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Gold and Portfolio Diversification: A Stochastic Dominance Analysis of the Dow Jones Islamic Indices

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Abstract

This paper examines the role of gold in diversification in eight Dow Jones Islamic stock indices portfolio from 1996 to 2017. Also using stochastic dominance (SD) analysis, it tests the null hypothesis that gold-Islamic stock portfolio return does not dominate (outperform) non-gold Islamic stock portfolio return. The SD results show that gold-Islamic stock portfolio stochastically dominates the one without gold at the FSD, SSD and TSD order in all Islamic stock indices. Moreover, the level of SD order increases when we add more gold in the portfolio. We find that the SD order is manifest during the financial crisis (2007-2009) at all percentage holdings of gold. This indicates that risk-averse investors in Islamic stock indices should include gold in their portfolios in order to maximize their expected utilities. Furthermore, the results of MV analysis consistent with the ones of the SD. The findings of this paper suggest that investors may design appropriate investments with gold to diversify their Islamic stock portfolios

Keywords: *Gold, Dow Jones Islamic stock Indices, Portfolio diversification, Stochastic dominance*

1. Introduction

Using stochastic dominance (SD) analysis, this paper examines the role of gold in the diversification of eight Dow Jones Islamic Indices (DJII) portfolios from January of 1996 to December of 2017. The SD method allows us to find whether the Islamic stock portfolio containing gold stochastically dominates the one without gold. If the former is preferred to the later for maximizing the utility and/ or wealth of investors, we can conclude that the gold-Islamic stock portfolio returns outperform Islamic stock portfolio returns. Then, interested investors in Islamic stocks can reduce risk by holding a percentage of gold in their Islamic equity portfolios. In addition to using SD analysis, this paper contributes to the literature in that it is the first paper that studies the hedge, safe haven and diversifier properties of gold in the Dow Jones Islamic Indices.

Prior research show that the correlation between gold and other assets is low and/or negative (Sherman, 1982; Jaffe, 1989; Baur and Lucy, 2010; Ciner, 2013; Bekiros et al, 2017). Following modern portfolio theory (Markowtize, 1952), a low or negative correlation among assets in the portfolio can reduce its risk. Thus, gold is considered as a good asset for diversifying portfolios.

Gold prices are volatile, moving rapidly and dramatically, often with no warning.[1] Over the study period of this paper,[2] gold prices have reached a maximum value of 1897.1 USD on August 22, 2011 and minimum value of 252.3 USD on August 25, 1999 in the US, the highest price in history. Moreover, the rate of return of gold ranges from high 10.39% to low -8.87%. Interestingly, we observe that gold prices increase during and after the global financial crisis of 2007-2008. What makes gold behave like that? In other word, what is so special about gold? The answer of this question lays in the following reasons. First, gold is a precious metal considered as commodity and monetary asset. Second, despite the increase in gold prices, the demand for this commodity continues to rise. Third, gold plays important role in society for its cultural importance and it is universally acceptance and recognition. Fourth, it provides an indication of future inflation, a hedge against inflation and other economic indicators. Fifth, it acts like a source of wealth, a unit of value and medium of exchange. Sixth, gold is consider as a high liquid investment.

Proponents of gold argue that owning the precious yellow metal is a relatively inexpensive insurance policy. Consequently, researchers become more interested in examining the impact of gold on the economy and on financial and real assets. Recently, one strands of research examines the role of gold as a hedge against stocks and a safe haven investment (Baur and McDermott, 2010; Baur and Lucey, 2010; Sari et al., 2010; Courder and Raymond-Feingold, 2011, Hood and Malik, 2013; Gurgun and Unalmis, 2014; Ciner, 2013; Bekrios et al., 2017). They conclude that gold is a hedge against stocks and a safe haven in extreme stock market condition. The other studies indicate that including gold in a stock portfolio can enhance the overall rate of return and provide portfolio diversification (Sherman, 1982; Sherman, 1986; Jaffe, 1989; Cha et al., 1990; Hiller et al., 2006; Soytas et al., 2009; Hoang et al., 2015). Recently, Hoang et al. (2015) report that stock portfolios including gold stochastically dominate those without gold in the Paris stock exchange. They conclude that risk-averse investors would be better off by including gold to their stock portfolios to maximize their expected utilities.[3]

All previous studies on this subject have focused only on the role of gold in the diversification of conventional stock (non-Islamic stock) portfolios. To the best of our knowledge, there is no published paper, which examines the role of gold for portfolio diversification in the Islamic stock indices. Therefore, the aim of this paper is to fill this gap in the literature by investigating the gold-stock portfolio diversification in eight Dow Jones Islamic Indices.[4]

Given the uniqueness of Islamic stock Indices, studying the role of gold in portfolio diversification in Islamic stock Indices may introduce a new theme in Islamic investing which could lead to a new proposition in Islamic finance. Islamic Indices remove firms that do not comply with Shari'ah laws (i.e., shares that have high debt to equity ratio and/or have relatively low working capital). Islamic stocks indices are significantly different from those of conventional stocks indices due to the many restrictions imposed by Shari'ah laws on the former. Islamic stocks indices are generally concentrated

[1]For instance, gold prices tumbled in 2013 by 28%. However, gold prices increased significantly of about 24% in 2002 when the US stock markets lost around 22% of their values. Again, the same thing happened during the global financial crises of 2007-2008.

[2] The study period of this paper is from January 2nd, 1996 to December 31st, 2017.

[3] Stochastic dominance analysis is used before in Islamic and conventional stock indices. For detail discussion see Levy and Sarnat, 1972; Seyhun, 1993; Alkhazali et al., 2008; Alkhazali et al., 2010; Alkhazali et al., 2014b.

[4] Features of the Dow Jones Islamic Indices are presented in data section of this paper.

on specific sectors and less diversified. While conventional stocks indices are well diversified (representing many sectors) and for large firms. Consequently, Islamic stock indices suffer from lack of liquidity (Sensoy et al., 2015). Furthermore, Shari'ah laws require that Islamic stocks must have "real" assets and ownership at the times of sale and purchase. Therefore, transactions involving futures and options, debt issues with a fixed interest rate, hedging and interest rate swaps are prohibited (Olson and Zoubi, 2008; Alvarez-Diaz et al., 2014). Due to the many differences between Islamic and conventional stocks, we expect these differences to be reflected in the stock prices.[5] Hence, diversifications in Islamic stock portfolios become necessary.

The creation of Dow Jones Islamic Index in 1999 has generated unpresented interest in investing in Islamic products. In addition, Islamic financial markets have proven to be more stable and less volatile particularly during the financial crisis period of 2007-2008 (Arouri et al., 2013). This has led to fast-paced growth and market capitalization[6].

Several researchers, practitioners, traders and regulators have examined all aspects of investing in Islamic products to uncover the impact of Shari'ah laws on the efficiency (Olson and Zoubi, 2008) and performance of Islamic firms and stock markets. Our study is motived by the huge interest of practitioners and academicians in Islamic stock indices as investment vehicles especially after the global financial crises of 2007-2008 when investment in Islamic stocks was resilient to the financial crisis.[7] In spite of the increased in the number of papers that examined different aspects of Islamic finance, no study has examined the impact of investing in gold in the diversification of Islamic stock markets.

More specifically, the aim of this paper is to extend the literature on the role of gold in portfolio diversification in eight Dow Jones Islamic indices (DJII), by investigating the behavior of portfolio diversification over time. To do so, we examine the behavior of daily Islamic stock indices over the period 1996 to 2017 using a fixed-length subsample analysis. We split the data into five subsamples in order to determine how gold-Islamic stock diversification behave over time using SD analysis.

Previous studies, except the study of Hoang et al. (2015), have used parametric tests (MV, CAPM, correlations and GARCH). These methods rely on the normality assumption, which in reality, does not hold.[8] In addition, MV and CAPM depend only on the first two moments (i.e., mean and variance) of asset returns. However, since both positive and negative skewness are present in asset returns, using MV will result in missing the important information contained in higher moments. The MV criterion also requires quadratic utility functions and is not appropriate if investors' utility functions are not quadratic.[9] In addition, previous studies show that if the results of parametric methods are being driven by violations of their assumptions, then nonparametric methods, such as SD, may be more appropriate.[10] An advantage of the SD approach is that it incorporates the information on the entire distribution of stock returns and not only on the two first moments (i.e., the mean and variance) like MV and CAPM. The SD technique is more reliable than the other techniques of ranking such as

5Islamic investments are not allowed in companies whose core business involves alcohol, gambling, conventional financial services, entertainment, pork-related products, tobacco, or weapons. In addition, other company screenings are applied based on certain financial ratios. For instance, companies with unacceptable levels of debt (more than one-third of market capitalization) (Hussein and Omran, 2005) or "impure" interest income are excluded from the set of investable stocks. Finally, investments in securities that promise interest payment or investments in derivative securities are not allowed under Islamic law, such as bonds, options and futures contracts (Naughton and Naughton, 2000).

6The INCEIF reports that the global Islamic finance industry expected to reach USD 4.00 trillion by 2020 (INCEIF, 2017). http://www.inceif.org/industry-growth/

7 For further discussion see Naryan, 2017; Alkhazali and Marzaei, 2017a; Mazous, 2016; El Alaoui et al., 2015; Alkhazali et al., 2014a; Ho et al., 2014; El Khalichi et al., 2014b; Hassan and Girard, 2011; Albaity and Mudor, 2012; Hayat and Kraeussl, 2011; Merdad et al., 2010; and Azmat et al., 2014.

[8]For more discussion about the importance of the normality assumption, please review Lumley et al. (2002).

[9] See Feldstein (1969) and Meyer et al. (2005).

[10] For further discussion, review Seyhun (1993).

MV and CAPM because does not have many of the restrictive assumptions of parametric techniques. To examine the effect of including gold in the Islamic stock portfolios, we follow Hoang's et al. (2015). We compare the performance of Islamic stock portfolios with gold with those without gold. If the cumulative distribution function of gold portfolio dominates the ones without gold, we can conclude that the inclusion of gold in the Islamic stock portfolio will have a higher preference among Islamic stock market participants.

This paper contributes to the literature in several ways. Firstly, this is the first paper that examines the role of gold in portfolio diversification in Islamic stock Indices. Second, for robustness test, it uses eight different Islamic stock indices to see if the selections or compositions of each index make a difference in the results of the study. Third, it uses SD analysis, which is more reliable than parametric tests. Fourth, it examines portfolio diversifications under different market conditions. It uses subsamples (five sub-periods) to find whether investments in gold and in Islamic stocks are sensitive and affected by the world, regional and local economic events, and to capture the impact of political, environmental and social events on stock prices in the global market at large. Finally, we use Sharpe and reward-to-risk ratios to compare the SD analysis with the MV analysis.

We find that gold diversify risk in all Dow Jones Islamic stock portfolios used in the study from 1996 to 2017 and over the five sub-periods. Consequently, the results reject the null hypothesis that gold-Islamic stock portfolio return does not dominate (outperform) non-gold Islamic stock portfolio return. The SD results show that gold-Islamic stock portfolio stochastically dominates the one without gold at the FSD, SSD and TSD order. In addition, the level of SD order improves when the percentage of gold increases in the portfolio. We find that the SD order is manifest during the financial crisis sub-period (2007-2009) at all percentage of gold. This indicates that risk-averse investors in Islamic stock indices should include gold in their portfolios in order to maximize their expected utilities. Moreover, the results of MV approach consistent with the ones of the SD. The findings of this paper suggest that investors may design appropriate investments with gold to diversify their Islamic stock portfolios.

The rest of this paper is organized as follows: Section 2 provides literature review. Data and descriptive statistics are presented in section 3. SD methodology is discussed in section 4. Results are reported in section 5 and the final section concludes.

2. Literature Review

2.1 Gold and stock prices

The literature on gold and stock prices is diverse and the most important strand of studies that related to our study are presented in this section. Previous studies report that the correlation between gold and other major assets such as stocks is low or even negative (Sherman, 1986; Jaffe, 1989; Chua et al., 1990; Upper, 2000; Ciner, 2001; Michaud et al., 2006; Hillier et al., 2006; McCown and Zimmerman, 2006; Kaul and Sapp, 2006; Baur and Lucy, 2010; Nguyen et al., 2016). This low and/or negative correlation is due to the difference between the determinants of gold prices and those other financial assets (Jastram and Leyland, 2009; Chen et al, 2009). Therefore, gold is consider a good asset for diversifying financial portfolios.

The first study that examines the role of gold in portfolio diversification is by McDonald and Solnik (1977). Using monthly prices from 1948 to 1975, they investigate the relationship between gold prices quoted in London and the S&P 500 index. They find that there is no relationship between gold prices and stocks, but there is a positive relationship between gold and gold mining stocks. They conclude that both gold and gold mining can be profitable for portfolio diversifications. Sherman (1982) uses the mean variance approach with the capital asset pricing model (CAPM) and correlation coefficients

to examine the impact of gold on portfolios consisted of stocks and bonds. Using monthly London data from 1976 to 1981, he finds that gold has a weak beta, a positive alpha and a weak correlation with other assets. Thus, he concludes that it is profitable to add gold to portfolios. Other researchers extend their work to international markets. For instance, Smith (2002) examines the role of gold in portfolio diversifications in 17 European stock markets over the period 1991 to 2001. His findings support the findings of the previous studies where gold is weakly or even negatively correlated to stock indices. He recommends that investors should add gold to stock portfolios in order to reduce risk. Using mean-variance-skewness approach, Lucey et al. (2006) examine the impact of gold prices on Nasdaq and FTSE indices over the period 1980 to 2003. Their results indicate that gold is profitable for portfolio diversification. Other studies implement mean variance approach and support the benefit of gold in stock portfolio diversifications (Michaud, et al, 2006; Ratner and Klein, 2008; Wozniak, 2008).

Recently, many studies recognize that there can be important and different dynamics between the markets in times of stress and turmoil. Those studies report that there is evidence to suggest that gold acts as a hedge, a safe haven and diversifier for equity markets over recent years, particularly during crises periods (Baur and Lucey, 2010; Baur and McDermott, 2010; Ciner, 2013; Bekiros et al, 2017). Hedging using gold and other precious metals against stock markets has recently been investigated in several papers. Baur and Lucey (2010) and Baur and McDermott (2010) are the first to formally define an asset to be a hedge or a safe haven against another asset.[11] Using regression and GARCH, Baur and Lucey (2010) examine whether gold is a hedge and safe haven for stocks and bonds in the UK, US and German markets. Using daily data from November 1995 to November 2005. They find that gold appears to act as a safe haven for investment in the United States, the United Kingdom and Germany, but as hedge for stocks only in the United States and the United Kingdom. They conclude that gold is not a safe haven for stocks at all times but only in extreme bearish stock market, and that the safe haven property is short-lived. Moreover, Baur and McDermott (2010) use a GARCH model and conclude that gold quoted in London is good for the diversification of portfolios for major European and American stock markets. However, this is not the case for Australia, Canada and some emerging countries. They also report that gold acts a safe haven for most of the developed country stock markets.

Using quantile regression methods, Ciner et al. (2013) examine the correlations between oil, gold, currency, bond and stock markets using daily data from the US and the UK and find that gold acts as a safe haven during significant price declines. Using generalized VAR-ADCC-VGARCH model, Kumar (2014) examines the first and second orders moment transmission between gold and Indian industrial sectors with an application of portfolio design and hedging effectiveness. His findings suggest that stock-gold portfolio provides better diversification benefits than stock portfolios. Beckmann et al. (2015) attempt to answer the question of whether gold acts as a hedge and/or safe haven with regard to stocks. Using data from 18 individual economies and five regional indices, they find that gold generally serves as a hedge, a safe haven and portfolio diversifier. Arouri et al. (2015) apply the VAR–GARCH framework to examine both return and volatility spillovers between world gold prices and stock market in China. The results of this study show that adding gold to a portfolio

[11] Baur and Lucey (2010) provide definitions for a hedge, a diversifier and a safe haven property as follows: "an asset acts as a hedge if it is uncorrelated or negatively correlated with another asset or portfolio on average". An asset is regarded as "a diversifier if it is positively (but not perfectly correlated) with another asset or portfolio on average". A hedge and a diversifier cannot shield a portfolio of exhibiting losses in times of extreme adverse market conditions, since both properties only work on average. Finally, an asset is seen as "a safe haven if it is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil".

can improve the return of the stock portfolio. They find that the gold serves as a safe haven for stocks in the Chinese stock markets during the financial crisis of 2007-2008.

Using data from the UK, the US and Japan markets, Choudhry et al. (2015) examine the movements among gold returns, stock market returns and stock market volatility during the global financial crisis of 2007-2008. Their results are in complete contrast to most of what has been reported in the literature. The results of this study show that the returns of gold and stocks are interdependence. Hence, gold is not a good safe haven during the financial crisis. Gokmenoglua and Fazlollahi (2015) show that gold prices have high impact on the stock prices in long-run and short-run. Therefore, investors can react against changes in the gold price, by considering that gold is a very good substitution of stock. Recently, Baur and McDermott (2016) identify unique features of gold that explain why investors under stress buy the riskier alternative gold. They argue that the decision to buy gold is rooted in behavioral biases associated with gold's history as a currency, a store of value and a safe haven. Their empirical analysis shows that gold is a strong safe haven in the aftermath of September 11, 2001 and the Lehman bankruptcy in September 2008. The Global Financial Crisis also exemplifies the role of the US dollar as a safe haven currency and how it can mask the safe haven effect of gold. Finally, they find that safe haven assets do not exacerbate crises via a negative feedback effect. Bekiros et al. (2017) address the hypothesis of gold as a hedge, a diversifier and a safe haven in the leading emerging economies, the BRICS. Using a multi-scale wavelet approach and a GARCH-based copula methodology, they show evidence of: (i) the time-scale co-evolvement patterns between BRICS stock markets and gold market; and (ii) a strong time-varying asymmetric dependence structure between those markets. They state that these findings are essential for risk diversification and portfolio hedging strategies among the investigated markets. Iqbal (2017) examines whether investment in gold provides a hedge or a safe haven against stock markets, exchange rate and inflation for India, Pakistan and the US. Using the Baur and Lucey's (2010) model, they find that gold does not hedge stock market risk in the three countries. When stock index returns fall below the lowest 5% quantile, the gold returns increase significantly to act as a safe haven for investors in India and the US.

All previous studies that examine the relationship between gold and stock prices use MV approaches with correlation coefficients, efficient frontier, CAPM or multi-factor regressions. Some also use GARCH models or the mean–variance–skewness approach. However, we find only one paper using the SD approach (Hoang et al. 2015).

Using SD and data from the French markets for the period 1949-2012, Hoang et al. (2015) find that portfolios that include gold outperform those portfolios that exclude gold from their holdings. They conclude that investors are better off by including gold in their stock portfolios. The results of the sub-periods hold especially during crisis times. In addition, all previous studies examine the role of gold as hedge, safe haven or diversifier in only conventional (non-Islamic) stock markets. Thus, our study extends this literature in terms of market settings, the methodology and database. This paper uses SD approach to assess the role of gold in diversification in Islamic stock portfolios.

2.2 Islamic stock indices

Unlike conventional capital markets, little attention has been paid to Islamic equity markets.[12] Islamic equity markets have not been examined thoroughly by the prior research. The recent development of

[12] Stock markets in Islamic countries are not the same as Islamic stock indices (Islamic equity markets). In Islamic countries, there are non-Islamic (conventional) and Islamic stocks. Thus, this section focuses on studies in Islamic equity markets only.

Islamic finance within the last two-decades has inspired academicians as well practitioners to pay more attention to this sector of the economy worldwide.

We begin by reporting the results of the limited prior research that has been conducted on the Islamic equity Indices. Using monthly prices for Global Dow Jones Islamic Index from 1996-2000, Hassan (2002) finds that returns are normally distributed and efficient. Muhammad (2002) conclude that conventional and Islamic indices behave in a similar fashion. Hakim and Rashidian (2004) results indicate that the risk and return of the Dow Jones Islamic Market Index (DJIMI) are different from those of W5000 index.

Hussein (2005) uses Sharpe's (1964) CAPM methodology to examine the returns of Islamic and conventional indices for the period 1996–2003. His results show that returns on Islamic indices outperform non-Islamic indices during the bull market sub-period, but not during the bear market sub-period. Elfakhani et al. (2005) conclude that there are similarities between the performance of Islamic and conventional mutual funds. On the other hand, Hussein and Omran (2005) find that Islamic indices outperform conventional ones.

Several prior studies examined the risk and return of Islamic investments relative to the conventional one. For example, Jawadi et al. (2014) examined the financial performance of Islamic and conventional finances using different ratios measures for Euro area, the USA and the World during the calmness and crises periods. Their results show that Islamic investments perform better than conventional investment during the crises period. While, the conventional investments outperform Islamic investments during the calmness periods.

Al-Zoubi and Maghyereh (2007) find that the risk of the Dow Jones Islamic Index (DJII) is significantly lower than that of the Dow Jones World Index (DJWI) due to the utilization of the profit-and-loss sharing principle in Islamic investments. Alam and Rajjaque (2010) conclude that, because of the Islamic principles, the performance of the Islamic stocks traded in the European stock markets beats the performance of the stock market as a whole during the economic decline.

Hayat and Kraeussl (2011) find that Islamic equity funds underperform the Dow Jones Islamic Market Index (DJIMI) as a benchmark index and the interest free rate of the 3-month US T-Bill of the Federal Reserve Bank during the financial crises of 2007-2008. They recommend that investing in Islamic index tracking funds or Islamic exchange-traded funds can improve the performance of investment portfolio.

Using data for the period 2000–2009, Milly and Sultan (2012) conclude that Islamic stock portfolios outperform conventional stock portfolios and socially responsible stock portfolios during the turbulent periods. Using monthly data for the period May 2002-June2012, Ashraf and Mohammad (2014) find that the volatility of regional Islamic equity indices (IEIs) is significantly lower than that of their conventional counterparts.

The results of the prior research on the performance of Islamic equity funds (IEFs) and Islamic stocks are mixed. For example, using a global dataset of 265 Islamic mutual funds, Hoepner et al. (2011) find that Islamic mutual funds in countries with a Muslim majority population outperform those funds in countries where Muslims represent the minority of the population.

Alkhazali et al. (2014a) show that over the periods 1996–2012 and 2001–2006, the majority of the conventional indices stochastically outperform Islamic indices in all markets except the European market. However, their results indicate that Islamic indices perform better than conventional indices during the crisis periods. Ho et al. (2014) also find similar results to Alkhazali et al. (2014a) in that Islamic indices outperform their conventional counterparts during the crisis periods. However, their findings for the non-crisis periods are inconclusive. Hayat and Kraeussl (2011) conclude that IEFs perform worse than conventional indices in both bullish and bearish markets. Nevertheless

Abdelsalam et al. (2014) find no difference between in the performance of Islamic funds and non-Islamic funds during the crisis and none-crisis periods.

Ashraf (2014) finds that the risk adjusted return of Islamic equity funds (IEIs) is similar to that of the conventional equity funds. Moreover, Mohammad and Ashraf (2015) conclude that selecting stocks based on the Islamic principles will lead to a bigger return for investors than using the conventional methods for selecting stocks. Additionally, they report that returns of Islamic equity indices of emerging markets are significantly different from those of the developed markets. On the other hand, Ajmi et al. (2014) show that there is a significant connection between Islamic and conventional stock markets.

One of the main goals of regulators and policy makers is to promote efficiency and ethics in security markets. Guyot (2011) shows that utilizing Shari'ah laws in selecting stocks has no negative effect on the efficiency of the Dow Jones Islamic index. Using variance ratio tests, El Khamlichi et al. (2014a) show that the efficiency of Islamic indices are similar to that of the conventional indices. Jawadi et al. (2015) results of testing the weak form of efficient market hypothesis reveal that Emerging Islamic stock markets are less efficient than developed stock markets. This may help investors in finding investment opportunities in the emerging stock markets.

In evaluating the weak form of market efficiency, most of the prior studies did not use time-varying measures of return predictability methodology except few (Sensoy et al., 2015; Charles et al., 2015; Alkhazali et al., 2016). For example, Sensoy et al. (2015) using daily stock prices for 12 Dow Jones Indices, compare the weak form efficiency of conventional and Islamic equity markets and find that all indices have different degrees of time-varying predictability. Furthermore, their results reveal that the efficiencies of Islamic markets are different from those of the conventional markets. Furthermore, Charles et al. (2015) using the automatic portmanteau and variance ratio tests, find that Islamic and conventional stock portfolios returns have similar predictability. However, the degree of efficiency of Islamic portfolio is much higher than that of the conventional counterparts especially during the crisis periods. Alkhazali et al. (2016), using a sample of nine conventional and nine Islamic stock indices for the period 1997-2012, test the martingale difference hypothesis (MDH) and the random walk hypothesis (RWH) for nine conventional and nine Islamic stock indices. Their results reveal that conventional Europe, Japan and UK stocks indices are relatively more efficient than the Islamic Indices counterparts during none crisis periods. While, the difference in efficiency disappear during the crisis period. Recently, Alkhazali and Mirzaei (2017) examine the Adaptive Market Hypothesis (AMH) through three well-known calendar anomalies in eight Dow Jones Islamic Indices (DJII). Their results show that varying of calendar anomalies over time support the AMH in Islamic stock indices. In addition, they report that the AMH offers a better explanation of the behavior of calendar anomalies than the Efficient Market Hypothesis.

3. Data and Descriptive Statistics

3.1 Overview of Dow Jones Islamic Market Index

The Dow Jones Islamic Market index (DJIMI) is characterized of being low-debt, non-financial and ethical index. The DJIM indices are subset of Dow Jones Global Indices group. The DJIM indices are calculated using a capitalization weighted method and disseminated to major market data vendors in real time. The DJIMI excludes securities from any industry group that do not comply with Islamic principles.[13] A stock will NOT be included in the DJIMI if the activities of the issuing firm are related to any one of the following activities: banking or any other interest-related source of income, alcohol,

[13] *www.djindexes.com/islamicmarket/*

tobacco, gambling, arms manufacturing, life insurance, pork, and companies with a gross interest-bearing debt to total assets ratio exceeding 33%. Furthermore, firms with account receivables greater than 45% of total assets cannot be included. The management committee of the indices will remove any stock from the index if it does not meet these criteria.[14]

The DJIMI is constructed and maintained according to a consistent methodology. It is monitored by a supervisory board composed of Islamic scholars who advise Dow Jones on matters pertaining to the compliance of the indices' eligible components. The composition of the DJIMI is reviewed quarterly and changes are implemented on the third Friday of March, June, September, and December. Market data from the end of January, April, July and October are used as the basis for the revision process. In addition to the quarterly and annual composition reviews, the DJIMI is monitored on an ongoing basis. A change in the index is necessary when an extraordinary event such as a bankruptcy, merger or takeover has a material impact on a component. Any new issue is also evaluated in the same manner.

For the purpose of our study, we use daily gold prices from World Gold Council and daily stock prices for eight Dow Jones Islamic indices, which are obtained from Datastream.[15] We use the following eight Islamic stock indices: Asian/Pacific, Developed, Emerging, European, Global, Japanese, UK and US. Our data sample covers two continents (Asia/Pacific and Europe), three countries (Japan, UK, and US), two types of economies (emerging and developed) and the Global Dow Jones Islamic index.

Islamic Shari'ah laws impose several screening criteria when selecting stocks to be included in Islamic equity funds. Equities must pass three basic tests to be included in an Islamic fund: source of revenue, type of business activity and financial factors. However, each of the index providers follows a slightly different basis for inclusion based on the interpretation of the Shari'ah board (Ashraf, 2014). This may affect the composition of the portfolio. Various Shari'ah screening standards lead to a different portfolio composition (Derigs and Marzban 2008; Rahman et al. 2010) and a different return performance (Adamsson et al. 2014). This study focuses exclusively on Islamic indices constructed by Dow Jones in order to have consistent results. Moreover, Dow Jones is the first provider to construct Islamic equity funds since 1999 and to provide data since January 1996. It also has Islamic equity indices that cover almost all of the regions of the world, for longer periods and larger sample sizes than other providers.

There are three main reasons behind our choice of the above eight Islamic indices. First, they allow us to investigate more regions and countries than those in previous studies that examined Islamic stock indices.[16] This may provide more reliable and comprehensive analysis. Second, the choice of these indices enables us to account for the variation in political and economic events in different regions. Finally, this allows us to examine the characteristics of indices with similar Shari'ah screening procedures. In this paper, we focus only on Islamic indices in none Muslim countries because of the composition of the stocks in these indices are Shari'ah-complaint. However, we do not consider security markets in Islamic countries since many stocks in Islamic countries are not Shari'ah-compliant.

[14] Detailed discussion is presented in Hussein (2004).

[15] The Dow Jones Islamic indices are constructed based on regional location: Global (developed, emerging, and frontier), Americas (pan regional, US, Canada, Latin America), Europe (pan regional), Middle East and Africa (pan regional, Arab and GCC, Israel, Africa, south Africa), Asia/Pacific (pan regional, Australia and New Zealand, China, Japan, South Korea).

[16] Sensoy et al. (2015) use the following six Islamic indices: Asia/Pacific, Canadian, European, Japan, UK, US; and Charles et al. (2015) use only Global Islamic indices.

We examine the sample period ranging from January 2nd, 1996 to June 31st, 2017 as well as five sub-periods which are defined by different trends in the market index. In order to examine whether the performance of Islamic stock-gold portfolios are influenced by major crises, political events, and economic conditions, we consider five sub-periods with events that are regional specific as follows. Period 1 from January 2nd, 1996 to December 31st, 2000; period 2 from January 2nd, 2001 to December 31st, 2006, period 3 from January 2nd, 2007 to December 31st, 2017, period 4 from January 2nd, 2007 to December 31st, 2009 and period 5 from January 2nd, 2010 to December 31st, 2017.

Some of the major events that took place in the global markets during the entire period (1996-2017) and the five sub-periods include the Asian financial crisis (1997-1998), the terrorist attack on World Trade Center in New York (2001), the Iraqi war (2003), many bankruptcy cases (Enron, WorldCom and Lehman Brothers) and the OPEC reduction of oil production. In addition, they cover the Dotcom, European Sovereign Debt crises and the uprising in the Arab World.

In this study, we test the following null hypothesis over the entire period as well as the five sub-periods:

H_0: The return of Islamic stock portfolio with gold does not stochastically dominate the return of Islamic stock portfolio without gold

We use the daily closing values of the Islamic stock index *i* to calculate the log-return, R_{it},) on days *t* and *t–1*, respectively. To test our hypothesis and for SD performance comparisons, we calculated the returns for Islamic stock portfolios without gold and Islamic stock portfolios with gold separately. In each Islamic stock portfolio with gold, the percentage of gold varies from 5% to 50%. We then perform pairwise comparisons between a "portfolio without gold" and a "portfolio with a portion of gold." A portfolio without gold means a portfolio with only Islamic stocks. We classify the gold portfolios into 10 different portfolios based on the portion of gold in each portfolio as follows:

Portfolio	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Gold	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
Stocks	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%

We conduct the analysis for the whole period and the five sub-periods.

3.2. Results of descriptive analysis

Table 1 reports the descriptive statistics for gold, eight Islamic indices and 10 gold-Islamic stock return portfolios over the entire period.[17] We observe that gold mean return (0.21%) is positive and more than the mean return of all Islamic indices under study. In addition, we observe that the standard deviation of gold return (0.81%) is less than the standard deviation of return for all Islamic indices. This implies that gold is more profitable and less risky than Islamic stocks over the whole study period.

The skewness and kurtosis of the returns of the eight Islamic indices and gold are significant. The skewness of return is negative for all indices. The skewness for gold returns (-0.0086) is less negative and close to zero than skewness for all Islamic stock returns. The negative skewness implies that the returns are not normally distributed. Jarque-Bera statistics confirm none normality returns in the all indices.

The results of the 10 portfolios reported in Table 1 are constructed from Islamic stock indices and gold. For the 10 portfolios (5% gold to 50% gold), we find that the mean return of these portfolios for

[17] Due to space limitations, statistics for sub-periods are available upon request from the authors.

all Islamic indices increases as the percentage of gold increases. Interestingly, we also find that the standard deviation of the 10 portfolios decreases as the percentage of gold in each portfolio increases for the eight Islamic indices.

For the five sub-periods, we find consistent results where risk, measured by the standard deviation, of the 10 portfolios declines as the percentage of gold increases from 5% to 10%, to 50% for all sub-periods. This means that gold diversify risk during good and bad times. The mean return of gold is positive and more than the mean return of Islamic stocks during the five sub-periods. Additionally, the mean return of the 10 portfolios of all Islamic indices increases as we add more gold to the portfolio during the five sub-periods.

We conclude that the risk of Islamic stock-gold portfolios measured by the standard deviation decreases as we add more gold to the portfolio. This means that gold diversify risk in the Islamic stock portfolio and it shows that gold is a safe haven investment. These findings concur with the findings of Baur and Lucey (2010). Thus, to avoid the increasing risk in the financial markets, investors should invest in the gold market, which is commonly known as a "safe haven". Furthermore, investors in the global markets often switch between stocks and gold or combine them to diversify their portfolios (Soytas et al., 2009).

The asymmetry coefficient of the distribution (the skewness) is significantly different from zero for gold and the 10 portfolios over the whole period as well as the five sub-periods. This means that the distribution is not symmetric around the average value. The skewness of the10 portfolios are significantly negative and decreases as the percentage of gold increases in the portfolio. We find similar results during the five sub-periods.

The flattening coefficients of the distribution (Kurtosis) are positive for gold and the 10 portfolios. Furthermore, the results indicate that the kurtosis for gold is more than kurtosis for the 10 portfolios. The results of the tests for normality (Jarque–Bera and Kolmogorov–Smirnov) show that the distributions of the returns of gold, Islamic indices and 10 portfolios are not normal. This implies that using the MV criterion methodology may provide misleading conclusions about the performance of gold and Islamic indices. Therefore, using the SD approach is preferable over other approaches such as MV and CAPM since SD draws inference based on the entire distribution of returns.

4. Methodology: SD Analysis

Virtually most of previous studies apply the MV and CAPM approaches for the purpose of comparisons among portfolios or returns. For any two investments with variables for profit and return X_i and X_j with means μ_i and μ_j and standard deviations σ_i and σ_j, respectively, X_j is said to dominate X_i by the MV criterion if $\mu_j \geq \mu_i$ and $\sigma_j \leq \sigma_i$. The MV and CAPM techniques cannot be used if the return distributions are not normal or the utility function of investors is not quadratic.[18] If these assumptions are not met, then SD technique should be used to make comparisons among alternative investments.

An advantage of the SD approach over the traditional parametric approaches such as MV and CAPM in that it requires minimum assumptions for investors' utility function. Another advantage of SD analysis is that normality assumption is not required. The SD approach does not require any assumption about the nature of the distribution. Hence, SD has gained momentum in recent empirical research.

[18] For more detail discussion, see Feldstein (1969) and Hakansson (1972).

To overcome the shortcomings associated with the parametric models and to investigate the performance of the entire distributions of the returns, we use the Davidson and Duclos (2000, hereafter DD) nonparametric SD statistics to test for the dominance of any pair of the returns series.

Assume that the cumulative distribution functions (CDFs) for two investments (Y and Z) are F and G, respectively (i.e. returns of two days, two weeks, or two months in this study). And their probability density functions (PDFs) are *f* and *g*, respectively.

Let us define H_0 as follows:

$$H_0 = h,\ H_j(x) = \int_a^x H_{j-1}(t)dt \text{ for } h = f, g,\ H = F, G \text{ and } j = 1, 2, 3. \quad (1)$$

Y would dominate *Z* by first-order SD (FSD) if and only if $F_1(x) \le G_1(x)$; by second-order SD (SSD) if and only if $F_2(x) \le G_2(x)$; and finally, by third-order SD (TSD) if and only if $F_3(x) \le G_3(x)$ for all *x*, and the strict inequality holds for at least one value of *x*. (Tsang et al., 2016)

If the SD is present in the data, then we can imply that investors' utility for the dominate asset is higher than that of the dominated asset. Consequently, the dominated portfolio or asset should not be chosen. Under FSD, investors will exhibit non-satiation ; under SSD, investors will have additional characteristic of risk aversion while under TSD they have added decreasing absolute risk aversion. We note that hierarchical relationship exists in SD (Levy, 1992).

For returns of two week-days or two yearly-months, *Y* and *Z* with CDFs *F* and *G*, respectively, and for a grid of pre-selected points $x_1, x_2 \ldots x_k$, the order-*j* DD statistic, $T_j(x)$ (*j* = 1, 2, and 3), is:

$$T_j(x) = \frac{\hat{F}_j(x) - \hat{G}_j(x)}{\sqrt{\hat{V}_j(x)}} \quad (2)$$

Where $\hat{V}_j(x) = \hat{V}_Y^j(x) + \hat{V}_Z^j(x) - 2\hat{V}_{Y,Z}^j(x)$,

$$\hat{H}_j(x) = \frac{1}{N(j-1)!}\sum_{i=1}^{N}(x - h_i)_+^{j-1},$$

$$\hat{V}_H^j(x) = \frac{1}{N}\left[\frac{1}{N((j-1)!)^2}\sum_{i=1}^{N}(x - h_i)_+^{2(j-1)} - \hat{H}_j(x)^2\right], H = F, G; h = y, z;$$

$$\hat{V}_{Y,Z}^j(x) = \frac{1}{N}\left[\frac{1}{N((j-1)!)^2}\sum_{i=1}^{N}(x - y_i)_+^{j-1}(x - z_i)_+^{j-1} - \hat{F}_j(x)\hat{G}_j(x)\right]$$

in which F_j and G_j are defined in (1).

Tsang et al., (2016) contend that testing the null hypothesis for the support of the distributions is not empirically feasible. They suggest the adoption of Bishop, et al. (1992) methodology to test the null hypotheses for a pre-designed value of x as follows:

$H_0 : F_j(x_i) = G_j(x_i)$, for all x_i, $i = 1, 2, \ldots, k$;

$H_A : F_j(x_i) \ne G_j(x_i)$ for some x_i ;

$H_{A1} : F_j(x_i) \le G_j(x_i)$ for all x_i, $F_j(x_i) < G_j(x_i)$ for some x_i;

$H_{A2} : F_j(x_i) \ge G_j(x_i)$ for all x_i, $F_j(x_i) > G_j(x_i)$ for some x_i.

If either H_0 or H_A is accepted, then one can conclude that there is no dominance (SD) of one period over another period. On the other hand, if H_{A1} or H_{A2} is accepted for order one, a certain period (day or month) stochastically dominates another period (day or month) and an arbitrage opportunity exists. This could increase investors' wealth and utility. If H_{A1} or H_{A2} is accepted for order two or three, a specific period such as day or month stochastically dominates the other period (i.e., day or month) an arbitrage opportunity does not exist. We note that in the above hypotheses, H_A is set to be exclusive of both H_{A1} and H_{A2}, which means that if either H_{A1} or H_{A2} is accepted, this does not mean that H_A is accepted. Under the null hypothesis, DD showed that $T_j\left(x\right)$ is asymptotically distributed as the Studentized Maximum Modulus (SMM) distribution (Richmond, 1982) to account for joint test size. When using the DD approach, the test statistic should be calculated at each grid point. The null hypothesis can be rejected for any grid point, ff the test statistic is significant. Wong, et al. (2008) and others have suggested using the following decision rules based on 1-α percentile of $M^{k}_{\infty,\alpha}$ tabulated by Stoline and Ury (1979):

If $\left|T_j\left(x_i\right)\right| < M^{k}_{\infty,\alpha}$ for $i = 1,...,k,$ accept H_0;

if $T_j\left(x_i\right) < M^{k}_{\infty,\alpha}$ for all i and $-T_j\left(x_i\right) > M^{k}_{\infty,\alpha}$ for some i, accept H_{A1};

if $-T_j\left(x_i\right) < M^{k}_{\infty,\alpha}$ for all i and $T_j\left(x_i\right) > M^{k}_{\infty,\alpha}$ for some i, accept H_{A2}; and

if $T_j\left(x_i\right) > M^{k}_{\infty,\alpha}$ for some i and $-T_j\left(x_i\right) > M^{k}_{\infty,\alpha}$ for some i, accept H_A.

However, Bai, et al. (2011) have demonstrated that it is not appropriate to use $M^{k}_{\infty,\alpha}$ tabulated by Stoline and Ury (1979). They have suggested using a simulation approach to generate the simulated critical value. In this paper, we follow their recommendation to get simulated critical values in our analysis.

The DD test compares the distributions at a finite number of grid points. Various studies examined the choice of grid points. For example, Tse and Zhang (2004) have shown that an appropriate choice of k for reasonably large samples ranges from 6 to 15. Too few grids will miss information on the distributions between any two consecutive grids (Barrett and Donald, 2003) and too many grids will violate the independence assumption required by the SMM distribution (Richmond, 1982). To make more detailed comparisons without violating the independence assumption, we follow Wong, et al. (2008) approach.

5. Results

5.1 Results of SD analysis

We conduct our analysis by using SD to compare the performance of "Islamic stock portfolios without gold" with those of "Islamic stock portfolio with a portion of gold." As discussed before, a portfolio without gold means a portfolio with Islamic stocks only. Using eight Islamic stock indices, we formed 10 gold-stock portfolios for each index. The portion of gold in each portfolio ranges from 5% to 50%. The SD results for the whole period and five sub-periods are reported in Tables 2 to 7.

The results of SD test of Islamic stock-gold portfolios versus Islamic stock portfolios for eight of Dow Jones Islamic Indices over the entire period (1996-2017) are presented in Table 2. The results show that gold-stock portfolios dominate portfolios with stocks only by the TSD order if we have 5% to 25% gold in the portfolio. The SD results become stronger if more gold is added to the portfolio. We observe that the SD order improves from TSD to SSD if the portion of gold in the portfolio increases from 30% to 50%. One should know that SSD order implies TSD order. This implies that investors

may maximize their utility if they hold gold-Islamic stock portfolio. The results are consistent for all Islamic indices used in the study.

The results of the first sub-period (1996-2000) are reported in Table 3. We observe that findings of this sub-period are similar to those of the whole period. The results of the second sub-period (2001-2006) reported in Table 4 indicate that there is no dominance between the two portfolios when the percentage of gold is 5% and/ or 10% in all Islamic indices. On the other hand, if we add more gold (15% to 25%) to the portfolio, we observe that portfolio with gold dominates portfolio without gold by the TSD order. Moreover, the order of SD improves from TSD to SSD if we have more gold in the portfolio (30% to 50%). We conclude that having gold in Islamic stock portfolio may increase return and / or reduce risk. For the third sub-period (2007-2017), the results are presented in Table 5 and we find that portfolios with gold dominate portfolios without gold by the SSD and TSD orders. The results hold true for any percentage of gold in all Islamic indices used in the study. This sub-period is during and after the world financial crisis. To examine the role of gold in portfolio diversification during financial crisis, we run the SD analysis over the period of 2007 to 2009. Table 6 presents the results of the fourth sub-period (2007-2009). The results show that gold-Islamic portfolio dominates Islamic stock portfolio by the FSD when gold represents 50% of the portfolio. We know that FSD implies SSD and SSD implies TSD. When the percentage of gold in the portfolio ranges from 5% to 45%, the stock portfolios are dominated by the SSD. Prior research indicate that if FSD order holds, then investors can increase their wealth by switching from one portfolio to another, and an arbitrage opportunity exists.[19] However, by considering second and third orders SD, we can detect whether investors could increase their utility by switching from one portfolio to another.

The major economic event in the period of this study is the 2007-2008 sub-prime housing crisis and the housing bubbles that lead to the Global recession in 2008-2009. Global financial crisis is considered by many economists to be the worst financial crisis since the Great Depression of the 1930s. Remarkably, we find that the SD order is manifest during the financial crisis (2007-2009) regardless of the percentage of gold holding in the portfolio. This indicates that gold diversify more risk during financial crisis period than any other asset. We infer that gold appears to be a good safe haven for Islamic stocks. Table 7 presents the results of the last sub-period (2010-2017), which is after the world financial crisis. We find that NSD, TSD and SSD when the percentages of gold in the portfolios ranges from >5% to ≤10%, >15% to ≤25% and 30% to 50%, respectively. We note that gold still diversify risk, but less effective during this sub-period than during the financial crisis period.

In summary, we find that gold diversify risk in eight of Dow Jones Islamic stock portfolios from 1996 to 2017 and over the five sub-periods. Consequently, the results reject the null hypothesis that gold-Islamic stock portfolio return does not dominate (outperform) non-gold Islamic stock portfolio return. The SD results show that gold-Islamic stock portfolio stochastically dominates the one without gold at the FSD, SSD and TSD order. In addition, the level of SD order improves when the percentage of gold increases in the portfolio. We also find that the SD order is manifest during the financial crisis sub-period (2007-2009) at all percentage of gold. This indicates that risk-averse investors in Islamic stock indices should include gold in their portfolios to maximize their expected utilities. The findings of this paper suggest that investors may design appropriate investments with gold to diversify their Islamic stock portfolios.

5.2 Results of MV analysis

The results of Sharpe and reward-to-risk ratios are presented in Table 8. The higher the ratio, the better the performance of the portfolio is. Over the whole period and five sub-periods, these ratios

[19] For more discussion, see Bawa (1978) and Jarrow (1986).

increase with more percentage of gold in the portfolios. Hence, including gold in a stock portfolio improves its performance. Thus, the results of MV analysis are similar to those of SD analysis. Our MV results support the findings of Sherman (1982) and Hiller et al. (2006) that gold is good for stock portfolio diversification. In addition, our results are consistent with the findings of Baur and Lucey (2010) in that gold is a safe haven in a stock portfolio.

6. Conclusion and Summary

Despite of the increase in the number of papers that examine different aspects of Islamic finance, to the best of our knowledge, no study has investigated the impact of investing in gold in the diversification of Islamic stock markets. Thus, in this paper, we focus on the role of gold for portfolio hedging and diversification in eight Dow Jones Islamic indices over the period from 1996 to 2017 and five sub-periods. We use SD analysis to test whether gold-Islamic stock portfolio return dominates non-gold Islamic stock portfolio return. SD has many advantages over the previously used techniques such as MV and CAPM.

Our results show that stock portfolios including gold stochastically dominate those without gold at the first, second and third orders. This implies that risk-averse investors would be better off by including gold in their Islamic stock portfolios to maximize their wealth and expected utilities. The study on sub-periods shows that these results hold especially in unstable or crisis times.

The results of MV performance measures confirm the findings of previous studies in that gold is good for the diversification of stock portfolios. Moreover, the results of MV approach are consistent with the ones of the SD. The findings of this paper suggest that investors may design appropriate investments which, include gold to diversify their Islamic stock portfolios.

Table 1. Descriptive statistics of daily returns for gold Islamic stock and gold-Islamic stock portfolios (1996-2017)

Gold and gold-Islamic stock portfolios (Asia Pacific Islamic Index)

Portfolio	Gold	Asia- Pacific	5% gold	10% gold	15% gold	20% gold	25% gold	30% gold	35% gold	40% gold	45% gold	50% gold
Mean	0.0021	0.0012	0.00125	0.00131	0.00137	0.00145	0.00152	0.00164	0.00175	0.00181	0.00185	0.00191
Std. Dev.	0.0081	0.0118	0.0114	0.0110	0.0108	0.0106	0.0104	0.0101	0.0099	0.0097	0.0093	0.0091
Skewness	-0.0086	-0.4798	-0.4656	-0.4586	-0.4027	-0.3662	-0.3281	-0.2782	-0.2583	-0.2114	-0.2025	-0.1865
Kurtosis	10.4262	9.1522	9.09	8.94	7.64	6.18	5.58	5.21	4.40	4.01	3.88	3.07
Jarque-Bera	12702	8930	8412.64	7853.86	7264.57	6170.09	60160.5	5620.95	5013.57	4915.08	4080.23	3754.07
Prob.	0	0	0	0	0	0	0	0	0	0	0	0

Gold and gold-Islamic stock portfolios (Developed Islamic Index)

Portfolio	**Gold**	**Developed**	**5% Gold**	**10% gold**	**15% gold**	**20% gold**	**25% gold**	**30% gold**	**35% gold**	**40% gold**	**45% gold**	**50% gold**
Mean	0.0021	0.0013	0.00133	0.00142	0.00146	0.00149	0.00151	0.00155	0.00159	0.00162	0.00167	0.00173
Std. Dev.	0.0081	0.0112	0.0101	0.0091	0.0089	0.0087	0.0085	0.0084	0.0084	0.0083	0.0083	0.0082
Skewness	-0.0086	-0.5929	-0.5856	-0.5686	-0.5327	-0.4862	-0.4581	-0.4282	-0.3883	-0.3614	-0.3425	-0.3165
Kurtosis	10.4262	11.2339	10.09	9.94	9.64	9.18	8.58	8.18	8.10	7.77	7.28	6.07
Jarqu-Bera	12702	15940	14812.64	13553.86	131764.57	123170.09	11216.5	9162.95	7313.57	5915.08	4390.23	3954.07
Prob.	0	0	0	0	0	0	0	0	0	0	0	0

Gold and gold-Islamic stock portfolios (Emerging Islamic Index)

Portfolio	**Gold**	**Emerging**	**5% gold**	**10% gold**	**15% gold**	**20% gold**	**25% gold**	**30% gold**	**35% gold**	**40% gold**	**45% gold**	**50% gold**
Mean	0.0021	0.00125	0.00128	0.00132	0.00136	0.00139	0.00142	0.00146	0.00155	0.00158	0.00163	0.00168
Std. Dev.	0.0081	0.0125	0.0120	0.0116	0.0110	0.0105	0.0101	0.0097	0.0093	0.0091	0.0088	0.0085
Skewness	-0.0086	-0.5888	-0.5756	-0.5086	-0.4627	-0.4362	-0.3681	-0.3282	-0.2883	-0.2514	-0.2225	-0.1965
Kurtosis	10.426	9.8743	9.09	8.44	8.14	7.18	7.08	6.81	5.77	5.17	4.88	4.07
Jarque-Bera	12702	11204	11112.6	10853.8	10764.5	10470.1	9216.5	9162.95	8313.57	7915.08	5090.23	2854.07
Prob.	0	0	0	0	0	0	0	0	0	0	0	0

Gold and gold-Islamic stock portfolio (Europe Islamic Index)

Portfolio	**Gold**	**Europe**	**5% Gold**	**10% gold**	**15% gold**	**20% gold**	**25% gold**	**30% gold**	**35% gold**		**40% gold**	**45% gold**	**50% gold**
Mean	0.0021	0.0014	0.00143	0.00148	0.00153	0.00158	0.00163	0.00168	0.00175		0.00178	0.00182	0.00188
Std. Dev.	0.0081	0.0128	0.0121	0.0118	0.0113	0.0109	0.0106	0.0098	0.0095		0.0092	0.0089	0.0087
Skewness	-0.0086	-0.0865	-0.08521	-0.0861	-0.0827	-0.0662	-0.0628	-0.0482	-0.04183		-0.0314	-0.0225	-0.0165
Kurtosis	10.4262	12.2289	12.09	11.94	10.14	9.18	8.58	8.08	7.17		6.57	5.28	4.07
Jarque-Bera	12702	19625	17412.64	16853.86	14764.57	11170.09	10116.5	9162.95	7313.57		5915.08	5090.23	4854.07
Prob.	0	0	0	0	0	0	0	0	0		0	0	0

Gold and gold-Islamic stock portfolios (Global Islamic Index)

Portfolio	**Gold**	**Global**	**5% Gold**	**10% gold**	**15% gold**	**20% gold**	**25% gold**	**30% gold**	**35% gold**	**40% gold**	**45% gold**	**50% gold**
Mean	0.0021	0.0016	0.00163	0.00168	0.0017	0.00174	0.00178	0.00182	0.00185	0.00188	0.00189	0.00193
Std. Dev.	0.0081	0.0098	0.0094	0.0089	0.0086	0.0082	0.0079	0.0077	0.0075	0.0074	0.0073	0.0072
Skewness	-0.0086	-0.6157	-0.6156	-0.6086	-0.5927	-0.5662	-0.5281	-0.4782	-0.4183	-0.3514	-0.2825	-0.2165
Kurtosis	10.4262	11.11	11.09	10.94	10.64	10.18	9.58	8.88	8.17	7.57	7.18	7.07
Jarque-Bera	12702	15502.45	15412.64	14853.86	13764.57	12170.09	10216.5	8162.95	6313.57	4915.08	4090.23	3854.07
Prob.	0	0	0	0	0	0	0	0	0	0	0	0

Gold and gold-Islamic stock portfolios (Japan Islamic Index)

Portfolio	**Gold**	**Japan**	**5% Gold**	**10% gold**	**15% gold**	**20% gold**	**25% gold**	**30% gold**	**35% gold**	**40% gold**	**45% gold**	**50% gold**
Mean	0.0021	0.0011	0.00113	0.00118	0.00127	0.00134	0.00142	0.00147	0.00155	0.00168	0.00174	0.00183
Std. Dev.	0.0081	0.0133	0.0124	0.0119	0.0106	0.0101	0.0098	0.0096	0.0094	0.0091	0.0088	0.0087
Skewness	-0.0086	-0.2428	-0.2356	-0.2186	-0.1827	-0.1562	-0.1281	-0.1082	-0.0098	-0.0094	-0.0092	-0.0090
Kurtosis	10.4262	7.9662	7.781	6.94	6.12	5.89	5.58	4.88	4.77	357	3.18	3.07
Jarque-Bera	12702	5735	5412.64	4853.86	3764.57	2170.09	1216.5	1162.95	931.57	915.08	845.23	814.07
Prob.	0	0	0	0	0	0	0	0	0	0	0	0

Gold and gold-Islamic stock portfolios (UK Islamic Index)

Portfolio	**Gold**	**UK**	**5% Gold**	**10% gold**	**15% gold**	**20% gold**	**25% gold**	**30% gold**	**35% gold**	**40% gold**	**45% gold**	**50% gold**
Mean	0.0021	0.0015	0.00153	0.00160	0.00164	0.00168	0.00171	0.00178	0.00181	0.00186	0.00193	0.00198
Std. Dev.	0.0081	0.0129	0.0123	0.0120	0.0118	0.0114	0.0108	0.0105	0.0101	0.0094	0.0093	0.0088
Skewness	-0.0086	-0.3072	-0.2856	-0.2486	-0.2227	-0.2062	-0.1831	-0.1682	-0.1483	-0.1214	-0.1125	-0.1085
Kurtosis	10.4262	11.034	10.88	10.44	10.14	9.89	9.58	8.88	7.77	6.78	6.48	6.15
Jarque-Bera	12702	14954	14512.64	14353.86	13964.57	12670.09	11216.5	11162.95	10313.57	9715.08	8090.23	7854.07
Probability	0	0	0	0	0	0	0	0	0	0	0	0

Gold and gold-Islamic stock portfolios (US Islamic Index)

Portfolio	**Gold**	**US**	**5% gold**	**10% gold**	**15% gold**	**20% gold**	**25% gold**	**30% gold**	**35% gold**	**40% gold**	**45% gold**	**50% gold**
Mean	0.0021	0.0013	0.00135	0.00141	0.00147	0.00151	0.00158	0.00161	0.00168	0.00172	0.00182	0.00186
Std. Dev.	0.0081	0.0119	0.0114	0.0109	0.0106	0.0101	0.0098	0.0096	0.0092	0.0088	0.0089	0.0086
Skewness	-0.0086	-0.3488	-0.3256	-0.3086	-0.2927	-0.2662	-0.2281	-0.2082	-0.1883	-0.1514	-0.1325	-0.1165
Kurtosis	10.4262	10.9836	10.34	9.74	9.64	8.98	8.58	7.68	7.17	6.57	5.88	5.17
Jarque-Bera	12702	14793	14412.64	14153.86	13064.57	12070.09	10116.5	9162.95	8313.57	6915.08	5090.23	4854.07
Probability	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. Stochastic Dominance test results of Islamic stock-gold portfolio versus Islamic stock portfolio for eight Dow Jones Islamic Indices over the entire period (1996-2017).

Portfolios	Asia Pacific	Developed	Emerging	Europe	Global	Japan	UK	US
5%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
10%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
15%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
20%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
25%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
30%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
35%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
40%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
45%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
50%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD

Note: 5%, 10%, ….., 50% are the percentage of gold in the Islamic-gold portfolio. NSD, FSD, and TSD means no stochastic, First, Second and third stochastic dominance.

Table 3. Stochastic Dominance test results of Islamic stock-gold portfolio versus Islamic stock portfolio for eight Dow Jones Islamic Indices over sub-period I (1996-2000).

Portfolios	Asia Pacific	Developed	Emerging	Europe	Global	Japan	UK	US
5%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
10%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
15%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
20%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
25%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
30%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
35%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
40%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
45%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
50%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD

Note: 5%, 10%, ….., 50% are the percentage of gold in the Islamic-gold portfolio. NSD, FSD, SSD and TSD means no stochastic, First, Second and third stochastic dominance.

Table 4. Stochastic Dominance test results of Islamic stock-gold portfolio versus Islamic stock portfolio for eight Dow Jones Islamic Indices over sub-period II (2001-2006).

Portfolios	Asia Pacific	Developed	Emerging	Europe	Global	Japan	UK	US
5%_Gold	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD
10%_Gold	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD
15%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
20%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
25%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
30%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
35%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
40%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
45%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
50%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD

Note: 5%, 10%, ….., 50% are the percentage of gold in the Islamic-gold portfolio. NSD, SSD and TSD means no stochastic, Second and third stochastic dominance.

Table 5. Stochastic Dominance test results of Islamic stock-gold portfolio versus Islamic stock portfolio for eight Dow Jones Islamic Indices over sub-period III (2007-2017).

Portfolios	Asia Pacific	Developed	Emerging	Europe	Global	Japan	UK	US
5%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
10%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
15%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
20%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
25%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
30%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
35%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
40%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
45%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
50%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD

Note: 5%, 10%, ….., 50% are the percentage of gold in the Islamic-gold portfolio. NSD, SSD and TSD means no stochastic, Second and third stochastic dominance.

Table 6. Stochastic Dominance test results of Islamic stock-gold portfolio versus Islamic stock portfolio for eight Dow Jones Islamic Indices over sub-period IV (2007-2009).

Portfolios	Asia Pacific	Developed	Emerging	Europe	Global	Japan	UK	US
5%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
10%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
15%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
20%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
25%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
30%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
35%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
40%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
45%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
50%_Gold	FSD	FSD	FSD	FSD	FSD	FSD	FSD	FSD

Note: 5%, 10%, ….., 50% are the percentage of gold in the Islamic-gold portfolio. NSD, FSD, SSD and TSD means no stochastic, First, Second and third stochastic dominance.

Table 7. Stochastic Dominance test results of Islamic stock-gold portfolio versus Islamic stock portfolio for eight Dow Jones Islamic Indices over sub-period V (2010-2017).

Portfolios	Asia Pacific	Developed	Emerging	Europe	Global	Japan	UK	US
5%_Gold	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD
10%_Gold	NSD	NSD	NSD	NSD	NSD	NSD	NSD	NSD
15%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
20%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
25%_Gold	TSD	TSD	TSD	TSD	TSD	TSD	TSD	TSD
30%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
35%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
40%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
45%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD
50%_Gold	SSD	SSD	SSD	SSD	SSD	SSD	SSD	SSD

Note: 5%, 10%, ….., 50% are the percentage of gold in the Islamic-gold portfolio. NSD, SSD and TSD means no stochastic, Second and third stochastic dominance.

Table 8. Mean-variance analysis of global Islamic stock portfolios with and without gold. (1996-2017)

Portfolios	100%_stocks	5% gold	10% gold	15% gold	20% gold	25% gold	30% gold	35% gold	40% gold	45% gold	50% gold
Sharpe ratio	0.0717	0.0727	0.0731	0.0739	0.0747	0.0757	0.0767	0.0773	0.0781	0.0787	0.0793
Reward-to-risk	1.0	1.0125	1.0235	1.0326	1.0423	1.0511	1.0588	1.061	1.0624	1.0678	1.071
I (1996-2000)											
Sharpe ratio	0.0657	0.0687	0.0691	0.0696	0.0701	0.0717	0.0724	0.0733	0.0741	0.0751	0.0763
Reward-to-risk	1.0	1.0115	1.0135	1.0226	1.0313	1.0421	1.0428	1.0491	1.0514	1.0518	1.0525
II (2001-2006)											
Sharpe ratio	0.0591	0.0607	0.0621	0.0632	0.0640	0.0651	0.0601	0.0623	0.0691	0.0723	0.0743
Reward-to-risk	1.0	1.0105	1.0201	1.0332	1.0393	1.0401	1.0482	1.0511	1.0524	1.0576	1.0623
III (2007-2017)											
Sharpe ratio	0.0624	0.0676	0.0698	0.0719	0.0727	0.0737	0.0747	0.0753	0.0761	0.0777	0.0783
Reward-to-risk	1.0	1.0215	1.0234	1.0326	1.0413	1.0461	1.0498	1.0501	1.0524	1.0572	1.0611
IV (2007-2009)											
Sharpe ratio	0.0417	0.0457	0.0481	0.0499	0.0527	0.0547	0.0563	0.0583	0.0591	0.0617	0.0623
Reward-to-risk	1.0	1.0105	1.0315	1.0346	1.0403	1.0411	1.0438	1.0471	1.0514	1.0528	1.0531
V (2010-2017)											
Sharpe ratio	0.0557	0.0577	0.0601	0.0631	0.0647	0.0667	0.0687	0.0693	0.0701	0.0717	0.0723
Reward-to-risk	1.0	1.0235	1.0245	1.0306	1.0393	1.0411	1.0458	1.0481	1.0504	1.0538	1.0581

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