes: Std. Dev. represent Standard Deviation. Med. represents Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. No. of Neg represent number of negative values from time-series data. % is computed as the number of negative dynamic hedge ratio divided by the total number of observations over this subsample period. Var. Hedge and Var. Unh. represent variance of hedge portfolio and variance of unhedged portfolio respectively. Hedging Eff. represents Hedging Effectiveness. ***, **, * denotes rejecting of null hypothesis that a unit root is present in a time series sample at the 1%, 5%, and 10% statistically significant level respectively.

Table 16 illustrates descriptive statistic of Post Subprime and Pre Covid-19 Crisis Period time-varying hedge ratios and hedging effectiveness. From panel A, BCOMIN has the highest average hedge ratio of 0.346, while BCOMPR has the least average hedge ratio of 0.163. For BCOMAG, the time-varying hedge ratio ranges from 0.064 to 0.924 with an average ratio of 0.255, or -0.011 to 0.831 units of BCOMEN with an average ratio of 0.196 to hedge one unit of W5DOW. While the hedge ratio for BCOMLI takes approximately 0.062 to 0.600 units for hedging W5DOW. In panel B, MSCI Bahrain is the cheapest hedge ratio among all indices with the average hedge ratio of 0.067 per unit, whereas the KLFTEMSI is the most expensive hedge at 0.697. Additionally, time-varying hedge ratio for JKII swung between 0.120 to 0.744 with average hedge ratio at 0.378, whereas the hedge ratios of MSCI Kuwait is between -0.044 and 0.308 with an average value of 0.070, and MSCI Qatar is between -0.029 and 1.121 with a mean average of 0.238.

The negative values depict in BCOMEN, BCOMPR, MSCI Bahrain, MSCI Kuwait and MSCI Qatar of 0.17%, 4.85%, 9.65%, 5.84%, and 0.08% of total hedge ratios respectively, implying that the investors should take long position in these indices to hedge long position in W5DOW portfolio in some periods. Besides, ADF is determined in this period. The results depict that only BCOMAG fails reject the null hypothesis that unit root. In contrast, the remaining selected indices reject the null hypothesis that unit root is exist at the 1% statistically significant level except for BCOMEN which reject the null hypothesis the 5% statistically significant level. This implies that rebalancing the portfolio during this period can improve overall portfolio performance. While it is difficult to enhance the portfolio performance if including BCOMAG in portfolio.

Hedging Effectiveness is determined the reduction of portfolio volatility. Overall results present that during this period, most of the selected indices are ineffectively hedged the portfolio which have the HE below 10%. During this time, the portfolio volatility would reduce by 0.24% to 45.85% from different assets. MSCI Bahrain yields the lowest hedging effective among all indices with the HE of 0.24%, followed by MSCI Kuwait with HE of 1.50%. On the other hand, KLFTEMSI and JKII yields the highest hedging effectiveness during this time horizon. Simultaneously, only two commodity indices namely BCOMEN and BCOMIN can also hedge the portfolio volatility effectively with the hedging effectiveness of 14.56% and 25.11% sequentially. While BCOMAG, BCOMLI, BCOMPR, MSCI Bahrain, MSCI Kuwait and MSCI Qatar are ineffective hedge with less than 10% portfolio volatility reduction.

Table 16: Descriptive statistic of time-varying Hedge Ratio and Hedging Effectiveness during Post Subprime and Pre Covid-19 crisis period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	ADF	No. of Neg (%)	Var. Hedge	Var. Unh.	Hedging Eff.
Panel A Commodity Indices											
BCOMAG	2413	0.255	0.110	0.232	0.064	0.924	-2.67	0 (0%)	0.854	0.922	7.41%
BCOMEN	2413	0.196	0.111	0.177	-0.011	0.831	-3.08**	4 (0.17%)	0.788	0.922	14.56%
BCOMIN	2413	0.346	0.102	0.336	0.131	0.888	-5.14***	0 (0%)	0.691	0.922	25.11%
BCOMLI	2413	0.173	0.073	0.162	0.062	0.600	-2.91**	0 (0%)	0.905	0.922	1.88%
BCOMPR	2413	0.163	0.101	0.159	-0.260	0.590	-5.70***	117 (4.85%)	0.871	0.922	5.55%
Panel B Islamic Stock Indices											
JKII	2413	0.378	0.108	0.356	0.120	0.744	-6.06***	0 (0%)	0.566	0.922	38.65%
KLFTEMSI	2413	0.697	0.194	0.696	0.134	1.332	-4.00***	0 (0%)	0.499	0.922	45.85%
MSCI Bahrain	2413	0.067	0.077	0.054	-0.074	0.617	-5.53***	233 (9.65%)	0.920	0.922	0.24%
MSCI Kuwait	2413	0.070	0.054	0.062	-0.044	0.308	-10.58***	141 (5.84%)	0.908	0.922	1.50%
MSCI Qatar	2413	0.238	0.160	0.182	-0.029	1.121	-4.80***	2 (0.08%)	0.844	0.922	8.45%

Notes: Std. Dev. represent Standard Deviation. Med. represents Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. No. of Neg represent number of negative values from time-series data. % is computed as the number of negative dynamic hedge ratio divided by the total number of observations over this subsample period. Var. Hedge and Var. Unh. represent variance of hedge portfolio and variance of unhedged portfolio respectively. Hedging Eff. represents Hedging Effectiveness. ***, **, * denotes rejecting of null hypothesis that a unit root is present in a time series sample at the 1%, 5%, and 10% statistically significant level respectively.

Table 17 presents the descriptive statistics of during Covid-19 Crisis Period Time-varying Hedge Ratio and Hedging Effectiveness. During this period, hedge ratio varies across all indices. In panel A, in order to long one dollar of W5DOW, the investors can hedge by pairing and short each index namely BCOMAG, BCOMEN, BCOMIN, BCOMLI, and BCOMPR on average of 31.50 cent, 16.40 cent, 40.80 cent, 16.80 cent, 14.90 cent where BCOMEN depicts the highest hedge ratio among all commodity indices. In panel B, KLFTEMSI is still held the highest hedge ratio value at 0.553 for the hedging. While MSCI Bahrain has the lowest hedge ratio at 0.072. JKII, MSCI Kuwait and MSCI Qatar on average are required to have short position of 34.20 cent, 9.20 cent and 27.20 cent respectively to long one dollar of W5DOW. However, at some point, BCOMPR, MSCI Bahrain, and MSCI Kuwait depicts the negative hedge ratio of 25 days, 27 days, and 19 days, implying that investors need to take long position in these indices to hedging long position in the portfolio at some point.

According to ADF test on time-varying hedge ratios, the results reveal that BCOMAG, BCOMEN, MSCI Kuwait, and MSCI Qatar reject null hypothesis that a unit root is present in dynamic hedge ratio at the at the 1% statistically significant level, while JKII and MSCI Bahrain. is rejected at the 5% statistically significant level. It is said that hedge ratios with unit root are considered as random hedge ratio. Whereas the majority of commodity indices including BCOMIN, BCOMLI, and BCOMPR and KLFTEMSI fail to reject the null hypothesis and the hedge ratios are considered as the random hedge ratio which are difficult to enhance portfolio performance during the period.

Furthermore, hedging effectiveness is determined to observe risk reduction ability in this period. The result shows that the HE values vary widely among selected indices and ranges between a maximum of 33.00% for KLFTEMSI and minimum of 0.80% for BCOMPR for portfolio variance reduction. BCOMIN offers the highest HE at 27.80% among all commodity indices during this period. While the other Islamic stock indices namely MSCI Bahrain, MSCI Kuwait, and MSCI Qatar offer the comparatively ineffective hedge to the portfolio as the variance reduction is less than 10%.

Table 17: Descriptive statistic of time-varying Hedge Ratio and Hedging Effectiveness during Covid-19 crisis period

Indices	Obs.	Mean	Std. Dev.	Med.	Min	Max	ADF	No. of Neg (%)	Var. Hedge	Var. Unh.	Hedging Eff.
Panel A Commodity Indices											
BCOMAG	459	0.315	0.226	0.262	0.055	1.396	-5.04***	0 (0%)	1.314	1.460	9.95%
BCOMEN	459	0.164	0.069	0.145	0.063	0.495	-3.54***	0 (0%)	1.272	1.460	12.84%
BCOMIN	459	0.408	0.244	0.345	0.151	1.777	-1.2900	0 (0%)	1.054	1.460	27.80%
BCOMLI	459	0.168	0.061	0.159	0.082	0.583	-0.94	0 (0%)	1.375	1.460	5.80%
BCOMPR	459	0.149	0.094	0.145	-0.218	0.550	-1.30	25 (5.45%)	1.448	1.460	0.80%
Panel B Islamic Stock Indices											
JKII	459	0.342	0.101	0.340	0.110	0.686	-3.34**	0 (0%)	1.060	1.460	27.37%
KLFTEMSI	459	0.553	0.170	0.532	0.270	1.168	-1.37	0 (0%)	0.978	1.460	33.00%
MSCI Bahrain	459	0.072	0.055	0.064	-0.037	0.256	-3.23**	27 (5.88%)	1.355	1.460	7.14%
MSCI Kuwait	459	0.092	0.056	0.085	-0.063	0.291	-3.44***	19 (4.14%)	1.399	1.460	4.16%
MSCI Qatar	459	0.272	0.108	0.241	0.109	0.721	-3.80***	0 (0%)	1.314	1.460	9.95%

Notes: Std. Dev. represent Standard Deviation. Med. represents Median. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study. No. of Neg represent number of negative values from time-series data. % is computed as the number of negative dynamic hedge ratio divided by the total number of observations over this subsample period. Var. Hedge and Var. Unh. represent variance of hedge portfolio and variance of unhedged portfolio respectively. Hedging Eff. represents Hedging Effectiveness. ***, **, * denotes rejecting of null hypothesis that a unit root is present in a time series sample at the 1%, 5%, and 10% statistically significant level respectively.

Table 18 illustrates analysis of average hedge ratio and hedging effectiveness by making pairwise comparison of the subperiods. As compared between the period of pre GFC and during the GFC, the hedge ratio of commodity indices in panel A is significantly climbed during the GFC from the former period, except for the BCOMPR that shows the fewer hedge ratio during market crash which declines from 0.281 to 0.181. In term of hedging effectiveness, the commodity indices seem to effectively hedge the portfolio during financial turbulence as the result shows the increment of hedging effectiveness in this period, excluding the BCOMIN and BCOMPR that show the decrease pattern in risk reduction ability which decline from 30.12% and 12.60% to 25.87% and 2.47%. Panel B also shows the similar pattern where there is an increment of hedge ratio in JKII, KLFTEMSI, and MSCI Bahrain during the GFC from 0.382, 0.607, and 0.012 to 0.424, 0.790, and 0.088, while MSCI Kuwait and MSCI Qatar present the lower hedge ratios consequently. The hedging effectiveness of panel B shows that ability to reduce the risk in the portfolio of MSCI Bahrain and MSCI Kuwait increase during the GFC from 0.08% and -0.60% to 4.71% and 1.53%, while JKII and KLFTEMSI essentially reduces their risk reduction ability during the GFC to 39.82% and 39.20% as compared to pre GFC period. While the MSCI Qatar remains comparatively stable with the slightly increased of 1.28% of hedging effectiveness during the GFC.

Further comparison between during the GFC and post GFC illustrate in Table 18. In the post GFC, the indices in panel A present essentially declined in the average dynamic hedge ratio as compared to the results during the GFC. At the same time, the hedging effectiveness also show the smaller values during the post GFC, except for BCOMPR that inclines almost doubled of risk reduction ability from 2.47% to 5.55%

in the post GFC. In panel B, it shows opposite result with the earlier comparison where JKII, KLFTEMSI, and MSCI Bahrain show relatively less average hedge ratio from 0.424, 0.790, and 0.088 to 0.378, 0.697, and 0.067 during post GFC, while MSCI Kuwait and MSCI Qatar present the increase of hedge ratio from 0.069 and 0.143 to 0.070 and 0.238 consequently. Regarding hedging effectiveness of Islamic stock indices, it is not significantly different between during the GFC period and post GFC period, except a wild increment of KLFTEMSI during post GFC and a sharp decline of risk reduction ability in MSCI Bahrain after the financial crisis period.

Moreover, the comparison between post GFC and during Covid-19 is reported in Table 18 and is analyzed accordingly. During Covid-19 period, the average dynamic hedge ratios of commodity indices in panel A show mixed trend both increase average hedge ratios namely BCOMAG and BCOMIN which is from 0.255 and 0.346 to 0.315 and 0.408, and decrease average hedge ratios namely BCOMEN, BCOMLI, and BCOMPR. During Covid-19 crisis, BCOMIN has the most expensive hedge among all commodities which is consistent with the post GFC result. For the hedging effectiveness, BCOMLI show the significant increase in Covid-19 period from 1.88% to 5.80%, while the ability to reduce the risk by including BCOMPR in portfolio decline sharply during financial market turbulence from 5.55% to 0.80%. In addition, in panel B, only JKII and KLFTEMSI depict the fewer hedge ratio during Covid-19 crisis than during post GFC, whereas the remaining indices, MSCI Bahrain, MSCI Kuwait, and MSCI Qatar have the greater average hedge ratio during the post GFC. This is in line with the hedging effectiveness where ability in reducing risk decline in JKII and KLFTEMSI from 38.65% and 45.85% to 27.37% and 33%, and incline in MSCI Bahrain, MSCI Kuwait, and MSCI Qatar during the financial turmoil.

Additionally, for clearer view, the study also provides analysis between during GFC and during Covid-19 period. Surprisingly, the average hedge ratio of all commodity indices during Covid-19 crisis present the cheaper hedge than during GFC. However, the risk reduction ability during Covid-19 crisis also decrease in all indices except for BCOMIN that shows more efficiency in Covid-19 period with the mean dispersion of 0.244 and increases from 25.87% during GFC to 27.80% during Covid-19. Simultaneously, the results in panel B show higher hedge ratios during GFC for JKII, KLFTEMSI, and MSCI Bahrain. In contrary, MSCI Kuwait and MSCI Qatar are the cheaper hedge to portfolio during global financial crisis. Regarding hedging effectiveness, JKII and KLFTEMSI has lower their ability in reducing portfolio risk, while MSCI Bahrain, MSCI Kuwait, and MSCI Qatar present that their inclusion can reduce more risk in Covid-19 crisis period than GFC period.

Table 18: Comparison of time-varying Hedge ratio and Hedging Effectiveness between subperiods.

Indices	Pre GFC			During GFC		
	Mean	Std. Dev.	Hedging Effectiveness	Mean	Std. Dev.	Hedging Effectiveness
	23/01/2007-30/11/2007			01/12/2007-30/06/2009		
Panel A Commodity Indices						
BCOMAG	0.246	0.149	9.92%	0.365	0.172	24.20%
BCOMEN	0.131	0.056	-4.43%	0.265	0.146	23.47%
BCOMIN	0.283	0.179	30.12%	0.426	0.162	25.87%
BCOMLI	0.216	0.086	3.09%	0.333	0.185	9.90%
BCOMPR	0.281	0.175	12.60%	0.181	0.107	2.47%
Panel B Islamic Stock Indices						
JKII	0.382	0.113	54.37%	0.424	0.208	39.82%
KLFTEMSI	0.607	0.210	58.22%	0.790	0.433	39.20%
MSCI Bahrain	0.012	0.069	0.08%	0.088	0.078	4.71%
MSCI Kuwait	0.081	0.055	-0.60%	0.069	0.066	1.52%
MSCI Qatar	0.227	0.152	7.26%	0.143	0.073	8.54%

Table 18: Continue

Indices	Post GFC			During Covid-19		
	Mean	Std. Dev.	Hedging Effectiveness	Mean	Std. Dev.	Hedging Effectiveness
	01/07/2009-30/12/2019			31/12/2009-31/12/2021		
Panel A Commodity Indices						
BCOMAG	0.255	0.110	7.41%	0.315	0.226	9.95%
BCOMEN	0.196	0.111	14.56%	0.164	0.069	12.84%
BCOMIN	0.346	0.102	25.11%	0.408	0.244	27.80%
BCOMLI	0.173	0.073	1.88%	0.168	0.061	5.80%
BCOMPR	0.163	0.101	5.55%	0.149	0.094	0.80%
Panel B Islamic Stock Indices						
JKII	0.378	0.108	38.65%	0.342	0.101	27.37%
KLFTEMSI	0.697	0.194	45.85%	0.553	0.170	33.00%
MSCI Bahrain	0.067	0.077	0.24%	0.072	0.055	7.14%
MSCI Kuwait	0.070	0.054	1.50%	0.092	0.056	4.16%
MSCI Qatar	0.238	0.160	8.45%	0.272	0.108	9.95%

Notes: Std. Dev. represent Standard Deviation. W5DOW represents Dow Jones Emerging Market Index, BCOMAG represents Bloomberg Agriculture Index, BCOMEN represents Bloomberg Energy Index, BCOMIN represents Bloomberg Industrial metal Index, BCOMLI represents Bloomberg Livestock Index, BCOMPR represents Bloomberg Precious metal Index, JKII represents Jakarta Islamic Index, KLFTEMSI represents The FTSE Bursa Malaysia EMAS Shari'ah Index, MSCI Bahrain represents MSCI Bahrain Price Index, MSCI Kuwait represent MSCI Kuwait Price Index, MSCI Qatar represents MSCI Qatar Price Index. The daily natural logarithms returns are applied to this study.

CHAPTER 6: CONCLUSION

This paper inclusively study on dynamic conditional correlations between Dow Jones Emerging Market Index (W5DOW) and ten selected indices including agriculture, energy, industrial metals, livestock, precious metals, JKII, KLFTEMSI, MSCI Bahrain, MSCI Kuwait, and MSCI Qatar by applying the bi-variate DCC-GARCH model for estimation. It also identifies the properties of the assets whether it is a diversifier, a hedger, or a safe-haven asset from the conditional correlations against W5DOW portfolio by using the t-test statistic. Besides, time-varying hedge ratio and hedging effectiveness are determined to observe hedging ability of the assets and the ability to decrease portfolio volatility accordingly. The study period is between January 23, 2007, to December 31, 2021, and the data is observed in daily basis.

This study finds the results of conditional correlations during the whole period analysis indicate that Islamic Stock Index namely MSCI Kuwait, offers the highest diversification benefits on average among all indices, followed by MSCI Bahrain. The lowest conditional correlation among all indices that offered by Islamic stock index is due to the strict Shariah screening criteria that do not recommend investing in securities of companies related to interests, non-halal products as well as entertainments (Saiti et al., 2019). The result can be answered Hypothesis 1 that there are differences of diversification benefits either to include commodity indexes or Islamic stock indexes in portfolio. Thus, Islamic Stock indices provide relatively less dynamic conditional correlations against W5DOW portfolio among all indices.

Interestingly, livestock index (BCOMLI) becomes the greatest benefit on average to diversifying portfolio among commodity indices, followed by precious

metals, agriculture, energy, and industrial metals respectively. However, the result is inconsistent with Bessler and Wolff (2015) that hardly find positive effect for livestock and agriculture index by including in the portfolio. In term of their property, the results in this period present that only energy, precious metal, MSCI Bahrain, MSCI Kuwait, and MSCI Qatar index are considered as hedging instruments with small percentage of negative correlations, but mostly serve as a diversifier to the portfolio which is like the remaining indices under consideration that serve as a diversifier throughout period.

Furthermore, this paper intensively analyzed the conditional correlations of selected indices based on subperiods namely pre GFC, during GFC, post GFC/pre Covid-19 outbreak, and during Covid-19 outbreak and make a comparison among them. The results suggest that MSCI Bahrain and MSCI Kuwait dominate other indices by offering the highest diversification benefits to the portfolio in every subperiod, indicating the best performance to diversify portfolio among all indices under consideration. At the same time, they also serve as a hedging instrument during normal period and safe-haven asset during financial turbulences at small points but mainly act as a diversifier. In contrary, the inclusion of Islamic stock index such as KLFTEMSI and JKII do not effectively diversify the portfolio of W5DOW.

However, it is noticed that the average conditional correlations of commodity indices tend to increase during the crisis period both GFC and Covid-19 as compared to period before and after them, implying there is an increase in the co-movement between commodity indices and stock indices. The result is consistent with several studies (i.e., Basak & Pavlova, 2013; Büyükşahin & Robe, 2014; Tang & Xiong, 2018) which discuss this phenomenon as financialization of commodity, where investors tend

to invest more in commodity indices to obtain the diversification benefits because they offer negative or low correlation to the equity portfolio during the earlier years. This causes commodity price to shoot up and inducing correlation between the commodity and equity consequently. Therefore, the alternative assets such as commodity tend to offer less benefit to portfolio diversification during the crises as compared to period before and after them.

Additionally, as observed, the average conditional correlations of the commodity indices during Covid-19 are less than the average dynamic conditional correlations during GFC, implying that having greater diversification benefits. This result is inconsistent with the Hypothesis 2 indicates that commodity indices offer greater diversification performance during Global Financial Crisis than during Covid-19 Crisis. The result of this paper is aligned with Borgards et al. (2021); Umar et al. (2021) that support strong diversification benefit of commodity during Covid-19 due to higher number of negative than positive overreactions during market burst. The overall results of Islamic stock indices also offer stronger diversification benefits to equity portfolio during Covid-19 then period of GFC, which is consistent with the Hypothesis 3 that Islamic stock indices offer less diversification performance during Global Financial Crisis than during Covid-19 Crisis. The result is consistent with the study from Arif et al. (2021) which concludes that it is because Islamic and conventional equity investments have lower return interdependence.

Precisely, during global financial crisis, the MSCI Kuwait provides the top performance in diversifying portfolio, and it is determined as the safe-haven instrument to the portfolio during financial crisis at some points. Similarly, precious metal is also

served as the safe-haven instrument to W5DOW during particular days with the shorter times. In the period of Covid-19 crisis, notice that the results show that MSCI Kuwait and MSCI Bahrain have ability to diversify portfolio and they serve as a flight to quality to the portfolio during market distress in particular days. Nonetheless, during some point of this period, precious metal also represents as the safe-haven instrument to compensate the losses for asset in portfolio during this extreme market condition. Although, these assets serve as a safe haven to portfolio in some days during both crises, but majority of property are diversifier to the Dow Jones Emerging Market Index portfolio.

Moreover, from hedging effectiveness analysis, the results from whole period analysis conclude that the inclusion of KLFTEMSI provide the highest risk reduction effectiveness in the portfolio as compared to the other indices under consideration. Likewise, JKII is considerably having the effectiveness in reducing portfolio volatility as well. For the subperiod analysis, it can be concluded that KLFTEMSI and JKII have the highest hedging effectiveness among all selected indices in every subperiod, implying inclusion of KLFETMSI and JKII outperform other indices in term of portfolio risk reduction into the portfolio. In contrary, BCOMPR seems to have the least hedging effectiveness during both crisis periods, GFC and Covid-19. Essentially, according to Chen and Tongurai (2021), the most effective hedges are assets with highly correlated return series with the benchmark portfolio.

From these findings, it can be inferred that the investors can increase investment opportunities by including alternative assets to the portfolio. Based on overall performances, the alternative assets that greatly provide the diversification benefits are

Islamic stock index namely MSCI Bahrain and MSCI Kuwait. They serve as a hedging instrument in few days during normal period and serve as a safe haven in small points during financial turbulence, while mainly act as a diversifier. In case of commodity index, only precious metals serve as a flight to quality in some days but mostly be a diversifier during market distress. While the other indices under consideration, majority of the time are considered as diversifier to the portfolio. Regarding the portfolio risk reduction, hedging strategies involving Dow Jones Emerging Market Index and Islamic stock indices such as JKII and KLFTEMSI lead to the highest portfolio's risk reduction. However, these two indices provide the most expensive hedging to prevent potential loss simultaneously. As a result, the findings shed some light on the importance of the inclusion of other assets in the portfolio for diversification purposes as well as to enhance portfolio performance and reduce portfolio volatility.

This study bestows that Islamic stock indices such as MSCI Bahrain and MSCI Kuwait are providing alternative opportunity to diversify equity portfolios for investors to gain higher returns as compared to the return that received from the inclusion of other assets in the portfolio such as commodity indices. Also, Islamic stock indices such as JKII and KLFTEMSI are the most effective indices to reduce portfolio volatility. Therefore, it can be concluded that it is safer and more dominant to include Islamic stock index to Dow Jones Emerging Market Index portfolio for the return enhancement and risk reduction as compared to other indices under consideration.

These findings provide additional evidence to support the existing literature on the comparison of commodity indices and Islamic stock indices, especially to the recent research that study on the impact of novel Coronavirus to the financial markets and

diversification benefits. The results also offer implementation of trading strategies and the evaluation of investment and asset allocation decisions to portfolio managers and investors to develop equity portfolio performances during both normal and distress periods where they may face difficulties to improve performance from rebalancing process in particular asset during crises. All these results depend mostly on the period of the study which is different among each subperiod.

This paper is limited by mainly focusing on emerging markets and applying composite commodity indices. Also, it only investigates the hedging strategies by not taking the transaction costs, the impact of liquidity risk, and the size of stock markets into consideration. For the transaction costs, it causes the portfolio rebalancing expense of dynamic hedge strategies to be more expensive than static hedge strategies. For the liquidity risk, it impacts minimizing hedge losses and avoiding extreme losses. For the size of stock markets, it reflects market volatility where the large cap market typically has lower volatility. Further research can observe and take transaction costs, the impact of liquidity risk, and the size of stock markets into consideration to have more efficient hedging strategies. Besides, the future study can be explored by applying alternative techniques to compare the single commodity index with the Islamic stock index in other regions and in other major crisis periods.

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จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

VITA

NAME SITA KHAN

DATE OF BIRTH 05 March 1994

PLACE OF BIRTH Narathiwat, Thailand

**INSTITUTIONS
ATTENDED** International Islamic University Malaysia

HOME ADDRESS 6 Lane 1 Prachapattana Rd. Bangnak, Mueng, Narathiwat
96000



จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY