T.C.
ANKARA YILDIRIM BEYAZIT UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES

EMPIRICAL ANALYSIS OF THE ISLAMIC FINANCE INVESTOR SENSITIVITY TO COMMODITY PRICE FLUCTUATIONS

Ph. D. THESIS

Ayyüce MEMİŞ KARATAŞ

DEPARTMENT OF FINANCE AND BANKING

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Supervisor
Prof. Dr. Ayhan KAPUSUZOĞLU

Ankara, 2022

APPROVAL OF THE THESIS

The thesis, prepared by Ayyüce MEMIŞ KARATAŞ, titled "Empirical Analysis of The Islamic Finance Investor Sensitivity to Commodity Price Fluctuations" is accepted as a doctoral thesis at Ankara Yıldırım Beyazıt University, Graduate School of Social Sciences, Department of Banking and Finance by unanimous/ majority vote.

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I approve that the thesis fulfills the necessities to be deemed a doctoral thesis at Ankara Yildirim Beyazit University, Institute of Social Sciences, Department of Banking and Finance.

Director of the Institute of Social Sciences Prof. Dr. Yaşar YİĞİT

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PLAGIARISM

I hereby declare that all information in this thesis has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work; otherwise, I accept all legal responsibility. 14/09/2022

Signature

Name SURNAME: Ayyüce MEMİŞ KARATAŞ

DEDICATION

I dedicate my doctorate thesis to my grandma Emine MEMİŞ who passed away during my Ph.D. education. The last thing my grandma said to me before she died " Don't let your efforts go to be wasted for anyone or anything ". I promised my grandma that I would never give up. May her soul rest in peace!

Secondly, I dedicate this thesis to my son Metehan Göktuğ KARATAŞ, and my husband Emin KARATAŞ.

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ABSTRACT

Empirical Analysis of The Islamic Finance Investor Sensitivity To Commodity Price Fluctuations

Since the 1990s, there have been major developments in both theory and practice of Islamic capital markets. Investors turn to alternative investment vehicles as a result of increased risk variety encountered by capital market investments as well as globalization and financial deregulation. Islamic indices are also attractive to conventional investors because, as a result of Islamic monitoring standards, they are less vulnerable to systematic risk sources. Commodity prices, in addition to other macroeconomic factors, are particularly significant for Islamic stock indexes since they support the real sector's operations particularly well and Islamic finance is a financial system built on the profit-loss sharing concept. commodities markets allow investors to profit more from the commodity markets that have an adverse price correlation with bonds and equities. The study aims to obtain appropriate portfolio diversification for each commodity and Islamic indices by using nonlinear and variance causality tests between Islamic indices and commodity prices. The data employed in this paper are daily time data and the sample periods range from 29.12.2009-28.10.2019 with 2557 daily observations. It has been concluded that according to the causality results, Islamic Indices will provide benefits in portfolio diversification, and the opportunity to diversify with energy and other Islamic indices and SGR, SYBN, and WHT (Model 14,15,16) data, However, there is no combination for all Islamic indices model (Model 1,2,3,4,5,6) and precious metal group models (Model 17, 18,19,20,21). Precious metal model, the results indicate that precious metals are not effective diversification tools, especially on variance causality.

Keywords: Nonlinearity, Causality in Variance, Islamic Finance, Commodities, Portfolio Diversification

ÖZET

İslami Finans Yatırımcısının Emtia Fiyatı Dalgalanmalarına Duyarlılığının Ampirik Analizi

1990'lardan bu yana İslami sermaye piyasalarının hem teorisinde hem de uygulamasında önemli gelişmeler olmuştur. Sermaye piyasası yatırımlarının artan risk çeşitliliği, küreselleşme ve finansal serbestleşme sonucunda yatırımcılar alternatif yatırım araçlarına yönelmektedir. İslami endeksler, İslami izleme standartlarının bir sonucu olarak sistematik risk kaynaklarına karşı daha az savunmasız oldukları için geleneksel yatırımcılar için de caziptir. Emtia fiyatları, diğer makroekonomik faktörlerin yanı sıra, özellikle reel sektörün işleyişini iyi desteklemesi ve İslami finansın kar-zarar paylaşımı konsepti üzerine kurulmuş bir finansal sistem olması nedeniyle İslami hisse senedi endeksleri için özellikle önemlidir. Emtia piyasaları, yatırımcılara tahvil ve hisse senetleri ile ters fiyat korelasyonu olan emtia piyasalarından daha fazla kâr etme fırsatı verir. Çalışmanın amacı, İslami endeks ile emtia fiyatları arasında doğrusal olmayan ve varyansta nedensellik testlerinden yararlanarak her bir emtia ve İslami endeks için uygun portföy çeşitlendirmesini elde etmektir. Bu yazıda kullanılan veriler günlük zaman verileridir ve örnek zaman periyotları 29.12.2009-28.10.2019 arasında 2557 günlük gözlem ile değişmektedir. Nedensellik sonuçlarına göre İslami Endekslerin portföy çeşitlendirmesinde fayda sağlayacağı ve enerji ve diğer İslami endeksler ile SGR, SYBN ve WHT (Model 14,15,16) verileri ile çeşitlendirme imkânı sağlayacağı sonucuna varılmıştır. Ancak tüm İslami endeks modelleri (Model 1,2,3,4,5,6) ve değerli metal grubu modelleri (Model 17,18,19,20,21) için bir kombinasyon bulunmamaktadır. Kıymetli metal modeli sonuçları, değerli metallerin özellikle varyans nedenselliği üzerinde etkili bir çeşitlendirme aracı olmadığını göstermektedir.

Anahtar Kelimeler: Doğrusal Olmayan Model, Varyansta Nedensellik, İslami Finans, Emtia, Portföy Çeşitlendirmesi

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LIST OF ABBREVIATIONS

ADF	: Augmented Dickey-Fuller
COMCEC	: Standing Committee for Economic and Commercial Cooperation of the Organization of the Islamic Cooperation
DJIM	: Dow Jones Islamic Market
GCC	: Gulf Cooperation Council
IFSI	: the Islamic Financial Services Industry
KPSS	: Kwiatkowski-Phillips-Schmidt-Shin
OPEC	: Organization of the Petroleum Exporting Countries
PP	: Phillips-Perron
S&P	: The Standard and Poor's
USA	: United States

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1. INTRODUCTION

Today, the Muslim population is increasing rapidly, according to growing population projects, between 2010-2050 by Pew Research Center, the expected world population is 9.3 billion approximately a 35% increase. For the same Project, they expected to Muslim population to increase by 73%, while the number of Christians was expected to increase rate 35%. For this reason, the importance of Islamic Finance is increasing and will increase in the incoming years.

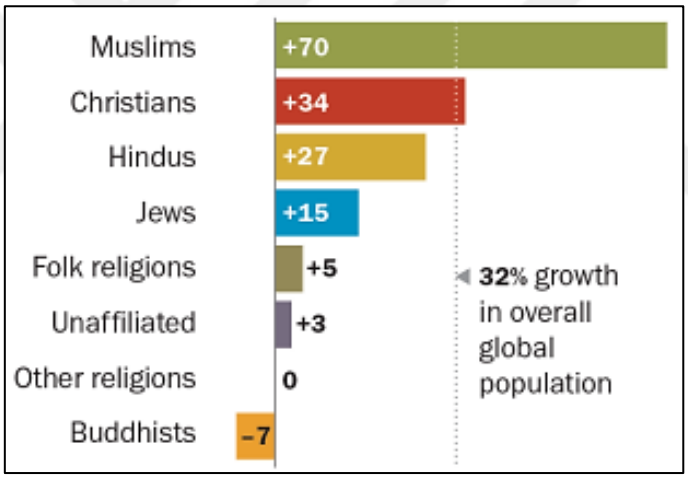

Figure 1. Estimated Percentage Change in Global Population Size 2015-2016
Source: Pew Research Center

According to Islamic Finance Outlook (2018), Islamic finance maintain oil-exporting countries, with the Gulf Cooperation Council (GCC), Malaysia, and Iran, which have 80% of the industry's assets. Because of the diversification, Malaysia's economy continued to perform adequately while GCC economies dropped significantly between 2012-2017. According to this report, Iran's economy will continue to scarcity of financing options and the remaining sanctions.

Islamic Finance, its banking and investment segment has significant importance in a huge part of the world region, especially in Muslim countries. According to Thomson

Reuters (2015) report, in s2015 Islamic equity in the global markets stood at an estimated size of US$60 billion in 2015 and by the end of 2019, this amount will rise to US$77 billion.

However, investing opportunity for Islamic investors is restricted because their investor behavior is governed by Sharia principles, so some sectors like hotels, entertainment, and weapon are prohibited from their investment (Masihh et al. 2018). Limited investment opportunities in the commodity markets for Islamic investment, must be tangible and spot commodities meet the requirements of the non-interest-bearing transactions (Nagayev at all: 2016). Broader Global Islamic Securities universe that which are part of the Islamic finance industry meet the criteria of Shariah principles. For that, Shariah-compliant securities are affected by volatility and price movements (IFSI Stability Report,2016).

Consequently, not only Muslim but also non-Muslim and retail clients apply Islamic Finance to diversifying their portfolios, and they are willing to the alternative investment solutions aftermath of the fiscal crisis. Over the past decade for this reason Islamic finance industry has been growing and reached $1.9 trillion in 2016, quadrupling the level seen in 2006.

In addition, for Emerging market economies growth show a slowdown, because commodity prices have fallen over the past decades. The trend of investment for commodities raised for the obtain diversification benefits (Naifar 2018). Because of the consideration of commodities as a popular asset class within the portfolio, financialization of the commodities has emerged since the early 2000s. Büyüksahin et al. (2010), Daskalakiand Skiadopulos (2011), Belousova and Dorfleitner (2012), Nagayev & Masih (2013), Saiti and Dahiru (2018) argued that because of the following characteristics of commodities institutional managers want to put them in their portfolios:

- Firstly, because of the strong connection between inflation and commodity prices, commodities offer an effective hedge against for the expected and unexpected inflation terms.

- Secondly, commodities give the investors greater diversification benefits and efficiency in the portfolio because commodities have little or no correlation with other assets. For taking higher returns Investors take higher risks, investing in the commodities provides the achieve this goal.

- Thirdly, the current state of the economy and business cycle determine the commodity prices.

Consequently, partnership, mutual solidarity, and goodwill are the symbols of the Islamic economic system. Quran and Hadith for Muslims to act on rumors prohibit it. Hence, investors of the Islamic financial system cannot work on overly optimistic or pessimistic expectations.

Investor sentiment is defined as the propensity to speculate (Barberis, Shleifer & Vishny 1998). Any kind of speculation, either intentional or partaking, is considered *haram* (not permissible) in Islam. Another common concept of investor sentiment is that sentimental investors value rumors more than fundamentals (Baker, Wurgler & Yuan 2010). The long-run significance of investor sentiment may also indicate that irrational investors outperform rational investors (Black 1986). Theoretically, Islamic finance should not be connected to investor sentiment. Islamic finance should rely on fundamentals, not on rumors. However, if investor sentiment has a significant influence on the Islamic Shari'ah stock index, it will probably close the gates for both neoclassical economics and Islamic capital markets.

1.1. Research Objective

The study aim of the study is to obtain appropriate portfolio diversification for each commodity and Islamic index data by making use of nonlinear and variance causality tests between Islamic index and commodity prices. For this aim, we use daily data because Naifa and Dohaiman (2013) argued that daily data more adequately capture the interaction of oil and stock prices in the region than low-frequency data. Narayan, Bannigidadmath, and Narayan (2016) investigate that daily data might be better than monthly data when the aim is obtaining much information The data employed in this paper are daily time data and the sample periods run from 29.12.2009-28.10.2019 with 2557 daily observation.

1.2. Research Questions

In this thesis following questions try to explain:

- Is there a non-linear relationship between the series?

- Does the commodity price cause the prices of the other commodities and Islamic stock indices or vice versa?

- Which commodities and Islamic stock markets investors should invest in to gain portfolio diversification benefits?

1.3. The Significance of Study

This study will be unique because the previous study mentioned the literature review only focus on some basic energy commodities and stock market relationship during the crisis period. This study contributes to the existing literature covering three different types of commodities: precious metal, energy, agriculture, and Islamic investors return for the significant area of the Islamic world when investors face volatiles of these commodity prices how will their reaction, and this study hopes to contribute with diversification benefits of commodities, and Islamic Indices.

Another contribution, before literature, when they decide on their econometric methodology, they didn't apply tests for linearity or non-linearity. The implementation of nonlinear models is the primary emphasis of this work, and the key considerations are as follows. Energy commodities and most precious metals have a nonlinear behavior over time, similar to an economic or financial variable, as a result of economic conditions. As a result, how they interact with one another is likewise nonlinear. The theoretical and empirical underlying principles of this nonlinear behavior may depend on the fragility of macroeconomic variables and may be brought on by wars, other geopolitical extreme events that have an impact on suppliers or demander nations (e.g., the first and second oil price shocks and the 2006 oil price shock, the Arab Spring, rising interest rates, the 1970s crisis, OPEC decisions, the 1997-1998 Asian Crisis, the 2008-2010 global financial crisis), economic crises (e.g. Under these conditions, the prices of agricultural, metal, and energy commodities show more complicated behavior than a linear and stable connection (Bildirici and Türkmen:2015; Ciner:2001, Naifa:2013).

1.4. Organization of Study

The following is how the thesis is organized:

Chapter one gives a fundamental introduction to the study including the objectives, significance, and organization.

In the second chapter of the study, extensive information about the Islamic Finance system is given and the subject of Islamic investment is mentioned.

In the third chapter of the study, the commodity market is discussed and the importance of commodities in terms of investment is given.

In the fourth chapter of the study, information about the financial theories that refer to portfolio diversification, which is the aim of the thesis, is given.

In the fifth part of the study, the previous studies that were used and contributed to the emergence of the study were mentioned.

After mentioning the data and data range used in the sixth chapter of the study, theoretical information about the econometric methods used is given.

In the seventh part of the study, the statistical results obtained with the econometric methods used are interpreted.

In the eighth chapter, information about the purpose, scope, limitations, and working range of the study is given and the statistical results obtained are presented.

2. ISLAMIC FINANCIAL SYSTEM

The purpose of this chapter is to present comprehensive information about the Islamic Finance system, Islamic Capital Market, and Islamic investing. It addresses the concept and the Principles of Islamic Finance, the Fundamentals of Prohibition of Islamic Finance, the Evolution of Islamic Finance, the Main Components of Islamic Finance, and Investing in Islamic Finance.

2.1. Introduction to Islamic Finance

The literature has a variety of Islamic finance definitions, ranging from basic definitions for certain components (such as Islamic banking) to more sophisticated definitions that encompass all financial processes. The following definition is more useful mentioned by Warde (2010:7) "*Islamic financial institutions are those that are based, in their purposes and operations, on Quran's precepts (principles of the Muslims' holy book*),". According to this definition, Islamic financial businesses do not include only banks, but also other sorts of financial intermediaries that follow Sharia rules (Gait and Worthington, 2007:4).

The provision of financial services in conformity with Islamic law and Islamic principles (Shari'ah) is referred to as Islamic finance and is derived from three significant sources; the Muslim Holy book name is Quran, the tradition and practice of Prophet Muhammad called Sunnah, and ijtihad which are the reasons of qualified scholars. It also demands parties adhere to fairness norms and contract integrity. Real economic activity must underpin transactions, and risks must be shared. In Islam, financial system and social system are correlated with each other. (Iqbal, 1997: 42; Islamic Capital Market Fact Finding Report, 2004:5; Dusuki,2006; Kammer et al., 2015:9; Hassan and Hussain, 2022:4.). On the other side social welfare, fairness, universal brotherhood, prosperity, and welfare of the entire society are the souls of the Islamic economic system (Iqbal, 1997; Haider and Azhar, 2011).

The Shariah-compliant investing business is still in its early stages, but it is expanding rapidly. Indeed, it is one of the fastest-growing sectors of the world's financial system. Shari'ah investment is not limited to Islamic investors. Values-based investment appeals to investors of all shades. Similarly, investments are not confined to Islamic enterprises but can

be made in any company that performs permissible activities. Aside from the socially responsible purpose, there are other motivations for non-Islamic investors to invest by Shariah principles. Islamic funds' operations are based on concepts of social responsibility, making them appealing to non-Muslim investors interested in "ethical" finance. Islamic investment funds have established a reputation as a crucial component of the expanding Islamic financial system by providing the dual duties of risk intermediation and effective deployment of excess liquidity. They offer a diverse range of portfolio management choices and mobilize long-term investments required for capital market development (Iqbal,2011; Kamso, 2013).

2.2. Historical Timeline of Islamic Finance

In 1963, the first experiments with modern Islamic finance took place in the countryside of Mit Ghamar in Lower Egypt. Savings/investment houses operated in tiny communities in Northern Egypt under the direction of Ahmed al-Najjar, giving finance to small businesspeople and poor farmers on a profit-loss sharing basis. The Pilgrims' Management and Fund Board (Tabung Haji) was founded in Malaysia in the same year to assist people in saving money for the hajj (pilgrimage) (Kok, 2014; COMCEC, 2016; Soage, 2020). Despite not being classified as an Islamic commercial bank, Tabung Haji has emerged to become the first Islamic financial institution in modern times (Omar et al., 2013). The money was invested in industrial and agricultural initiatives.

The Organization of the Islamic Conference (OIC, now Organization of Islamic Cooperation) established the Islamic Development Bank in 1974 as a multilateral lending agency to offer Sharî'a-compliant funding to member countries' development initiatives. It first opened its doors in 1977. Several large Islamic commercial banks were created around the same period, the whole first being Dubai Islamic Bank in 1975, followed by Faisal Islamic Bank of Sudan and Kuwait Finance House in 1977. In the aftermath of the 1979 Islamic Revolution, Iran overhauled its banking sector in the 1980s. At the same time, Pakistan attempted but failed, to Islamize the entire financial system (Kok, 2014; COMCEC, 2016; Iqbal and Molyneux,2016; Alswaidan,2017; Soage, 2020).

Several non-bank financial institutions were established in the 1980s. Mudaraba companies were founded in Pakistan following the passage of the Mudaraba Ordinance in 1980. Established in 1989, Al-Fallah Aam Unnayan Sangstha in Bangladesh was one of the

first Islamic microfinance institutions. Islamic cooperatives were developed in non-Muslim nations where banking rules prohibited the creation of Islamic banks. Ansar and Islamic Co-operative Housing Corporation Ltd., the first Islamic cooperative in the Western world, was founded in Toronto, Canada in 1981 to provide Shariah-compliant house finance to the country's Muslims. In Trinidad & Tobago, the Muslim Credit Union was founded in 1983, while the Pattani Islamic Saving Cooperative began operations in 1987 (COMCEC, 2016; Alswaidan,2017).

Table 1. represents the evolution of various Islamic financial institutions over time, and major milestones are detailed below.

Table 1. Historical timeline of Islamic Finance

Period	**Financial Innovations**
1960s	-First experiments of Modern Islamic Finance
1970s	- First Islamic commercial banks - First Tekaful company
1980s	-Retakaful -Mudarabah Companies -Microfinance Institutions -Cooperatives/Credit Unions -Investment Banks
1990s	-Private equity and venture capital firms -Project Finance -Pawn shops -Islamic Indices -Corporate Sukuk
2000s	-Awqaf Properties Investment Fund -Infrastructure fund -Leasing companies -Sovereign Sukuk -Hedge Funds -Islamic real estate investment trust
2010s	-Crowd funding platforms -Social Sukuk -Green Sukuk

Source: Ahmed, 2017

Other sorts of nonbank financial institutions emerged in the 1990s. Muassasah Gadaian Islam Terengganu, Malaysia's first Islamic pawnshop, opened in 1992 in the Malaysian state of Terengganu (Hisham et al., 2013; Othman and Abdullah, 2019). The first large co-financed transaction incorporating project financing under Islamic project financing was the USD 1.8 billion Hub River power project in Pakistan, which began in 1993. Al-Rajhi Banking and Investment Corporation offered a USD 92 million Istisna' facility as part of a USD 1.8 billion total investment in the project (Hamwi and Aylward, 1999; Esty, 2000; COMCEC, 2016). Likewise, Kuwait Finance House provided a USD 200 million tranches in 1996 for a USD 2 billion petrochemical plant for the Equate Petrochemical Firm, a joint venture between the Union Carbide business and the Petrochemical Industries Company, a subsidiary of Kuwait's national oil company. Shell issued the first corporate Sukuk in Malaysia in 1990. In addition, to address the needs of Muslim investors, the Dow Jones Islamic index was launched in 1999 (Omar et al., 2013; COMCEC, 2016).

In 2001, the IDB (Islamic Development Bank) launched the Awqaf Properties Investment Fund to invest in commercially developing awqaf properties around the world. The IDB also formed the first infrastructure fund in the same year, with a capital commitment of USD 730 million. Seven Injazat Technology Fund E.C, founded in 2001 in Dubai, was one of the first Islamic venture capital funds. In Asia, the first Islamic private equity fund, CIMB Muamalat Fund I, was established in 2002 (Wouters, 2008; Hamza, 2021; COMCEC, 2016). Islamic leasing companies began in 2000, and several have subsequently been founded in the GCC region (COMCEC, 2016).

Aside from an increase in the number of Islamic banks, non-bank financial institutions, and capital markets in various jurisdictions, the 2010s saw additional changes. Recently, a few fintech organizations, such as Shariah-compliant crowdfunding and asset management platforms, have been established. A few new forms of social and green sukuk were issued in capital markets (Ahmed, 2017; COMCEC, 2016).

2.3. The Framework of the Islamic Financial System

This section gives detailed information about fundamental prohibitions and main principles of Islamic Finance.

2.3.1. Fundamental Prohibitions of Islamic Finance

According to meeting the Maqasid (objectives) of Shariah, all parts of society should be ruled and directed by Islamic teachings and beliefs, and there should be no distinction between social life and economic or commercial life. Because of this, three basic prohibitions for Islamic Finance: Riba (interest), Maysir (gambling), and Gharar (uncertainty) (Iqbal, 1997; Haider and Azhar, 2011; Omar, 2013). Figure 2 shows the fundamental prohibitions of Islamic Finance.

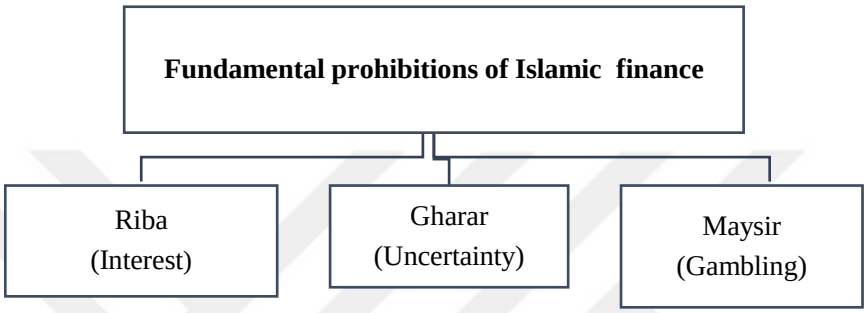

Figure 2. Fundamental prohibitions of Islamic Finance

2.3.1.1. Riba

Riba is called interest and it's related to the return on money with a fixed or floating interest rate. Riba is prohibited if one contract includes riba rate this contract becomes invalid. This prohibition might be seen as a rejection of time's value of money. The time value of money is not prohibited in Islamic law financial theory and practice if it is not part of a loan relationship in which it is claimed as a fixed value. Shari'ah does not forbid an increase in loan in the price of a commodity in any sale contract to be paid at a future date, hence Islamic finance does not rule out the time value of money. Making money's temporal value an aspect of a loan relationship when it is claimed as a predetermined value is prohibited by Shari'ah. In this case, Shari'ah mandates that a loan be repaid in the same currency in which it was provided. The buying power (worth) of paper currencies varies due to changes in numerous variables over which the two parties to a loan arrangement often have no influence (Ahmad and Hassan, 2006).

The following three points explain the reasons why Shariah law forbids riba (interest-based funding). The first point is that riba creates an unbalanced environment and a major cause of unfairness for lenders and borrowers. Second, riba means improper confiscation of

other people's property. According to Khan and Mirakhor (1987), interest on money is considered as reflecting the unjustifiable establishment of instantaneous property rights: unjustified, because interest is a property right asserted outside the lawful framework of recognized property rights. Instantaneous, because the lender obtains a claim to the borrower's property as soon as the contract for a loan on interest is signed. Last and third point, both of human wealth and personality riba cause social corruption and a fall in social welfare. Such activity is forbidden in Islam since the rate of return should not be promised for just lending money. It is also important to note that not only the Islamic religion prohibits and forbids actions involving riba or usury. Original forms of both Christianity and Judaism, according to Cornell (2006), forbid such activities (Merdad, 2012).

2.3.1.2. Gharar

El-Gamal (2006) defines Gharar as uncertainty about future situations and the quality of goods, and it may be the outcome of one-sided or two-sided, purposeful, or inadvertent incompleteness of knowledge (Adamsson, 2015). El-Gamal (2000) defined the Gharar as a situation that includes danger, uncertainty, ambiguity, and deception. For instance, selling anything that is not owned or that cannot be accurately characterized in terms of nature, size, and amount, see (Merdad, 2012). Gharar in modern finance may be seen in speculative actions in the stock market, derivatives instruments, and short-selling contracts (Uddin, 2015).

Gharar is classified into two types: fahish (excess Gharar) and yasir (light Gharar). As evidenced by the Al Hadith (words and deeds of Prophet Muhammed), there are several examples of Gharar fahish in contracts, which are usually related to the reasons why Gharar sales are forbidden. Gharar yasir, which means tiny in size or minor, on the other hand, is the uncertainty that is always present in all contracts and conducts, and hence its existence is accepted. Obaidullah (2005) claims that preventing all risk and uncertainty is so difficult, only prohibited excessive quantity of the danger and high-level uncertainty conditions by Shariah (Merdad, 2012; Uddin,2015).

Three key characteristics must be addressed in any financial contract to avoid Gharar. The first one is that both the subject and the price must exist, and the other party must be capable of delivering it. Second, all the counter-attributes values and quantities must be

provided. Third, the quantity, quality, and timing of future supply must be determined ahead of time (Visser,2009; Merdad, 2012).

2.3.1.3. Maysir (Gambling)

Maysir is described as gambling, which is forbidden, and it includes chance games, money from speculation, and money from slot machines. Maysir is involved in contracts in which the ownership of a thing is contingent on the occurrence of a predefined but unpredictable future event (Gassner and Wackerbeck: 2007). Gambling is luck for profit, and some of those participating conduct fraud, getting what we should not receive or passing up an opportunity. Maysir is a game of chance in which we rely on the results and one side must bear the weight of the other party because of the conclusion. (Saratian et al., 2019). This prohibition indicates that games of chance cannot be used to increase wealth.

Overall, the prohibition of Gharar and Maysir has significant significance for financial markets, particularly the derivatives market. Besides from these fundamental prohibitions, the following practices are either prohibited or encouraged:

Prohibition of unlawful activities, investing should only support actions and items that are not prohibited—or even discouraged—by Islam. An Islamic bank would not finance the sale of pork and pork products, drugs, alcohol, nightclub activities, pornography, or similar activities; a real estate loan for the construction of a casino; and the bank could not lend money to other banks at interest (Gait and Worthington,2007; Okte,2010; Qadri and Iqbal, 2021).

Price manipulation is forbidden, market demand and supply factors should decide the pricing of products and services, with no influence from regulators. However, some Islamic scholars have stated that price fixing is occasionally required to prevent market manipulation. For illustration, if demand is intentionally stimulated to boost prices to benefit speculators, the regulator can intervene to stabilize prices (Abdullah and Chee, 2010; Amalia and Saputri, 2022).

It is encouraged that adequate information is disclosed, when two parties enter a contract, they must both have fair and equal access to information. If one party is restricted, he has the option to cancel. This feature is intended to safeguard the vulnerable from being misled and to maintain the sanctity of contracts.

2.4. Key Principles of Islamic Finance

Figure 3 shows the five key principles of Islamic Finance mentioned by Abdullah and Chee (2010:5). These principles are the belief in divine guidance, the prohibition of paying interest in any transaction, money should only be invested in worthwhile initiatives, business partners being urged to share risks, the encouragement of risk sharing among business partners, and real asset-backed finance is required.

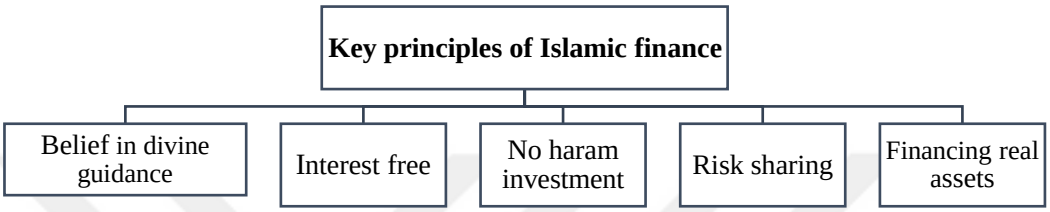

Figure 3. Key principles of Islamic finance
Source: Abdullah and Chee (2010)

The first principle is the belief in divine guidance; God (Allah) created the whole universe with certain goals that can be achieved by following God's laws and directives. These laws and directives apply to all aspects of life, including economics, finance, and every other facet of existence, whereas in the conventional financial system, government and religion are separate and autonomous (Abdullah and Chee, 2010).

The second principle is interest-free; according to this rule earning interest rate is banned by God’s rule. Furthermore, as compared to traditional financing, people may take a percentage of their project to the bank and share it (Abdullah and Chee, 2010; Haider and Azhar; 2011).

The third principle is forbidding haram investments; according to this rule, people must be avoided investing in haram products like alcohol, tobacco, arms, or pornography are avoided. And allow investment opportunities which increase the financial return and social goods like socially responsible investing (Abdullah and Chee, 2010; Haider and Azhar; 2011).

The fourth principle is sharing risk between the lender and the borrower is encouraged. Iqbal and Mirakhor (2011) defined risk as a probability of loss according to an event. This

risk is not confined to default risk but includes any risk like market risk, capital risk, and economic risk which are resulting in losses. According to Shariah, risk sharing is the fair distribution of risk, profit, and loss. Thus, risk sharing allows promoting openness and justice among consumers, business partners, and institutions (Iqbal, 1997; Abdullah and Chee, 2010).

The last principle is asset-backed finance which is the most important characteristic of the Islamic Financial System. According to this system, money has no intrinsic value and thus except in some cases, Islam does not acknowledge money as a vehicle of trade. Unlike the traditional financial system, Islamic financing is always based on illiquid assets that generate actual assets and inventories (Abdullah and Chee, 2010; Habib, 2018).

2.5. Islamic Financing Methods

As mentioned in the previous section, Islamic finance is based on Sharia-compliant core concepts. This section focuses on the most widely used Islamic finance practices used by Islamic banks and other Islamic financial institutions. The following are the primary instruments: Murabaha, Mudarabah, Musharaka, Ijarah, Salam, and Istisna.

2.5.1. Murabaha (Cost-Plus Sales)

Murabaha is described as the selling of an asset for the price paid for it plus a predetermined share of profit. The buyer and seller must reach an agreement on the cost and profit margin (El-Gamal,2000; Hussain et al, 2016). Murabaha is a Shari'ah-compliant selling transaction that is commonly utilized in trade and asset finance. The bank purchases the items and gives them to the client, delaying payment until a mutually agreed-upon period. Murabaha sales and asset-backed loans are similar in that the expected return is frequently linked with interest payments on conventional loans. Murabaha, on the other hand, is a deferred payment sale transaction in which the objective is to assist the acquisition of items rather than to swap money for additional money (or monetary equivalents) over time (Iqbal and Mirakhor, 2011; Hussain et al, 2016).

2.5.2. Mudarabah

Mudarabah is a form of partnership based on profitmaking where one party contributes capital (not labor) while the other party contributes labor (only entrepreneurial skill). This instrument includes two parties: The capital provider (investor) is known as rab al-maal, and the partnership manager is known as mudarib (Iqbal and Mirakhor, 2011; Alamad, 2019). This structure involves the bank bearing the entire financial risk of the capital injection. Mudarabah is known as a "sleeping partnership" because the mudarib manages the business and the financier is not allowed to intervene in management (Hussain et al, 2016; Akintan et al., 2021).

Mudarabah is sometimes known as a sleeping partnership because the mudarib mana ges the business and the financier is not allowed to intervene in management, though criteri a may be imposed to ensure better capital management. Furthermore, this structure necessitates complete openness between the parties and is concerned about the occurrence of profit non-disclosure/non-reporting. A screening process and a request for collateral before contracting can lessen this risk (Kok, 2014).

It should be noted, however, that the lender (bank) is only right to a principal payback if there are profits. If the investment loses money, the lender suffers a percentage of the loss, and it does not constitute a default on the borrower's part unless it can be demonstrated that the loss was caused by mismanagement and incompetence (Kok, 2014). Mudarabah could be applicated in Modern Islamic financial transactions like project financing and Sukuk structuring (Muhammad et al., 2015).

2.5.3. Musharaka

A musharaka or shirakah is a type of partnership in which two or more people join their wealth or labor to share profits and losses and have similar rights and duties. A mudarabah is a unique case of capital-labor collaboration that is the foundation of Islamic financial intermediation. In general, the term musharaka refers to partnerships, but there are further sub-classifications of partnerships based on the levels of authority and responsibility of the partners, as well as the sort of contributions they provide, such as management skills or goodwill (Iqbal and Mirakhor, 2011). Profits and losses are distributed by a specified ratio, which is normally established before contracting and is dependent on the initial money

invested. Musharaka contracts are mostly used for long-term investment projects. Because both parties contribute funds to the venture, they both have voting rights and can take part in the management of the investment opportunity (Kok, 2014; Hussain et al, 2016).

2.5.4. Ijarah

This contract is a lease contract which is not a non-profit loss-sharing. It involves the transfer of an asset and the right to use it for fixed a length of time. A bank purchases an asset for a client and leases them to the customer for a predetermined length of time for a preset rental fee. If the bank (licensor) preserves asset ownership, Shariah allows rental charges for property services (Tabash and Dhankar, 2014; Salisu et al., 2022).

The ijarah contract is canceled when the asset stops to providing the service for which it was leased. If the asset is destroyed within the duration of the agreement, it will still be valid. Both parties, lessee, and lessor are required to agree on the service or usufruct resulting from the asset's use. The lessor retains legal ownership of the asset being financed, and the lessor is responsible for its maintenance. If the lessee wishes to purchase the rented item after the rental period, the price of the asset may not be established until the end of the rental contract (Kamal, 2001).

2.5.5. Salam

Salam is organized around the principle of forward sale. This strategy enables an entrepreneur to provide some specified goods to a bank at a price defined and paid at the time of contract, with future delivery of the goods (Hussain et al, 2016; Tabash and Dhankar, 2014; Salisu et al., 2022). In general, the seller takes on the risk connected with salam until the delivery time. The buyer has the right to check the goods, and, in addition, the buyer has the option to reject taking possession of the goods on sight if the features of the goods do not match the description agreed upon (Al-Omar and Haq, 1996; Kamal, 2001; Muhammad et al., 2015).

2.5.6. Istisna (Manufacturing Contracts)

This arrangement enables the "buyer" to enter a contract with the "manufacturer" to produce or manufacture a "particular" good for delivery within a "specified" period. Islamic

banks are increasingly using istisna. These banks can use istisna in a wide range of applications, from shoelace manufacturing to aircraft manufacturing. Considering that many Islamic law schools let the producing party outsource the manufacturing process by contracting a second istisna with a third party (Vogel and Hayes,1998; Kamal, 2001).

One of the most essential features of istisna is the flexibility it provides in terms of payment form and date. It is not essential to pay the amount in advance, nor is it necessary to pay it at the time of delivery. The parties can agree on a payment plan that works for both, and payments can also be done in installments (Iqbal and Mirakhor, 2011).

2.6. Equity Investment in Islamic Finance

The last section discussed permissible methods for Muslims to acquire funds to finance purchases of equipment, real estate, etc., or finance their debt. This section gives information about investment instruments allowed by Sharia.

Due to Islamic prohibitions on some commercial operations, a large majority of the Muslim population did not participate in stock market investments until the 1970s. in the early 1990s, the Saudi Arabian Fiqh Academy, the Muslim world's main authority on religious issues, issued a decree stating that, under certain conditions, investing in stock is acceptable under Shariah law. A significant breakthrough in religious regulations regarding equities investing occurred in the 1990s, and Islamic equity firms have subsequently begun to function (Siddiqi, 2002; Hussein, 2007; Merdad, 2012).

Common shares in a publicly traded corporation are, as the name implies, "shares" in the firm's assets. Thus, Muslims are permitted to possess such common shares if the company's operation is legitimate, and its conduct is in accordance by Sharia law. As a result, common stock can be acquired and sold as the future owner sees fit. While the common stock is held, it earns a percentage of the firm's overall earnings, a portion of which may be returned to shareholders as dividends, and the remainder may be reinvested in the company. Thus, the first portion of the profit share is paid to the shareholder directly, while the second part is taken back indirectly through a growth in the company's capital, a defined proportion of which is claimed by the held share. Because common stock in Islamically acceptable corporations can therefore be acquired and sold, mutual funds in such equities can also be established. A mutual fund would pool the funds of several participants and manage them

by investing in a portfolio of allowed equities and purchasing and selling them as needed. Mutual fund managers are compensated for their efforts in researching market circumstances as well as the prospects of each company. Some Islamic mutual funds" calculate and pay the relevant Zakah on shares on behalf of their owners in some Islamic nations, in addition to screening the numerous stocks and setting the portfolio weights based on their best judgment (El-Gamal, 2000).

Figure 4 shows the breakdown of the market share of various investment funds, demonstrating that equities funds dominate the market in 2019. Most funds are equity-focused with 34.7 % share, whereas money market-based funds share is 26.9%, followed by commodities at 23.2%, fixed income /sukuk at 8.9%, mixed allocation at 6.2%, real estate at 0.1%. The figure indicates that funds are mainly invested in equity-based and market-based in 2019.

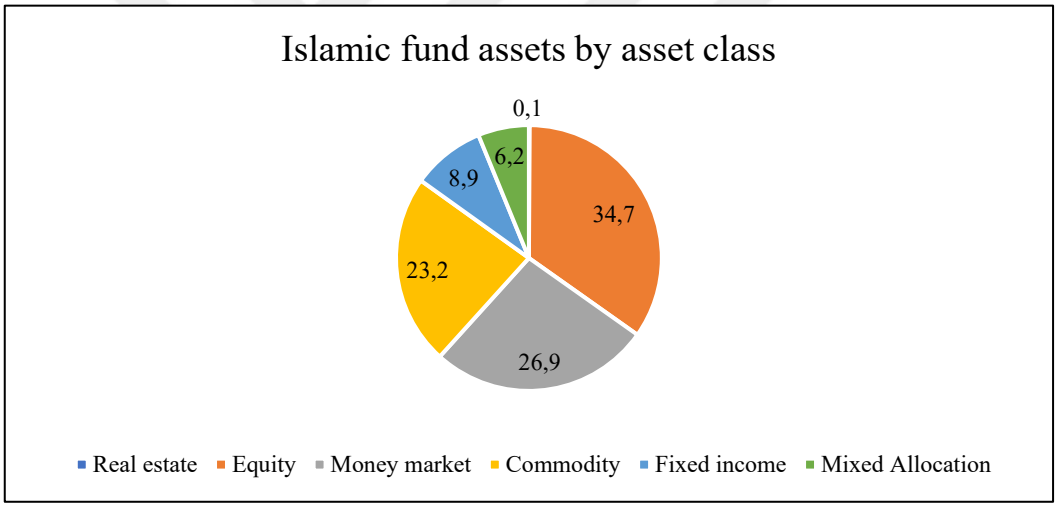

Figure 4. Islamic fund assets by asset class

Source: IFSB, 2020, Stability report

It is claimed that investing in mutual equity funds has a variety of benefits. These benefits make investing in mutual-based funds a viable option for some investors. According to Kamal (2001), a mutual fund is a conveniently packaged investment program that provides the benefits of diversification and expert investment advising, as well as management, custodial, and administrative services for a low cost in comparison to alternative investment programs.

2.6.1. Shariah Screening Methodology

As previously stated, equities funds are the most common form of vehicle, accounting for 34.7% of the overall sharia-compliant fund universe. Investing in shares is the same as purchasing a stake in a company. Naturally, whether an equity investment is sharia-compliant is largely determined by the sharia permissibility of the business's operations and its financial structure. This is because broad Shariah indexes like Dow Jones Islamic Markets (DJIM), Standard & Poor's, FTSE, MSCI, and Russell are easily accessible. The Shariah indexes have established clear Shariah stock screening systems that are reviewed regularly (Kamso, 2013).

Stock screening is the process of narrowing the universe of all available stocks down to a handful that meets the criteria of an investment strategy. It brings together strategy, data, and screeners. Strategy is analogous to a cake recipe, data to the ingredients, and screeners to the tools. Stock screening is critical since it decreases the magnitude of the problem that we are attempting to address. It is easier to analyze a few stocks rather than all of them. To identify between Shariah-compliant and non-Shariah-compliant equities in each market, screening is performed with Shariah-compliant stocks. This Shariah-compliant stock screening is meant to help investors who are concerned with Islamic principles find their ideal market opportunity (Omar et al, 2013).

To be considered Shariah-compliant, and hence have its shares permitted, a company must follow all the Islamic finance rules stated above. To identify these enterprises from conventional ones or to define non-compliant financial practices and commercial activities in an Islamic firm, Shariah scholars proposed various regulations or recommendations that can be summed up in the following two screen: the ethical/ industry/business screen and the financial screen (Merdad, 2012; Karbani, 2015). Jaffer, (2004) claimed that for Muslim investors using this screening has significant advantages; first, it provides broader portfolio diversification to diminish risk or rise return with a certain risk. It also ensures the ability to take part in novel risks. Another advantage is for special portfolio management with fund managers who are well informed to make investment decisions than individual ones. What is more, fund managers face smaller transaction costs while trading.

The global Islamic financial system has become more dependent on the application of Shariah screening as Islamic banking has expanded outside of traditional Muslim economies.

These filters are used to create indexes that are compliant with Shariah and contain securities that are consistent with Shariah (Kok,2014). The screening procedure differs from index to index.

2.6.1.1. Industry Screen

The business/industry screen focuses on the company's commercial activity. If the business engages in Shariah-compliant activities, the Shariah-sensitive investor is forbidden from investing in it. If a company's principal activities are selling and manufacturing alcohol; gambling, gaming, casino operations; pornography, selling and production of pork-based or non-halal meat business lines, it is considered Shariah non-compliant (Merdad, 2012; Karbani, 2015; Muhammad et al., 2015). Furthermore, due to cultural and geographical changes between marketplaces, their screening techniques change.

According to Muhammed et al. (2015), the following problems occur while applying industry screening.

Availability of information: Detailed sales information is needed to accurately determine how much of a supermarket's revenues come from halal product sales and how much from pork products and alcoholic beverages.

Change of business focus: Even though the company's non-permissible revenues at the time of monitoring are below 5%, these revenues may exceed this threshold value over time. This situation requires that Shariah auditors constantly monitor the companies' fields of activity and income.

Customer exclusivity: A company that is considered Islamically appropriate can produce goods or services for another company operating in a business that is not permissible.

2.6.1.2. Financial Screen

Most companies borrow to finance their long-term investments or meet their working capital needs and pay interest on these debts. The financial transactions of the company to which Islamic investors will be partners must be interest-free. To fulfill this requirement, the assets and resource structures of the companies are scanned in the monitoring techniques

and the companies within the threshold value limits determined for each element are considered financially permissible.

The financial screen is further subdivided into three subsets: liquidity, interest, and gearing. These, as the names suggest, are concerned with the institution's liquidity, interest rate, and gearing. In terms of liquidity, a firm must keep less than 50% of its market capitalization in cash and short-term investments. The interest screen requires that interest revenue not exceed 5% of total income, while the gearing screen requires that the percentage of debt carried not exceed a specified threshold. This restriction is typically established at 30% or 33%, depending on the various exchanges with their interpretation of Shariah law (Khatkhatay et al., 2007; Kok, 2014).

2.6.2. Islamic Indices

Stock market indexes are essential for macroeconomists, financial economists, and financial players. Indices that are regularly produced through time are vital for assessing the regularities that aid in comprehending the real behavior of financial players, the growth of the economy, and its place in international comparisons. However, financial indices are still more valuable for traders or investors looking for concise, accurate, and quickly accessible information on stock markets. Throughout history, a wide range of indices has been developed to track the performance of stock markets. This variety has grown very fast in recent years (Hautcoeur, 2006).

Islamic finance indexes, for example, screen a huge number of businesses to ensure Shari'ah compliance. According to Shari’ah, enterprises might be screened out due to a lack of acceptable track record, strong exposure to borrowing, and little operating capital. As a result, Islamic stocks differ from traditional stocks in that they are less diversified, smaller in size, specialized in certain areas, and have limited leverage. These Islamic Shari'ah-compliant equities with tiny capitalizations are typically less liquid than regular stocks. Islamic stock indexes exclude companies that pay or receive a considerable amount of interest (Khazali et al., 2017).

It is unknown when the first Islamic index existed. The first Islamic fund is thought to have been established in July 1987, following the fatwa on Islamic equities funds issued by Justice Muhammad Taqi Usmani, Professor Saleh Tug, and Sheikh Mohammad Al Tayyeb

Al Najar. Others claim that it began with the establishment of the Amana Income Fund in the United States in 1986.However, the fatwa proved to be a game changer and eye-opener for the whole Islamic financial industry, prompting Islamic sponsors such as Saudi Arabia's major commercial bank, Dallah Al Baraka, via Al Amin, to launch Islamic equities funds (Siddiqui, 2004; Htay et al., 2013; Muhammad et al., 2015).

Islamic indices were initially merged in the late 1990s. In April 1998, two private banks, "Faisal Finance" and "Bank Vontobel," formed the first DMI 150 merger. In the same year, another index, the "SAMI" (Socially Aware Muslim Index), was introduced, which monitored the performance of 500 Shari'a-compliant enterprises. Following this start, various financial markets and index providers began to build Islamic indexes in both Islamic and non-Islamic nations. Dow Jones Company is a pioneer in the development of unique indices for both established and growing markets. The DJ Islamic Market Index (DJIM), which was introduced on February 9, 1999, is the world's first Islamic equities benchmark index. Since October 1999, the FTSE group has introduced its Global Islamic index series (GIIS) on the London Stock Exchange. In 2006, Standard & Poor's introduced its first Shari'a indexes. In March 2007, MSCI Barra launched its worldwide family of Islamic indices. Stoxx Limited established the first Shari'a-compliant indices for Europe and the Eurozone in February 2011 (Siddiqui, 2004; Muhammad et al., 2015; Trabelsi and Naifar, 2017; Curuk, 2018).

Dow Jones Islamic Market indices, among others, are employed in this study since they are one of the most notable and well-acknowledged Islamic indexes. The index is a collection of equities that are suitable for Islamic investors.

2.6.2.1. The Dow Jones Islamic Market Index Framework

The Dow Jones Islamic Market (DJIM) indices are the Islamic equity benchmark index, and it seeks to deliver accurate investing information through disclosure, openness, and accountability. The index encourages enterprises to convey to Islamic investors information that will help them make intelligent and informed decisions regarding how and where to invest by allowing them to compare equivalent performance (Siddiqui, 2004). DJIM indices are built and maintained using a consistent process. It is supervised by an advisory group of Islamic scholars who assist Dow Jones on topics relevant to the indexes' eligible components' compliance. The DJIM indices composition is evaluated quarterly, and

modifications are enacted on the third Friday of March, June, September, and December. The adjustment procedure is based on market data from the end of January, April, July, and October. The DJIM indices are evaluated on an ongoing basis, in addition to quarterly and yearly composition reviews. If an unusual event such as bankruptcy, merger, or takeover affects an index component, the index must be changed. Furthermore, when a new issue is added to the Dow Jones Global Indices, it is examined by using the DJIM criteria to decide whether it will be included in the DJIM (Hussein, 2007).

Siddiqui (2004) claims that Dow Jones Islamic Indices consist of 10 economic sectors, 40 market sectors, and 70 sub-groups. Table 2 shows the Dow Jones Global Islamic Indices Sector Allocation.

Table 2. Dow Jones global Islamic indices sector allocation (%)

SECTOR	DJIMI	DJIDEV	DJIEMG	DJIMAP	DJIEU	DJIMU
Technology	32.9	31.7	43.7	29.8	13.5	39.6
Health Care	19	20.3	6.6	15	28.6	18.5
Industrials	13.9	14.5	8.9	17.8	17.3	11.6
Consumer Goods	12.7	13	10.6	14.3	24.9	9.6
Consumer Services	7.6	7.5	8.6	7.4	4.8	8.5
Basic Materials	4.9	4.7	7.2	7.3	8.4	2.3
Financials	4.8	4.9	3.4	1.5	0.6	6.7
Oil & Gas	2.8	2.7	4.1	1	1	3.3
Telecommunications	0.9	0.3	5.8	3.6	0.4	0
Utilities	0.5	0.4	1.2	2.3	0.5	0

Source: S&P Dow Jones Indices/Fact sheet as of 31 March 2020

The financial sector has one of the lowest allocations of the Islamic index. Hence the 2008 financial crisis has a minimum impact on this Islamic index (GIFR, 2011). Technology, Health Care, and Industrials sectors are the leading sector of the Dow Jones Islamic Indices respectively and their total allocation is more than 50 % of all.

Table 3 shows the market capitalization of Dow Jones Global Islamic Indices which are used in this study. The DJIM index has 2909 constituents with a market capitalization of USD 10683.28 billion. DJIDEV index has 1551 constituents with a market capitalization of

USD 15070.16 billion. DJIEMG index has 1358 constituents with a market capitalization of USD 5672.92 billion. The DJIMAP index has 1810 constituents with a market capitalization of USD 4587.9 billion. DJIEU index has 296 constituents with a market capitalization of USD 15796.02 billion. In comparison, the DJIMU has 517 constituents with the highest market capitalization of USD 29458.86 billion.

Table 3. Market capitalization of Dow Jones global Islamic indices

Index	Number of constituents	Market capitalization (Billion Dollar)
DJIMI	2 909	10 683.28
DJIDEV	1 551	15 070.16
DJIEMG	1 358	5 672.92
DJIMAP	1 810	4 587.9
DJIEU	296	15 796.02
DJIMU	517	29 458.86

Source: S&P Dow Jones Indices/Fact sheet as of 31 March 2020

Figure 5 shows the general performances of the Islamic Indices between 28.11.2009-29.10.2019. While DJIMU has generally highest performance in the observed terms, DJIMAP has the lowest performance.

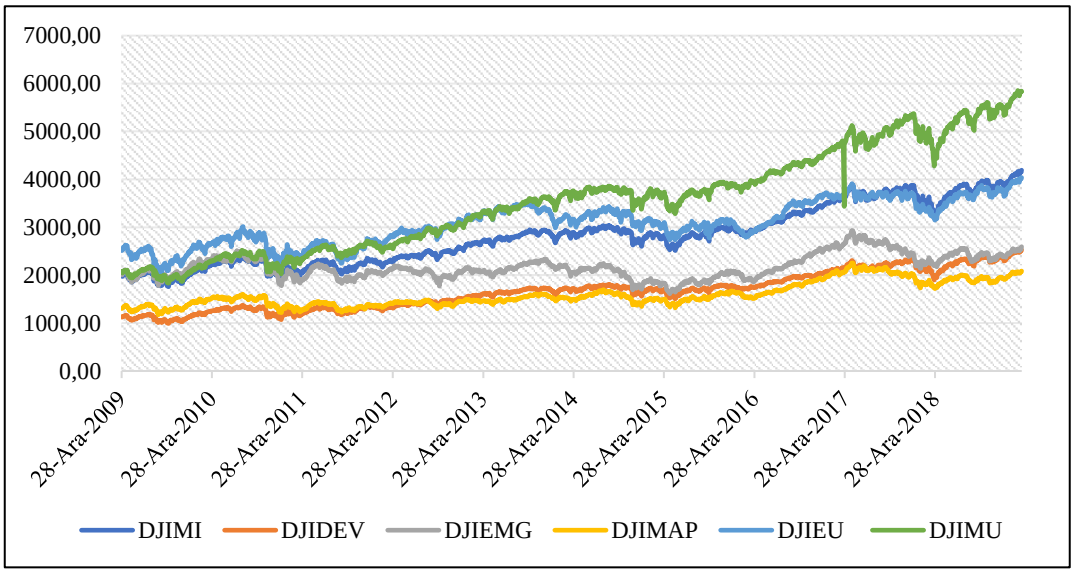

Figure 5. Dow Jones global Islamic market indices historical prices (USD)

Source: Bloomberg database

3. CONCEPTUAL FRAMEWORK OF COMMODITY MARKETS

3.1. Definition of Commodity

Commodity is defined as any good or service created by human effort and supplied as a property for sale or exchange on the market according to Classical political economy and mostly in Karl Marx's view of political economy. Furthermore, this definition of a commodity paves the way for terminological ambiguity, for instance, Karl Marx's German word "Ware" is classically translated as "Commodity," even though it encompasses not only commodities but also products (Tvalchrelidze, 2011).

However, commodities are defined in a variety of ways recently. Geman (2009) argues different definitions of the commodity in his work, according to an economist's commodity is a consumption asset and has a significant influence on global and regional economic growth and development. According to the bankers, commodity is not a financial security, leading to a flow of cash and a price based on net present value. According to an environmentalist, commodity is a natural good whose original integrity should be protected. Lastly according to academic, commodity is a sample numeraire against which portfolio values should be evaluated when given the present volatility of all currencies.

Furthermore, commodities defined in the 1936 Commodity Exchange Act as a hard asset which is ranging from wheat to gold to oil. While this Act include trading agricultural and natural commodities, the Act regards financial products as commodities, it does not consider them to be commodities (Brock and Amadeo, 2021).

As investment vehicle commodities are contracts to buy or sell goods in a future date. In accordance with commodity trading is very complex because of commodity markets volatility investors cannot rely on. (Stevens, 2006). Commodity is defined as a natural resource or its downstream semi-product that may be sold on mercantile exchanges under spot or futures contracts or delivered directly by seller to consumer for downstream processing (Tvalchrelidze, 2011).

3.2. Classification of Asset Class Commodities

The subject of whether commodities are a distinct asset class has received considerable attention in both academic and practitioner literature (Greer, 1978; Huberman, 1995; Strongin and Petsch,1995; Froot,1995). For many investors, the question is no more whether commodities investing is an asset class, but if it is fit for a certain investor, and if so, what is the best strategy to execute the investment (Georgiev, 2001).

Gorton and Rouwenhorst (2006) examine commodity price returns from 1959 to 2004, to better understand the features of commodities as an asset class. Commodity returns are shown to be: (a) equivalent to stock returns but with lower volatility, (b) negatively connected with stock and bond returns, and (c) favorably correlated with inflation (Dania, 2011).

Commodities are real assets although commodities are widely recognized as a distinct asset class. This suggests that they have same investing characteristics that apart from other asset types. Commodities are hedge instrument against expected and unexpected inflation and they have intrinsic value and influence price level fluctuations. Second, commodity prices are influenced by the status of the economy and fluctuate with the economic cycle. As a result of increasing demand and the inflation-hedging features of commodities, times of high expansion correlate with rising commodity prices. Third, most commodity prices are priced in US dollars. A general decline in the value of the dollar contributes to a rise in commodity prices, whilst a gain in the value of the dollar leads to a fall in commodity prices. Finally, because they do not provide a consistent flow of cash flows, commodities are not assets that generate income. As a result, commodity values cannot be predicted using conventional valuation methods. They are influenced by the relationship of supply and demand and the state of the economy at the time. Despite the fact that all commodities share some characteristics that make them a distinct asset class, there is a lot of variation across specific commodities. Several factors separate commodities apart from traditional investments, the most notable of which is their poor connection with equities and bonds. Commodity markets, however, demonstrate significant market dynamics with a consistent rise in trade volumes and overall turnover. The expansion of financial activity suggests that more investors are becoming aware that commodities represent a distinct investment class. As a result, investors think about including commodities into their portfolios. The increased

demand for commodities results in greater liquidity and better price efficiency (Belousova, Dorfleitner,2012).

Product quality is not standardized; each commodity has its own unique qualities. Commodities can be either directly generated by the primary or the outcome of transformation activities and can be diversified according to this production cycle. Commodities in general diversify into two categories: hard commodities and soft commodities. Hard commodities are aluminum, copper, crude oil, gold, iron ore, palladium, platinum, and silver. Soft commodities are included agricultural products such as coffee, corn, rice, salt, soybeans, sugar, and wheat. Hard and soft commodities share a characteristic in that they can be stored and transported (Abate ,2016; Eller and Sagerer:2008; Alrifai, 2015:122). As shown Figure 6, subdivision of commodities basically categorized. Hard commodities can be subdivided into metals, energy, and chemicals while soft commodities are divided into consumable products, industrial products, and animal products.

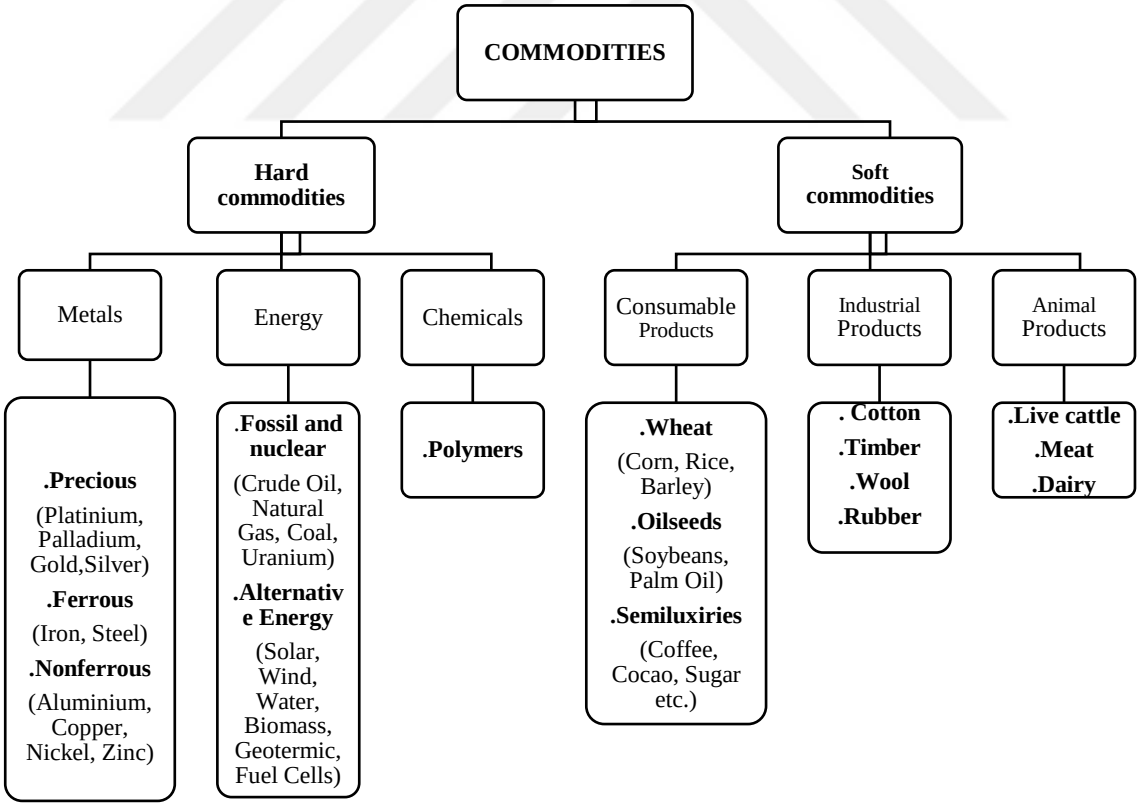

Figure 6. Subdivision of commodities

Source: Adapted by Author

3.3. Commodity markets

Commodity markets are markets where commodities are traded, its history date back to prehistory, but only since the mid-1800s have they been organized and controlled. Meanwhile, in this market raw and primary products are traded rather than manufactured products. These raw commodities are traded on controlled commodity markets under standardized contracts (Tvalchrelidze,2011:2). A range of derivative contracts, such as spot contracts, forwards, futures, options on futures, and swap contracts are available on commodities markets in addition to the physical trading of the real commodity. Futures trading predates stock markets by millennia, and there is evidence of rice futures trading in China as early as 6000 B.C.E (Geman, 2009:434; Teall, 2018: 74-75).

Generally, direct investment in physical goods, indirect investment in firms' equities of natural resource, commodity mutual funds, investing commodity futures and investing structured products based on commodity indexes are main important financial instruments which can be used in commodity markets. Well-developed commodity markets require that the commodities be well-defined and standardized (Fabozzi, Fuss, Kaiser, 2008:10).

3.3.1. Major Events in Commodity Markets

Major events in commodity markets between 1973-2011 have summarized in Table 4. The Yom Kippur War caused the OPEC Oil Embargo in 1973. On October 19, 1973, Saudi Arabia, Libya, and other Arab countries punished the United States for its diplomatic and military support for Israel. Although oil market became strained, Arab oil ministries began to utilize oil as a weapon to achieve their economic and political targets. The government refused to expand supply to stop price fluctuations at the time without the US supported the Arabs and production cutting by 5% per month until the West gave up. OPEC members set the official oil price, which increased from $3/barrel to $11.65/barrel. The embargo triggered a global economic downturn that impacted the world's largest economies (Haqeem and Zulkifli, 2022).

The price of oil jumped, making all forms of transportation more expensive. Major producers, such as Cuba and Brazil, favored the development of biofuels as a replacement for the "petrol shock" or oil crisis (Betchoo, 2015). According to Cooper and Lawrence (1975), an unusual increase in commodities prices occurred in 1973-74. Even excluding

crude oil as an outlier, primary commodity prices on one index more than doubled between mid-1972 and mid-1974, while the cost of several individual commodities, such as sugar and urea (nitrogenous fertilizer), increased more than fivefold (Haqeem and Zulkifli, 2022). Sugar prices began to rise, going from $40 to $330 per ton. The Mauritian quota under the European Economic Community Sugar Protocol was increased from 380 000 tons to 505 000 tons at a fixed price of £260 per ton, up from $57 per ton previously (Betchoo, 2015).

The coffee boom was a significant, though temporary, trade shock induced by frost in Brazil. It was acknowledged as both transient and remarkable at the time. Between 1975 and the peak of the boom in 1977, the price Kenya got for its coffee exports more than doubled, resulting in a 38% improvement in the barter terms of trade. However, the boom experienced by Kenya during this era was much larger: the coffee boom resulted in a significant increase in tea prices, as well as other terms of trade improvements, with a total increase in barter terms of trade of 54% (Bevan et al., 1992; de Nicola et al., 2016).

Another oil shock triggered a global crisis in 1979 with price increase to above $30 . Iran's oil, which had previously provided 10% of the world's oil, making it the world's second largest supplier, abruptly fell out of the market. Oil prices more than doubled in a short period of time, reaching a new all-time high (Bösch and Graf, 2014). According to de Nicola et al., 2016, because of the decreasing production sugar, cause increasing price of sugar in 1980.

The 1988 drought, the most severe weather disaster in US history, with damages estimated at $40 billion, had a significant impact on maize and soybean production. According to data, national maize output was down 45% from the 1985-87 average, while soybean production was down 26%. The anticipated agricultural losses were $15.6 billion (Wu and Wilhite, 2004).

Furthermore, during the 1990-1991 Persian Gulf War, Iraq's southern oil industry was destroyed, with production capacity falling to 75,000 bbl/d in mid-1991. Following Iraq's invasion of Kuwait, oil field development plans were placed on hold, with Iraq efforts focusing on sustaining output at existing fields (Hussain et al., 2006; Nicola et al., 2016). Meanwhile, coffee prices began to rise in 1994, when a severe frost in Brazil damaged a large portion of the country's yearly harvest. Prices then began to fall beginning in 1998, owing primarily to increasing supply from Vietnam and Brazil (Albertus, 2019). After 2

years later, because of the adverse weather conditions, maize, wheat, and soybeans crop fell in the US in 1996 (de Nicola et al., 2016).

In 2008, declining in growth of agricultural production, global grain stocks and increasing energy prices raise production costs and these factors have contributed to increased food prices. The already severe worldwide hunger problem was exacerbated by an 83% increase in global food costs between 2005 and 2008. Between January 2005 and June 2008, maize prices nearly quadrupled, wheat prices jumped 127%, and rice prices increased 170%. According to early estimates from the Food and Agriculture Organization of the United Nations (FAO), increased food costs drove an extra 40 million people into poverty in 2008, bringing the global total of undernourished people to 963 million, up from 923 million in 2007 (Mittal, 2009).

Growing demand and sluggish supply in 2007-2008 cause the 3rd oil shock. Global economic growth was great in 2004 and 2005, with the IMF calculating that real gross global product increased at an annual pace of 4.7% on average. 24 During this time, global oil consumption increased by 5 million barrels per day, or 3% per year. These high demand pressures were the primary cause for the constant rise in oil prices throughout this time, even though there was originally enough extra capacity to keep production expanding in tandem with demand (Hamilton, 2010). Poor harvest because of the bad weather conditions in Brazil and Colombia cause the Coffee shock in 2011 (de Nicola et al., 2016).

Table 4. Timeline of major fluctuations in commodity markets

Period	Major Events
1973-1974	- First oil shock
1974	- Sugar price boom,
1977	- Coffee prices shock
1979	- Second oil shock (energy crisis)
1980	- Sugar price boom
1988	- Grain Shock
1990-1991	- Cut down in oil production
1994	- Coffee price shock
1996	- Grain shock
2007-2008	- Global food price crisis
2007-2008	- Third oil shock
2011	- Coffee price shock

Source: Adapted by Author

3.4. Investing in Commodities

Investments in international commodities markets differ significantly from other types of investments in various respects. To begin, commodities are real assets that are mostly consumed rather than invested in. They have intrinsic value and serve a purpose in industrial manufacture or consumption. Likewise, supply is restricted since commodities have a limited availability at any time. Renewable commodities, such as grains, may be produced nearly unlimitedly. Their annual crop, however, is carefully limited. Furthermore, the supply of many goods has a significant seasonal component. While metals may be mined practically all year, agricultural commodities such as soybeans are seasonal.

Despite price instability, commodity investment has increased over the last decade. The theoretical arguments for investing in commodities focus on the benefits of portfolio diversity and commodities' position as an inflation hedge. Commodity prices, for example, frequently rise in reaction to a catastrophic occurrence, such as a drought or geopolitical conflict, but other assets, such as shares, generally decline. Other investors may hold a macroeconomic theory that predicts rising commodity prices, such as the peak oil and super cycle hypotheses (Bain, 2013).

It was suggested that having commodities assets would offer an asset manager with a hedge against macroeconomic or market shocks that would affect most other financial assets in a similar way. Commodity diversification advantages have been investigated by Ankrim and Hensel (1993), Becker and Finnerty (2000), Belousova, and Dorfleitner, (2012); Rehman et al., (2019), and others. Between 1971 and 2007, commodity markets had positive returns in six of the eight years when the S&P 500 stock market index returned negative returns. During market downturns, commodities were thought to outperform both stocks and bonds. Abanomey and Mathur (2001) investigate if include commodities in their overseas investment portfolio improves international diversification. The authors discover evidence that adding commodities to their international portfolio of equities and bonds increases portfolio efficiency. Because of these qualities, it is not surprising that investors, particularly institutional investors, are contemplating adding commodity-linked indexes to their portfolio for diversification purposes (Dani, 2019). However, the exponential increase in commodities investment has begun to diminish the benefits of diversification. Commodity markets have grown increasingly vulnerable to investor portfolio rebalancing, making them more connected with other financial asset markets (Bain, 2013).

3.5. Investing in Commodities and World Commodity Market Perspective

3.5.1. Agriculture Commodity Market

Agriculture is rapidly being recognized as an emergent asset class by financial experts ranging from institutional investors to "alternative" portfolio managers (Chen et al., 2015). Investors' interest in these assets is based on fundamental and financial analyses that all tend to highlight the same driving factors: strong long-term economic and financial essentials; alluring historical returns on land investment; a mix of current income and capital recognition; uncorrelated returns with the stock market; and a strong hedge against inflation (Ducastel and Anseeuw, 2017).

3.5.1.1. Coffee

Coffee is one of the most traded agricultural export commodities with over fifty producing nations and thirty importers. Coffee is a perennial crop, which means it is grown from the same root system for two or more years. Coffee production begins three years after the tree is planted and continues for 15 years (Kebede 1992). Compared to other commodities like cocoa or sugar, the price volatility of coffee has historically been far higher. Most oil-producing countries (for example, Brazil, Colombia, El Salvador, Nicaragua, Panama, Ethiopia, and Zaire) require foreign exchange to pay for imports of crude oil. As a result, they often ship coffee as rapidly as they can, which invariably results in oversupply and drives down prices. The price sensitivity of coffee consumers also contributes to price fluctuation. The sensitivity of coffee production to weather-related pressures as well as its geographical and climatic restrictions further assure ongoing volatility of coffee prices. It is also worth noting that coffee is a seasonal crop; seasons change from nation to country, making supplies unpredictable (Spurga, 2016). Coffee production, trade, and consumption are key contributors to socioeconomic development for many developing nation governments, the private, and multilateral sectors (Kebede, 1993; Lashermes et al., 2008).

The major corn producing countries include Brazil, Vietnam, and Colombia, they meet about 60 percent of the world's coffee production in given years in Table A.1. Brazil is the world’s largest coffee producer. Furthermore, these countries are the top three coffee exporting countries. It is given the percentage coffee exporting distribution by country in

Table A.2. On the other hand, the regions that both consume and import the most coffee are the European Union and United States respectively, according to Table A.3. and Table A.4.

3.5.1.2. Corn (Maize)

Corn (maize) is a herbaceous plant of the Poaceae (grass) family. It has been utilized by indigenous people in Mexico for 10 000 years. It gets its name from the wild grass teosinte. Maize is the primary plant utilized in the manufacture of industrial goods and animal feed. It is also the foundation of human nutrition (Kazerooni et al., 2019). According to Global Corn Market Outlook (2020) corn refers to the yellow or white corn seeds that are mostly utilized as animal feed and human nutrition. It is also known as maize or Indian corn, and it is a cereal plant that belongs to the grass family Poaceae and has edible grain. The domesticated plant originated in the Americas, particularly Mexico, and is now one of the world's most extensively spread food crops.

The major corn producing countries include the United States, China, and Brazil they meet about 60 percent of the world's corn production in given years in Table A.5. And with the United States accounting for above 30% of the total global output. The United States is also responsible for over 36% of the global exports, followed by Argentina and Brazil as the other major exporters of the corn in given years in Table A.8. On the other hand, major corn consumption same regions include United States, China, and European Union in given years in Table A.6. China is responsible for over 13% of the global imports, followed by Mexico and Japan are the other major importers of the corn in given years Table A.7.

3.5.1.3. Cotton

Cotton is a natural fiber derived from the cotton plant's seedpod. Cotton has been harvested and weaved into textiles for at least 7,000 years (Yadav and Gupta, 2015). Cotton has a substantial and somewhat consistent position on the stock market due to its demand, making it a favorite among investors. Cotton can be purchased or sold using a variety of investment vehicles (Finder, 2021).

The major cotton producing countries include the India, China, and United States, they meet about 60 percent of the world's cotton production in given years in Table A.9. While United States third cotton producing power, it is leader of the cotton exporting countries.

Furthermore, Brazil and India as the other major exporters of the cotton in given years in Table A.12. On the other hand, major cotton consumption first three countries include China, India and Pakistan in given years in Table A.10. China is responsible for nearly 22% of the global imports, followed by Bangladesh and Vietnam are the other major importers of the cotton in given years Table A.11.

3.5.1.4. Sugar

Sugar is a vital commodity that helps to feed the world's population. It is also an important component of the global food market, in which it plays an essential role. The global sugar and sugar-containing product market is continually changing. Its current structure is being formed notably by the progress of modernization of the world agricultural commodities market (Svatoš, et al., 2013).

The major sugar producing countries include Brazil, India, and European Union, they meet about 50 percent of the world's sugar production in given years in Table A.13. Brazil is the world’s largest sugar producer and exporter. While India is the second sugar producer countries, it is not exporting countries in given years in Table A.16. On the other hand, major sugar consumption first three countries include India, European Union and China in given years in Table A.14. China is responsible for nearly 10% of the global imports, followed by Indonesia and Bangladesh are the other major importers of the sugar in given years Table A.15.

3.5.1.5. Soybean

Soybeans are one of the few full proteins plant-based foods that include all nine necessary amino acids. As a result, the soybean has become a key source of protein for both humans and animals, with 85% of its production designated for animal feed and the 15% for direct human use. Furthermore, because the soybean market may be divided into animal feed, food and beverage, personal care, nutritional supplements, medicines, and biomaterials, particularly biofuels, the adaptability of soybeans will be a crucial factor for maintaining demand growth. Soybean demand has been linked to world meat consumption and is predicted to rise, fueled by Asia (Voora et al., 2020).

The major soybean producing countries include Brazil, United States, and Argentina they meet about 50 percent of the world's soybean production in given years in Table A.17. While China is the first soybean consumer countries, it is also leader of the soybean importing countries in given years in Table A.19. Major soybean consumption other leader countries include United States and Brazil in given years in Table A.18. Brazil is both leader of the among soybean producer countries and exporter countries. Furthermore, United States, which is the second soybean producer leader is also second soybean exporter in given years in Table A.20.

3.5.1.6. Wheat

Wheat is an important worldwide commodity in terms of land and tradeable value, as well as a fundamental in most people's diets. Climate, yields, oil prices, lag pricing, and imports are all variables that influence wheat prices. These market dynamics are expected to have an influence on worldwide pricing and, ultimately, food security, in addition to steadily and regularly growing global wheat consumption (Enghiad et al., 2017).

The major wheat producing countries include European Union, China, an India, they meet about 50 percent of the world's wheat production in given years in Table A.21. European Union is the world’s largest coffee producer and exporter. While China is the second wheat producer countries, it is not exporting countries in given years in Table A.24. On the other hand, major wheat consumption first three countries include China, European Union, and India in given years in Table A.22. While other total countries are responsible for nearly 60% of the global imports, leader major importer countries are Egypt, Turkey and Indonesia in given years Table A.23.

3.5.2. Energy Commodities

The government and several organizations which are involved in the financial markets are interested in energy commodities. Energy costs are critical to economic development from the perspective of nations and governments, and therefore raises issues about energy vulnerability. Energy enterprises, consumers, and the economy can all be negatively impacted by energy price uncertainties, such as price increases. Energy producers, consumers, and portfolio managers may all benefit from commodities and commodity derivatives markets from the perspective of financial markets. They are crucial to associated

risk-sharing procedures. Energy commodities have since evolved into an asset class that is frequently employed for diversification, hedging, or speculating opportunities (Gorton and Rouwenhorst, 2006; Gatfaoui, 2019).

3.5.2.1. Crude Oil

Oil has long been seen as a critical commodity on the global economy. It is known as the "blood of industries". Additionally, oil is a major source of energy for industrial production and is also extensively utilized in transportation, as well as in the residential and business sectors (Bradley and Fulmer, 2004). So, the price of oil, which is a major issue for governments, businesses, and investors in many nations, is becoming more and more important (Fan et al., 2008). The most traded commodity in the world is crude oil. Crude oil futures are traded on the New York Mercantile Exchange (NYMEX) and the London International Petroleum Exchange (IPE). The NYMEX trades two types of crude oil: light sweet crude oil and Brent crude oil. Light sweet crude oil is preferred by refineries because it has a minimum sulfur content and produces a significant number of high-value products such as gasoline and heating oil. Brent crude is based on North Sea light sweet crude oil (Spurga, 2016).

The major crude oil producer countries include United States, Saudi Arabia, and Iraq, they meet about 35 percent of the world's wheat production in given years in Table A.25. United States has the world's largest crude oil producer and demand distribution among other countries. While United States is the first crude oil producer countries, it is also ranks second after China second in importing countries in given years in Table A.27. On the other hand, Japan, and Brazil other leading countries in terms of crude oil demand in given years in Table A.26. Furthermore, the top exporter countries are Saudi Arabia, Russia and Iraq in given years Table A.28.

3.5.2.2. Gasoline

The largest product made from crude oil is gasoline, a complicated mixture of hydrocarbons. In a three-step process, refineries turn more than half of every barrel of crude oil produced into gasoline. Crude is divided into its chemical components, chemicals are broken down into molecules (hydrocarbons), and then hydrocarbons are transformed and combined with various additives. The New York Mercantile Exchange (NYMEX) Division

New York Harbor unleaded gasoline futures contract is the most widely utilized risk-management instrument in regional and national gasoline markets. These contracts are based on delivery at petroleum product facilities in New York harbor, the primary East Coast trading center for imports and domestic supplies from refineries (Spurga, 2016).

The countries of OECD Americas, China, and other Asia countries are leading in terms of gasoline demand with about 60% gasoline demand of the world in given years in Table A.29. While the countries of OECD Americas and Asia except from China are the leader importer countries with nearly 55% gasoline importing in given years in Table A.30. OECD countries are also the leading gasoline exporter countries in given years in Table A.31.

3.5.2.3. Heating Oil

Heating oil, a heavy fuel oil, accounts for 25% of an oil barrel's production. As a result, heating oil is also known as Number 2 oil, coming in second to gasoline, which accounts for around half of the production from a barrel of oil. The price of heating oil is directly associated with the price of crude oil, much like it is with gasoline. To benefit on increased volatility in the energy market, the New York Mercantile Exchange (NYMEX) launched the world's first effective energy contract in 1978. The contract was first utilized mostly by retailers and major customers of heating oil in the New York region. Its use eventually extended outside New York, and it was also utilized as a hedge for diesel fuel. Participants in a range of oil-related businesses now utilize the contract as a risk-management tool (Spurga, 2016).

The OECD countries and China are leading in terms of heating oil demand with about 50% heating oil demand of the world in given years in Table A.32. While the countries of OECD Europe and Asia except from China are the leader importer countries with nearly 50% heating oil importing in given years in Table A.33, total OECD countries are also the leading heating oil exporter countries in given years in Table A.34.

3.5.2.4. Natural Gas

As a fossil fuel with a relatively high energy content, natural gas has long been sought for its ability to burn cleanly. The Chinese began harnessing natural gas as early as 500 BCE, squeezing it through bamboo pipes to distill drinking water from saltwater. In 1785, the first

commercial usage of natural gas occurred in the United Kingdom, when gas was created from coal to light streetlamps. But the first well that was constructed particularly to extract natural gas wasn't sunk until 1821 by an American named William Hart. The natural gas futures contract on the New York Mercantile Exchange (NYMEX) Division was introduced on April 3, 1990, and trades in increments of 10,000 million Btu. It is based on delivery at the Henry Hub in Louisiana, which connects 16 intrastate and interstate natural gas pipeline networks serving markets on the East Coast, Gulf Coast, and Midwest. The contract is extensively utilized as a national natural gas benchmark price (Spurga, 2016).

The percentage of world natural gas reserve distribution is given in Table A.35. According to this table Russia, IR Iran and Qatar have the highest percentage of world natural gas reserve. The United States, Russia and China are leading in terms of natural gas demand with about 40% natural gas demand of the world in given years in Table A.36. Germany, China and Japan are the leader natural gas importer countries in given years in Table A.37. On the other hand, Russia, the United States and Qatar are leading natural gas exporter countries in given years in Table A.38.

3.5.3. Precious Metal Commodities

Precious metals are metallic elements, occur naturally and rare, which are accepted as an investment tool and industrial commodities, thus they have important economic value. Since each precious metal commodity has different risk-return characteristics, so as an investment tool precious metals give investors an opportunity of portfolio diversification (Mike, 2014; Siemaszkiewicz, 2019). During times of economic trouble, investors rebalance their portfolios with less risky securities, for instance treasury bills and fixed income securities. But recently when they face to high volatile market conditions and financial contagion, they try to diversify tend to use precious metals as a hedge or haven (Abel, 1988; Low et al., 2016). From a long-term perspective, precious metals are generally accepted as a hedge against inflation at the general price level. These metals have underlying supply and demand characteristics and they also low return correlation with other equity markets assets hence these metals give diversification opportunity and make better the risk-reward parameters of an investment portfolio (Hillier et al. 2006; Darst, 2013).

3.5.3.1. Copper

The earliest metal known to man, copper, is thought to have been produced around 10,000 years ago. In the present-day nations of Jordan, Egypt, and Israel, archaeologists have discovered copper smelting sites that date to around 4500 BCE. Copper tubing used for plumbing that is still functional may be found in ancient Egypt's temples and tombs (Spurga, 2016).

The percentage of world copper production distribution is given in Table A.39. According to this table Chile and Peru have the highest percentage of world copper production. China, Japan and South Korea are the leader copper importer countries in given years in Table A40. On the other hand, Chile, Peru and Australia are leading copper exporter countries in given years in Table A.41.

3.5.3.2. Gold

Gold has been valued for thousands of years for its beauty and scarcity and used as a medium of commerce on a global scale as well as a symbol of prosperity, power, and religion (Darst, 2013). Gold is a precious metal that is also a commodity and monetary asset. Gold is utilized in manufacturing, jewelry, as an investment asset, and as a reserve asset. It has served as a multifunctional metal throughout the centuries, with properties comparable to money in that it serves as a store of wealth, medium of exchange, and unit of worth (Solt and Swanson, 1981).

The percentage of world gold production distribution by countries is given in Table A.42. According to this table China, Australia and Russia have the highest percentage of world gold production. Switzerland, United Kingdom, and United States are the leader gold importer countries in given years in Table A. 43. On the other hand, Switzerland, Hong Kong, and United Arab Emirates are leading gold exporter countries in given years in Table A.44.

3.5.3.3. Palladium

Along with rhodium, iridium, osmium, and ruthenium, palladium is a member of the platinum group of metals (Spurga, 2016). Beginning in the 1970s, palladium was

increasingly used in the construction of car catalytic converters. Palladium is an important component of catalytic converters, which are used to minimize car emissions. Palladium is also widely utilized in the electronics, dentistry, jewelry, and chemical industries. Platinum became popular for producing beautiful jewelry around the end of the nineteenth century and the beginning of the twentieth. The United States military proclaimed platinum a strategic metal at the start of World War II, and its usage for nonmilitary reasons was restricted. Platinum had returned to being a widely used jewelry element at the turn of the twentieth and the beginning of the twenty-first centuries (Darst, 2013).

The percentage of world palladium production distribution by countries is given in Table A.45. According to this table Russia, South Africa and Canada have the highest percentage of world palladium production with the percentage of nearly %85 of total world palladium production. United Kingdom, United States and Germany are the leader palladium importer countries in given years in Table A. 46. On the other hand, Russia, United States, and South Africa are leading palladium exporter countries in given years in Table A.47.

3.5.3.4. Platinum

The metallic element platinum, which is more expensive than gold and chemically inert, is noted for its exceptional resistance to assault by air, water, single acids, and common reagents. Its various industrial applications stem from its capacity to tolerate high temperatures, acid damage, disintegrating atmospheres, and extreme stress (Spurga, 2016). Platinum jewelry was made for King Louis XVI by a French jeweller in 1790, and the monarch subsequently referred to platinum as "a metal appropriate exclusively for royalty." First pure platinum sample was acquired by English doctor William Hyde Wollaston in 1801 (Darst, 2013). When German geologist Hans Merensky unearthed the greatest platinum resources ever known in South Africa in 1924, the continent became a major supplier of the metal. Platinum is both heavier and rarer than gold and other precious metals (Darst, 2013; Spurga, 2016).

The percentage of world platinum production distribution by countries is given in Table A.48. According to this table Russia, Zimbabwe and South Africa have the highest percentage of world platinum production in 2020. United States, United Kingdom, and Germany are the leader platinum importer countries in given years in Table A. 49. On the

other hand, South Africa, Russia, and United Kingdom are leading platinum exporter countries in given years in Table A.50.

3.5.3.5. Silver

The best metal for heat and electrical conductivity is silver, a white metallic element. It is the most malleable metal, next after gold. Silver has been mined since prehistoric times when numerous silver deposits were near the earth's surface. Ancient civilizations replaced the older barter system of trade with the use of silver as currency, much like they did with gold (Spurga, 2016).

The percentage of world silver production distribution by countries is given in Table A.51. According to this table Mexico, Peru and China have the highest percentage of world silver production. United States, Canada and United Kingdom are the leader silver importer countries in given years in Table A. 52. On the other hand, United Kingdom, China, and Mexico are leading silver exporter countries in given years in Table A.53.

4. THEORETICAL BACKGROUND

The reason for the special attention given to portfolio theory is that portfolio theory has been the basis of the capital market for many years. In this section, the concepts of portfolio and portfolio management will be explained in detail. To comprehend the phenomenon of portfolio diversification, one must first understand portfolio theory and how to construct an efficient asset portfolio. It is also critical to understand what co-movement is and that its meaning is still unclear in financial theory.

4.1. Concept of Portfolio and Portfolio Management

Portfolio refers to all the securities held by investors or used on behalf of investors. In terms of securities, a portfolio is a set of securities, which consists of securities. Portfolio can be defined as financial assets that consist of various securities, especially stocks, bonds and derivative products and owned by a specific person also literally means of portfolio is wallet (Demirtaş and Güngör, 2004; Akkaya, 2021). In a broader sense, a portfolio is a new asset with a specific relationship and unique measurable quality owned by investors who want to achieve certain goals. Even though the portfolio consists of certain securities, there is a relationship between these securities and the portfolio is a unique, measurable asset. Therefore, the portfolio is not only the sum of the securities it contains (Ceylan and Korkmaz, 2012).

Stock investments, like those in all other financial assets, have two fundamental characteristics: risk and return. All investors must choose between risk and return because these variables are inversely related. Furthermore, there are two types of risks which are occur systematic and unsystematic risk. Systematic risk, as opposed to unsystematic systematic risk, is the risk that inherently comes with investment as a result of changes in the general economic, political, and social environment. Unsystematic risk, however, varies and is firm-specific. Modern portfolio theory claims that a portfolio's risks decrease as the number of securities in the portfolio increases (Biswas,2015).

Portfolio management has been practiced since 1000 BC. "Everyone should split his own money into three parts and invest one third in land, one third in work, and the remaining third in reserve," the Talmud instructs. Portfolio management is the notion of professionally

managing assets that emerged as a profession with the rise of investment bankers in Europe during the Industrial Revolution. Since the early twentieth century, it has risen fast and played a key part in the financial services sectors of all industrialized countries (Maginn and Tuttle, 1983).

In the 1950s, Harry Markowitz developed the portfolio theory. According to portfolio theory, investors do not generally invest in a single security. Investors distribute their savings among a variety of securities. The purpose of this is to allocate the savings of investors among various securities in the most appropriate way. By holding multiple risky assets rather than just one, an investor can spread the risk of the portfolio. This is defined as diversification. The purpose of diversification is to lower risk while preserving the portfolio's expected return level (Ramaswamy, 2003). Harry Markowitz was the first to demonstrate mathematically why and how diversity reduces risk. Since then, other academics such as Fama and French (1995), Lintner (1965), Sharpe (1964), Ross (1976) and others have modified and developed Markowitz's theory to become what it is now. Modern portfolio theory describes how a risk-averse investor should form an asset portfolio effectively while optimizing expected return on the portfolio and simultaneously limiting its risk level. Diversifying the asset holdings among a range of risky assets is a key step in establishing an optimal portfolio (Guedira and Ariff. 2020).

4.1.1. Portfolio Diversification

The concept of "Portfolio Diversification" is well-known among investors worldwide. The concept may be summed up with the expression "Don't put all of your eggs in one basket." (Lorie, 1975). Diversification, in general, refers to efforts to minimize or spread the risk of a portfolio of assets. Diversification is a methodology used to minimize risk for investors who are risk-averse, prefer higher return to less risk, and desire to raise their income and well-being while also time. Diversification in the classical sense refers to the inclusion of several securities from various industries within the portfolio constructed (Islam and Faisal, 2011).

Investors are consistently looking for ways to boost returns and lower risks in order to enhance the performance of their portfolios. Through asset allocation and portfolio diversification, investors try to lower systemic risk. Considering that equities, securitized bonds, long-term government securities, and residential real estate constitute the majority of

an investor's portfolio, knowledge of the correlations between the asset returns can help investors decide how to vary their portfolios and allocate their assets (Kim, Francis, 2013).

It is important to mention Markowitz's basic theory of portfolio diversification. Given that a portfolio contains assets with imperfectly correlated returns, Markowitz contributed create today's portfolio theory, which states that a portfolio's volatility should be lower than the weighted average volatility of the securities it comprises. The following formula can be used to determine the variance of the expected return on a portfolio:

$$\sigma_p^2 = \sum V_i^2 \, \sigma_i^2 + \sum \sum V_i V_j \, Cov_{ij} \qquad \textbf{(4.1)}$$

in which the sums include all of the portfolio's securities, V_i is the fraction of the portfolio that is invested in security i, σ_i is the standard deviation of expected returns of security i, and Cov_{ij} is the covariance of expected returns of securities of i and j. This will be lower than the weighted average of the standard deviation of the expected returns of the securities, assuming that the covariance is smaller than one (which is true in general). For this reason, diversification lowers risk (Markowitz, 1959). Markowitz (1959), states that optimal portfolios should be created by considering the expected return and the variance of this expected return. The expected return consists of three parts. These are; risk-free rate, expected excess return and alpha which define the difference between the expected returns. The method that can also be used for this is the mean variance model. According to this model, the best portfolios are created by considering the expected return and the variance of these returns. The mean variance model assumes that “investors are risk-averse individuals, and the probability distribution of investments is approximately normal”. From this point of view, investors will choose the less risky of two investment options with the same level of expected return. In other words, they will choose the option with the highest expected return among the options with the same risks. When a choice is made based on the mean variance criterion, the expected return for the investor is maximum if the assumptions are correct.

The notion that the portfolio variances are distributed uniformly was one of the objections leveled at previous versions of modern portfolio theory. According to Markowitz, a measure of risk should not be one with a regularly distributed variance. On the other hand, a symmetric and fat-tailed distributions, that are better in line with actual data, are used in future models. To better capture the fat-tailed characteristics of the distribution of index

returns, the methodology of this project, GARCH-DCC, can adopt a student-t distribution of variances (Pesaran & Pesaran, 2010).

4.1.2. Correlation

The correlation between two risky assets in a portfolio plays a significant role in determining the overall risk of the investment. Correlation is defined as the degree to which asset return rates move together. Investment risk rises when there is a positive correlation between the various instruments or securities. Diversification is a managerial characteristic that is highly regarded as an investing attribute. When managing a portfolio, the effect of diversity is usually measured using correlation coefficients. Low correlation suggests international diversification as a means of reducing risk on the investor's portfolio. If more assets with low correlation are added to the portfolio, the variance of the portfolio will be smaller (Elton et al., 2007, Islam and Faisal, 2011).

It is difficult to find completely correlated assets; rather, all of the stocks we discovered exhibit some degree of connection. It is common practice to assess the diversification impact using the correlation, which really measures the strength of the association between two variables. The correlation might be anything from -1 to +1. A positive correlation occurs when the increment of one variable causes an increase in the other. On the other hand, with a negative correlation, when one variable's level rises, another variable's level rises. If the correlation is zero, the securities are said to have no correlation and are referred to as totally random (Islam and Faisal, 2011).

4.2. The Excess Co-Movement Hypothesis (ECH)

Pindyck and Rotemberg (1990) discover that there is a persistent trend for the prices of raw materials that are essentially unrelated to move in tandem. The standard theory of co-movement holds that it arises from shifts in core assumptions in frictionless markets like arbitrage with logical investors (Pindyck and Rotemberg, 1990). According to this theory, changes in an asset's actual value can result from changing rational expectations as to its future cash flows or from utilizing diverse discount rates to such cash flows. As a result, correlations in yields could be caused by shifts in both rationally expected cash flows and discount rates. It is also stated that common variations in discount rates could also occur from changes in interest rates, risk aversion, or changes in how rationally asset risk is viewed.

Pindyck and Rotemberg (1990) investigated whether changes in significant macroeconomic factors might account for the co-movement of specific equity markets. The current value model of asset valuation, which assumes that variations in discount rates are only caused by shifts in macroeconomic factors, served as the theoretical foundation for the test (Ocran et al., 2009).

Fund managers may respond to news in a similar way, whether it be local or global, and therefore, they may behave in the manner Pindyck and Rotemberg refer to as acting "in the herd." To make a well-informed investment decision, one must have a thorough comprehension of the excess co-movement phenomena, thus more research on the topic is also necessary.

5. THE LITERATURE REVIEW

In the literature studies try to explain “Are commodities hedging or diversification tools “or “Are their movement correlated each other and what is the role of these commodities in the financial market.” Too many studies related to investor sentiment according to price fluctuations. While these studies focus on the traditional markets, studies related to Islamic share market is limited. The literature review is divided to three-section accordance with the purpose of this study: literature that analyzed Islamic Market, literature related to traditional market and literature related to investor sentiment.

5.1. Studies Related to Cointegration Between Commodity Price and Islamic Stock Market

Nagayev and Masih (2013) examined the link between price returns of gold, silver, corn, all wheat, soybeans, crude oil and livestock spot price and Shariah-compliant equities (developed and emerging markets-Dow Jones Islamic Index) for the period 01.1996-04.2013 applying the DCCM-GARCH method. Their findings show this correlation for the variable is highly volatile every time and Islamic Investors willing to diversification benefits to with including the commodities their portfolios

Chebbi, Derbali (2015), examined the dynamic correlation between strategic commodities (oil, natural gas) and Islamic stock market indices (QE Al Rayan Islamic Index) applying the Dynamic Correlation coefficient (DCC) for the period 15.03.2011-25.12.2014. They investigate that commodity returns volatilities are correlated with the Islamic stock Indices.

In a recent paper, Mensi, Hammoudeh, and Kang (2015a) investigate the relationship between silver and WTI oil, gold, wheat, corn and rice; develop implications for Saudi-Arabian investors derived from daily data between 01.06.2005-13.08.2014 applying DCC-FIAPARCH models. Their results show a a negative linear correlation between silver and Saudi Arabian stock returns and also adding the commodity future to Saudi stock portfolio, help reducing the portfolio risk for Saudi investors.

Mensi et al. (2015b) analyzed whether the Sharia-compliant stocks measured by the Dow Jones Islamic world emerging market index (DJIWEM) and gold can serve as a hedge

and/or a safe-haven asset in the the Abu Dhabi General Index (Abu Dhabi-ADX) for the United Arab Emirates (UAE), the Bahrain Stock Exchange (BSE) for Bahrain, six GCC stock markets(Tadawul All Share Index) for Saudi Arabia, , and the Qatar Doha Securities Market Index (QAT) for Qatar), both the Dubai Financial Market General Index (Dubai-DFM) and the Kuwait Stock Exchange Index (KUW) for Kuwait, the Muscat Securities Market Index (OMN) for Oman's MSM 30 index , by using a vine copula approach examine the weekly data between the period 03.06.2005-04.07.2014. The result shows that Global and GCC investors realized the risk diversification benefits and they include gold or DJIWEM in their portfolios during downturn and tranquil periods for downside risk reduction.

Abdullah, Saiti and Masih (2016) investigate the time–scale dependent volatilities and time varying correlations between the Islamic Stock indices of Southeast Asian counties and three commodities (crude oil, gold and corn) between the period of 01.06.2007-28.02.2014 daily data applying the VECM and recent wavelet technique MODWT. The results show that in the short run crude oil price correlated with Philippine Islamic stock index and Investors can gain who put the crude oil including Malaysian Islamic stock index in the portfolio.

Nagayev et al. (2016) examine the relationship between commodity markets and Dow Jones Islamic Market Worl Index for the period 01.1999-04.2015 using the GARCH-DCC and Wavelet Coherence. The result suggest that gold, natural gas, soft commodities, grains and livestock are better portfolio diversifiers than oil and other metals.

Mensi et al. (2017) investigated the risk spillovers between crude oil, gold and ten different Dow Jones Islamic stock index based on basic materials, consumer services, consumer goods, energy, financials, health care, technology, industrials, telecommunications and utilities sector, using the DECO-FIAPARCH model and Diebold and Yilmaz (2012)’s spillover index for the period 09.11.1998-05.03.2015. They adviced the according to their findings for the better portfolio diversification investors must be provide gold with Islamic sector index.

Saitu and Dahiru (2017) examined the diversification benefits in Metal, Energy and Agriculture commodities for MSCI world Islamic index investor for their aim they use multivariate GARCH-DCC method, using the 18 commodities daily data for the period of

1.06.2007-31.12.2016. This study shows that there is a strong correlation between MSCI World Islamic Index and 18 commodities, and medium-to-long term investors could gain better diversification benefit for the natural gas, gold, wheat, sugar coffee commodities during the all markets periods.

Badeeb and Lean (2018) examined the asymmetric impact of oil price on ten Dow Jones Islamic Indices using the non-linear Autoregressive Distributed Lag cointegration methodology applying the monthly data from01.1996-06.2016. Their results investigate the weak linkages between Islamic Index and oil price changes and their relationship tend to follow a nonlinear pattern

Mezghani and Boujelbene (2018) try to investigate herding on the transmission between oil market and GCC Islamic Market and conventional stock markets during the tranquil and turmoil crises periods of 2008-2014. They use monthly returns of two indices for market Dow Jones Islamic GCC (DJIGCC) and the Dow Jones Conventional GCC (DJGCC) and using Brent oil applying the two econometric model; DCC and Kalman Filter, from 01.12.2006- 25.11.2016. Their findings show that during the turmoil period oil price, and GCC Islamic and conventional stock markets increase significantly in 2014 but for 2008 crises there is no regime changes between the variables.

Tuna (2018) analyzed the long-term relationship between four precious metal prices, such as gold, palladium, platinum, and silver and 21 developed and 11 developing Islamic countries markets which grouped by the Morgan Stanley Capital Index, applying the monthly data from 2002 to 2015. For this aim Pedroni panel cointegration analysis and full modified ordinary least square methods were used, according to the test result these precious metals are effective diversification tools for developed Islamic countries but for developing countries only gold and palladium are effective diversification tools.

Sakti, Masih, Saiti and Tareq (2018) examined the Indonesian Sharia compliant investors can benefit from the diversification of their portfolio with Islamic Indices, they use daily crude oil, cocoa, gold prices from 4.06.2007-30.12.2016, for their aim, they apply wavelet coherence and multivariate-generalized autoregressive conditional heteroscedastic method. Their findings claim that gold is a safe haven instruments also if investors want to exposure in commodities, they willing to invest Indonesian Islamic equity.

Yahya, Hussein, Muhammad, Razak, Tha and Marwan (2013) try to investigate the link between gold, oil price and FTSE Bursa Malaysia Emma's Shariah Index, for the monthly period 01.2007-12.2011 applying cointegration, causality method and Impulse Response Function (IRF) and Variance Decomposition) analysis. According to their result, there is a bi-directional causality relationship between Islamic stock returns and oil price and Islamic stock is not affected by gold prices.

5.2. Studies related to Commodities and Conventional Market

Ciner (2001) applies linear and nonlinear causality tests to examine the dynamic relationship between oil prices and stock markets, and that a statistically significant relationship exists between real stock returns and oil price futures is non-linear.

Wo and Hui (2012) investigate the nonlinear dynamic relationship between the Volatility Index (VIX) and the Morgan Stanley Capital International (MSCI) for Emerging Market Index (MSCI-E) as control variables between USD/yen and gold futures, and their findings suggest that the role of gold can be determined by the oil price. This indicates that gold acts as a hedge when the price of oil falls.

Sensoy (2013) examines the implications of volatility shift contagion in the returns of four main precious metals (gold, silver, platinum, and palladium) using the DCC and DECO models, but finds no discernible impact on the volatility levels of gold and silver during the stormy year of 2008. According to his research, gold has a unidirectional shift contagion impact on other metals, but silver has a unidirectional shift contagion effect on platinum and palladium.

Bildirici and Türkmen (2015b) try to investigate cointegratıın and causal relationship between oil(equally weighted average of Brent, West Texas Intermediate (WTI), Dubai oil) , silver, and copper,. They perform a nonlinear ARDL approach analyses examining monthly data between 01.1973 and 11. 2012.Results shows that there is a positive long-run relationship between oil and silver, where a 1% increase in the price of oil results in a 1.33% increase in the price of silver.

Kang, McIver, and Yoon (2017) investigate volatility spillover effects among six commodity futures markets (gold, silver, West Texas Intermediate crude oil, corn, whea8t, and rice) examining the weekly data between the period of 04.01.2002-28.07.2016 by

employing the multivariate DECO-GARCH model and the spillover index. They investigate that during the Global Financial Crisis, there is a equicoreelation between commodity futures and comparing the other commodity futures markets silver is a net information transmitter.

Using a Markov Switching model, Charlot and Marimoutou (2014) investigate the volatility and correlation of commodities (WTI oil, gold, silver, platinum, the Euro/US Dollar exchange rate, and the S&P 500) using daily data from January 2005 to December 2012. According to the findings, silver volatility is significantly tied to economic shocks such as the 2008 Financial Crisis, but platinum volatility responds slowly.

The effect of commodity futures (oil, gold, platinum, and silver) in forecasting commodity spot markets is investigated by Narayan et al. (2013). Furthermore, they demonstrate how investors may use futures market information to develop trading strategies and profit. According to dynamic trading systems, earnings from all commodities are tied to structural break-dependent and all of them are volatile.

Naifar and Dohaiman (2013) examine the nonlinear structure of oil prices by using Markov regime-switching model covering the period from 07.07.2004 -10.11.2011 for GCC countries. According to result there is a e significant symmetric dependence between crude oil prices and the short-term interest rate during the financial crisis.

In 2013, Jain and Ghosh use the ARDL limits test to evaluate the cointegration and causation link between gold, silver, platinum, and oil prices, as well as the Indian Rupee-US Dollar exchange rate, during the period 02.02.2009-30.12.2011. The results of the research reveal that the relative independence of platinum and silver may be used to construct an efficient portfolio that diversifies risk and provides risk-adjusted returns.

Khan and Masih (2014) using the daily price of energy, precious metals, agricultural, non-ferrous metal and soft spot index daily price between 03.01.2011-28.03.2013 with the DCC GARCH method, they examined the correlation between the stock and commodity markets, concluded that the link between commodity price and Islamic stock markets are highly volatile and unstable. During the global debt crisis this volatility has a crucial role.

Iscan (2015) try to investigate the relationship between commodity price and stock market in Turkey applying multivariate analysis for the monthly period 2002 to 2014 The study found no relation between commodity prices and stock markets.

In 2016, Nicola, Pace and Hernandez examined the co-movement of major energy (coal, crude oil and natural gas), agriculture (barley, maize, rice, sorghum, soybean oil, wheat) and food commodity price (coffee and sugar) using monthly price of these 11 commodities data between 1970 and 2013 applying the multivariate dynamic condition correlation method. Their findings show that energy and agriculture commodity price returns are highly correlated, and they find after 2007 stock market volatility related to positively co-movements of price return.

Table 5. Studies Related to Cointegration Between Commodity Price and Islamic Stock Market

Writer	Period	Data Set	Method	Result
Yahya et al. (2013)	01.2007-12.2011 (Monthly data)	-Gold, -Oil Price -Ftse Bursa Malaysia Emas Shariah Index	-Cointegration -Causality -Impulse Response Function (IRF) -Variance Decomposition	-There is a bi-directional causality relationship between Islamic stock returns and oil price and Islamic stock is not affected by gold prices.
Nagayev et al. (2013)	01.1996-04.2013	-Gold -Silver -Corn, -All Wheat, -Soybeans, -Crude Oil -Livestock Spot Price -Developed And Emerging Markets-Dow Jones Islamic Index	DCC M-GARCH	-Correlation for the variable is highly volatile and Islamic Investors willing to diversification benefits to with including the commodities their portfolios
Chebbi et al. (2015)	15.03.2011-25.12.2014	-Strategic Commodities (Oil, Natural Gas) -Islamic Stock Market Indices (QE Al Rayan Islamic Index)	Dynamic Correlation coefficient (DCC)	-Commodity returns volatilities are correlated with the Islamic stock Indices
Mensi et al. (2015a)	01.06.2005-13.08.2014 (Daily data)	-Silver -WTI Oil, -Gold, -Wheat, -Corn -Rice;	DCC-FIAPARCH	-Results shows a negative linear correlation between silver and Saudi Arabian stock returns
Mensi et al. (2015b)	03.06.2005-04.07.2014 (weekly data)	-Dow Jones Islamic World Emerging Market Index (DJIWEM) -Gold -Six GCC Stock Markets.	-Vine copula approach	Global and GCC investors realized the risk diversification benefits and they include gold or DJIWEM in their portfolios during downturn and tranquil periods for downside risk reduction.
Abdullah, et al. (2016)	01.06.2007-28.02.2014 (Daily data)	-Islamic Stock Indices Of South East Asian Countries -Crude Oil, -Gold, -Corn	-VECM -MODWT	-Crude oil price correlated with Philippine Islamic stock index and Investors can gain who put the crude oil including Malaysian Islamic stock index in the portfolio.

Table 5. (continued) Studies Related to Cointegration Between Commodity Price and Islamic Stock Market

Writer	Period	Data Set	Method	Result
Nagayev et al. (2016)	01.1999-04.2015	-Commodity Markets -Dow Jones Islamic Market World Index	-GARCH-DCC -Wavelet Coherence.	-Gold, natural gas, soft commodities, grains and livestock are better portfolio diversifiers than oil and other metals.
Mensi et al. (2017	09.11.1998-05.03.2015	-Crude Oil -Gold -Ten different Dow Jones Islamic Stock Index Based On Basic Materials, Consumer Services, Consumer Goods, Energy, Financials, Health Care, Technology, Industrials, Telecommunications and Utilities Sector,	-DECO-FIAPARCH -Diebold and Yilmaz (2012)'s spillover index	-Investors must provide gold with Islamic sector index.
Saitu et al. (2017)	1.06.2007-31.12.2016 (Daily data)	-Metal -Energy -Agriculture Commodities for MSCI World Islamic Index Investor	-Multivariate GARCH-DCC	-Strong correlations between MSCI World Islamic Index and 18 commodities, and medium-to-long term investors could gain better diversification benefit for the natural gas, gold, wheat, sugar coffee commodities
Badeeb et al. (2018)	01.1996-06.2016 (monthly data)	-Oil Price -Ten Dow Jones Islamic Indices	-Non-linear Autoregressive Distributed Lag cointegration	- The weak linkages between Islamic Index and oil price changes and their relationship tend to follow a nonlinear pattern
Mezghani et al. (2018)	01.12.2006-25.11.2016	-Dow Jones Islamic GCC (DJIGCC) -Dow Jones Conventional GCC (DJGCC) - Brent Oil	-DCC -Kalman Filter	- During the turmoil period oil price, and GCC Islamic and conventional stock markets increase significantly in 2014 but for 2008 crises there is no regime changes between the variables
Tuna (2018)	2002 -2015 (monthly data)	-Gold, -Palladium, -Platinum -Silver -Morgan Stanley Capital Index	-Pedroni panel cointegration -OLS	-Metals are effective diversification tools for developed Islamic countries but for developing countries only gold and palladium are effective diversification tools.
Sakti, et al. (2018)	4.06.2007-30.12.2016 (daily data)	-Crude Oil, -Cocoa, -Gold Prices	-Wavelet coherence and multivariate-generalized autoregressive conditional heteroscedastic method	- Gold is a safe haven instruments also if investors want to exposure in commodities, they willing to invest Indonesian Islamic equity

Table 6. Studies related to Commodities and Conventional Market

Writer	Period	Data Set	Method	Result
Ciner (2001)	-	-Oil Prices and Stock Markets	-Linear and nonlinear causality tests	-Significant relationship exists between real stock returns and oil price futures is non-linear
Wo et al. (2012)		-Volatility Index (VIX) -Morgan Stanley Capital International (MSCI) for Emerging Market Index (MSCI-E) as control variables between USD/yen and gold futures	-Nonlinear dynamic relationship	-Gold perform like a hedging function when the oil price is slow.
Sensoy (2013)		-Gold, -Silver, -Platinum -Palladium	-DCC -DECO	-No significant effect on the volatility levels of gold and silver during the turbulent year of 200
Charlot et al. (2014)	01.2005-10.2012 (Daily data)	-Gold, -Silver, -West Texas Intermediate crude oil -Platinum, -The Euro/US Dollar Exchange rate -S&P 500	Markov Switching Model	-Silver volatility strongly related to economic shocks such as the Financial Crisis of 2008, while the response of platinum volatility is very slow.
Narayan et al. (2013)		-Gold, -Silver, -Oil -Platinum,	-Dynamic Trading	-The profits from all commodities are related to structural break-dependent and all of them profitable.
Naifar et al. (2013)	07.07.2004-10.11.2011	- Oil Prices	-Markov Regime-Switching Model	-There is a significant symmetric dependence between crude oil prices and the short-term interest rate during the financial crisis.
Jain et al. (2013)	02.02.2009-30.12.2011	-Gold, -Silver, -Oil -Platinum, -Indian Rupee–Us Dollar Exchange Rate	-Cointegration -Causality - ARDL Bounds	- The relative independence of platinum and silver can be exploited to make an efficient portfolio
Khan et al. (2014)	03.01.2011-28.03.2013 (daily data)	-Energy -Precious Metals, -Agricultural non-ferrous Metal -Soft Spot Index	-DCC -GARCH	-Islamic stock markets are highly volatile and unstable. During the global debt crisis this volatility has a crucial role.
Iscan (2015)	2002 – 2014 (monthly data)	-Commodity Prices -Stock Market	-Multivariate Analysis	-No relation between commodity prices and stock markets.

Table 6. (continued) Studies related to Commodities and Conventional Market

Writer	Period	Data Set	Method	Result
Bildirici et al. (2015b)	01.1973- 11.2012 (monthly data)	-Oil, -Silver -Copper	-Cointegration -Causality - Nonlinear ARDL	-There is a positive long-run relationship between oil and silver, where a 1% increase in the price of oil results in a 1.33% increase in the price of silver.
Nicola et al. (2016)	1970 - 2013	-Coal, -Crude Oil -Natural Gas -Barley, -Maize, -Rice, -Sorghum, -Soybean Oil, -Wheat - Coffee -Sugar prices	-Multivariate Dynamic Condition Correlation	-Energy and agriculture commodity price returns are highly correlated and they find after 2007 stock market volatility related to positively co-movements of price returns
Kang et al. (2017)	04.01.2002-28.07.2016 (weekly data)	-Gold, -Silver, -West Texas Intermediate crude oil -Corn, -Wheat, -Rice	-Multivariate DECO-GARCH - The Spillover Index	-During the Global Financial Crisis, there is a equicoreelation between commodity futures and comparing the other commodity futures markets silver is a net information transmitter.

6. DATA SET AND ECONOMETRIC METHODOLOGY

6.1. Data Set

The data employed in this paper are daily time data and the sample time periods runs from 29.12.2009-28.10.2019 with 2557 daily observation. Daily data used for this study because Daily data, as opposed to low frequency data, better reflect the relationship between oil and stock prices in the region, according to Naifa and Dohaiman's (2013) argument. Furthermore, Narayan, Bannigidadmath, and Narayan (2016) investigate that daily data might be better than the monthly data when the aim is obtaining much information. Energy data will obtain from Energy Information Administration and other data will obtained from Eikon Datastream database terminal. Before the analysis, logarithmic return will be calculated for the variables.

Table 7. Notations of variables

Group	Notations	Variable	References
Islamic Indices	**DJIDEV**	Dow Jones Islamic Developed Market -Index	-Saitu and Dahiru (2017) -Tuna (2018) -Khan and Masih (2014).
	DJIEU	Dow Jones Islamic Europe Market Index	
	DJIEMG	Dow Jones Islamic Emerging Market Index	
	DJIMI	Dow Jones Islamic Market World Index	
	DJIMU	Dow Jones Islamic Market U.S Index	
	DJIMAP	Dow Jones Islamic Asia Market Index	
Energy Commodities	**CO**	Crude Oil- Brent Oil Spot Price	-Nicola et al. (2016) - Saitu and Dahiru (2017) - Naifar (2018) -de Nicola, de Pace, Hernandez (2016)
	GO	Gasoline Spot Price	
	HO	Heating Oil Spot Price	
	NG	Natural Gas (Henry Hub) Spot Price	
Agriculture Commodities	**CFF**	Coffee Spot Price	-Nicola et al. (2016) - Saitu and Dahiru (2017) - Naifar (2018) -de Nicola, de Pace, Hernandez (2016)
	CRN	Corn Spot Price	
	CTN	Cotton Spot Price	
	SYBN	Soybean Spot Price	
	SGR	Sugar Spot Price	
	WHT	Wheat Spot Price	
Precious Metal	**GLD**	Gold Spot Price	-Sensoy (2013) -Saitu and Dahiru (2017) -Naifar (2018), -Tuna (2018)
	SLVR	Silver Spot Price	
	CPR	Copper Spot Price	
	PLDM	Palladium Spot Price	
	PLTNM	Platinum Spot Price	

6.2. Nonlinear Time Series

6.2.1. Testing Linearity

The series features, such as linearity or nonlinearity, stationary or unit root, seasonal impacts, and so on, are highly important concerns in theoretical and empirical econometrics analyses. Researchers examine at these features. For the empirical investigation, the linearity test is critical in time series analysis. In the last 30 years, many linearity tests have been created [For example; Ramsey (1969), Engle(1982); McLeod and Li (1983); Keenan (1985); Tsay (1986); Brock et al. (1987) etc. Terasvirta (1994), Lin and Hansen (1999), Harvey and Leybourne (2007), Harvey at all. (2008)].

The foundation of conventional nonlinearity testing is the belief that the variables have I (0) or I (1) characteristics. This presents difficulties for empirical research. As a result, Harvey et al. (2008) present a novel linearity test that may be used with either the I (0) or I (1) process in a recent addition. This study suggests a Wald test, which is a weighted average of the Wald tests for the null of linearity when the variable is known to have a unit root and when it is known to be stationary, when the order of integration is unknown.

6.2.2. Nonlinear Unit Root Test

6.2.2.1. Kapetanios, Shin, and Snell (KSS-2003)

Kapetanios et al. (2003) employed the smooth transition autoregressive (STAR) nonlinear unit root test, which is a nonlinear variant of the linear Augmented Dickey Fuller (ADF) test, to test for nonlinear stationarity. These authors discuss the consequences of a specific type of nonlinear dynamics for unit root testing processes. Furthermore, they present an alternate method for testing the null of a unit root process against a globally stationary nonlinear exponential smooth transition autoregressive (ESTAR) process. The exponential smooth transition STAR model from the first level is shown as follows:

$$\Delta y_t = \beta y_{t-1} + \gamma y_{t-1}\, \Theta\,(\Theta; y_{t-d}) + \varepsilon_t \quad t=1,..,T \qquad \textbf{(6.1)}$$

Where "ε_t" IID (0, σ^2), "β" and "γ" represents the unknown parameters. Assuming variable "y_t" has stochastic processes, the model is set up as follows:

$$\Theta(\Theta; y_{t-d}) = 1-\exp(1-\Theta y^2_{t-d}) \quad \textbf{(6.2)}$$

Here $\Theta \geq 0$ and $d \geq 0$ are delay parameters. The exponential transitive function is constrained between (0-1) values and has the form R (0;1). $\Theta(0) = 0$ and $\Theta(x)=1$ have a symmetrical structure around zero. Shown below as the exponential ESTAR model.

$$\Delta y_t = \phi y_{t-1} + \gamma y_{t-1} [1- \exp(1- \Theta y^2_{t-d}) + \varepsilon_t \quad \textbf{(6.3)}$$

When the time series are evaluated according to the linear ADF test with the classical approach exhibits a low power for nonlinear processes. That's why ESTAR Consider the Θ test parameter being zero under the main hypothesis and positive under the alternative hypothesis.

H_0: $\Theta = 0$

H_1: $\Theta > 0$

6.2.2.2. Sollis (2009) Unit Root Test

Sollis (2009) is a new test that improves the ESTAR model with symmetric and asymmetric nonlinear effects. This model, created by the effect of the asymmetrical ESTAR structure, is called AESTAR. AESTAR, the extended version of the ESTAR model, tests nonlinearity with exponential asymmetric correction under the alternative hypothesis against the unit root hypothesis. The AESTAR exponential and logistic model is as follows:

$$\Delta y_t = G(\gamma_1, y_{t-1}) \{S_t(\gamma_2, y_{t-1}) \rho_1 + (1- S_t(\gamma_2, y_{t-1}) \rho_2 \} y_{t-1} + \varepsilon_t + \sum k_i \Delta y_{t-i} + \varepsilon_t \quad \textbf{(6.4)}$$

In there $G(\gamma_1, y_{t-1}) = 1- \exp(-\gamma_1(y^2_{t-1}))$ and $\gamma_1 \geq 0$.

$S_t(\gamma_2, y_{t-1}) = \{1+ \exp(-\gamma_2 y_{t-1}) \}^{-1}$ with $\gamma_2 \geq 0$

where y_t, similar KSS test, is raw, demeaned or detrended data. The null hypothesis of nonstationarity is:

H_0: $\Theta = 0$

H_1: $\Theta > 0$

When the null hypothesis is rejected, the null hypothesis of symmetric ESTAR.

6.2.2.3. Kruse (2011)

Kruse (2011) developed a unit root test based on the ESTAR model structure in his article. This test is basically in Dickey-Fuller test format and the developed unit root test model is shown in the below**:**

$$\Delta y_t = a y_{t-1} + \phi y_{t-1} (1 - \exp \{-\gamma (y_{t-1} - c)^2 \} + \varepsilon_t \quad \textbf{(6.5)}$$

Where "ε_t " represents IID (0, σ^2). If the smooth exponential smooth transition parameter approaches zero, the ESTAR model will resemble the AR(1) model structure. The AR(1) model process expressed here:

$\Delta y_t = a y_{t-1} + \varepsilon_t$; $-2<a<0$

Lagged values of the dependent variable can be included in the model to eliminate the autocorrelation problem. In this case hypothesis are shown below:

H_0: $\gamma = 0$ Unit root

H_1: $\gamma > 0$ Stationary ESTAR process

Kruse (2011) implemented Using 20,000 replications with Monte Carlo research, calculate the asymptotic critical value. After the model is estimated, t-statistic value of the critical table values provided by Kruse for each of the three cases raw data (case 1), the demeaned (case 2), detrended (case 3) data to cope with zero mean, non-zero mean or a deterministic trend, respectively.

6.2.3. Nonlinear Causality Test

6.2.3.1. The Diks and Panchenko Nonparametric Test

Nonlinear causality was chosen for the study because it avoids the problem in the linear causality test, which assumes that economic factors adjust symmetrically. Instead, the process of adjustment to economic variables may be non-linear and asymmetric (Enders and Siklos 2001). Furthermore, Diks and Pachenko (DP) test is better than the Hiemstra Jones (HJ) (1994) test, so it solved the problem of over-rejection. The model is shown in the figure below**:**

$$H_0 = Y_{t+1}\left|(x_t^{\ell X}; Y_t^{\ell Y}\right.) \sim Y_{t+1}\left|Y_t^{\ell Y}\right. \quad \textbf{(6.6)}$$

H_0 for the DP non-causality from one series(X_t) to another series(Y_t) is that $X_t^{\ell x}$; has no further information Y_{t+1} that is. For a strictly stationary bivariate time series Eq. (6) comes down to a statement about the invariant distribution of the $(\ell_X + \ell_Y + 1)$-dimensional vector $W_t = (X_t^{\ell X}, Y_t^{\ell Y}, Z_t)$ where $Z_t = Y_{t+1}$. To keep the notation compact, and to bring about the fact that the null hypothesis is a statement about the invariant distribution of $(X_t^{\ell X}, Y_t^{\ell Y}, Z_t)$ we drop the time index and also $\ell_X = \ell_Y = 1$ is assumed. Hence, under the null, the conditional distribution of Z given $(X, Y) = (x, y)$ is the same as that of Z given $Y = y$

$\varepsilon_n = Cn^{-\beta}\left(c > 0, \frac{1}{4} < \beta < \frac{1}{3}\right)$ then Diks and Panchenko (2006) prove test statistic:

$$\sqrt{n}\,\frac{T_n(\varepsilon_n) - q}{S_n} \xrightarrow{D} N(0,1) \quad \textbf{(6.7)}$$

S_n represent the asymptotic variance of $T_n(.)$. $\xrightarrow{D}$ denotes the distribution of convergence S_n is an estimator of the asymptotic variance

6.3. Causality in Variance

The Granger causality-in-variance test proposed by Hafner and Herwartz (2006) is used in this research to assess portfolio diversification between series. A Langrange Multiplier (LM) statistic is employed by Hafner and Herwartz (2006) and is also calculated using univariate GARCH calculations. They claim that because it is necessary to address the dimensionality issue, employing univariate GARCH estimations is easier than utilizing multivariate versions. The study's authors use a Monte Carlo simulation to assess the LM statistic's relative performance to CCF-based testing and its empirical power. Another test known as CCF was carried out by Cheung and Ng (1996) and Hong (2001), who propose causality tests based on CCF (cross-correlation functions) of residuals produced from univariate GARCH models.

They draw the conclusion that the LM technique has greater empirical power than the CCF statistic and that the performance of the CCF test is severely affected by the selection

of an improper sequence. The latter method is favored in this investigation due to the previously mentioned criteria.

For the Hafner and Herwartz (2006) technique of causality in variance testing, the estimation of univariate ARMA (p,q)-GARCH (1,1) is required. While the model's ARMA (p,q) component is referred to as the mean equation, the GARCH (1,1) component is known as the variance equation.

According to the ARMA (p,q) model, in addition to the present and lagged values of a white noise error term, concurrent terms of a series y rely linearly on those values as well. That can be indicated as;

$$y_t = \mu_t + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} + \varepsilon_t \quad \textbf{(6.8)}$$

with $E(\varepsilon_t) = 0$; $E(\varepsilon_t^2) = \sigma^2$; $E(\varepsilon_t \varepsilon_s) = 0$, $t \neq s$

Even though there have been ARMA models before Box and Jenkins (1976), they were the first to approach the subject of estimating an ARMA model in a systematic way. The methodology consists of three steps: identification, estimation, and diagnostic testing.

To capture the dynamic aspects of the data, the order of the AR and MA terms, p and q, must be determined in order to identify an ARMA. Information criteria can be used to choose the best model. The goal of the technique is to decide on the number of parameters needed in order that the value of the information criteria could be reduced (Brooks, 2008). The Maximum Likelihood approach is employed to predict ARMA models, while OLS can be used if the process is an AR(p) process.

An ARMA process ought to be invertible, stationary, and stable. Because lagged values of residuals do not decrease over time in a non-stationary series model, stationarity must be satisfied for a series. This works against common sense and is questionable in terms of the evidence.

Although it relates to the MA process, invertibility is mathematically equivalent to stationarity. The following is one way to put them. Using the lag operator notation, we could rearrange Equation (9) as;

$$\phi(\mathrm{L})y_t = \phi(\mathrm{L})\varepsilon_t \quad \textbf{(6.9)}$$

$\phi(\mathrm{L}) = 1 - \phi_1\mathrm{L} - \cdots - \phi_p L^{\mathrm{p}}$ and $\theta(\mathrm{L}) = 1 - \theta_1\mathrm{L} - \cdots - \theta_p L^{\mathrm{p}}$.

That procedure is both stable and stationary if $\phi(z) \neq 0$ for $|z| \leq 1$, and also invertible if $\theta(z) \neq 0$ for $|z| \leq 1$.

The feasibility of the model is tested during diagnostic checking. Box and Jenkins suggest using residual diagnostics and overfitting. Here, determining whether residual autocorrelation exists is the main goal. If this is the case, the model is inappropriate since it still neglects certain important information. To remove autocorrelation, additional terms should be added —a process known as overfitting. Because a model with superfluous lags results in greater coefficient standard errors, making it difficult to identify significant relationships in the dataset, it is crucial to choose the most practical model that addresses the autocorrelation problem (Brooks, 2008).

One of the most often used tests to identify autocorrelation is the Durbin-Watson test, which was proposed by Durbin and Watson (1951). Nonetheless, the test demands that the dependent variable not experience any delays. Hence, the Breusch-Godfrey Serial Correlation LM Test is employed in the thesis.

The test begins by estimating a linear regression with OLS and obtaining the residuals $\hat{u}_t$. The residuals are then regressed on each of the first equation's regressors and their lags up to the *r*th degree. Secondary regression is represented by;

$$\hat{u}_t = a_0 + a_1 x_{1t} + a_{21} x_{2t} + a_3 x_{3t} + \rho_1 \hat{u}_{t-1} + \rho_2 \hat{u}_{t-2} + \rho_3 \hat{u}_{t-3} + \cdots + \rho_r \hat{u}_{t-r} + \upsilon_t \quad \textbf{(6.10)}$$

with $\upsilon_t \sim N(0, \sigma_t^2)$, where *T* represent the number of observations and calculating R from the (10), the statistical test is derived by; $T - R^2 \sim \chi^2$.

The null and alternative hypotheses are as follows;

$H_0 : \rho_1 = 0$ and $\rho_2 = 0$ and ... and $\rho_r = 0$

$H_1 : \rho_1 \neq 0$ and $\rho_2 \neq 0$ and ... and $\rho_r \neq 0$

According to the null hypothesis, there is no relation between the current error and its r preceding values. Following that, the test statistic asymptotically approaches a chi-square

distribution with r-degrees of freedom. Regardless of the value of r, no sign of autocorrelation should be present in the residuals if the model is statistically accurate.

In order to apply the Hafner and Herwartz (2006) method, an ARMA (p, q) model should be estimated. This model differs from the classical case for that error terms don't possess constant variance, making them heteroscedastic. It could be expressed as;

$$y_t = \mu_t + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \theta_1 c + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} + \varepsilon_t \qquad \textbf{(6.11)}$$

with $\varepsilon_t \sim N(0,\sigma_t^2)$, after that, a GARCH model can be constructed to determine this heteroscedasticity. Here the GARCH (1,1) model is utilized as in Equation (12) in accordance with Hafner and Herwartz (2006).

$$(\sigma_{it}^2) = \omega_i + a_i \varepsilon_{it-1}^2 + \beta_i \sigma_{it-1}^2 \qquad \textbf{(6.12)}$$

The following null hypothesis is going to be tested for the given i, j = 1, ..., N, i≠ j,

$$H_0: Var(\varepsilon_{it} \left| F_{t-1}^{(j)}\right.) = Var(\varepsilon_{it} \,|F_{t-1}) \qquad \textbf{(6.13)}$$

Where $F_t^{(j)} = F_t \setminus \sigma(\varepsilon_{j\tau}, \tau \leq t)$, and ε_{it} are the univariate model's residuals. To test the H_0, the aforementioned model should be used.

$$\varepsilon_{it} = \xi_{it} \sqrt{\sigma_{it}^2 g_t}\,,\ g_t = 1 + z_{jt}'\,\pi, z_{jt} = (\varepsilon_{jt-1}^2, \sigma_{jt-1}^2)'\,, \qquad \textbf{(6.14)}$$

Granger non-causality in variance has the condition $\pi = 0$ in Equation (14), which is a sufficient condition for Equation (13). The Gaussian log-likelihood function of ε_{it} yields a score that is given by;

$x_{it}\ (\xi_{it}^{\ 2} - 1)/2$, where $x_{it} = \sigma_{it}^{-2}\left(\frac{\delta \sigma_{it}^2}{\delta \theta_i}\right)$, $\theta_i = (\omega_i, a_i, \beta_i)'$, and the following test statistic is suggested:

$$\lambda_{LM} = \left(\frac{1}{4T}\right)\left(\sum_{t=1}^{T}(\xi_{it}^{\ 2} - 1)\, z_{jt}'\right) V\left(\theta_i^{-1}\right)\left(\sum_{t=1}^{T}(\xi_{it}^{\ 2} - 1)\, z_{jt}\right) \xrightarrow{d} \chi^2 \qquad \textbf{(6.15)}$$

where

$$V(\theta_i) = \left(\frac{\kappa}{4T}\right)\left(\sum_{t=1}^{T}(z_{jt})\, z_{jt}' - \sum_{t=1}^{T}(z_{jt})\, x_{it}' \left(\sum_{t=1}^{T} x_{it}\, x_{it}'\right)^{-1} \sum_{t=1}^{T}(x_{it})\, z_{jt}'\right),$$

$$\kappa = \left(\frac{1}{T}\right)\left(\sum_{t=1}^{T}(\xi_{it}{}^{2} - 1)^{2}\right)$$

According to the quantity of misspecification indications in z_{jt}, the asymptotic distribution of λ_{LM} will change. In that situation, there are two such indicators, making it possible to construct a classical asymptotic $\chi 2(2)$ distribution.

7. EMPIRICAL RESULTS

7.1. Descriptive Statistics

The descriptive statistics for all the variables given in Table B.1. According to table, while the average daily return is positive within the sample period of the Islamic index data, the average return is found to be higher for the DJIMU, DJIDEV and DJIMI indices. When standard deviation values are examined, it is seen that DJIEU and DJIMU indices have higher standard deviations, and therefore it can be said that the risk of DJIEU and DJIMU index is higher than other Islamic indices. Furthermore, average daily return for agriculture variables are SGR, WHT and CFF are negative and average return was found to be higher for the CRN. When the standard deviation values are examined, it can be seen SGR and CFF variables have higher standard deviations, and therefore it can be said that the risk of SGR and CFF variables is higher than other agriculture commodities. Additionally, it can be seen that energy average daily return are negative within the sample period of energy commodity data, the average return is found to be higher for the go. When standard deviation values are examined, it is seen that ng variable has higher standard deviations, and therefore it can be said that the risk of NG variable is higher than other energy commodities. Also, precious metal average daily return is found to be higher for the PLDM. When standard deviation values are examined, it is seen that SLVR variable has higher standard deviations, and therefore it can be said that the risk of SLVR variable is higher than other precious metal commodities.

Finally, all return series exhibit negative skewness and excess kurtosis which point to a leptokurtic distribution for returns. The normal distribution assumption for the returns series is rejected at the 1% level according to the Jarque-Bera normality test. The Box-Pierce Q statistics for return and squared return series show that there is a autocorrelation in the returns. The ARCH LM test results show that all returns series exhibit volatility clustering. According to linear unit testing using Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS), all returned series are stationary in levels.

7.2. Linearity Test Results

In the first step of the analysis, running the Terasvirta (1994), (Harvey and Leybourne (2007), Harvey et al. (2008) tests to test the linearity of the series The obtained findings were presented in Appendix C. Table C.1.

According to Terasvirta (1994), Harvey and Leybourne (2007) and Harvey and Leybourne (2008) test results, while the null hypothesis of linearity is rejected for DJIMI, DJIEMG, DJIDEV and DJIMU Islamic Indexes,; CO, GO, HO, ng energy commodities; CRN, CTN agriculture commodities and SLVR precious metal series at the level of 1% , for three test results DJIMAP, DJIEU Islamic Indexes; WHT agriculture commodities and GLD, CPR, PLDM, PLTNM precious metal series null hypothesis of linearity is not rejected.

Furthermore, according to Terasvirta (1994) test results, SYBN and PLDM series the null hypothesis of linearity is rejected while other two test results linearity is not rejected. SGR agriculture commodity series is the null hypothesis of linearity is rejected with respect to Harvey and Leybourne (2007) test. In addition, SLVR precious metal series the null hypothesis of linearity is rejected both Terasvirta (1994) and Harvey and Leybourne (2007) test results.

7.3. Nonlinear Unit Root Test Results

The unit root test advocated in the study by KSS (2003), Sollis (2009) and Kruse (2011) was used for these series and Appendix C. Table C.2. presents the findings of these tests for three cases raw, demeaned and detrended. This table also includes the critical values for these three tests.

It is seen that the SLVR series are not nonlinear stationary in level and have a nonlinear unit root. In other words, H_0 hypothesis could not be rejected in KSS (2003), Sollis (2009) and Kruse (2011). The CPR series are not nonlinear stationary in level and have a nonlinear unit root. In other words, H_0 hypothesis could not be rejected in KSS (2003), but H_0 hypothesis was rejected in Sollis (2009) and Kruse (2011) tests.

As can be seen in the table, CTN and NG series are not nonlinear stationary in level and have a nonlinear unit root. In other words, H_0 hypothesis could not be rejected in KSS (2003) and and Kruse (2011) tests, but H_0 hypothesis was rejected in Sollis (2009).

For the other variables, null hypothesis is rejected, this result reports that this series are nonlinear stationary for all cases and these 3 tests supported the results.

Except SLVR other series are nonlinear stationary at the I(0), for this reason we can go with the nonlinear causality test. Because the cointegration test allows the original values of the series, which are not stationary at the level but become stationary when their differences are taken, to be used in the analysis (Işık, 2004).

7.4. Nonlinear Causality Test Results in Mean

7.4.1. Nonlinear Causality among Commodities to Islamic Indices

The study employed the Diks and Panchenko (2006) nonlinear causality test to examine the nature of the nonlinear causal link between the variables within the model.

Nonlinear causality between from commodities to Islamic Indices result presented in Appendix C. Table C.3. It is concluded that with the 10% statistical significance level of PLTNM and SLVR variables are the nonlinear cause of DJIMI, 5% statistical significance level of NG, WHT variables are the nonlinear cause of DJIMI, with the 1% statistical significance level of PLDM variable is the nonlinear cause of DJIMI thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation but also it is seen that CO, GO, HO, CFF, CRN, CTN, SGR, SYBN, GLD and CPR variables are not the cause of DJIMI and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIMI variable and the PLTNM, SLVR, NG, WHT, PLDM variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, CFF, CRN, CTN, SGR, SYBN, GLD and CPR variables that do not have a non-linear causality on the mean relationship between the DJIMI variable.

It is concluded that with the 1% statistical significance level of PLTNM, PLDM, CPR and SLVR variable are and whit the 5% statistical significance level of CTN, CFF and NG variables are and with the 10% statistical significance level of CO, GLD variables are the nonlinear cause of DJIMAP thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that go, HO, CRN, SGR, SYBN and WHT variables are not the cause of DJIMAP and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIMAP variable and the PLTNM, PLDM, CPR,

SLVR, CTN, CFF, NG, CO and GLD variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the GO, HO, CRN, SGR, SYBN and WHT variables that do not have a non-linear causality on the mean relationship between the DJIMAP variable.

It is concluded that with the 1% statistical significance level of PLDM, SLVR variables are and with the 5% statistical significance level of CTN, GLD, CPR and PLTNM variables are and with the 10% statistical significance level of CRN variable is the nonlinear cause of DJIEU thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, NG, CFF, SGR, SYBN and WHT variables are not the cause of DJIEU and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIEU variable and the PLDM, SLVR, GLD, CPR, PLTNM and CRN variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, SGR, CTN, SYBN and WHT variables that do not have a non-linear causality on the mean relationship between the DJIEU variable.

It is concluded that with the 1% statistical significance level of PLDM, SLVR variables are and with the 5% statistical significance level of GLD, CPR and co variables are and with the 10% statistical significance level of CTN variable is the nonlinear cause of DJIEMG thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that go, HO, NG, CFF, CRN SGR, SYBN, WHT and variables are not the cause of DJIEMG and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIEMG variable and the PLDM, SLVR, GLD, CPR and CTN variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the GO, HO, NG, CFF, CRN SGR, SYBN, WHT variables that do not have a non-linear causality on the mean relationship between the DJIEMG variable.

It is concluded that with the 1% statistical significance level of PLDM variable is and with the 5% statistical significance level of NG variable is and with the 10% statistical significance level of co, SLVR variable is the nonlinear cause of DJIDEV thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that GO, HO, NG, CFF, CRN SGR, SYBN variables are not the cause of DJIDEV and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIDEV variable and the PLDM, NG, CO and SLVR variables that have a non-

linear causality relationship on the mean. It is possible to make portfolio diversification for the go, HO, CFF, CRN, SGR, SYBN, PLTNM variables that do not have a non-linear causality on the mean relationship between the DJIDEV variable.

It is concluded that with the 5% statistical significance level of CO, NG and PLDM variable is and with the 10% statistical significance level of SLVR, WHT and CRN variable is the nonlinear cause of DJIMU thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that GO, HO, CFF, CTN,SGR, SYBN, CPR, GLD and PLTNM and variables are not the cause of DJIMU and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIMU variable and the CO, NG, PLDM variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the GO, HO, CFF, CTN, SGR, SYBN, CPR, GLD and PLTNM variables that do not have a non-linear causality on the mean relationship between the DJIMU variable.

7.4.2. Nonlinear Causality among from Islamic Indices to Commodities

Appendix C. Table C.4. shows nonlinear causality results from Islamic indices to commodity prices. This result shows that with the 1% statistical significance level of DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV and DJIMU are nonlinear cause the CO. Thus, the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the co variable and DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 1% statistical significance level of DJIMI, DJIDEV and DJIMU variables are and with the 5% statistical significance level of DJIMAP and DJIEMG variables are the nonlinear cause of go thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIEU variable is not the cause of go and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the go variable and DJIMI, DJIDEV, DJIMU, DJIMAP and DJIEMG variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIEU variable that do not have a non-linear causality on the mean relationship between the go variable.

It is concluded that DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV and DJIMU variables are not cause of HO, so the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the HO variable and DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV and DJIMU variables are not cause NG, so the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the NG variable and DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 1% statistical significance level of DJIMI variable and with the 5% statistical significance level of DJIDEV and DJIMU variables are and with the 10% statistical significance level of DJIMAP variable is the nonlinear cause of CFF thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIEU and DJIEMG variables are not the cause of CFF and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the CFF variable and DJIMI, DJIDEV, DJIMU, DJIMAP variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIEU and DJIEMG variables that do not have a non-linear causality on the mean relationship between the CFF variable.

It is concluded that with the 5% statistical significance level of DJIMI, DJIEU and DJIMU variables are and and with the 10% statistical significance level of DJIDEV variable is the nonlinear cause of CRN thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIMAP and DJIEMG variables are not the cause of CRN and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the CRN variable and DJIMI, DJIEU, DJIMU, DJIDEV variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIMAP and DJIEMG variables that do not have a non-linear causality on the mean relationship between the CRN variable.

It is concluded that with the 5% statistical significance level of DJIMAP and DJIMU variables are and with the 1% statistical significance level of DJIEMG variable is the nonlinear cause of CTN thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIMI, DJIEU and DJIDEV variables are not

the cause of CTN and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the CTN variable and DJIMAP, DJIMU and DJIEMG variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIMI, DJIEU and DJIDEV variables that do not have a non-linear causality on the mean relationship between the CTN variable.

It is concluded that with the 1% statistical significance level of DJIMI, DJIMAP, DJIEMG, DJIDEV and DJIMU variables and with the 10% statistical significance level of DJIEU variable is the nonlinear cause of SGR thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the SGR variable and DJIMI, DJIMAP, DJIEMG, DJIDEV, DJIMU and DJIEU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 5% statistical significance level of DJIMI variable is and with the 10% statistical significance level of DJIEU and DJIDEV variables are the nonlinear cause of SYBN thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIEU and DJIEMG variables are not the cause of SYBN and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the SYBN variable and DJIMI, DJIEU and DJIDEV variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIEU and DJIEMG variables that do not have a non-linear causality on the mean relationship between the SYBN variable.

It is concluded that with the 1% statistical significance level of DJIMI variable and with the 5% statistical significance level of DJIDEV and DJIMU variables are and with the 10% statistical significance level of DJIMAP variable is the nonlinear cause of CFF thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIEU and DJIEMG variables are not the cause of CFF and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the CFF variable and DJIMI, DJIDEV, DJIMU and DJIMAP variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIEU and DJIEMG variables that do not have a non-linear causality on the mean relationship between the CFF variable.

It is concluded that with the 1% statistical significance level of DJIMI, DJIEU and DJIDEV variables and with the 10% statistical significance level of DJIEMG variable is the nonlinear cause of WHT thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIMAP variable is not the cause of WHT and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the CTN variable and WHT, DJIMI, DJIEU, DJIDEV and DJIEMG variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIMAP variable that do not have a non-linear causality on the mean relationship between the WHT variable.

It is concluded that with the 1% statistical significance level of DJIMI, DJIDEV and DJIMU variables and with the 5% statistical significance level of DJIMAP and DJIEU variables are the nonlinear cause of GLD thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIEU and DJIEMG variables are not the cause of GLD and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the GLD variable and DJIMI, DJIDEV, DJIMU, DJIMAP and DJIEU variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIEU and DJIEMG variables that do not have a non-linear causality on the mean relationship between the GLD variable.

It is concluded that with the 5% statistical significance level of DJIMAP, DJIDEV and DJIMU variables are the nonlinear cause of SLVR thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIMI variable is not the cause of SLVR and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the SLVR variable and DJIMAP, DJIDEV and DJIMU variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIMI, variable that do not have a non-linear causality on the mean relationship between the SLVR variable.

It is concluded that with the 5% statistical significance level of DJIEMG and with the 10% statistical significance level of DJIMI, DJIMAP, DJIEU, DJIDEV and DJIMU variables are the nonlinear cause of CPR thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the CPR variable and DJIEMG, DJIMI, DJIMAP, DJIEU, DJIDEV and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 1% statistical significance level of DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV and DJIMU variables are the nonlinear cause of PLDM thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the PLDM variable and DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with 5% statistical significance level of DJIMI, DJIEU, DJIEMG and DJIDEV variables are the nonlinear cause of PLTNM thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIMU variable is not the cause of PLTNM and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the PLTNM variable and DJIMI, DJIEU, DJIEMG and DJIDEV variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the DJIMU, variable that do not have a non-linear causality on the mean relationship between the SLVR variable.

7.4.3. Nonlinear Causality Among Commodities

Appendix C. Table C.5 shows nonlinear causality results among commodity prices.

It is concluded that with the 1% statistical significance level of go and HO variables and with the 5% statistical significance level of CFF, CPR, PLDM and PLTNM variables are and with the 10% statistical significance level of SGR variable is the nonlinear cause of co thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that NG, CRN, CTN, SYBN, WHT, GLD and SLVR variables are not the cause of CO and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the co variable and GO, HO, CFF, CPR, PLDM, PLTNM and SGR variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the NG, CRN, CTN, SYBN, WHT, GLD and SLVR variables that do not have a non-linear causality on the mean relationship between the co variable.

It is concluded that with the 1% statistical significance level of CO, GLD and PLTNM variables and with the 5% statistical significance level of HO and CPR variables are the nonlinear cause of go thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that NG, CFF, CRN, CTN, SGR, SYBN, WHT, PLDM

and SLVR variables are not the cause of go and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the go variable and CO, GLD, PLTNM, HO, and CPR variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the NG, CFF, CRN, CTN, SGR, SYBN, WHT, PLDM and SLVR variables that do not have a non-linear causality on the mean relationship between the go variable.

It is concluded that with the 1% statistical significance level of co and PLTNM variables and with the 5% statistical significance level of GO, NG and CPR variables are the nonlinear cause of HO thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CFF, CRN, CTN, SGR, SYBN, WHT, GLD, PLDM and SLVR variables are not the cause of HO and the H_0 hypothesis could not be rejected. . It is not appropriate to diversify the portfolio between the GO variable and CO, GLD, PLTNM, HO, and CPR variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the NG, CFF, CRN, CTN, SGR, SYBN, WHT, PLDM and SLVR variables that do not have a non-linear causality on the mean relationship between the go variable.

It is concluded that with the 5% statistical significance level of co variable is the nonlinear cause of NG thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that GO, HO, CFF, CRN, CTN, SGR, SYBN, WHT, GLD, CPR and SLVR variables are not the cause of NG and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the NG variable and co variable that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the GO, HO, CFF, CRN, CTN, SGR, SYBN, WHT, GLD, CPR and SLVR variables that do not have a non-linear causality on the mean relationship between the NG variable.

It is concluded that with the 10% statistical significance level of go variable is the nonlinear cause of CFF thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, HO, NG, CRN, CTN, SGR, SYBN, WHT, GLD, CPR, SLVR, PLDM and PLTNM variables are not the cause of CFF and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the CFF variable and go variable that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, HO, NG, CRN, CTN, SGR, SYBN,

WHT, GLD, CPR, SLVR, PLDM and PLTNM variables that do not have a non-linear causality on the mean relationship between the CFF variable.

It is concluded that with the 10% statistical significance level of GLD variable is the nonlinear cause of CTN thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, NG, CFF, CRN, SGR, SYBN, WHT, CPR, SLVR, PLDM and PLTNM variables are not the cause of CTN and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the CTN variable and GLD variable that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, SGR, SYBN, WHT, CPR, SLVR, PLDM and PLTNM variables that do not have a non-linear causality on the mean relationship between the CTN variable.

It is concluded that with the 1% statistical significance level of CO, NG, CTN and CPR variables and with the 5% statistical significance level of WHT and PLDM variables are the nonlinear cause of SGR thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that GO, HO, CFF, CRN, SYBN, GLD, SLVR and PLTNM variables are not the cause of SGR and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the SGR variable and CO, NG, CTN, CPR, WHT and PLDM variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, SGR, SYBN, WHT, CPR, SLVR, PLDM and PLTNM variables that do not have a non-linear causality on the mean relationship between the SGR variable.

It is concluded that with the 1% statistical significance level of CRN variable and with the 10% statistical significance level of GLD variable is the nonlinear cause of SYBN thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, NG, CTN, SGR, WHT, SLVR, CPR, PLDM and PLTNM variables are not the cause of SYBN and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the SYBN variable and CRN and GLD variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, NG, CTN, SGR, WHT, SLVR, CPR, PLDM and PLTNM variables that do not have a non-linear causality on the mean relationship between the SYBN variable.

It is concluded that with the 1% statistical significance level of SGR and CPR variable and with the 10% statistical significance level of CTN and GLD variables are the nonlinear cause of WHT thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, NG, CFF, CRN, SYBN, SLVR, PLDM and PLTNM variables are not the cause of WHT and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the WHT variable and SGR, CPR, CTN and GLD variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, SYBN, SLVR, PLDM and PLTNM variables that do not have a non-linear causality on the mean relationship between the WHT variable.

It is concluded that with the 1% statistical significance level of SLVR and CPR variables and with the 5% statistical significance level of GO, SYBN and PLTNM variables are and with the 10% statistical significance level of HO, and CRN variables are the nonlinear cause of GLD thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, NG, CFF, CTN, SGR and WHT variables are not the cause of GLD and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the GLD variable and SLVR, CPR, GO, SYBN, PLTNM, HO, CRN variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, NG, CFF, CTN, SGR and WHT variables that do not have a non-linear causality on the mean relationship between the GLD variable.

It is concluded that with the 10% statistical significance level of SYBN and GLD variables are the nonlinear cause of SLVR thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, NG, CFF, CRN, CTN, SGR, WHT, CPR, PLDM and PLTNM variables are not the cause of SLVR and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the SLVR variable and SYBN, GLD, variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, CTN, SGR, WHT, CPR, PLDM and PLTNM that do not have a non-linear causality on the mean relationship between the SLVR variable.

It is concluded that with the 5% statistical significance level of WHT variable is and with the 10% statistical significance level of CTN and PLDM variables are the nonlinear cause of CPR thus the H_0 hypothesis was rejected as it puts forward that there is no causality

relation, but also it is seen that CO, GO, HO, NG, CFF, CRN, SGR, SYBN, GLD, SLVR and PLTNM variables are not the cause of CPR and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the CPR variable and WHT, CTN and PLDM variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, SGR, SYBN, GLD, SLVR and PLTNM that do not have a non-linear causality on the mean relationship between the CPR variable.

It is concluded that with the 1% statistical significance level of NG variable and with the 5% statistical significance level of CO, CRN, SGR, SLVR and CPR variables are and with the 10% statistical significance level of go variable is the nonlinear cause of PLDM thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that HO, CFF, CTN, SYBN, WHT, GLD and PLTNM variables are not the cause of PLDM and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the PLDM variable and NG, CO, CRN, SGR, SLVR and CPR variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the HO, CFF, CTN, SYBN, WHT, GLD and PLTNM that do not have a non-linear causality on the mean relationship between the PLDM variable.

It is concluded that with the the 5% statistical significance level of SLVR variable is and with the 10% statistical significance level of WHT variable is the nonlinear cause of PLTNM thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, NG, CFF, CRN, CTN, SGR, SYBN, GLD, CPR, and PLDM variables are not the cause of CPR and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the PLTNM variable and SLVR and WHT variables that have a non-linear causality relationship on the mean. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, CTN, SGR, SYBN, GLD, CPR, and PLDM that do not have a non-linear causality on the mean relationship between the PLTNM variable.

7.4.4. Nonlinear Causality Between Islamic Indices

Appendix C. Table C.6 shows nonlinear causality results among commodity prices. It is concluded that with the 1% statistical significance level of DJIDEV, DJIEMG, DJIMAP, DJIEU and DJIMU variables are the nonlinear cause of DJIMI thus the H_0 hypothesis was

rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the DJIMI variable and DJIDEV, DJIEMG, DJIMAP, DJIEU and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 1% statistical significance level of DJIMI, DJIEMG, DJIMAP, DJIEU and DJIMU variables are the nonlinear cause of DJIDEV thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the DJIDEV variable and DJIMI, DJIEMG, DJIMAP, DJIEU and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 1% statistical significance level of DJIMI, DJIDEV, DJIMAP, DJIEU and DJIMU variables are the nonlinear cause of DJIEMG, thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the DJIEMG variable and DJIMI, DJIDEV, DJIMAP, DJIEU and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 1% statistical significance level of DJIMI, DJIDEV, DJIEMG, DJIEU and DJIMU variables are the nonlinear cause of DJIMAP, thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the DJIMAP variable and DJIMI, DJIDEV, DJIEMG, DJIEU and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 1% statistical significance level of DJIMI, DJIDEV, DJIEMG, DJIMAP and DJIMU variables are the nonlinear cause of DJIEU thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the DJIEU variable and DJIMI, DJIDEV, DJIEMG, DJIMAP and DJIMU variables that have a non-linear causality relationship on the mean.

It is concluded that with the 1% statistical significance level of DJIMI, DJIDEV, DJIEMG, DJIMAP and DJIEU variables are the nonlinear cause of DJIMU thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation. It is not appropriate to diversify the portfolio between the DJIMU variable and DJIMI, DJIDEV,

DJIEMG, DJIMAP and DJIEU variables that have a non-linear causality relationship on the mean.

7.5. Causality in Variance Test Result

It is important because it represents that volatility (volatility) affects the volatility in the other variable.

7.5.1. Causality in Variance Among Commodities to Islamic Indices

The study employed the Hafner and Herwatz (2006) to examine the causality in variance between the variables within the model.

Causality in variance from commodities to Islamic Indices result presented in Appendix C. Table C.7. It is concluded that with the 5% statistical significance level of CRN and SGR variables are the variance cause of DJIMI, with the 1% statistical significance level of PLTNM and CTN variables are the variance cause of DJIMI thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation but also it is seen that CO, GO, HO,NG, CFF, SYBN,WHT, GLD, SLVR, CPR and PLDM variables are not the cause in variance of DJIMI and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIMI variable and the CRN, SGR, CTN, PLTNM variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, SYBN, WHT, GLD, SLVR, CPR and PLDM variables that do not have a causality in variance relationship between the DJIMI variable.

It is concluded that with the 5% statistical significance level of CFF, SLVR and CPR variables are the variance cause of DJIMAP, with the 1% statistical significance level of PLDM variable is the variance cause of DJIMAP thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation but also it is seen that CO, GO, HO,NG, CRN, CTN, SGR, SYBN,WHT, GLD, PLTNM variables are not the cause in variance of DJIMAP and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIMAP variable and the CFF, SLVR, CPR and PLDM variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, NG, CRN, CTN, SGR, SYBN, WHT, GLD, and

PLTNM variables that do not have a causality in variance relationship between the DJIMAP variable.

It is concluded that with the 5% statistical significance level of SGR variable is the variance cause of DJIEU, with the 10% statistical significance level of CTN variable is the variance cause of DJIEU thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation but also it is seen that CO, GO, HO,NG,CFF, CRN, SYBN,WHT, GLD, SLVR, CPR, PLDM and PLTNM variables are not the cause in variance of DJIEU and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIEU variable and the SGR, CTN variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, SYBN, WHT, GLD, SLVR, CPR, PLDM and PLTNM variables that do not have a causality in variance relationship between the DJIEU variable.

It is concluded that with the 5% statistical significance level of SGR variable is the variance cause of DJIEU, with the 10% statistical significance level of CTN variable is the variance cause of DJIEU thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation but also it is seen that CO, GO, HO,NG,CFF, CRN, SYBN,WHT, GLD, SLVR, CPR, PLDM and PLTNM variables are not the cause in variance of DJIEU and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIEU variable and the SGR, CTN variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, SYBN,WHT, GLD, SLVR, CPR, PLDM and PLTNM variables that do not have a causality in variance relationship between the DJIEU variable.

It is concluded that with the 5% statistical significance level of NG variable is the variance cause of DJIEMG, with the 10% statistical significance level of GLD variable is the variance cause of DJIEMG and with the 1% statistical significance level of CRN, PLDM and PLTNM variables are the variance cause of DJIEMG thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation but also it is seen that CO, GO, HO, CFF, CTN, SGR, SYBN, WHT, SLVR and CPR variables are not the cause in variance of DJIEMG and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIEMG variable and the NG, CRN, PLDM, PLTNM, and GLD variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, CFF, CTN, SGR, SYBN, WHT, SLVR and

CPR variables that that do not have a causality in variance relationship between the DJIEMG variable.

It is concluded that with the 5% statistical significance level of CRN, SGR and WHT variables are the variance cause of DJIDEV with the 1% statistical significance level of CTN variable is the variance cause of DJIDEV thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation but also it is seen that CO, GO, HO,NG,CFF, SYBN, GLD, SLVR, CPR, PLDM and PLTNM variables are not the cause in variance of DJIDEV and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIDEV variable and the CRN, SGR and WHT, CTN variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, SYBN, GLD, SLVR, CPR, PLDM and PLTNM variables that do not have a causality in variance relationship between the DJIEU variable.

It is concluded that CO, GO, HO, NG, CFF, CRN, CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, PLDM and PLTNM variables are not the cause in variance of DJIMU and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for the that CO, GO, HO, NG, CFF, CRN, CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, PLDM and PLTNM variables that do not have a causality in variance relationship between the DJIMU variable.

7.5.2. Causality in Variance from Islamic Indices to Commodities

Causality in variance from commodities to Islamic Indices result presented in Appendix C. Table C.8.

It is concluded that with the 1% statistical significance level of DJIEMG variables are the variance cause of co. It is not appropriate to diversify the portfolio between the co variable and the DJIEMG variable that have a causality relationship on the variance It is concluded that DJIMI, DJIMAP, DJIMU, DJIEU and DJIDEV variables are not the cause in variance of co and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for the DJIMI, DJIMAP, DJIMU, DJIEU and DJIDEV variables that do not have a causality in variance relationship between the co variable.

It is concluded that with the 1% statistical significance level of DJIEMG variables are the variance cause of go. It is not appropriate to diversify the portfolio between the co variable and the go variable that have a causality relationship on the variance It is concluded that DJIMI, DJIMAP, DJIMU, DJIEU and DJIDEV variables are not the cause in variance of go and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for the DJIMI, DJIMAP, DJIMU, DJIEU and DJIDEV variables that do not have a causality in variance relationship between the go variable.

It is concluded that with the 1% statistical significance level of DJIEMG variables are the variance cause of HO. It is not appropriate to diversify the portfolio between the DJIEMG variable and the HO variable that have a causality relationship on the variance It is concluded that DJIMI, DJIMAP, DJIMU, DJIEU and DJIDEV variables are not the cause in variance of HO and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for the DJIMI, DJIMAP, DJIMU, DJIEU and DJIDEV variables that do not have a causality in variance relationship between the HO variable.

It is concluded that with the 5% statistical significance level of DJIMAP variable is the variance cause of NG with the 1% statistical significance level of DJIEMG variable is the variance cause of NG thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation but also it is seen that DJIMI, DJIMU, DJIEU and DJIDEV variables are not the cause in variance of NG and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the NG variable and the DJIMAP and DJIEMG, variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the DJIMI, DJIMU, DJIEU and DJIDEV variables that do not have a causality in variance relationship between the DJIEU variable.

It is concluded that with the 1% statistical significance level of DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV variables are the variance cause of CFF thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation. It is not appropriate to diversify the portfolio between the CFF variable and the DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV, variables that have a causality relationship on the variance.

It is concluded that with the 5% statistical significance level of DJIMI, DJIMAP, DJIEMG and DJIMU variable are the variance cause of CRN with the 10% statistical

significance level of DJIDEV variable is the variance cause of CRN thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation It is not appropriate to diversify the portfolio between the CRN variable and the DJIMI,DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV, variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV variables are the variance cause of CTN thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation. It is not appropriate to diversify the portfolio between the CTN variable and the DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV, variables that have a causality relationship on the variance.

It is concluded that with the 5% statistical significance level of DJIMI, variable are the variance cause of SGR , with the 10% statistical significance level of DJIDEV variable is the variance cause of SGR thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation but also it is seen that DJIMAP, DJIEU, DJIEMG and DJIMU variables are not the cause in variance of SGR and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the SGR and DJIDEV and DJIMI variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the DJIMAP, DJIEU, DJIEMG and DJIMU variables that do not have a causality in variance relationship between the SGR variable.

It is concluded that DJIMI, DJIMAP, DJIEU, DJIEMG and DJIMU variables are not the cause in variance of SYBN and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for these variables that do not have a causality in variance relationship between the SYBN variable.

It is concluded that DJIMI, DJIMAP, DJIEU, DJIEMG and DJIMU variables are not the cause in variance of WHT and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for these variables that do not have a causality in variance relationship between the WHT variable.

It is concluded that with the 5% statistical significance level of DJIEMG variable is the variance cause of GLD , with the 10% statistical significance level of DJIMU variable is the variance cause of GLD and with the 1% statistical significance level of DJIMI, DJIMAP,

DJIEU variables are the variance cause of GLD thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation It is not appropriate to diversify the portfolio between the these variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV variables are the variance cause of SLVR thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation. It is not appropriate to diversify the portfolio between the SLVR variable and the DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV, variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV variables are the variance cause of CPR thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation. It is not appropriate to diversify the portfolio between the CPR variable and the DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV, variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV variables are the variance cause of PLDM thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation. It is not appropriate to diversify the portfolio between the PLDM variable and the DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV, variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV variables are the variance cause of PLTNM thus the H_0 hypothesis was rejected as it puts forward that there is no causality in variance relation. It is not appropriate to diversify the portfolio between the PLTNM variable and the DJIMI, DJIEMG DJIMAP, DJIMU, DJIEU and DJIDEV, variables that have a causality relationship on the variance.

7.5.3. Causality in Variance Among Commodities

Appendix C. Table C.9 shows causality in variance results among commodity prices.

It is concluded that with the 1% statistical significance level of DJIDEV variance cause of go thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIMAP, DJIEU, DJIEMG and DJIMU variables are not the variance cause of DJIMI and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIDEV variable and DJIMI and DJIMAP, DJIEU, DJIEMG and DJIMU variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the DJIMAP, DJIEU, DJIEMG and DJIMU variables that do not have a causality on the variance relationship between the go variable.

It is concluded that with the 1% statistical significance level of CRN and GLD variance cause of HO thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that co, go, NG, CFF, CTN, SGR, SYBN, WHT, SLVR, CPR, PLDM and PLTNM variables are not the variance cause of go and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the go variable and CRN and GLD variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the HO and CO, GO, NG, CFF, CTN, SGR, SYBN, WHT, SLVR, CPR, PLDM and PLTNM variables that do not have a non-linear causality on the variance relationship between the HO variable.

It is concluded that with the 1% statistical significance level of CRN and GLD variance cause of NG thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, CFF, CTN, SGR, SYBN, WHT, SLVR, CPR, PLDM and PLTNM variables are not the variance cause of NG and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the NG variable and CRN and GLD variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, CFF, CTN, SGR, SYBN, WHT, SLVR, CPR, PLDM and PLTNM variables that do not have a causality on the variance relationship between the NG variable.

It is concluded that with the 1% statistical significance level of CO, GO, HO, NG, CRN CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, PLDM and PLTNNM variables are the variance cause of CFF and the H_0 hypothesis rejected. It is not appropriate to diversify the

portfolio between the NG variable and CO, GO, HO, NG, CRN CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, PLDM and variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of CPR, PLDM variables are the variance cause of CRN, with the 5% statistical significance level of CO, GO, HO, NG, CFF, CTN, SGR, SYBN, WHT, GLD, SLVR, and PLTNNM variables are the variance cause of CRN and the H_0 hypothesis rejected. It is not appropriate to diversify the portfolio between the NG variable and CO, GO, HO, CFF, NG, CRN CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, PLDM and PLTNNM variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of CO, GO, HO, NG, CFF, CRN, SGR, SYBN, WHT, GLD, SLVR, CPR, PLDM and PLTNM variables are the variance cause of CTN and the H_0 hypothesis rejected. It is not appropriate to diversify the portfolio between the NG variable and CO, GO, HO, NG, CFF, CRN, SGR, SYBN, WHT, GLD, SLVR, CPR, PLDM and PLTNM variables that have a causality relationship on the variance.

It is concluded that with the 5% statistical significance level of CTN and with the 1% statistical significance level of CRN and PLTNM variables are variance cause of SGR thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, NG, CFF, CTN, SYBN, WHT, GLD, SLVR, CPR, PLDM variables are not the variance cause of SGR and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the SGR variable and CRN, CTN and PLTNM variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CTN, SYBN, WHT, GLD, SLVR, CPR, PLDM variables that do not have a causality on the variance relationship between the SGR variable.

It is concluded that with the 1% statistical significance level of SGR variable is variance cause of SYBN thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, NG, CFF, CRN, CTN, SYBN, WHT, GLD, SLVR, CPR, PLDM, PLTNM variables are not the variance cause of SYBN and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the SYBN variable and CRN, CTN and PLTNM variables that have a causality

relationship on the variance. It is possible to make portfolio diversification for the CO, GO, HO, NG, CFF, CRN, CTN, SYBN, WHT, GLD, SLVR, CPR, PLDM, PLTNM variables that do not have a causality on the variance relationship between the SYBN variable.

It is concluded that with the 10% statistical significance level of NG and CTN variables and 5% statistical significance level of SGR variable is variance cause of WHT thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that CO, GO, HO, CFF, CRN, SYBN, GLD, SLVR, CPR, PLDM, PLTNM variables are not the variance cause of WHT and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the WHT variable and NG, CTN and SGR variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the that CO, GO, HO, CFF, CRN, SYBN, GLD, SLVR, CPR, PLDM, PLTNM variables that do not have a causality on the variance relationship between the WHT variable.

It is concluded that with the 10% statistical significance level of CO, GO, HO, NG, CFF, CRN, CPR and PLDM variables, with the 5% statistical significance level of NG, CFF, CRN, CPR and PLDM variables and with the 1% statistical significance level of SLVR are the variance cause of GLD and the H_0 hypothesis rejected. It is not appropriate to diversify the portfolio between the GLD variable and all of the other variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of CO, GO, HO, NG, CFF, CRN CTN, SGR, SYBN, WHT, GLD, CPR, PLDM and PLTNM variables are the variance cause of SLVR and the H_0 hypothesis rejected. It is not appropriate to diversify the portfolio between the SLVR variable and CO, GO, HO, NG, CFF, CRN CTN, SGR, SYBN, WHT, GLD, CPR, PLDM and PLTNM variables that have a causality relationship on the variance.

It is concluded that with the 5% statistical significance level of CO, GO, HO and CFF variables and with the 1% statistical significance level of NG, CRN CTN, SGR, SYBN, WHT, GLD, SLVR CPR, PLDM and PLTNM variables are the variance cause of CPR and the H_0 hypothesis rejected. It is not appropriate to diversify the portfolio between the CPR variable and CO, GO, HO, NG, CFF, CRN CTN, SGR, SYBN, WHT, GLD, SLVR, PLDM and PLTNM variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of CO, GO, HO, NG, CFF, CRN CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, and PLTNM variables are the variance cause of PLDM and the H_0 hypothesis rejected. It is not appropriate to diversify the portfolio between the PLDM variable and CO, GO, HO, NG, CFF, CRN CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, and PLTNM variables that have a causality relationship on the variance.

It is concluded that with the 1% statistical significance level of CO, GO, HO, NG, CFF, CRN CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, and PLDM variables are the variance cause of PLTNM and the H_0 hypothesis rejected. It is not appropriate to diversify the portfolio between the PLTNM variable and CO, GO, HO, NG, CFF, CRN CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, and PLDM variables that have a causality relationship on the variance.

7.5.4. Causality in Variance Among Islamic Indices

Appendix C. Table C.10 shows nonlinear causality results among commodity prices.

It is concluded that GO, HO, NG, CFF, CRN, CTN, SGR, SYBN, WHT, GLD, SLVR, CPR, PLDM and PLTNM variables are not the variance cause of CO and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for these variables that do not have a causality on the variance relationship between the co variable.

It is concluded that with the 1% statistical significance level of variance cause of DJIMI, DJIEU and DJIDEV variables are variance cause of DJIMAP thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIEMG, and DJIMU variables are not the variance cause of DJIMAP and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIMAP with DJIMI, DJIEU and DJIDEV variables that have a causality relationship on the variance. It is possible to make portfolio diversification for the DJIEMG, and DJIMU variables that do not have a causality on the variance relationship between the DJIMAP variable.

It is concluded that with the 1% statistical significance level of variance cause of DJIMU, variable is variance cause of DJIEU thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIMI, DJIMAP, DJIEMG and DJIDEV variables are not the variance cause of DJIEU and the H_0 hypothesis could not

be rejected. It is not appropriate to diversify the portfolio between the DJIMU variables that has a causality relationship on the variance. It is possible to make portfolio diversification for the DJIMI, DJIMAP, DJIEMG and DJIDEV variables that do not have a causality on the variance relationship between the DJIEU variable.

It is concluded that with the 5% statistical significance level of variance cause of DJIMI and DJIDEV variables are variance cause of DJIEMG thus the H_0 hypothesis was rejected as it puts forward that there is no causality relation, but also it is seen that DJIMAP, DJIEU DJIEMG and DJIMU variables are not the variance cause of DJIEMG and the H_0 hypothesis could not be rejected. It is not appropriate to diversify the portfolio between the DJIMI and DJIDEV variables that has a causality relationship on the variance. It is possible to make portfolio diversification for the DJIMAP, DJIEU DJIEMG and DJIMU variables that do not have a causality on the variance relationship between the DJIEMG variable.

It is concluded that DJIMI, DJIMAP, DJIEU, DJIEMG, DJIMU variables are not the variance cause of DJIDEV and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for the DJIMI, DJIMAP, DJIEU, DJIEMG, DJIMU variables that do not have a causality on the variance relationship between the DJIDEV variable.

It is concluded that DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV variables are not the variance cause of DJIMU and the H_0 hypothesis could not be rejected. It is possible to make portfolio diversification for the DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV variables that do not have a causality on the variance relationship between the DJIMU variable.

7.6. Summary of Analysis Results

In this study, the relationship between the variables was examined to decide the model suitable for portfolio diversification. It is expected that there is no relationship between variables or negative for portfolio diversification. In the ECH hypothesis, it is presented in the theory in which different commodities are moved in common. Putting the commodities in the common direction with each other will minimize the diversification advantage. In the study, it was found that energy commodities have a relationship with precious metals. This is due to the use of precious metals in the industry and the change in input prices due to the need for energy in the industry is also affected by the outputs in the industry.

Furthermore, energy is used in the transportation of agricultural products. The change in energy prices also affects the price change in agricultural products. This also supports the ECH hypothesis. In addition, Islamic finance is based on trade. And this is done with commodities. For this reason, the presence of commodities and Islamic indices in the outputs of the analysis stems from the fact that Islamic finance is based on trade. As a result, precious metals are seen as a means of protection, especially for Islamic investors, but do not offer portfolio diversification.

Table 8 is prepared to see the 21 models formed among 21 variables in a given table. While preparing the table, the variables that have a causal relationship between unidirectional and bidirectional causality on the mean and variance for portfolio diversification were evaluated and eliminated from the table, thus optimal portfolio variables were determined for each model.

Table 8. Summaries of Analysis

Model	Variable	Porfolio Variable for Mean Model	Porfolio Variable for Variance Model
1	**DJIMI**	**Islamic Index:** **Energy:** HO **Agriculture:** CTN **Precious Metal: -**	**Islamic Index:** DJIEU, DJIMU **Energy:** CO, GO, HO, NG **Agriculture:** SYBN, WHT **Precious Metal:**
2	**DJIMAP**	**Islamic Index:** **Energy:** HO **Agriculture:** CRN, SYBN, WHT **Precious Metal: -**	**Islamic Index:** DJIEMG, DJIMU **Energy:** CO, GO, HO **Agriculture:** SGR, SYBN, WHT **Precious Metal:**
3	**DJIEU**	**Islamic Index:** **Energy:** CO, GO, HO, NG **Agriculture:** CFF **Precious Metal: -**	**Islamic Index:** DJIMI, DJIEMG, DJIDEV **Energy:** CO, GO, HO, NG **Agriculture:** SYBN, WHT **Precious Metal:**
4	**DJIEMG**	**Islamic Index:** **Energy:** HO, NG **Agriculture:** CFF, CRN, SYBN **Precious Metal: -**	**Islamic Index:** DJIMAP, DJIEU, DJIMU **Energy:** **Agriculture: SGR,** SYBN, WHT **Precious Metal:**
5	**DJIDEV**	**Islamic Index:** **Energy:** HO **Agriculture:** CTN **Precious Metal:**	**Islamic Index:** DJIEU, DJIMU **Energy:** CO, GO, HO, NG **Agriculture:** SYBN **Precious Metal: -**
6	**DJIMU**	**Islamic Index:** **Energy:** HO **Agriculture:** CTN **Precious Metal:** PLTNM	**Islamic Index:** DJIMI, DJIMAP, DJIEMG, DJIDEV **Energy:** CO, GO,HO, NG **Agriculture:** SGR, SYBN, WHT **Precious Metal: -**

Table 8. (continued) Summaries of Analysis

Model	Variable	Porfolio Variable for Mean Model	Porfolio Variable for Variance Model
7	**co**	**Islamic Index:** DJIEU **Energy:** CRN, CTN, SYBN, WHT **Agriculture:** GLD **Precious Metal:**	**Islamic Index:** DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV, DJIMU **Energy:** GO, HO, NG **Agriculture:** SGR, SYBN **Precious Metal: -**
8	**go**	**Islamic Index:** DJIEU **Energy:** NG **Agriculture:** CRN, CTN, SGR, SYBN, WHT **Precious Metal:** SLVR	**Islamic Index:** DJIMI, DJIMAP, DJIDEV, DJIMU **Energy:** CO, HO, NG, **Agriculture:** SGR, SYBN **Precious Metal: -**
9	**HO**	**Islamic Index:** DJIMI, DJIMAP, DJIEU, DJIEMG **Energy:** **Agriculture:** CFF, CRN, CTN, SGR, SYBN, WHT **Precious Metal:** SLVR, PLDM, PLTNM	**Islamic Index:** DJIMI, DJIMAP, DJIEU DJIDEV, DJIMU **Energy:** CO, GO, NG **Agriculture:** CFF, SGR, SYBN, WHT **Precious Metal: -**
10	**NG**	**Islamic Index:** **Energy:** GO **Agriculture:** CRN, CTN, SYBN, WHT **Precious Metal:** GLD, SLVR, CPR	**Islamic Index:** DJIMI, DJIEU DJIDEV, DJIMU **Energy:** CO, GO **Agriculture:** SGR, SYBN **Precious Metal: -**
11	**CFF**	**Islamic Index:** DJIEU, DJIEMG **Energy:** HO, NG **Agriculture:** CRN, CTN, SGR, SYBN, WHT **Precious Metal**: GLD, SLVR, CPR, PLDM, PLTNM	**Islamic Index: (-)** **Energy: (-)** **Agriculture: (-)** **Precious Metal**: **(-)**
12	**CRN**	**Islamic Index:** DJIMAP, DJIEMG **Energy:** CO, GO, HO, NG **Agriculture:** CFF, CPR **Precious Metal:**	**Islamic Index: (-)** **Energy: (-)** **Agriculture: (-)** **Precious Metal**: **(-)**
13	**CTN**	**Islamic Index:** DJIMI, DJIMU **Energy:** CO, GO, HO, NG **Agriculture:** CFF, SGR, SYBN **Precious Metal:** SLVR, PLDM, PLTNM	**Islamic Index:** **Energy:** **Agriculture:** **Precious Metal**:
14	**SGR**	**Islamic Index: (-)** **Energy:** GO, HO **Agriculture:** CFF, SYBN **Precious Metal:** GLD, SLVR, PLTNM	**Islamic Index:** DJIMAP, DJIMU **Energy:** CO, NG, GO, HO **Agriculture:** **Precious Metal**: **(-)**
15	**SYBN**	**Islamic Index:** DJIMAP, DJIMU **Energy:** CO, GO, HO, NG **Agriculture:** CFF, CTN, SGR, WHT **Precious Metal:** CPR, PLDM, PLTNM	**Islamic Index:** DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV, DJIMU **Energy:** CO, GO, HO, **Agriculture: WHT** **Precious Metal**: **(-)**

Table 8. (continued) Summaries of Analysis

Model	Variable	Porfolio Variable for Mean Model	Porfolio Variable for Variance Model
16	**WHT**	**Islamic Index:** DJIMAP **Energy:** CO, GO, HO, NG **Agriculture:** CFF, SYBN, **Precious Metal:** SLVR, PLDM	**Islamic Index:** DJIMI, DJIMAP, DJIEU, DJIEMG, DJIDEV, DJIMU **Energy:** CO, GO, HO, **Agriculture:** SYBN **Precious Metal**: **(-)**
17	**GLD**	**Islamic Index: (-)** **Energy:** CO, NG **Agriculture:** CFF, SGR, WHT **Precious Metal: (-)**	**Islamic Index: (-)** **Energy: (-)** **Agriculture: (-)** **Precious Metal**: **(-)**
18	**SLVR**	**Islamic Index:** **Energy:**CO, GO, HO, NG **Agriculture:**CFF, CTN, SGR, WHT **Precious Metal:** CPR	**Islamic Index: (-)** **Energy: (-)** **Agriculture: (-)** **Precious Metal**: **(-)**
19	**CPR**	**Islamic Index: (-)** **Energy:** NG **Agriculture:** CFF, CRN, SYBN **Precious Metal:** SLVR, PLTNM	**Islamic Index: (-)** **Energy: (-)** **Agriculture: (-)** **Precious Metal**: **(-)**
20	**PLDM**	**Islamic Index: (-)** **Energy:** HO **Agriculture:** CFF, CTN, SYBN, WHT **Precious Metal:** PLTNM	**Islamic Index: (-)** **Energy: (-)** **Agriculture: (-)** **Precious Metal**: **(-)**
21	**PLTNM**	**Islamic Index:** DJIMU **Energy: (-)** **Agriculture:** CFF, CRN, CTN, SGR, SYBN **Precious Metal:** CPR, PLDM	**Islamic Index: (-)** **Energy: (-)** **Agriculture: (-)** **Precious Metal**: **(-)**

8. CONCLUSION AND DISCUSSION

Since the 1990s, there have been major developments in both theory and practice of Islamic capital markets. Investors turn to alternative investment vehicles as a result of increased risk variety encountered by capital market investments as well as globalization and financial deregulation. Islamic indices are also attractive to conventional investors because, as a result of Islamic monitoring standards, they are less vulnerable to systematic risk sources. But right now, the most crucial question is whether Islamic indices provide traditional investors with diversification options and whether they may be utilized for hedging.

Commodity prices, in addition to other macroeconomic factors, are particularly significant for Islamic stock indexes since they support the real sector's operations particularly well and Islamic finance is a financial system built on the profit-loss sharing concept. Additionally, certain measures relating to liquidity, interest rates, debt, and unfavorable gains must be disclosed to meet the quantitative requirements needed to create Islamic stock indexes. This circumstance could compel the index-compliant businesses to seek for actual marketplaces. Therefore, it is predicted and seen to be significant that there is a link between Islamic indices and commodities markets. Commodity prices and investment levels drastically surged following the dot.com bubble burst in 2000, or the fall of high-tech firms' (mostly Internet companies') shares. To diversify their portfolios and provide investors the return they need, commodities markets give investors the opportunity to profit more from the commodity markets that have an adverse price correlation with bonds and equities (Doyle et al., 2007; Sakarya et al., 2018).

The aim of the study is to obtain appropriate portfolio diversification for each commodity and Islamic indices by making use of nonlinear and variance causality tests between Islamic index and commodity prices. For this aim daily data is used because Naifa and Dohaiman (2013) argued that daily data more adequately capture the interaction of oil and stock prices in the region than low frequency data. The data employed in this paper are daily time data and the sample time periods range from 29.12.2009-28.10.2019 with 2557 daily observation.

This study tries to investigate the answers to following research questions; “Is there a non-linear relationship between the series?”, “Does the commodity price cause the prices of

the other commodities and Islamic stock indices or vice versa?", "Which commodities and Islamic stock markets the investors should invest in to gain portfolio diversification benefits?".

This study contributes the existing literature; firstly, covers three different types of commodities: precious metal, energy, agriculture, and Islamic investors return for the significant area of Islamic world and study hope to contribute with diversification benefits of commodities, and Islamic Indices.

Other contribution is that; before literature, when academicians decide their econometric methodology, they didn't apply test for linearity or non-linearity. The implementation of nonlinear models is the primary emphasis of this work, and the key considerations are as follows. Energy commodities and most precious metals have a nonlinear behavior over time, similar to an economic or financial variable, as a result of economic conditions. As a result, how they interact with one another is likewise nonlinear. The theoretical and empirical underlying principles of this nonlinear behavior may depend on the fragility of macroeconomic variables and may be brought on by wars, other geopolitical extreme events that have an impact on suppliers or demander nations (e.g., the first and second oil price shocks and the 2006 oil price shock, the Arab Spring, rising interest rates, the 1970s crisis, OPEC decisions, the 1997-1998 Asian Crisis, the 2008-2010 global financial crisis), economic crises (e.g. Under these conditions, the prices of agricultural, metal, and energy commodities show more complicated behavior than a linear and stable connection (Bildirici and Türkmen :2015, Ciner:2001, Naifa:2013).

It has been concluded that Islamic Indices will provide benefits in portfolio diversification according to Model 1,2,3,4,5 and 6, which gives causality results in both mean and variance, and that it is a more effective tool in portfolio diversification than causality analysis in variance with risk. (Nagayev,2013; Chebbbi et al. 2015; Saitu et. Al, 2017). In addition, it was concluded that the variance, where volatility is taken into account, will provide the opportunity to diversify with energy and other Islamic indices and SGR, SYBN and WHT (Model 14,15,16) data according to the causality results. However, there is no combination for all Islamic indices model (Model 1,2,3,4,5,6) and precious metal group models (Model 17, 18,19,20,21).

In addition, as a result of the causality test in variance, a suitable diversification could not be found for Model 11, 12,13, which gives portfolio combinations of agricultural commodities, and models that is given 17,18,19,20 and 21, precious metal portfolio combinations. These models show agricultural commodities and precious metals, respectively. In cases where the volatility models 14, 15, 16 offer the opportunity to diversify according to other agricultural commodities (Živkov, 2022).

Unlike Tuna (2018), according to Model 17,18, 19,20,21, precious metal model, result show that especially on variance causality precious metals are not effective diversification tool.

This study's lack of diversity in index providers is one of its major, if not its primary, limitations. All indices were obtained from DJIM, and as was already said, the performance of Islamic stock indexes is likely to be influenced by the technique employed to calculate them. Expanding the coverage even more and incorporating indices from all other sources would be beneficial. The study covers a 10-year period consisting of only 2557 days of data. If the periods of crisis are taken into account, there are different results. In addition, general indices were used instead of sector-based Islamic indices in the study. If sector-based Islamic indices are included in the study, different and sector-based results can be obtained for each commodity group. In periods of macroeconomic developments, financial data may contain volatility, breakouts, and divergent observations due to their structure.

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10. APPENDIXES

APPENDIX A.

Table A.1. Total Global Coffee Production (%)

	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
Brazil	34.85	32.60	37.65	35.73	39.76
Vietnam	16.59	18.33	17.21	18.49	16.49
Colombia	9.07	8.65	7.85	8.33	8.13
Indonesia	6.58	6.51	6.00	6.32	6.09
Ethiopia	4.31	4.38	4.16	4.41	4.32
Uganda	3.03	2.88	2.63	3.23	3.41
Honduras	4.67	4.76	4.25	3.31	3.55
India	3.23	3.30	3.01	2.93	2.93
Peru	2.62	2.74	2.49	2.32	1.92
Mexico	2.05	2.50	2.01	2.19	2.01
Guatemala	2.22	2.37	2.13	2.15	1.89
Nicaragua	1.63	1.71	1.67	1.63	1.50
Malaysia	1.30	1.31	1.19	1.12	1.14
China	1.12	1.20	1.25	1.12	1.02
Costa Rica	0.81	0.95	0.71	0.87	0.84
Other Countries	1.31	1.28	1.10	1.32	1.17
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Coffee: World Markets and Trade

Table A.2. Total Coffee Exports (%)

	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
Brazil	24.85	22.78	29.03	29.09	31.63
Vietnam	19.87	22.38	19.85	19.74	17.98
Colombia	10.33	9.52	9.61	9.40	9.69
Indonesia	6.14	5.99	4.31	5.17	5.39
Uganda	3.46	3.22	3.12	3.87	4.14
India	4.63	4.60	4.05	3.75	3.97
Honduras	5.39	5.41	4.78	3.68	3.94
Ethiopia	2.89	2.91	2.93	2.99	2.81
Peru	3.02	3.13	3.01	2.69	2.33
European Union	1.94	2.13	2.08	2.52	2.43
Other Countries	17.47	17.93	17.23	17.11	15.68
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Coffee: World Markets and Trade

Table A.3. Total Coffee Imports (%)

	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
European Union	33.64	34.28	33.38	34.12	33.83
United States	20.50	19.08	20.38	19.22	19.36
Japan	6.22	5.95	6.05	5.59	5.69
Philippines	4.97	4.70	4.44	4.35	4.32
Canada	3.52	3.66	3.55	3.71	3.74
Russia	3.67	3.44	3.60	3.55	3.16
United Kingdom	3.33	2.92	2.91	2.97	2.73
China	2.75	2.15	1.91	2.27	2.65
Korea South	2.11	2.04	2.01	2.29	2.29
Switzerland	2.01	2.12	2.04	2.33	2.48
Other Countries	17.26	19.67	19.73	19.60	19.74
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Coffee: World Markets and Trade

Table A.4. Total Coffee Consumption (%)

	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
European Union	25.14	26.20	25.40	24.81	24.79
United States	16.43	15.92	16.36	16.04	15.81
Brazil	13.93	13.96	13.99	14.17	14.29
Japan	5.29	5.13	4.76	4.69	4.64
Philippines	4.50	4.08	3.69	3.77	3.79
Canada	2.93	2.96	2.95	2.98	3.05
Indonesia	2.06	2.22	2.59	3.02	2.73
Russia	3.05	2.78	2.98	2.85	2.57
China	2.07	1.92	1.99	2.28	2.39
United Kingdom	2.77	2.36	2.41	2.38	2.23
Other Countries	6.14	5.78	6.15	6.11	5.39
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Coffee: World Markets and Trade

Table A.5. Total Corn Production, (%)

	2017/18	2018/19	2019/20	2020/21	2021/22Jul
United States	34.38	32.33	30.93	32.30	32.24
China	24.00	22.83	23.31	23.37	22.43
Brazil	7.60	8.96	9.12	7.80	9.88
European Union	5.75	5.71	5.97	5.78	5.58
Argentina	2.96	4.53	4.56	4.35	4.27
Ukraine	2.23	3.18	3.21	2.72	3.14
India	2.66	2.46	2.57	2.71	2.47
Mexico	2.55	2.46	2.38	2.42	2.34
South Africa	1.21	1.05	1.42	1.54	1.42
Russia	1.22	1.01	1.28	1.24	1.29
Other Countries	15.43	15.48	15.26	15.77	14.94
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Grain: World Markets and Trade

Table A.6. Total Corn Consumption (%)

	2017/18	2018/19	2019/20	2020/21	2021/22Jul
United States	28.81	27.10	27.28	27.24	26.49
China	24.13	23.92	24.50	25.33	24.84
European Union	6.90	7.42	6.94	6.57	6.50
Brazil	5.83	5.85	6.04	5.96	6.17
Mexico	3.90	3.85	3.86	3.83	3.72
India	2.45	2.49	2.40	2.44	2.48
Egypt	1.46	1.41	1.49	1.45	1.43
Vietnam	1.25	1.24	1.28	1.45	1.44
Japan	1.43	1.40	1.41	1.35	1.35
Canada	1.28	1.32	1.23	1.23	1.23
Other Countries	22.57	24.01	23.58	23.15	24.36
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Grain: World Markets and Trade

Table A.7. Total Corn Imports, (%)

	2017/18	2018/19	2019/20	2020/21	2021/22Jul
China	2.24	2.58	4.32	14.12	13.38
Mexico	10.45	9.60	9.40	8.96	8.75
Japan	10.15	9.25	9.04	8.36	8.18
European Union	11.44	13.59	9.89	7.17	7.72
Vietnam	6.09	6.28	6.83	6.68	6.69
Korea South	6.49	6.26	6.76	6.25	6.02
Egypt	6.13	5.40	5.93	5.43	5.35
Colombia	3.37	3.49	3.40	3.26	3.19
Iran	5.77	5.19	3.87	3.26	3.60
Algeria	2.62	2.78	2.93	2.61	2.68
Other Countries	35.25	35.60	37.63	33.90	34.44
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Grain: World Markets and Trade

Table A.8. Total Corn Exports, Local Marketing Years (%)

	2017/18	2018/19	2019/20	2020/21	2021/22Jul
United States	41.24	28.41	26.73	39.38	32.42
Argentina	15.68	18.95	22.71	18.74	19.55
Brazil	16.27	22.34	19.42	15.21	19.04
Ukraine	11.68	17.47	16.46	12.76	15.69
Russia	3.58	1.60	2.32	1.68	2.26
European Union	1.77	2.46	3.07	1.79	2.21
South Africa	1.53	0.68	1.40	1.74	1.65
Paraguay	0.96	1.47	1.18	1.41	1.39
Serbia	0.53	1.63	1.78	1.90	1.60
India	0.70	0.28	0.64	1.36	0.62
Other Countries	6.07	4.71	4.30	4.02	3.57
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Grain: World Markets and Trade

Table A.9. Total Cotton Production (%)

	2017/18	2018/19	2019/20	2020/21	2021/22Jul
India	23.39	21.76	23.72	25.17	24.29
China	22.18	23.40	22.45	26.24	22.41
United States	16.88	15.49	16.40	12.99	14.91
Brazil	7.44	10.96	11.35	9.56	11.10
Pakistan	6.62	6.41	5.11	4.00	4.19
Australia	3.87	1.86	0.51	2.49	3.27
Turkey	3.23	3.16	2.84	2.58	2.85
Other Countries	16.39	16.96	17.61	16.96	16.99
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Cotton: World Markets and Trade

Table A.10. Total Cotton Consumption (%)

	2017/18	2018/19	2019/20	2020/21	2021/22Jul
China	33.37	32.79	32.09	33.61	33.29
India	19.65	20.17	19.45	20.17	20.71
Pakistan	8.87	8.88	8.95	8.74	8.53
Bangladesh	6.10	5.98	6.71	7.06	6.82
Turkey	6.14	5.73	6.42	6.47	6.66
Vietnam	5.37	5.81	6.42	6.13	6.17
Uzbekistan	2.03	2.32	2.92	2.65	2.60
Brazil	2.77	2.82	2.63	2.52	2.52
Indonesia	2.85	2.61	2.33	2.02	2.03
United States	2.62	2.47	2.09	1.93	2.03
Other Countries	10.22	10.41	9.99	8.71	8.65
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Cotton: World Markets and Trade

Table A.11. Total Cotton Imports (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Jul
China	13.74	22.72	17.52	26.35	21.78
Bangladesh	18.29	16.50	18.41	17.56	17.42
Vietnam	16.85	16.35	15.91	15.04	16.55
Pakistan	8.18	6.72	9.76	10.95	11.54
Turkey	10.57	8.50	11.47	11.06	11.33
Indonesia	8.46	7.19	6.17	4.65	5.44
India	4.04	4.24	5.60	1.65	2.18
Mexico	2.23	2.00	1.45	1.81	1.96
Malaysia	1.78	1.75	2.09	1.45	1.74
Egypt	1.32	1.18	1.23	1.24	1.25
Other Countries	14.54	12.85	10.42	8.24	8.80
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Cotton: World Markets and Trade

Table A.12. Total Cotton Exports (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Jul
United States	39.05	35.70	37.62	34.03	33.10
Brazil	10.01	14.48	21.67	22.92	17.86
India	12.43	8.47	7.76	12.70	13.07
Australia	9.39	8.74	3.30	2.81	7.19
Greece	2.58	3.26	3.56	3.17	3.16
Benin	2.57	3.35	2.35	2.91	3.05
Mali	3.12	3.25	2.85	1.25	2.50
Cote d'Ivoire	1.49	2.15	1.56	2.48	2.29
Burkina Faso	2.94	1.93	2.26	1.77	2.07
Cameroon	0.96	1.38	1.21	1.20	1.36
Other Countries	15.47	17.29	15.86	14.76	14.36
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Cotton: World Markets and Trade

Table A.13. Total Sugar Production (%)

	2016/17	2017/18	2018/19	2019/20	2020/21
Brazil	22.74	20.02	16.46	18.22	23.38
India	12.90	17.67	19.14	17.38	18.77
European Union	9.01	10.05	9.35	9.96	8.18
Thailand	5.83	7.57	8.14	4.99	4.21
China	5.40	5.30	6.01	6.25	5.84
United States	4.73	4.34	4.56	4.45	4.69
Pakistan	3.96	3.72	2.94	3.25	3.34
Mexico	3.67	3.28	3.80	3.37	3.43
Russia	3.60	3.38	3.39	4.69	3.20
Australia	2.96	2.31	2.64	2.58	2.41
Other Countries	25.20	22.36	23.57	24.87	22.55
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Sugar: World Markets and Trade

Table A.14. Total Sugar Consumption (%)

	2016/17	2017/18	2018/19	2019/20	2020/21
India	15.09	15.30	15.93	15.80	16.30
European Union	9.14	9.82	9.85	9.72	9.66
China	9.23	9.07	9.15	9.01	9.02
United States	6.50	6.31	6.36	6.54	6.40
Brazil	6.24	6.12	6.14	6.23	5.91
Indonesia	3.66	3.68	4.09	4.31	4.33
Russia	3.47	3.53	3.49	3.58	3.50
Pakistan	3.02	3.06	3.13	3.28	3.35
Mexico	2.82	2.61	2.50	2.55	2.45
Egypt	1.75	1.76	1.80	1.90	1.94
Other Countries	39.08	38.75	37.57	37.08	37.13
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Sugar: World Markets and Trade

Table A.15. Total Sugar Imports (%)

	2016/17	2017/18	2018/19	2019/20	2020/21
China	8.32	7.80	7.65	8.17	9.08
Indonesia	8.65	7.76	10.04	8.82	9.63
Bangladesh	3.79	4.76	4.55	4.44	4.54
United States	5.32	5.33	5.21	7.12	5.30
Algeria	3.86	4.06	4.36	4.58	4.45
Malaysia	3.42	3.59	4.00	3.64	3.94
European Union	5.26	2.89	4.44	4.14	3.70
Korea South	3.18	3.34	3.74	3.57	3.52
Nigeria	3.29	3.35	3.50	3.50	3.48
Saudi Arabia	2.73	2.58	2.51	2.63	2.77
Other Countries	52.16	54.52	49.99	49.38	49.59
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, *Sugar*: World Markets and Trade

Table A.16. Total Sugar Exports (%)

	2016/17	2017/18	2018/19	2019/20	2020/21
Brazil	47.46	42.86	33.88	36.32	50.01
Thailand	11.68	16.58	18.34	12.57	11.36
India	3.54	3.40	8.12	10.93	9.33
Australia	6.66	5.47	6.46	6.78	5.19
Guatemala	3.29	2.86	3.67	3.50	2.69
Mexico	2.14	1.74	4.04	2.42	2.47
European Union	3.31	6.61	4.17	2.75	1.56
South Africa	0.36	1.17	1.80	2.73	1.53
Pakistan	0.67	2.43	1.90	0.14	0.08
Colombia	1.16	1.11	1.38	1.47	1.09
Other Countries	19.72	15.77	16.24	20.38	14.69
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Sugar: World Markets and Trade

Table A.17. Total Soybean Production (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Sep
Brazil	35.85	33.12	37.83	37.71	37.38
United States	34.88	33.35	28.46	30.98	31.12
Argentina	10.98	15.30	14.37	12.66	13.50
China	4.44	4.42	5.33	5.40	4.93
India	2.43	3.02	2.74	2.88	2.91
Paraguay	3.21	2.36	2.97	2.73	2.73
Canada	2.24	2.05	1.81	1.75	1.58
Other Countries	5.96	6.38	6.50	5.89	5.85
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Oilseeds: World Markets and Trade

Table A.18. Total Soybean Crush (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Sep
China	30.51	28.45	29.29	29.46	30.12
United States	18.96	19.06	18.86	18.38	18.24
Brazil	14.98	14.24	14.96	14.65	14.37
Argentina	12.52	13.58	12.41	13.01	12.95
European Union	4.85	5.02	4.99	5.05	4.79
India	2.61	3.21	2.69	2.95	2.92
Mexico	1.78	2.06	1.92	1.94	1.93
Egypt	1.08	1.17	1.50	1.44	1.45
Russia	1.56	1.56	1.49	1.39	1.45
Paraguay	1.36	1.28	1.12	1.03	1.13
Other Countries	9.79	10.37	10.77	10.69	10.67
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Oilseeds: World Markets and Trade

Table A.19. Total Soybean Imports (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Sep
China	61.17	56.62	59.73	58.89	59.40
European Union	9.05	9.84	9.06	9.11	8.74
Mexico	3.17	4.02	3.48	3.64	3.61
Egypt	2.12	2.51	2.97	2.73	2.80
Argentina	3.06	4.40	2.96	3.04	2.74
Thailand	1.61	2.16	2.32	2.43	2.39
Japan	2.12	2.27	2.02	1.97	1.92
Turkey	1.87	1.65	1.91	1.82	1.86
Indonesia	1.61	1.80	1.60	1.61	1.57
Taiwan	1.73	1.79	1.64	1.58	1.57
Other Countries	12.49	12.93	12.31	13.18	13.40
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Oilseeds: World Markets and Trade

Table A.20. Total Soybean Exports (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Sep
Brazil	49.68	50.28	55.82	50.02	53.80
United States	37.90	32.04	27.69	37.29	32.67
Paraguay	3.93	3.29	4.01	4.00	3.76
Argentina	1.39	6.11	6.06	2.24	3.67
Canada	3.21	3.53	2.37	2.79	2.26
Other Countries	3.88	4.74	4.06	3.65	3.83
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, *Oilseeds*: World Markets and Trade

Table A.21. Total Wheat Production (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Jul
European Union	17.93	16.83	18.17	16.23	17.44
China	17.61	17.97	17.50	17.30	17.16
India	12.92	13.65	13.57	13.90	13.63
Russia	11.17	9.80	9.64	11.00	10.73
United States	6.21	7.01	6.89	6.40	6.00
Ukraine	3.54	3.43	3.82	3.28	3.79
Australia	2.75	2.41	1.90	4.25	3.60
Pakistan	3.50	3.43	3.19	3.22	3.41
Canada	3.98	4.42	4.28	4.53	3.98
Argentina	2.43	2.67	2.59	2.27	2.59
Other Countries	17.98	18.38	18.47	17.60	17.69
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Grain: World Markets and Trade

Table A.22. Total Wheat Consumption (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Jul
China	16.31	17.00	16.83	19.12	18.71
European Union	15.30	14.45	14.39	13.29	13.66
India	12.89	13.00	12.74	13.14	13.28
Russia	5.79	5.51	5.34	5.42	5.37
United States	3.94	4.08	4.07	3.88	4.11
Pakistan	3.37	3.45	3.41	3.34	3.41
Egypt	2.67	2.73	2.71	2.65	2.67
Turkey	2.47	2.56	2.67	2.63	2.68
Iran	2.14	2.19	2.30	2.24	2.23
United Kingdom	2.15	2.08	1.99	1.74	2.01
Other Countries	32.97	32.94	33.54	32.57	31.87
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Grain: World Markets and Trade

Table A.23. Total Wheat Imports (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Jul
Egypt	6.64	6.94	6.57	6.14	6.44
Turkey	3.26	3.66	5.69	4.07	4.96
Indonesia	5.76	6.14	5.43	5.28	5.15
China	2.11	1.77	2.76	5.36	4.96
Algeria	4.37	4.22	3.67	3.88	3.47
Bangladesh	3.46	2.86	3.49	3.64	3.67
Brazil	3.58	4.18	3.62	3.21	3.22
Philippines	3.24	4.25	3.63	3.09	3.17
Nigeria	2.76	2.62	2.74	3.33	2.87
Japan	3.14	3.21	2.92	2.77	2.77
Other Countries	61.68	60.16	59.49	59.25	59.32
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Grain: World Markets and Trade

Table A.24. Total Wheat Exports (%)

	2017/18	2018/19	2019/20	2020/21	2021/22 Jul
European Union	13.32	13.86	20.41	15.01	17.59
Russia	22.17	20.14	17.70	19.44	17.34
Australia	8.30	5.52	5.19	9.96	12.14
Ukraine	9.51	8.99	10.78	8.51	11.64
United States	12.42	14.71	13.54	13.48	12.14
Canada	11.78	13.73	12.05	13.99	7.68
Argentina	7.49	7.12	6.98	4.85	6.44
Kazakhstan	4.56	4.93	3.53	4.10	3.57
Turkey	3.60	3.75	3.40	3.32	2.97
India	0.28	0.28	0.31	1.82	2.23
Other Countries	6.59	6.97	6.11	5.52	6.25
World Total	100.00	100.00	100.00	100.00	100.00

Source: Adapted from by author, Grain*:* Adapted from by author, World Markets and Trade

Table A.25. World crude oil producer countries (%)

	2017	2018	2019	2020	2021
United States	12.57	14.47	16.33	16.32	16.06
Saudi Arabia1	13.37	13.64	13.04	13.33	13.10
Iraq	6.00	5.83	6.08	5.78	5.70
Brazil	3.52	3.42	3.70	4.25	4.17
United Arab Emirates	3.98	3.98	4.06	4.02	3.90
Kuwait1	3.63	3.62	3.56	3.53	3.47
IR Iran	5.19	4.68	3.14	2.88	3.44
Norway	2.13	1.97	1.87	2.45	2.54
Mexico	2.62	2.39	2.23	2.41	2.39
Kazakhstan	1.97	2.07	2.11	2.13	2.14
Other Countries	45	44	44	43	43
Total World	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.26. World crude oil demand distribution by country (%)

	2017	2018	2019	2020	2021
United States	20.48	20.76	20.54	20.12	20.56
Japan	4.03	3.88	3.73	3.65	3.52
Brazil	3.17	3.19	3.23	3.37	3.31
Saudi Arabia	3.34	3.13	3.13	3.21	3.06
South Korea	2.69	2.59	2.59	2.67	2.67
Canada	2.52	2.54	2.62	2.53	2.43
Germany	2.50	2.35	2.34	2.36	2.20
I.R.Iran	1.86	1.87	1.83	1.86	1.83
Indonesia	1.75	1.79	1.85	1.78	1.83
Mexico	2.06	1.95	1.95	1.73	1.69
Other Countries	66.6	66.07	67.20	67.70	67.00
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.27. World crude oil importer countries (%)

	2017	2018	2019	2020	2021
China	18.04	19.69	21.75	25.29	24.10
United States	17.06	16.52	14.53	13.69	14.30
India	9.29	9.66	9.63	9.40	9.93
South Korea	6.51	6.45	6.25	6.20	6.11
Japan	6.93	6.50	6.46	5.76	5.83
Germany	3.92	3.66	3.71	3.88	3.85
Italy	2.87	2.66	2.72	2.36	2.68
Spain	2.85	2.90	2.86	2.57	2.65
Netherlands	2.34	2.33	2.46	2.33	2.48
Thailand	1.94	2.00	1.99	1.95	2.02
Other Countries	28.25	27.61	27.65	26.55	26.04
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.28. World crude oil exporter countries (%)

	2017	2018	2019	2020	2021
Saudi Arabia	15.59	16.05	15.55	15.84	15.10
Russia	11.32	11.34	11.58	10.99	10.94
Iraq	8.51	8.41	8.77	8.16	8.34
Canada	6.47	6.92	7.42	7.48	7.75
United States	2.59	4.46	6.59	7.63	7.23
United Arab Emirates	5.32	5.00	5.34	5.75	5.59
Kuwait	4.50	4.46	4.39	4.35	4.22
Nigeria	4.05	4.31	4.44	4.47	3.86
Norway	3.05	2.73	2.73	3.57	3.79
Kazakhstan	3.07	3.05	3.12	3.37	3.21
Other Countries	35.55	33.3	30	28.39	30
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.29. World gasoline demand by countries (%)

	2017	2018	2019	2020	2021
OECD Americas	42.48	42.08	41.74	40.32	40.45
China	11.79	11.86	12.23	13.30	13.55
Other Asia	6.79	7.05	7.21	7.60	7.53
OECD Europe	7.34	7.57	7.67	7.37	7.50
Latin America	7.38	7.22	7.20	7.15	6.99
Middle East	6.43	6.40	6.29	6.07	6.20
OECD Asia Pacific	5.98	5.85	5.71	5.69	5.31
Africa	4.26	4.39	4.44	4.65	4.56
Russia	3.54	3.48	3.37	3.70	3.55
India	2.39	2.51	2.63	2.67	2.79
Other Eurasia	1.11	1.04	0.88	0.88	0.91
Other Europe	0.51	0.55	0.63	0.59	0.65
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.30. World gasoline importer countries (%)

	2017	2018	2019	2020	2021
OECD Americas	27.17	27.46	29.76	27.32	31.22
Other Asia	22.36	23.27	23.93	25.67	23.06
Africa	13.05	11.25	12.97	15.34	14.49
OECD Europe	11.72	9.99	10.26	11.31	11.24
Latin America	6.57	6.57	7.05	7.33	6.80
Middle East	14.09	16.41	10.45	6.27	6.45
OECD Asia Pacific	2.76	2.92	3.03	3.98	4.22
Other Eurasia	1.60	1.29	1.04	1.12	1.19
Other Europe	0.59	0.53	0.55	0.78	0.74
India	0.07	0.13	0.80	0.62	0.43
China	0.01	0.17	0.13	0.22	0.15
Russia	0.01	0.02	0.00	0.05	0.03
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.31. World gasoline exporter countries (%)

	2017	2018	2019	2020	2021
OECD Europe	34.37	32.75	33.63	31.97	31.62
OECD Americas	20.25	21.23	21.04	22.02	23.11
Other Asia	14.64	13.18	13.62	12.72	13.32
OECD Asia Pacific	5.88	5.84	6.06	5.58	6.61
China	4.67	5.45	7.05	7.91	6.41
Middle East	4.66	7.49	4.17	4.44	5.56
India	6.31	5.64	5.60	5.70	5.54
Latin America	2.91	2.99	2.79	2.36	2.49
Russia	1.96	1.80	2.26	2.83	1.88
Other Eurasia	1.85	1.19	1.06	1.74	1.24
Other Europe	1.61	1.57	1.75	1.69	1.21
Africa	0.90	0.86	0.97	1.04	1.02
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.32. World heating oil demand by countries (%)

	2017	2018	2019	2020	2021
OECD Europe	23.22	22.83	22.71	22.51	22.46
OECD Americas	18.47	19.02	18.82	18.62	18.21
China	12.43	12.56	12.07	12.75	12.56
Other Asia	7.57	7.64	7.63	7.81	8.35
Latin America	7.48	7.34	7.32	7.18	7.25
OECD Asia Pacific	6.81	6.73	6.78	6.76	6.57
Middle East	6.35	6.25	6.26	6.15	6.13
Africa	6.03	6.09	6.20	6.20	6.10
India	5.95	6.04	6.09	5.64	5.72
Russia	2.78	2.55	3.03	3.14	3.34
Other Eurasia	1.73	1.75	1.85	1.92	2.05
Other Europe	1.18	1.20	1.24	1.32	1.27
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.33. World heating oil importer countries (%)

	2017	2018	2019	2020	2021
OECD Europe	38.39	36.57	37.89	38.28	37.08
Other Asia	18.44	17.58	17.50	15.86	14.66
Africa	12.24	12.40	12.57	13.32	13.21
OECD Americas	7.94	9.13	9.29	9.31	10.07
Latin America	9.10	9.46	9.38	8.38	9.40
OECD Asia Pacific	4.43	4.81	5.16	5.96	6.72
Other Europe	2.20	2.14	2.54	3.03	3.12
Middle East	4.47	5.60	2.58	2.44	2.83
Other Eurasia	2.21	2.03	2.27	2.53	2.59
China	0.18	0.18	0.31	0.34	0.21
Russia	0.04	0.02	0.01	0.09	0.08
India	0.35	0.08	0.51	0.46	0.04
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.34. World heating oil exporter countries (%)

	2017	2018	2019	2020	2021
OECD Europe	25.71	22.74	22.81	23.26	24.61
OECD Americas	19.85	18.45	19.89	20.05	18.80
Middle East	10.37	13.89	11.76	10.40	12.75
Russia	11.13	12.05	11.61	12.09	11.45
Other Asia	10.56	10.87	9.58	10.21	10.01
OECD Asia Pacific	8.78	8.86	10.05	9.13	8.55
India	6.24	6.12	6.68	7.01	7.17
China	3.72	3.96	4.69	4.53	3.93
Other Eurasia	1.55	1.06	1.21	1.38	1.36
Africa	0.51	0.51	0.56	0.89	0.68
Other Europe	0.80	0.72	0.91	0.73	0.53
Latin America	0.77	0.78	0.25	0.33	0.15
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.35. World proven natural gas reserves distribution by country (%)

	2017	2018	2019	2020	2021
Russia	24.28	23.95	23.54	23.09	23.20
IR Iran	16.25	16.10	16.23	16.43	16.51
Qatar	11.47	11.52	11.41	11.52	11.58
Turkmenistan	6.71	6.74	6.68	6.75	6.78
United States	5.96	6.49	6.31	6.37	5.95
Saudi Arabia	4.19	3.99	4.01	4.08	4.13
United Arab Emirates	2.93	2.94	3.70	3.74	3.98
Nigeria	2.70	2.74	2.76	2.78	2.84
Venezuela	2.74	2.74	2.72	2.70	2.69
Algeria	2.17	2.18	2.16	2.18	2.19
Other Countries	20.61	20.6	20.5	20.4	20.16
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.36. World natural gas demand distribution by country (%)

	2017	2018	2019	2020	2021
United States	20.62	21.88	22.02	21.86	21.03
Russia	11.68	11.44	11.24	11.22	11.34
China	6.33	7.09	7.50	8.17	8.59
IR Iran	5.84	5.85	5.79	5.90	5.93
Canada	3.57	3.55	3.48	3.37	3.33
Saudi Arabia	3.08	3.03	3.07	3.02	2.93
Japan	3.26	3.13	2.86	2.84	2.69
Germany	2.48	2.19	2.30	2.26	2.28
Mexico	2.21	2.15	2.16	2.14	2.08
United Kingdom	2.13	2.08	1.98	1.86	1.87
Other Countries	38.81	37.63	37.61	37.36	37.94
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.37. World natural gas imports distribution by country (%)

	2017	2018	2019	2020	2021
Germany	11.29	11.58	11.16	11.33	10.94
China	6.77	8.65	9.11	9.94	10.11
Japan	8.86	8.51	7.82	7.81	7.40
United States	6.31	5.83	5.45	5.26	5.63
Italy	5.12	4.84	4.98	4.82	5.15
Mexico	3.74	3.94	4.17	4.28	4.34
South Korea	3.58	4.14	3.78	3.90	4.32
Turkey	4.05	3.56	3.17	3.51	4.16
Netherlands	3.99	4.34	4.16	4.36	4.07
United Kingdom	3.50	3.43	3.34	3.20	3.62
Other Countries	42.8	41.18	42.86	41.58	40.26
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

Table A.38. World natural gas exports distribution by country (%)

	2017	2018	2019	2020	2021
Russia	17.926	19.045	19.217	18.185	17.416
United States	6.978	7.787	9.659	11.362	13.278
Qatar	9.860	9.662	9.473	9.680	9.481
Norway	9.618	9.143	8.294	8.526	7.855
Australia	5.845	6.980	7.342	7.779	7.541
Canada	6.651	6.070	5.612	5.387	5.607
Germany	2.464	2.930	3.064	3.804	4.413
Algeria	4.211	3.920	3.133	2.997	3.859
Netherlands	4.385	4.152	3.491	3.036	3.050
Nigeria	2.540	2.182	2.633	2.703	2.711
Other Countries	29.53	28.13	28.09	26.54	24.79
Total world	100	100	100	100	100

Source: OPEC, Data (2021), Adapted from by author, https://asb.opec.org/data/ASB_Data.php

COPPER

Table A.39. Global Copper Production Distribution (%)

	2017	2018	2019	2020
United States	6.3	5.71	6.18	5.83
Australia	4.3	4.52	4.58	4.30
Chile	27.5	27.62	28.38	27.82
China	8.55	7.62	8.24	8.35
Congo (Kinshasa)	5.45	5.71	6.32	7.77
Mexico	3.71	3.62	3.50	3.56
Peru	12.25	11.43	12.06	10.44
Russia	3.525	3.38	3.93	3.93
Zambia	3.97	4.14	3.91	4.14
Other Countries	24.45	26.24	22.91	23.88
World Total	100	100	100	100

Source: Adapted from by author, Mineral Commodity Summaries derived from https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries, 25 December 2021

Table A.40. Global Copper Importer Countries Distribution (%)

	2017	2018	2019	2020
China	42.5	49.2	52.6	54.8
Japan	14.00	14.8	13.00	13.8
South Korea	6.74	6.70	6.62	6.82
Germany	3.68	3.21	3.09	3.29
Spain	3.87	3.86	2.35	2.91
Bulgaria	4.82	4.28	3.03	2.63
Mexico	1.55	1.62	2.87	2.08
India	7.77	4.20	3.13	1.86
Other Countries	15.07	12.13	13.31	11.81
World Total	100	100	100	100

Source: Adapted from by author, The Observatory of Economic Complexity (OEC)

Table A.41. Global Copper Exporter Countries Distribution (%)

	2017	2018	2019	2020
Chile	28.1	28.9	30.7	34.6
Peru	20.4	20.3	20.4	14.9
Australia	6.92	7.03	7.74	6.22
Canada	4.71	4.37	4.63	5.04
Mexico	3.33	3.81	4.05	4.73
Indonesia	5.63	6.48	2.38	3.80
Mongolia	2.74	3.14	3.01	2.87
Kazakhstan	1.86	1.85	1.94	2.37
Other Countries	26.31	24.12	25.15	25.47
World Total	100	100	100	100

Source: Adapted from by author, The Observatory of Economic Complexity (OEC)

GOLD

Table A.42. Global Gold Production Distribution (%)

	2017	2018	2019	2020
China	13.19	12.27	11.52	11.88
Australia	9.32	9.51	9.85	10.00
Russia	8.36	9.05	9.24	9.38
United States	7.34	6.44	6.06	5.94
Ghana	3.96	3.99	4.30	4.38
Indonesia	2.32	2.61	4.21	4.06
Peru	4.67	4.45	3.88	3.75
Canada	5.08	5.67	5.30	3.13
Other Countries	26.31	24.12	25.15	25.47
World Total	100	100	100	100

Source: Adapted from by author, Mineral Commodity Summaries derived from https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries, 25 December 2021

Table A.43. Global Gold Importer Countries Distribution (%)

	2017	2018	2019	2020
Switzerland	19.40	20.70	18.7	20.7
United Kingdom	11.8	9.23	19.00	19.80
United States	3.09	2.84	3.01	11.40
United Arab Emirates	9.67	8.43	8.87	9.10
Turkey	5.01	3.59	3.40	5.62
India	10.09	9.95	9.91	5.19
Singapore	3.58	3.58	3.19	4.87
Hong Kong	8.58	8.24	4.5	4.75
Other Countries	28.78	33.44	29.42	18.57
World Total	100	100	100	100

Source: Adapted from by author, Mineral Commodity Summaries derived from https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries, 25 December 2021

Table A.44. Global Gold Exporter Countries Distribution (%)

	2017	2018	2019	2020
Switzerland	20.30	20.50	17.30	16.20
Hong Kong	6.40	3.72	4.07	7.81
United Arab Emirates	6.81	5.21	6.06	6.81
Russia	0.76	0.39	1.97	4.43
Australia	7.47	5.18	7.53	4.20
United Kingdom	3.68	9.92	7.02	4.06
United States	5.94	6.59	3.83	3.89
Canada	3.93	4.47	4.27	3.42
Other Countries	44.71	44.02	47.95	49.18
World Total	100	100	100	100

Source: Adapted from by author, Mineral Commodity Summaries derived from https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries, 25 December 2021

PALLADIUM

Table A.45. Global Palladium Production Distribution (%)

	2017	2018	2019	2020
Russia	37.87	40.91	43.17	43.33
South Africa	38.58	36.64	35.55	33.33
Canada	7.56	9.09	8.81	9.52
United States	6.04	6.50	6.30	6.67
Zimbabwe	5.33	5.45	5.02	5.71
Other Countries	4.80	13.27	10.66	12.38
World Total	100	100	100	100

Source: Adapted from by author, Mineral Commodity Summaries derived from https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries, 25 December 2021

Table A.46. Global Palladium Importer Countries Distribution (%)

	2017	2018	2019	2020
United Kingdom	10.30	5.47	15.10	17.00
United States	29.00	33.80	15.90	15.00
Germany	6.66	16.90	15.00	14.00
Japan	17.00	21.60	11.50	10.20
China	3.45	2.89	7.40	9.20
Hong Kong	3.49	3.39	7.02	8.34
Italy	11.50	4.79	4.49	5.79
Switzerland	8.56	2.44	4.90	5.65
Other Countries	10.04	8.72	18.69	14.82
World Total	100	100	100	100

Source: Adapted from by author, The Observatory of Economic Complexity (OEC).

Table A.47. Global Palladium Exporter Countries Distribution (%)

	2017	2018	2019	2020
Russia	26.20	25.4	25.60	25.50
United States	10.10	11.10	10.60	14.50
South Africa	18.70	20.80	17.30	12.90
United Kingdom	15.50	12.20	10.90	12.00
Italy	6.75	6.90	6.70	8.61
Belgium	3.92	3.60	8.25	7.25
Germany	7.27	9.77	8.43	7.13
Switzerland	4.26	3.22	5.05	3.36
Other Countries	7.30	7.01	7.17	8.75
World Total	100	100	100	100

Source: Adapted from by author, The Observatory of Economic Complexity (OEC).

PLATINUM

Table A.48. Global Platinum Production Distribution (%)

	2017	2018	2019	2020
Russia	10.95	11.58	12.90	12.35
Zimbabwe	7.04	7.89	7.26	8.24
South Africa	71.86	72.11	69.89	7.06
Canada	4.77	3.89	3.76	4.59
United States	2.00	2.21	2.26	2.35
Other Countries	3.27	2.37	1.99	2.24
World Total	100	100	100	100

Source: Adapted from by author, Mineral Commodity Summaries derived from https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries, 25 December 2021

Table A.49. Global Platinum Importer Countries Distribution (%)

	2017	2018	2019	2020
United States	15.90	18.50	16.20	17.90
United Kingdom	13.70	12.90	17.20	17.10
Germany	14.70	15.00	13.30	12.30
China	5.93	5.89	6.63	9.26
Japan	11.70	11.70	10.60	9.18
Hong Kong	8.22	7.42	6.87	8.27
Switzerland	5.51	5.30	6.07	5.79
Italy	4.89	3.71	4.28	4.26
Other Countries	19.45	19.58	18.85	15.94
World Total	100	100	100	100

Source: Adapted from by author, The Observatory of Economic Complexity (OEC),

Table A.50. Global Platinum Exporter Countries Distribution (%)

	2017	2018	2019	2020
South Africa	27.10	28.50	24.30	18.80
Russia	15.30	13.30	16.40	16.60
United Kingdom	17.00	14.80	12.20	14.70
United States	7.84	8.77	9.40	12.90
Germany	7.39	9.74	9.63	9.02
Belgium	2.94	3.62	7.36	7.10
Italy	5.89	5.80	5.76	6.44
Switzerland	4.39	3.77	4.17	3.97
Other Countries	12.15	11.7	10.78	10.47
World Total	100	100	100	100

Source: Adapted from by author, The Observatory of Economic Complexity (OEC).

SILVER

Table A.51. Global Silver Production Distribution (%)

	2017	2018	2019	2020
Mexico	22.71	22.59	22.34	22.40
Peru	15.99	15.93	14.57	13.60
China	13.01	13.33	12.98	12.80
Russia	4.16	4.44	7.55	7.20
Australia	4.46	4.44	5.02	5.20
Chile	4.68	4.81	5.09	5.20
Poland	4.80	4.81	5.55	5.20
Bolivia	4.61	4.44	4.38	4.40
United States	3.83	3.33	3.69	4.00
Argentina	3.79	4.07	4.08	4.00
World Total	100	100	100	100

Source: Adapted from by author, Mineral Commodity Summaries derived from https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries, 25 December 2021

Table A.52. Global Silver Importer Countries Distribution (%)

	2017	2018	2019	2020
United States	20.00	17.80	19.10	22.20
Canada	2.87	2.54	4.26	13.40
United Kingdom	14.40	10.50	10.20	10.50
Hong Kong	9.54	8.68	10.50	9.63
China	5.65	5.53	5.91	5.59
Switzerland	2.25	2.17	3.39	5.04
Japan	5.58	5.61	4.92	4.82
India	14.40	21.60	16.50	4.56
Other Countries	25.31	25.57	25.22	24.26
World Total	100	100	100	100

Source: Adapted from by author, The Observatory of Economic Complexity (OEC)

Table A.53. Global Silver Exporter Countries Distribution (%)

	2017	2018	2019	2020
United Kingdom	4.06	7.55	6.41	11.80
China	10.20	9.63	9.77	9.86
Mexico	10.00	10.00	11.40	9.54
United States	5.31	6.78	5.68	7.53
Germany	7.47	6.08	7.26	7.43
South Korea	7.50	7.37	7.53	6.70
Japan	7.27	6.54	6.93	6.37
Hong Kong	9.51	7.11	5.97	5.39
Other Countries	38.68	38.94	39.05	35.38
World Total	100	100	100	100

Source: Adapted from by author, The Observatory of Economic Complexity

APPENDIX B.

Table B.1. Descriptive Statistics

	std.dev	mean	Skewness	Kurtosis	Jarque-Bera	ARCH (5)	Q (50)	Qs (50)	ADF (Constant)	ADF (Constant and Trend)	PP (Constant)	PP (Constant and Trend)	KPSS (Constant)	KPSS (Constant and Trend)
DJIMI	0.77	0.027	-0.39	5.18	570.55 (0.00)	61.56 (0.00)	23.27 (0.50)	1049.2 (0.00)	-43.10 (0.00)	-43.10 (0.00)	-42.66 (0.00)	-42.65 (0.00)	0.04 (0.00)	0.02 (0.00)
DJIDEV	0.79	0.029	-0.40	5.37	664.42 (0.00)	44.44 (0.00)	24.73 (0.42)	936.48 (0.00)	-45.18 (0.00)	-45.17 (0.00)	-44.92 (0.00)	-44.91 (0.00)	0.04 (0.00)	0.02 (0.00)
DJIEMG	0.85	0.003	-0.39	4.09	193.289 (0.00)	36.16 (0.00)	33.09 (0.10)	730.25 (0.00)	-39.82 (0.00)	-39.81 (0.00)	-39.47 (0.00)	-39.46 (0.00)	0.05 (0.00)	0.04 (0.00)
DJIMAP	0.80	0.017	-0.36	3.94	148.45 (0.00)	30.72 (0.00)	60.74 (0.14)	767.79 (0.00)	-46.83 (0.00)	-46.82 (0.00)	-46.82 (0.00)	-46.81 (0.00)	0.05 (0.00)	0.04 (0.00)
djueu	1.01	0.018	-0.23	4.57	284.62 (0.00)	40.04 (0.00)	35.28 (0.08)	1020.8 (0.00)	-50.56 (0.00)	-50.55 (0.00)	-50.61 (0.00)	-50.60 (0.00)	0.04 (0.00)	0.03 (0.00)
DJIMU	0.94	0.041	-0.30	6.50	1340.76 (0.00)	90.72 (0.00)	31.68 (0.167)	1300.95 (0.00)	-51.69 (0.00)	-51.68 (0.00)	-52.98 (0.00)	-52.96 (0.00)	0.02 (0.00)	0.02 (0.00)
CFF	1.79	-0.013	0.10	3.57	0.00 (0.00)	7.46 (0.00)	42.47 (0.20)	97.82 (0.00)	-50.75 (0.00)	-50.75 (0.00)	-50.75 (0.00)	-50.75 (0.00)	0.11 (0.00)	0.08 (0.00)
CRN	1.41	0.012	0.09	3.86	8E+01 (0.00)	21.98 (0.00)	32.45 (0.14)	438.70 (0.00)	-49.50 (0.00)	-49.49 (0.00)	-49.49 (0.00)	-49.48 (0.00)	0.14 (0.00)	0.14 (0.00)

Notes: The figures in square brackets show the probability (p-values) of rejecting the null hypothesis. ARCH (5) is the LM conditional variance test statistic. Q (50) and Qs (50) are the Box-Pierce serial correlation test statistics for return and squared return series respectively. *** indicate the series in question is stationary at the 1% significance level.

Table B.1. (continued) Descriptive Statistics

std.dev	mean	Skewness	Kurtosis	Jarque-Bera	ARCH (5)	Q (50)	Qs (50)	ADF (Constant)	ADF (Constant and Trend)	PP (Constant)	PP (Constant and Trend)	KPSS (Constant)	KPSS (Constant and Trend)	std.dev
CTN	1.56	0.003	-0.09	3.97	0.00 (0.00)	113.75 (0.00)	29.77 (0.19)	1688.50 (0.00)	-44.57 (0.00)	-44.57 (0.00)	-44.37 (0.00)	-44.37 (0.00)	0.13 (0.00)	0.09 (0.00)
SYBN	1.15	0.003	-0.02	3.65	45.01 (0.00)	14.05 (0.00)	16.18 (0.90)	303.08 (0.00)	-49.53 (0.00)	-49.54 (0.00)	-49.55 (0.00)	-49.55 (0.00)	0.14 (0.00)	0.07 (0.00)
SGR	1.83	-0.001	0.16	3.87	91.34 (0.00)	12.23 (0.00)	42.61 (0.10)	447.14 (0.00)	-49.89 (0.00)	-49.90 (0.00)	-50.03 (0.00)	-50.03 (0.00)	0.17 (0.00)	0.08 (0.00)
WHT	1.63	-0.003	0.18	3.22	19.23 (0.00)	22.90 (0.00)	28.50 (0.28)	293.82 (0.00)	-49.05 (0.00)	-49.05 (0.00)	-49.05 (0.00)	-49.05 (0.00)	0.08 (0.00)	0.06 (0.00)
bo	1.80	-0.034	-0.18	4.72	326.87 (0.00)	19.52 (0.00)	24.63 (0.48)	543.22 (0.00)	-49.85 (0.00)	-49.85 (0.00)	-49.90 (0.00)	-49.90 (0.00)	0.2 (0.00)	0.15 (0.00)
ho	1.57	-0.031	-0.17	3.82	83.64 (0.00)	21.31 (0.00)	40.59 (0.02)	427.69 (0.00)	-48.50 (0.00)	-48.50 (0.00)	-48.6567 (0.00)	-48.65 (0.00)	0.09 (0.00)	0.06 (0.00)
GO	1.77	-0.018	-0.17	3.41	29.90 (0.00)	7.76 (0.00)	51.03 (0.02)	229.11 (0.00)	-50.13 (0.00)	-50.14 (0.00)	-50.19 (0.00)	-50.19 (0.00)	0.27 (0.00)	0.17 (0.00)
ng	3.01	-0.038	-0.10	6.43	1 254.22 (0.00)	77.22 (0.00)	67.75 (0.00)	662.45 (0.00)	-588.11 (0.00)	-587.73 (0.00)	-47.97 (0.00)	-47.97 (0.00)	0.06 (0.00)	0.02 (0.00)

Notes: The figures in square brackets show the probability (p-values) of rejecting the null hypothesis. ARCH (5) is the LM conditional variance test statistic. Q (50) and Qs (50) are the Box-Pierce serial correlation test statistics for return and squared return series respectively. *** indicate the series in question is stationary at the 1% significance level.

Table B.1. (continued) Descriptive Statistics

std.dev	mean	Skewness	Kurtosis	Jarque-Bera	ARCH (5)	Q (50)	Qs (50)	ADF (Constant)	ADF (Constant and Trend)	PP (Constant)	PP (Constant and Trend)	KPSS (Constant)	KPSS (Constant and Trend)	std.dev
CPR	1.29	0.001	0.03	4.12	134.38 (0.00)	10.87 (0.00)	34.27 (0.10)	294.55 (0.00)	-835.32 (0.00)	-835.48 (0.00)	-51.402	-51.39 (0.00)	0.10 (0.00)	0.0902
GLD	0.87	0.008	-0.13	4.14	146.58 (0.00)	13.81 (0.00)	16.20 (0.91)	185.81 (0.00)	-745.35 (0.00)	-744.05 (0.00)	-50.93	-50.92 (0.00)	0.21 (0.00)	0.18 (0.00)
PLDM	1.54	0.059	-0.27	3.29	40.57 (0.00)	9.65 (0.00)	26.90 (0.36)	176.22 (0.00)	-999.99 (0.00)	-1018.83 (0.00)	-48.54 (0.00)	-48.53 (0.00)	0.25 (0.00)	0.22 (0.00)
PLTNM	1.11	-0.016	-0.14	3.18	12.65 (0.00)	6.35 (0.00)	34.13 (0.10)	63.38 (0.00)	-578.66 (0.00)	-577.79 (0.00)	-49.95 (0.00)	-49.96 (0.00)	0.16 (0.00)	0.09 (0.00)
SLVR	1.59	0.010	-0.2574	5.077	487.9 (0.00)	65.23 (0.00)	39.15 (0.30)	471.75 (0.00)	-51.36 (0.00)	-51.38 (0.00)	-51.3612 (0.00)	-51.37 (0.00)	0.26 (0.00)	0.16 (0.00)

Notes: The figures in square brackets show the probability (p-values) of rejecting the null hypothesis. ARCH (5) is the LM conditional variance test statistic. Q (50) and Qs (50) are the Box-Pierce serial correlation test statistics for return and squared return series respectively. *** indicate the series in question is stationary at the 1% significance level.

APPENDIX C.

Table C.1. Linearity Test Result

VARIABLE	Terasvirta (1994)	Harvey and Leybourne (2007)**			Harvey et all . (2008)*
		%10	%5	%1	
DJIDEV	3.23	3.09	3.09	3.10	2.00
DJIEMG	0.13	1.68	1.69	1.69	1.55
DJIEU	0.06	6.11	6.12	6.12	0.64
DJIMAP	0.00***	109.17*	109.2**	109.42***	105.85***
DJIMI	0.00***	357.54*	357.76**	358.15***	361.06***
DJIMU	0.00***	877.74*	877.94**	878.29***	1078.78***
CO	0.00***	864.84*	865.03**	865.37***	1245.47***
GO	0.00***	864.21*	864.40**	864.74***	1258.30***
HO	0.00***	918.38*	918.59**	918.97***	1201.49***
NG	0.07*	13.56*	13.58**	13.60***	6.66**
CFF	0.00***	15.18*	15.20**	15.23***	10.80***
CRN	0.00***	31.60*	31.63**	31.69***	26.51***
CTN	0.43	9.70*	9.72**	9.74	2.16
SGR	0.04**	6.29	6.29	6.30	2.43
SYBN	0.08	3.71	3.72	3.72	1.85
WHT	0.28	2.23	2.24	2.24	0.57
CPR	0.00***	9.36*	9.48**	9.39	3.26
GLD	0.62	0.86	0.86	0.86	0.78
PLDM	0.02**	6.74	6.75	6.76	0.55
PLTNM	0.43	3.32	3.32	3.33	1.85
SLVR	0.35	0.43	0.43	0.43	0.67

Note: The symbols *, ** and *** mean rejection of the null hypothesis of linearity at the 1%, 5% and 10% respectively. Harvey et al. (2008) test critical values, 9.21, 5.99 and 4.60 respectively and Harvey Leybourne (2007) test critical values 13.27, 9.48, 7.77 .

[a] mean rejection of the null hypothesi of linearity at the 5% respectively accarding to Terasvirta (2004).

Table C.2. Nonlinear Unit Root Test Results

VARIABLE	k	KSS_R	KSS_D	KSS_T	k	$SOLLIS_R$	$SOLLIS_D$	$SOLLIS_T$	k	$Kruse_R$	$Kruse_D$	$Kruse_T$
DJIDEV	11	-5.89 ***	-5.91 ***	-5.94 ***	12	15.75 ***	15.96 ***	16.1 ***	12	31.84 ***	31.97 ***	32.26 ***
DJIEMG	12	-5.62 ***	-5.62 ***	-5.63 ***	12	15.8 ***	15.83 ***	15.87 ***	12	32.21 ***	32.23 ***	32.35 ***
DJIEU	12	-4.24 ***	-4.33 ***	-4.31 ***	12	13.13 ***	13.2 ***	13.29 ***	12	29.46 ***	29.86 ***	29.94 ***
DJIMAP	12	-6.32 ***	-6.33 ***	-6.35 ***	12	20.04 ***	20.2 ***	20.29 ***	12	40.2 ***	40.27 ***	40.46 ***
DJIMI	11	-5.28 ***	-5.32 ***	-5.34 ***	12	12.57 ***	12.81 ***	12.9 ***	12	26.28 ***	26.54 ***	26.74 ***
DJIMU	12	-2.61 **	-2.76 **	-2.76	12	6.96 ***	7.07 ***	7.07 **	12	17.03 ***	17.75 ***	17.74 ***
CO	12	-4.73 ***	-4.67 ***	-4.64 ***	12	11.68 ***	11.5 ***	11.38 ***	12	28.35 ***	28.04 ***	27.91 ***
GO	12	-5.65 ***	-5.67 ***	-5.66 ***	12	17.4 ***	17.38 ***	17.32 ***	12	33.63 ***	33.73 ***	33.52 ***
HO	12	-6.24 ***	-6.27 ***	-6.26 ***	12	20.34 ***	20.27 ***	20.22 ***	12	39.7 ***	39.82 ***	39.68 ***
NG	12	-2.38 **	-2.4	-2.41	12	9.47 ***	9.38 ***	9.37 ***	12	6.83	6.91	6.97
CFF	12	-4.24 ***	-4.23 ***	-4.22 ***	12	10.61 ***	10.64 ***	10.53 ***	12	19.47 ***	19.4 ***	19.29 ***
CRN	12	-4.98 ***	-4.98 ***	-4.97 ***	12	13.02 ***	13.11 ***	13.12 ***	12	24.82 ***	24.82 ***	24.78 ***
CTN	12	-1.53	-1.53	-1.52	12	5.04 ***	5.04 ***	5.39	12	5.2	5.17	5.4
SGR	12	-4.81 ***	-4.81 ***	-4.75 ***	12	15.96 ***	15.96 ***	15.57 ***	12	27.05 ***	27.05 ***	26.35 ***
SYBN	12	-4.24 ***	-4.23 ***	-4.18 ***	12	10.86 ***	10.87 ***	10.75 ***	12	20.05 ***	20.03 ***	19.71 ***
WHT	12	-5.74 ***	-5.74 ***	-5.76 ***	12	17.73 ***	17.74 ***	17.81 ***	12	33.87 ***	33.86 ***	34.07 ***
	1%	-2.82	-3.48	-3.93	**1%**	4.24	6.23	8.34	**1%**	13.15	13.75	17.1
Critical Values	**5%**	-2.22	-2.93	-3.4	**5%**	2.5	4.55	6.29	**5%**	9.53	10.17	12.82
	10%	-1.92	-2.66	-3.13	**10%**	1.83	3.72	5.37	**10%**	7.85	8.6	11.1

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively.

Table C.2. (continued) Nonlinear Unit Root Test Results

VARIABLE	k	KSS_R	KSS_D	KSS_T	k	$SOLLIS_R$	$SOLLIS_D$	$SOLLIS_T$	k	$Kruse_R$	$Kruse_D$	$Kruse_T$
CPR	12	-3.56	-3.56	-3.55 **	12	6.84 ***	6.84 ***	6.72 ***	12	14.73 ***	14.74 ***	14.52 ***
GLD	12	-6.19 ***	-6.2 ***	-6.2 ***	12	19.21 ***	19.23	19.29	12	38.43 ***	38.44 ***	38.54 ***
PLDM	12	-4.37 ***	-4.43 ***	-4.45 ***	12	9.92 ***	10	10.11	12	20.11 ***	20.4 ***	20.66 ***
PLTNM	12	-6.47 ***	-6.44 ***	-6.44 ***	12	21.01 ***	20.93	20.9	12	42.5 ***	42.4 ***	42.34 ***
	1%	-2.82	-3.48	-3.93	**1%**	4.24	6.23	8.34	**1%**	13.15	13.75	17.1
Critical Values	**5%**	-2.22	-2.93	-3.4	**5%**	2.5	4.55	6.29	**5%**	9.53	10.17	12.82
	10%	-1.92	-2.66	-3.13	**10%**	1.83	3.72	5.37	**10%**	7.85	8.6	11.1

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively.

Table C.3. Nonlinear Causality between from Commodities to Islamic Indices

VARIABLE	DJIMI	DJIMAP	DJIEU	DJIEMG	DJIDEV	DJIMU
co	1.09 (0.13)	1.41 (0,07) *	1.05 (0,14)	1.83 (0.03) **	1.34 (0.08)*	2.05 (0.02) **
GO	0.71 (0.23)	-0.04 (0,50)	1.19 (0.11)	0.90 (0.18)	0.97 (0.16)	0.50 (0.30)
HO	-0.44 (0.67)	-0.85 (0.80)	-1.28 (0.90)	-0.36 (0.64)	-0.68 (0.75)	-0.07 (0.47)
NG	1.69 (0.04)**	2.07 (0.02) **	1.07 (0.14)	-0.58 (0.72)	1.72 (0.04) **	1.86 (0.03) **
CFF	0.54 (0.29)	1.70 (0.04) **	-0.41 (0.66)	-0.32 (0.62)	1.05 (0.14)	0.35 0.36
CRN	1.17 (0.12)	0.63 (0.26)	1.28 (0.09) *	0.95 (0.17)	0.90 (0.18)	1.48 (0.07) *
CTN	0.78 (0.21)	1.69 (0.04) **	1.63 (0.05) **	1.34 (0.08) *	0.61 (0.27)	-0.01 (0,50)
SGR	0.53 (0.29)	1.19 (0.11)	0.65 (0.25)	0.27 (0.39)	0.15 (0.43)	1.20 (0.88)
SYBN	-0.04 (0.50)	0.40 (0.34)	0.68 (0.24)	0.33 (0.36)	0.33 (0.37)	-0.81 ((0.79)
WHT	2.09 (0.02)**	-0.01 (0.51)	2.24 (0.01)	1.27 (0.10)	2.00 (0.02)	1.58 (0.06) *
GLD	1.21 (0.11)	1.29 (0.09) *	1.89 (0.02) **	1.99 (0.02) **	1.11 (0.13)	-0.22 (0.50)
SLVR	1.59 (0.06)*	3.34 (0.00) ***	2.58 (0.00) ***	2.69 (0.00) ***	1.55 (0.06)*	1.51 (0.07) *
CPR	1.27 (0.10)	2.69 (0.00) ***	1.91 (0.02) **	2.29 (0.01) **	0.91 (0.18)	0.74 0.23
PLDM	2.34 (0.00)***	2.76 (0.00) ***	3.19 (0.00) ***	2.83 (0.00) ***	2.64 (0.00)***	1.82 (0.03) **
PLTNM	1.46 (0.07)*	2.21 (0.01) ***	1.86 (0.03) **	2.44 (0.00) ***	1.21 (0.11)	0.07 (0.46)

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively.

Table C.4. Nonlinear Causality between from Islamic Indices to Commodities

VARIABLE	CO	GO	HO	NG	CFF	CRN	CTN	SGR	SYBN	WHT	GLD	SLVR	CPR	PLDM	PLTNM
DJIMI	3.18 (0.00) ***	2.32 (0,01) ***	-0.34 (0.61)	-1.15 (0.87)	2.31 (0.01) ***	1.71 (0.04) **	0.77 (0.22)	3.01 (0.00) ***	1.62 (0.05) **	2.56 (0.00) ***	2.38 (0.00) ***	0.34 (0.36)	1.57 ((0.06) *	2.88 (0.00) ***	1.76 (0.03) **
DJIMAP	2.19 (0.01) ***	1.72 (0.04) **	0.34 (0.36)	0.86 (0.80)	1.52 (0.06) *	0.43 (0.33)	1.83 (0.03) **	3.05 (0.00) ***	0.63 (0.26)	0.81 (0.20)	1.59 (0.05) **	1.66 (0.04) **	1.37 (0.08) *	2.37 (0.00) ***	1.53 (0.06) *
DJIEU	2.90 (0.00) ***	0.61 (0.26)	-0.12 (0.54)	-1.69 (0.95)	0.90 (0.18)	1.98 (0.02) **	1.21 (0.11)	1.37 (0.08) *	1.43 (0.07) *	2.37 (0.00) ***	1.63 (0.05) **	0.90 (0.18)	1.32 (0.09) *	3.10 (0.00) ***	2.08 (0.02) **
DJIEMG	2.36 (0.00) ***	1.74 (0.04) **	0.42 (0.33)	0.72 (0.23)	0.75 (0.22)	0.42 (0.33)	0.24 (0.01) ***	2.48 (0.00) ***	0.48 (0.31)	1.41 (0.07) *	1.22 (0.11)	0.75 (0.22)	2.20 (0.02) **	2.57 (0.00) ***	1.45 (0.07) **
DJIDEV	3.05 (0.00) ***	2.00 (0.02) ***	-0.55 (0.71)	-1.34 (0.91)	1.64 (0.05) **	1.49 (0.06) *	0.69 (0.24)	2.87 (0.00) ***	1.32 (0.09) *	2.36 (0.00) ***	2.49 (0.00) ***	1.64 (0.05) **	1.46 (0.07) *	3.04 (0.00) ***	1.46 (0.07) **
DJIMU	3.73 (0.00) ***	2.71 (0.00) ***	-0.57 (0.71)	-1.20 (0.88)	2.00 (0.02) **	1.68 (0.04) **	0.77 (0.21)	3.43 (0.00) ***	-0.47 (0.68)	1.52 (0.06) *	2.26 (0.01) ***	2.00 (0.02) **	1.45 (0.07) *	3.44 (0.00) ***	0.65 (0.25)

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively.

Table C.5. Nonlinear Causality between Commodities

VARIABLE	CO	GO	HO	NG	CFF	CRN	CTN	SGR	SYBN	WHT	GLD	SLVR	CPR	PLDM	PLTNM
CO	-	2.24 (0.01) ***	2.19 (0.01) ***	1.92 (0.03) **	0.18 (0.43)	-1.24 (0.89)	-1.15 (0.88)	2.94 (0.00)	-0.08 (0.53)	0.28 (0.39)	0.49 (0.31)	0.03 (0.48)	1.16 (0.12)	1.58 (0.06) **	0.48 (0.32)
GO	2.76 (0.00) ***	-	1.62 (0.05) **	0.02 (0.50)	1.47 (0.07) *	0.94 (0.82)	-0.64 (0.74)	-0.66 (0.74)	-0.36 (0.64)	-0.12 (0.55)	1.86 (0.03) **	0.06 (0.50)	0.61 (0.27)	1.52 (0.06) *	1.22 (0.11)
HO	2.32 (0.00) ***	1.79 (0.03) **	-	1.98 (0.16)	0.537 (0.70)	-1.13 (0.87)	-1.00 (0.84)	-0.18 (0.57)	-1.52 (0.93)	0.60 (0.27)	1.35 (0.08) *	1.23 (0.10)	0.60 (0.27)	0.99 (0.16)	0.75 (0.22)
NG	0.55 (0.28)	-0.61 (0.73)	1.78 (0.03) **	-	0.07 (0.46)	-2.75 (0.99)	-0.91 (0.82)	2.08 (0.01) ***	-1.85 (0.96)	1.08 (0.13)	0.97 (0.16)	0.14 (0.44)	0.12 (0.45)	2.47 (0.00) ***	0.39 (0.34)
CFF	1.79 (0.03) **	0.67 (0.75)	0.74 (0.22)	-0.22 (0.58)	-	0.86 (0.20)	0.78 (0.21)	-0.04 (0.52)	-0.03 (0.51)	-0.01 (0.50)	0.14 (0.44)	-0.15 (0.56)	-0.85 (0.80)	0.13 (0.44)	0.25 (0.40)
CRN	-1.07 (0.85)	-0.51 (0.69)	-1.64 (0.95)	-3.32 (0.99)	0.64 (0.26)	-	1.06 (0.15)	0.74 (0.23)	2.55 (0.00) ***	0.94 (0.17)	1.59 (0.06) *	1.24 (0.10)	1.01 (0.15)	1.63 (0.05) **	0.30 (0.38)
CTN	-0.74 (0.77)	-0.20 (0.57)	-0.75 (0.77)	-0.41 (0.66)	0.18 (0.42)	2.97 (0.00) ***	-	2.71 (0.00) ***	0.29 (0.38)	1.56 (0.06) *	0.45 (0.32)	0.59 (0.27)	1.60 (0.06) *	1.15 (0.12)	-0.80 (0.78)
SGR	1.60 (0.06) *	1.27 (0.10)	0.90 (0.18)	0.22 (0.41)	0.28 (0.38)	1.33 (0.09) *	1.04 (0.14)	-	-0.42 (0.66)	2.40 (0.00)	0.21 (0.41)	0.86 (0.19)	0.17 (0.56)	1.68 (0.04) **	-1.98 (0.97)
SYBN	-0.37 (0.64)	-1.15 (0.87)	-1.17 (0.88)	0.79 (0.78)	0.85 (0.19)	2.10 (0.02) **	0.16 (0.43)	-0.27 (0.60)	-	0.80 (0.21)	1.95 (0.02) **	1.55 (0.06) *	-0.78 (0.71)	0.42 (0.33)	0.60 (0.27)
WHT	0.23 (0.40)	-1.41 (0.92)	-0.24 (0.59)	-2.43 (0.99)	0.03 (.0.48)	2.74 (0.00) ***	0.81 (0.21)	1.81 (0.03 **	1.18 (0.12)	-	0.05 (0.47)	0.65 (0.25)	2.03 (0.02) **	0.99 (0.16)	1.40 (0.08) *

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively

Table C.5. (continued) Nonlinear Causality between Commodities

VARIABLE	co	GO	ho	ng	CFF	CRN	CTN	SGR	SYBN	WHT	GLD	SLVR	CPR	PLDM	PLTNM
GLD	1.28 (0.10)	3.01 (0.00) ***	0.04 (0.48)	-0.69 (0.75)	0.29 (0.38)	2.52 (0.00)	1.60 (0.06) *	-0.26 (0.60)	1.37 (0.08) *	1.30 (0.09)	-	1.01 (0.15)	-0.54 (0.29)	0.49 (0.31)	-0.03 (0.51)
SLVR	-0.09 (0.53)	0.45 (0.32)	0.73 (0.23)	0.59 (0.27)	0.65 (0.25)	2.17 (0.02) **	1.19 (0.11)	0.45 (0.32)	0.81 (0.20)	1.11 (0.13)	4.83 (0.00) ***	-	0.49 (0.31)	2.18 (0.02) **	2.38 (0.00) ***
CPR	1.93 (0.02) **	1.81 (0.04) **	1.44 (0.07) *	0.02 (0.49)	-0.06 (0.52)	0.79 (0.21)	0.39 (0.34)	2.92 (0.00) ***	1.14 (0.12)	2.63 (0.00) ***	2.65 (0.00) ***	1.02 (0.15)	-	1.66 (0.04) **	1.06 (0.14)
PLDM	2.04 (0.02) **	0.82 (0.20)	1.02 (0.15)	-1.40 (0.92)	0.97 (0.16)	0.88 (0.18)	0.56 (0.28)	2.04 (0.02) **	1.16 (0.12)	1.07 (0.14)	1.29 (0.09) *	0.80 (0.21)	1.37 (0.08) *	-	0.88 (0.18)
PLTNM	2.07 (0.02) **	2.77 (0.00) ***	1.28 (0.10) *	1.25 (0.11)	0.30 (0.56)	-0.10 (0.64)	0.61 (0.26)	-0.04 (0.52)	-0.51 (0.69)	1.13 (0.12)	1.99 (0.02) **	-0.10 (0.53)	-0.01 (0.50)	0.77 (0.22)	-

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively

Table C.6. Nonlinear Causality between Islamic Indices

VARIABLE	DJIMI	DJIMAP	DJIEU	DJIEMG	DJIDEV	DJIMU
DJIMI	-	6.09 (0.00) ***	4.44 (0.00) ***	4.38 (0.00) ***	2.86 (0.00) ***	3.92 (0.00) ***
DJIMAP	3.28 (0.00) ***	-	3.44 (0.00) ***	3.07 (0.00) ***	2.69 (0.00) ***	3.43 (0.00) ***
DJIEU	3.03 (0.00) ***	5.28 (0.00) ***	-	3.63 (0.00) ***	2.97 (0.00) ***	(2.47) (0.00) ***
DJIEMG	1.80 (0.03) **	5.35 (0.00) ***	2.11 (0.01) ***	-	2.13 (0.02) **	2.93 (0.00) ***
DJIDEV	2.36 (0.00) ***	5.94 (0.00) ***	4.47 (0.00) ***	4.45 (0.00) ***	-	3.17 (0.00) ***
DJIMU	4.26 (0.00) ***	6.47 (0.00) ***	4.63 (0.00) ***	4.28 (0.00) ***	4.09 (0.00) ***	-

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively

Table C.7. Causality in Variance between from Commodities to Islamic Indices

variable	DJIMI	DJIMAP	DJIEU	DJIEMG	DJIDEV	DJIMU
CO	1.16 (0.55)	0.88 (0.64)	1.062 (0.58)	0.94 (0.62)	1.86 (0.39)	2.26 (0.32)
GO	1.28 (0.52)	0.65 (0.71)	1.21 (0.54)	0.98 (0.61)	1.93 (0.38)	2.26 (0.32)
HO	1.28 (0.52)	0.67 (0.71)	1.21 (0.54)	0.97 (0.61)	1.93 (0.38)	2.61 (0.27)
NG	2.65 (0.26)	2.87 (0.23)	3.99 (0.13)	6.86 (0.03) **	3.45 (0.17)	3.04 (0.21)
CFF	2.24 (0.32)	6.06 (0.04) **	2.76 (0.25)	2.71 (0.25)	2.4 (0.3)	2.99 (0.22)
CRN	7.39 (0.02) **	2.35 (0.3)	4.26 (0.11)	14.97 (0.00) ***	5.94 (0.05) **	2.99 (0.22)
CTN	8.19 (0.01) ***	1.83 (0.39)	5.35 (0.06) *	3.42 (0.18)	14.12 (0.00) ***	2.53 (0.3)
SGR	7.62 (0.02) **	2.58 (0.27)	6.36 (0.04) **	2.81 (0.24)	5.86 (0.05) **	2.28 (0.31)
SYBN	2.43 (0.29)	0.93 (0.62)	2.16 (0.33)	1.15 (0.56)	1.83 (0.39)	3.71 (0.15)
WHT	3.96 (0.13)	3.03 (0.21)	3.54 (0.17)	2.6 (0.27)	5.86 (0.05) **	2.76 (0.25)
GLD	0.93 (0.62)	0.98 (0.61)	1.12 (0.56)	4.79 (0.09) *	1.67 (0.43)	2.9 (0.23)
SLVR	2.48 (0.28)	6.11 (0.04) **	4.42 (0.1)	3.88 (0.14)	3.42 (0.18)	2.42 (0.29)
CPR	0.84 (0.65)	7.21 (0.02) **	0.64 (0.72)	0.63 (0.72)	1.76 (0.41)	2.39 (0.3)
PLDM	2.29 (0.31)	8.57 (0.01) ***	3.55 (0.16)	8.59 (0.01) ***	3.5 (0.17)	2.32 (0.31)
PLTNM	0.25 (0.00) ***	2.47 (0.29)	1.51 (0.46)	8.96 (0.01) ***	2.08 (0.35)	2.35 (0.3)

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively

Table C.8. Causality in variance between from Islamic Indices to Commodities

VARIABLE	CO	GO	HO	NG	CFF	CRN	CTN	SGR	SYBN	WHT	GLD	SLVR	CPR	PLDM	PLTNM
DJIMI	0.14 (0.93)	0.49 (0.78)	1.24 (0.53)	2.49 (0.28)	10.68 (0.00) ***	14.07 (0.00) **	19.93 (0.00) ***	5.88 (0.05) **	1.6 (0.44)	0.95 (0.62)	9.04 (0.01) ***	35.77 (0.00) ***	20.85 (0.00) ***	67.60 (0.00) ***	2.76 (0.00) ***
DJIMAP	0.032 (0.98)	3. (0.22)	3.47 (0.17)	5.16 (0.07) **	13.68 (0.00) ***	6.5 (0.03) **	19.98 (0.00) ***	2.52 (0.28)	3.03 (0.21)	0.67 (0.71)	7.78 (0.01) ***	37.28 (0.00) ***	25.36 (0.00) ***	82.16 (0.00) ***	42.72 (0.00) ***
DJIEU	0.27 (0.77)	0.5 (0.77)	1.22 (0.54)	2.57 (0.27)	10.72 (0.00) ***	17.03 (0.00) ***	20.29 (0.00) ***	2.05 (0.35)	3.13 (0.20)	2.20 (0.33)	8.11 (0.01) ***	36.86 (0.00) ***	24.48 (0.00) ***	84.69 (0.00) ***	37.45 (0.00) ***
DJIEMG	60.45 (0.00) ***	640.37 (0.00) ***	644.12 (0.00) ***	867.35 (0.00) ***	10.54 (0.00) ***	7.28 (0.02) **	21.24 (0.00) ***	1.18 (0.55)	3.91 (0.14)	0.8 (0.67)	6.15 (0.04) **	41.18 (0.00) ***	15.58 (0.00) ***	55.85 (0.00) ***	29.60 (0.00) ***
DJIDEV	0.14 (0.92)	0.52 (0.77)	1.28 (0.52)	2.51 (0.28)	10.82 (0.00) ***	14.14 (0.06)*	19.9 (0.00)***	5.26 (0.07)*	1.43 (0.48)	1.81 (0.40)	9.11 (0.01) ***	34.5 (0.00) **	18.00 (0.00) ***	65.4 (0.00) ***	28.10 (0.00) ***
DJIMU	0.04 (0.97)	0.2 (0.9)	0.88 (0.64)	2.26 (0.32)	9.74 (0.00) ***	7.12 (0.02) **	20.2 (0.00) ***	1.85 (0.39)	1.24 (0.53)	1.31 (0.51)	5.56 (0.06) *	33.35 (0.00) ***	7.68 (0.02) **	45.89 (0.00) ***	17.56 (0.00) ***

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively

Table C.9. Causality in Variance between Commodities to Commodities

VARIABLE	CO	GO	HO	NG	CFF	CRN	CTN	SGR	SYBN	WHT	GLD	SLVR	CPR	PLDM	PLTNM
CO	-	0.20 (0.90)	0.87 (0.64)	2.29 (0.31)	0.10 (0.00) ***	6.34 (0.04) **	20.50 (0.00) ***	1.64 (0.66)	0.81 (0.66)	1.38 (0.50)	4.88 (0.08) *	33.20 (0.00) ***	7.44 (0.02) **	46.27 (0.00) ***	16.87 (0.00) ***
GO	0.03 (0.98)	-	0.91 (0.63)	2.62 (0.26)	9.73 (0.00) ***	6.18 (0.04) **	20.32 (0.00) ***	1.76 (0.41)	0.67 (0.71)	1.86 (0.39)	5.17 (0.07) *	33.42 (0.00) ***	7.00 (0.03) **	45.76 (0.00) ***	18.91 (0.00) ***
HO	0.03 (0.96)	0.20 (0.90)	-	2.61 (0.27)	9.73 (0.00) ***	6.17 (0.04) **	20.33 (0.00) ***	1.76 (0.41)	0.69 (0.70)	1.82 (0.40)	5.18 (0.07) *	33.44 (0.00) ***	7.01 (0.03) **	45.76 (0.00) ***	18.91 (0.00) ***
NG	0.18 (0.91)	0.30 (0.85)	0.98 (0.61)	-	10.47 (0.00) ***	7.02 (0.02) ***	21.61 (0.00) ***	3.55 (0.16)	1.96 (0.37)	5.29 (0.07) *	5.62 (0.06) **	33.87 (0.00) ***	11.06 (0.00) ***	54.44 (0.00) ***	21.48 (0.00) ***
CFF	1.38 (0.50)	0.43 (0.80)	1.08 (0.58)	2.50 (0.28)	-	7.30 (0.02) ***	20.11 (0.00) ***	1.77 (0.41)	3.06 (3.21)	1.10 (0.57)	6.06 (0.04) **	34.31 (0.00) ***	7.16 (0.02) **	48.85 (0.00) ***	24.27 (0.00) ***
CRN	0.43 (0.80)	11.32 (0.00) ***	12.04 (0.00) ***	13.37 (0.00) ***	12.17 (0.00) ***	-	35.72 (0.00) ***	20.28 (0.00) ***	4.29 (0.11)	0.36 (0.17)	7.20 (0.02) **	40.86 (0.00) ***	10.79 (0.00) ***	52.71 (0.00) ***	17.77 (0.00) ***
CTN	1.47 (0.47)	0.40 (0.81)	1.075 (0.58)	2.46 (0.29)	9.70 (0.00) ***	8.52 (0.02) ***	-	7.25 (0.02) **	3.24 (0.38)	5.05 (0.07) *	5.26 (0.07) *	38.60 (0.00) ***	10.16 (0.00) ***	49.18 (0.00) ***	16.96 (0.00) ***
SGR	0.51 (0.77)	1.18 (0.55)	1.95 (0.37)	3.21 (0.20)	9.64 (0.00) ***	3.82 (0.14)	24.47 (0.00) ***	-	12.45 (0.00) ***	17.73 (0.00) ***	5.03 (0.08) *	34.52 (0.00) ***	14.61 (0.00) ***	67.65 (0.00) ***	17.49 (0.00) ***
SYBN	0.76 (0.68)	0.57 (0.74)	1.22 (0.54)	2.63 (0.26)	11.16 (0.00) ***	7.16 (0.02) **	22.71 (0.00) ***	2.59 (0.27)	-	2.68 (0.26)	4.95 (0.08) *	35.18 (0.00) ***	8.18 (0.00) ***	47.59 (0.00) ***	17.74 (0.00) ***
WHT	0.09 (0.95)	0.86 (0.64)	1.51 (0.46)	2.95 (.0.22)	10.55 (0.00) ***	6.93 (0.03) **	28.24 (0.00) ***	1.33 (0.51)	1.18 (0.12)	-	5.43 (0.06) *	33.48 (0.00) ***	13.17 (0.00) ***	49.85 (0.00) ***	19.41 (0.00) ***
GLD	0.27 (0.87)	14.66 (0.00) ***	15.33 (0.00) ***	16.59 (0.00) ***	11.60 (0.00) ***	7.94 (0.01) **	19.26 (0.00) ***	3.62 (0.16)	1.37 (0.08) *	1.06 (0.58)	-	37.24 (0.00) ***	12.64 (0.00) ***	54.23 (0.00) ***	29.13 (0.00) ***
SLVR	0.106 (0.94)	3.33 (0.18)	4.05 (0.13)	5.34 (0.06) *	11.16 (0.00) ***	7.32 (0.02) **	24.20 (0.00) ***	1.50 (0.47)	0.81 (0.20)	2.30 (0.31)	5.83 (0.00) ***	-	13.78 (0.31)	54.56 (0.00) ***	24.85 (0.00) ***

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively

Table C.9. (continued) Causality in Variance between Commodities to Commodities

VARIABLE	CO	GO	HO	NG	CFF	CRN	CTN	SGR	SYBN	WHT	GLD	SLVR	CPR	PLDM	PLTNM
CPR	0.32 (0.84)	1.81 (0.04) **	0.34 (0.84)	2.41 (0.29)	15.79 (0.00) ***	8.82 (0.01) ***	20.54 (0.00) ***	3.16 (0.20)	1.14 (0.12)	1.76 (0.41)	7.51 (0.02) **	41.50 (0.00) ***	-	22.67 (0.00) ***	30.90 (0.00) ***
PLDM	0.53 (0.76)	0.82 (0.20)	1.31 (0.51)	3.35 (0.18)	12.38 (0.00) ***	13.24 (0.00) ***	23.30 (0.00) ***	3.15 (0.20)	1.16 (0.12)	2.45 (0.29)	8.25 (0.02) **	34.23 (0.00) ***	13.53 (0.00) ***	-	32.65 (0.00) ***
PLTNM	0.15 (0.92)	2.77 (0.00) ***	2.63 (0.26)	4.77 (0.09) *	14.75 (0.00) ***	6.27 (0.04) **	20.28 (0.00) ***	7.07 (0.00) ***	-0.51 (0.69)	2.38 (0.30)	10.18 (0.00) ***	33.76 (0.00) ***	15.64 (0.00) ***	47.19 13.53 (0.00) ***	-

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively

Table C.10. Causality in Variance between Islamic Indices

VARIABLE	DJIMI	DJIMAP	DJIEU	DJIEMG	DJIDEV	DJIMU
DJIMI	-	112.44 (0.00) ***	2.49 (0.28)	6.94 (0.03) **	2.11 (0.34)	2.43 (0.29)
DJIMAP	1.19 (0.55)	-	2.36 (0.30)	2.21 (0.33)	2.45 (0.29)	2.41 (0.29)
DJIEU	1.91 (0.38)	36.04 (0.00) ***	-	2.61 (0.27)	1.80 (0.40)	(2.29) (0.31)
DJIEMG	1.26 (0.53)	1.54 (0.46)	2.08 (0.35)	-	2.11 (0.34)	2.28 (0.31)
DJIDEV	2.36 (0.00) ***	114.715 (0.00) ***	3.08 (0.21)	7.27 (0.02) **	-	2.42 (0.29)
DJIMU	3.80 (0.14)	0.644 (0.72)	4.63 (0.00) ***	0.99 (0.60)	2.07 (0.35)	-

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively

Table C.11. Nonlinear Granger Causality among Commodities and Islamic Indices

VARIABLE	DJIMI	DJIMAP	DJIEU	DJIEMG	DJIDEV	DJIMU
CO	←	↔	←	↔	↔	↔
GO	←	←		←	←	←
HO						
NG	→	→			→	→
CFF	←	↔			←	←
CRN	←		↔		←	↔
CTN		↔	→	↔		
SGR	←	←		←	←	←
SYBN	←		←		←	
WHT	↔		←	←	←	←
GLD	←	↔	↔	↔	←	←
SLVR	→	↔	→	→	↔	↔
CPR	←	↔	↔	↔	←	←
PLDM	↔	↔	↔	↔	↔	↔
PLTNM	↔	↔	↔	↔	←	

Table C.12. Nonlinear Granger Causality among Commodities

VARIABLE	CO	GO	HO	NG	CFF	CRN	CTN	SGR	SYBN	WHT	GLD	SLVR	CPR	PLDM	PLTNM
CO	-	↔	↔	→									←	↔	←
GO	↔		↔		→						↔		←	→	←
HO	↔	↔									→		←		←
NG	←		→					→						→	
CFF	→	←													
CRN							←	←	↔	←	→			→	
CTN						→		→		→			→		
SGR	→			←		→	←			↔			←	↔	
SYBN					→	↔					↔	→			
WHT							↔	←	↔				→		→
GLD		↔				←	→	↔						←	←
SLVR						→			←		→			→	→
CPR	→	→	→				←	→		←				↔	
PLDM	↔	←		←		←		↔			→	←	↔		
PLTNM	→	→	→							←	→	←			

Table C.13. Nonlinear Granger Causality among Islamic Indices

VARIABLE	DJIMI	DJIMAP	DJIEU	DJIEMG	DJIDEV	DJIMU
DJIMI	-	↔	↔	↔	↔	↔
DJIMAP	↔	-	↔	↔	↔	↔
DJIEU	↔	↔	-	↔	↔	↔
DJIEMG	↔	↔	↔	-	↔	↔
DJIDEV	↔	↔	↔	↔	-	↔
DJIMU	↔	↔	↔	↔	↔	-

Table C.14. Causality in Variance among Commodities and Islamic Indices

variable	DJIMI	DJIMAP	DJIEU	DJIEMG	DJIDEV	DJIMU
CO				←		
GO				←		
HO				←		
NG		←		↔		
CFF	←	↔	←	←	←	←
CRN	↔	←	↔	↔	↔	←
CTN	↔	←	↔	←	↔	←
SGR	↔		→		↔	
SYBN						
WHT						
GLD	←	←	←	↔	←	←
SLVR	←	↔	←	←	←	←
CPR	←	↔	←	←	←	←
PLDM	←	↔	←	↔	←	←
PLTNM	↔	←	←	↔	←	←

Table C.15. Causality in Variance among Commodities

VARIABLE	CO	GO	HO	NG	CFF	CRN	CTN	SGR	SYBN	WHT	GLD	SLVR	CPR	PLDM	PLTNM
CO	-				→	→	→				↔	→	→	→	→
GO					→	↔	→				→	→	↔	→	↔
HO					→	↔	→				↔	→	→	→	→
NG					→	↔	→			→	↔	↔	→	→	↔
CFF	←	←	←			↔	→	←	←	←	↔	↔	↔	↔	↔
CRN	←	↔	↔	↔	↔		→	→	←	←	↔	↔	↔	↔	↔
CTN	←	←	←		↔	↔		↔	←	↔	↔	↔	↔	↔	↔
SGR					→	←	↔		→	→	→	→	→	↔	↔
SYBN					→	→	→	←			↔	→	→	→	→
WHT				←	→	→	↔	←			→	→	→	→	→
GLD	↔	↔	↔	↔	↔	↔	↔	←	↔	←	-	↔	↔	↔	↔
SLVR	←	←	←	↔	↔	↔	↔	←	←	←	↔	-	←	↔	↔
CPR	←	↔	←	←	↔	↔	↔	←	←	←	↔	→		↔	↔
PLDM	←	←	←	←	↔	↔	↔	←	←	←	↔	↔	↔	-	↔
PLTNM	←	↔	↔	↔	↔	↔	↔	↔	←	←	↔	↔	↔	↔	-

Table C.16. Causality in Variance among Islamic Indices

VARIABLE	DJIMI	djımap	DJIEU	DJIEMG	DJIDEV	DJIMU
DJIMI		→		→		
DJIMAP	←	-				
DJIEU		→	-			
DJIEMG				-		
DJIDEV	→	→		→	-	
DJIMU			→			-