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# Is Gold Different for Islamic and Conventional Portfolios? A Sectorial Analysis

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## Abstract

This article investigates the impact of gold in portfolios in distinguishing between Islamic and conventional stocks as well as between risk-averse and risk-seeking investors, while considering sectorial specificities. Using daily data from the Dow Jones indexes and the London gold market over the 2002-2014 period, the results obtained show that the stochastic dominance method is more robust than the mean-risk method to detect the difference between Islamic and conventional portfolios. For most sectors, risk-aversers prefer conventional portfolios, while risk-seekers prefer Islamic portfolios. On the other hand, risk-aversers prefer portfolios with gold, while risk-seekers prefer portfolios without gold. A robustness check on different sub-periods shows that these results are time-varying following the behavior of gold prices. These findings can provide useful information to investors respecting Sharia and looking for a diversification with commodities such as gold.

*JEL Classifications:* G11, C58

*Keywords:* Islamic vs. Conventional stocks; Risk-averse vs. Risk-seeking investors; Gold; Portfolio diversification; Mean-risk; Stochastic dominance.

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## **Introduction**

The use of gold to diversify portfolios has been widely investigated during the last several decades, especially starting in 2010 following the studies of Baur and Lucey (2010) and Baur and McDermott (2010). Indeed, these studies demonstrate that gold can be a safe haven asset in stock portfolios. Following this idea, many other articles have investigated this role of gold in different countries and periods, e.g., Baur (2011), Ciner et al. (2013), Sadorsy (2014), Beckmann et al. (2015), Nguyen et al. (2016).<sup>1</sup> Overall, these studies show that gold acts as a safe haven for stocks and bonds. However, it is time-varying and market-specific. To the best of our knowledge, there has been no research studying whether gold is different for Islamic and conventional stocks. Though Nagayev et al. (2016) investigate the dynamic links between Islamic stocks and commodities (including gold), they have not considered the comparison with conventional stocks. Sadorsy (2014) distinguishes between socially responsible and conventional stocks, Islamic stocks have not been considered. Furthermore, there has been no distinction between risk-averse and risk-seeking investors in most of the previous studies on gold investments. In our opinion, this distinction is important because Hoang et al. (2015b) show that, in China, investments in gold are more suitable to risk-seeking investors than risk-averse ones.

As for Islamic finance, the first quantitative studies focus on Islamic mutual funds in Malaysia (Ismail and Shakrani, 2003). Their study has been followed by numerous studies comparing the performance of Islamic stocks to that of their conventional counterparts, after Dow Jones and the FTSE built the first Islamic indexes. The results of these studies are not unanimous. Some find that Islamic stocks outperform conventional ones (e.g., Arouri et al., 2013), while some others find evidence to the contrary (e.g., Al-Khazali et al., 2014). Furthermore, the majority of studies find that there is no significant difference between Islamic and conventional stocks (e.g., Dewandaru et al., 2015). To the best of our knowledge, there has been no study investigating the relationship between Islamic stocks and gold taking into consideration the distinction between sectors or between risk-averse and risk-seeking investors. For example, Ghazali et al. (2015) focus on the official gold and gold accounts compatible with Sharia (Islamic law) principles in Malaysia. However, they do not compare conventional and Islamic stocks. Furthermore, Abdullah et al. (2016) find that gold has a significant relationship with Islamic stocks in south-east Asian countries. However, they do not make a comparison with conventional stocks. In our opinion, this comparison should raise

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<sup>1</sup> For a more complete literature review on the financial economics of gold, please refer to O'Connor et al. (2015).

interesting results because when considering the principles of Islamic finance (e.g., *riba*, *gharar*, *takaful*, etc.), one may think that there is a significant difference between Islamic stocks and conventional stocks in their relationship with gold (see Section 2 for more details about Islamic finance). Gold is considered in this comparison because it is an important commodity for Islamic finance, as shown by Lee (2011) and Mohammad Daud Bakar<sup>2</sup> at the Global Islamic Finance Forum in Kuala Lumpur (May 10-12, 2016).

In order to investigate the difference between Islamic and conventional stocks regarding their relationship with gold, our methodology is based on two different approaches: mean-risk (MR) (mean-variance and mean-MVaR)<sup>3</sup> and stochastic dominance (SD), in distinguishing the preferences of risk-averse and risk-seeking investors. Using these two methods, we compare 4 types of portfolios: PF1 (100% stocks); PF2 (50% stocks+50% gold); PF3 (Markowitz minimal-variance portfolios); and PF4 (CCC-GARCH portfolios). Looking at these four portfolios, we carry out a double comparison: First, between Islamic and conventional portfolios; Second, between portfolios with gold and those without gold. In each case, the sectorial effect is taken into account. The daily data under study range from 31/12/2002 to 31/12/2014 with 2,942 observations. Data for stocks are taken from Dow Jones and data for gold prices are taken from London. To check the robustness of the results, we also test for the effect of time (based on 3 sub-periods).

The MR analysis shows that there is no significant difference between Islamic and conventional portfolios for most sectors (except for Financials and Utilities). The SD analysis shows that in most sectors, risk-aversers prefer investing in portfolios with gold, while risk-seekers prefer those without gold, for both Islamic and conventional portfolios. Furthermore, risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer the corresponding Islamic portfolios, in most sectors. The diversification strategies with gold can significantly change the relationships between Islamic and conventional portfolios. In addition, these results are time-dependent. Last, we find that gold is a safe haven asset for risk-aversers in the period when gold prices were on an upward trend (2002-2011). However, it is not the case in a downward period (2011-2014) when both risk-averse and risk-seeking investors prefer to invest in portfolios without gold. These findings can provide useful information to investors respecting Sharia as well as investors looking for a better allocation between Islamic or conventional stocks and gold.

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<sup>2</sup> Founder and chairman of [Amanie Advisors](#).

<sup>3</sup> MVaR = Modified Value-at-Risk of Gregoriou and Gueyie (2003). These criteria for risk-averse and risk-seeking investors are also applied in Hoang et al. (2015b).

The rest of the paper is organized as follows. Section 2 presents a twofold literature review on gold investments and Islamic finance. Section 3 presents the data set while Section 4 details the methodology. The empirical results are discussed in Section 5, while Section 6 is devoted to a robustness check. Section 7 concludes.

## **2. Literature review: Gold investments and Islamic finance**

This section aims to present a literature review on two different topics. The first one concerns the relationship between gold and stocks, and the second one concerns a comparison between Islamic and conventional stocks.

### **2.1. Gold in the diversification of portfolios**

The first study to investigate gold investments was McDonald and Solnik (1977), several years after the abolition of the Bretton-Woods system. It was followed by Sherman (1982), Jaffe (1989), Chua et al. (1990), Blose (1996), Blose and Shieh (1995), Davidson et al. (2003), and Lucey et al. (2006). These studies reveal the significant relationship between gold and stocks, and the positive role of gold in the diversification of portfolios. Baur and Lucey (2010) and Baur and McDermott (2010) investigate the role of gold as a safe haven asset, which is defined as “*an asset that is negatively correlated (or uncorrelated) with another asset or portfolio in certain periods only, e.g., in times of falling stock markets.*” Following these two studies, many others, for example, Hood and Malik (2013), Beckmann et al. (2015), and Ghazali et al. (2015), Nguyen et al. (2016), examine the role of gold as a safe haven in different countries and periods.

Baur (2011) uses US data from 1979 to 2011 to conclude that gold evolved as a safe haven only recently. In assessing the impact of the Asian and global financial crises on precious metals over the period 1995-2010, Morales et al. (2011) show that precious metals are not affected by crises, except gold, which tends to generate effects on other precious metals. Creti et al. (2013) confirm that gold is a safe haven for stocks. Ciner et al. (2013) show that stocks, bonds, gold, and oil in the US and UK can be used as a safe haven for each other. Hood and Malik (2013) show that, unlike other precious metals, gold can serve as a hedge and a weak safe haven for the US stock market. Soucek (2013) finds that in unstable periods, the correlation between gold and equity tends to be weak or negative. Gold can thus serve as a safe haven as well as offer the benefit of diversification. However, Beckmann et al. (2015) find that the role of gold as a hedge and safe haven may be market-specific. Sadorsy (2014) reveals that gold and oil can also be used as a hedge and safe haven for socially responsible stocks, in a way similar to that for conventional stocks. Comparing gold to bonds, Flavin et al.

(2014) find that both gold and longer-dated bonds can be considered as safe-haven assets. Applying the wavelet approach on daily data from 1980 to 2013, Bredin et al. (2015) conclude that gold acts as a safe haven for stocks and bonds only for horizons up to one year, but this was not true in the early 1980s. Chkili (2016) finds that gold is a safe haven for stocks in BRICS countries. Overall, the above-mentioned studies show that gold acts as a safe haven for stocks and bonds. However, it is time-varying and market-specific. These two findings are confirmed by Ghazali et al. (2015) and Nguyen et al. (2016). Ghazali et al. (2015) shows that domestic gold in Malaysia, in particular the Islamic gold account,<sup>4</sup> is not a safe haven during episodes of extreme drops in the stock market.

Other studies do not investigate the specific role of gold as a safe haven but rather its impact on the diversification of portfolios. For example, Hammoudeh et al. (2013) find a significant relationship between gold and stocks. Gold can thus play an important role in the diversification of stock portfolios. Kumar (2014) shows that stock+gold portfolios perform better than stock-only portfolios. Based on a wavelet analysis, Michis (2014) concludes that gold provides the lowest contribution to the portfolios' risk at medium- and long-term investment horizons. Baur and Löffler (2015), Choudhry et al. (2015), and Malliaris and Malliaris (2015) confirm the results of previous studies about the significant impact of gold in the diversification of portfolios. Hoang et al. (2015a) find that portfolios with gold quoted on the Paris Stock Exchange stochastically dominate those without gold from 1949 to 2012. Hoang et al. (2015b) show that gold is more suitable to risk-seeking investors and in crisis periods in China, using data from the Shanghai Gold Exchange. Other papers confirm the significant relationship between gold and stocks, e.g., Narayan et al. (2013), Narayan et al. (2015), Raza et al. (2016), Jain and Biswal (2016), Kaabia et al. (2016), Basher and Sadorsy (2016), Zhang (2016), Barunik et al. (2016).

The contributions of our article to this literature concern our simultaneous distinction between Islamic and conventional stocks, between portfolios with and without gold, between risk-averse and risk-seeking investors, and also between 10 different sectors. Although Hoang et al. (2015b) also separate risk-averse and risk-seeking investors, they do not distinguish between Islamic and conventional stocks and between different sectors.

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<sup>4</sup> The Islamic gold account needs to meet the following conditions: (1) the exchange of one monetary form to another on a spot basis, (2) gold bought by investors will be deposited into a gold account, with the bank as the debtor and the investor as the creditor. Please refer to Ghazali et al. (2015), p. 194, for more details.

## 2.2. Islamic vs. conventional stocks

The literature on Islamic finance covers different aspects related to the application of Sharia and its impacts, for example in the banking system (Adebifar et al., 2013 and 2016; Beck et al., 2013), in financial markets (Kenourgios et al., 2016), in corporate governance (Mollah and Zaman, 2015), or in mutual funds (Abdelsalam et al., 2014). In this section, we will present first the landscape of Islamic finance before reviewing previous studies about the comparison between Islamic and conventional stocks.

### *A. Islamic financial landscape*

The second angle of our study concerns the literature on Islamic finance. Indeed, ethical finance could be either morally or socially responsible. Islamic finance is faith-based and therefore considered morally responsible (Ghoul and Karam, 2007). The origin of Islamic finance can be traced back to the beginnings of Islam, but the development of modern Islamic financial institutions dates only from the middle of the 20th century. Hence, after some modest attempts to establish Islamic banks during the early sixties, the real beginning of the Islamic financial industry took place during the mid-seventies. In 1975, the Islamic Development Bank was set up to provide financing and professional advice to Islamic countries. In the same year, the Dubai Islamic Bank was created to be the first commercial bank providing Sharia-compliant products and services to customers.

Islamic finance is based on a set of principles referred to as Sharia. These principles are the cornerstones of the theory and practice of Islamic finance. Hence, the prohibition of *riba* (illegitimate increase, or interest) is absolute, while agency contracts and partnerships are allowed. Islamic financial institutions reorient their activities on a non-interest basis, which means that profit- and loss-sharing (PLS) activities are encouraged. The allocation of financial resources on the basis of PLS gives a maximum weight to the investment profitability, whereas an interest-based allocation gives it to creditworthiness (Iqbal, 2002). Also, Islamic finance prohibits *gharar*, which means exposing oneself to excessive uncertainty in business activities (Iqbal, 2002). This excessive uncertainty could concern ambiguities in terms of the deal (regarding the price, quality, quantity, delivery date, etc.), exposing either of the parties to unnecessary risks. Another principle of Islamic finance is that each financial transaction must be tied to a tangible underlying asset (real estate or commodities, etc.). This is known as the asset-backing principle. In addition to the previous principles, Islamic financial institutions must avoid dealing with non-ethical sectors (such as alcohol, pornography, pork-related activities, tobacco, gambling, etc.).

In recent years, Islamic banking and finance has been recognized as a rapidly growing part of the financial sector. This is the result of the increasing attention to investments driven by innovations in Islamic finance. Actually, Islamic banks have received a lot of academic support and the literature on the subject is well documented. Hence, since the activities of Islamic banks are not based on interest, many researchers study to what extent these banks are different from conventional ones in terms of efficiency, risk, asset quality, and financial stability (e.g., Cihak and Hesse, 2010; Beck et al., 2013, Abedifar et al., 2013). Other researchers focus on their performance (e.g., Mollah and Zaman, 2015), as well as their contribution to financial development and economic welfare in Muslim countries (e.g., Abedifar et al., 2016). In addition to banking activities, Islamic finance covers many other segments, such as investment funds, money markets, stock markets, microfinance, the insurance industry (*takaful*), as well as Islamic indexes and securities.

#### *B. Islamic mutual funds and indexes*

The first wave of academic studies on Islamic financial markets takes a qualitative approach. They analyze the Islamic stock market in its early stages and its particularities in terms of practices and regulations (El gari, 1993; Naughton and Naughton, 2000; Obaidollah, 2001). With the development of data on Islamic financial stock markets, many papers start to adopt a quantitative approach either for mutual funds or indexes. As for Islamic mutual funds, the study of Ismail and Shakrani (2003) is among the first quantitative papers published in this field. Then, various studies are conducted in order to assess the performance of such ethical funds, but the benchmarks used are very different. Indeed, researchers use Islamic indexes (Muhammad and Mokhtar, 2008), conventional indexes (Mansor and Bhatti, 2011), or both indexes (Haddad et al., 2009). The results of these papers are very heterogeneous, since some of them find that Islamic mutual funds perform better during recession periods (Abdullah et al., 2007), while Hayat and Kraeussl (2011) document that Islamic funds significantly underperform during the last financial crisis. During expansion periods, Mansor and Bhatti (2011) find no difference, since they distinguish between two bullish periods and find that Islamic funds over-perform their benchmarks during the first period but underperform them during the second. In addition to the performance analysis, Abdelsalam et al. (2014) study the performance persistence of Islamic funds compared to their socially responsible counterparts. They find that the performance persistence exists for both types of funds, but only for the worst and best funds.



Since the inception of the Dow Jones and FTSE Islamic indexes, in February and October 1999, respectively, many researchers have conducted quantitative studies in this field. Most of the Islamic indexes are sub-indexes of global one.<sup>5</sup> They are obtained using both qualitative (sector) and quantitative (financial) screens<sup>6</sup> to filter out stocks and to assess whether they are compliant with Islamic principles (Sharia-compliant). As a result of the screening process, the asset universe gets relatively smaller for Sharia-compliant portfolio management (Derigs and Marzban, 2009). Furthermore, Islamic stocks are found to be less exposed to interest rate risk than their conventional counterparts.

The results of previous studies on the subject vary considerably. Some studies find that Islamic indexes and conventional ones are not significantly different from each other (Ahmad and Ibrahim, 2002; Abul-Hassan et al., 2005; Girard and Hassan, 2008; Dewandaru et al., 2015). In the meanwhile, others find that Islamic indexes generate higher returns than their conventional benchmarks (Walkshäusl and Lobe, 2012; Arouri et al., 2013; Mohammad and Ashraf, 2015, Charles and Darné, 2015). Narayan and Bannigidadmath (2015) find that mean-variance investors prefer investing in Islamic stocks. Furthermore, some studies (e.g., Ahmad and Ibrahim, 2002; Hussein and Omran, 2005) show that the performance level depends on market conditions (growth or decline periods). Regarding informational efficiency, some papers find that Islamic indexes are less efficient (Sensoy et al., 2015), while other studies find that they are at least as efficient as their conventional counterparts (Guyot, 2011; El khamlichi et al., 2014a). On the other hand, Islamic indexes are not considered homogeneous, since emerging Islamic stock markets seem to be less efficient than developed Islamic markets (Jawadi et al., 2015). Furthermore, neither the over-performance nor the underperformance of Islamic indexes, compared to their conventional counterparts, has gained scholars' unanimous support and the debates are not over yet (El khamlichi et al., 2014b).

The contribution of our paper to the current Islamic finance literature is threefold. First, to the best of our knowledge, there has been no study investigating the relationship between Islamic stocks and gold, taking into consideration sectorial distinctions. Though a recent paper (Ghazali et al., 2015) focuses on stocks and the official gold and gold accounts suitable to Islamic principles in Malaysia, neither Islamic stocks nor sectorial distinctions are investigated. Second, since Islamic screens could lead to a higher concentration in some

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<sup>5</sup> Except for the financial sector, for which all of the components are either Islamic banks or Islamic financial institutions.

<sup>6</sup> More details regarding both screens are given in Section 3.

sectors (Charles and Darné, 2015), we also consider sectorial differences in our empirical analysis. For that, we use the ten industries included in the Industry Classification Benchmark (ICB) structure. Third, we use both the mean-risk and the stochastic dominance approaches in distinguishing between risk-averse and risk-seeking investors. Though Mensi et al. (2015) also use gold, the Dow Jones Islamic World Emerging Market index (DJIWEM), and Treasury bills (T-bills) to study their hedge and/or safe haven characteristics in 6 GCC stock markets, they do not investigate sectorial differences and those between risk-averse and risk-seeking investors.

The next section explains the data set used in our empirical analysis.

### **3. Data**

Our data set is composed of daily values from December 31, 2002, to December 31, 2014. The stock sectors studied include Basic Materials, Consumer Goods, Consumer Services, Financials, Health Care, Industrials, Oil and Gas, Technology, Telecommunication, and Utilities. Islamic and conventional indexes for these sectors are formulated by Dow Jones and cover stocks worldwide. Gold prices are taken from the London gold market, the biggest spot gold market in the world. These prices are for one gold ounce (28.35 grams) quoted in the [afternoon fixing](#) since they include more information than the morning fixing (Hoang et al., 2016). All indexes and gold prices are nominal values expressed in USD. In total, there are 2,942 observations for each series.

Data for Islamic and conventional indexes are retrieved from the FactSet financial database. All Islamic indexes follow the same stock screening process using Sharia compliance criteria developed by Sharia scholars and regulators. The qualitative and quantitative screens are used to filter out stocks and to assess their compliance with Islamic principles. A qualitative screen is commonly known as a negative screen. It consists of excluding firms operating in specific activities. For the Dow Jones Islamic indexes, the screening is carried out using the Industry Classification Benchmark (ICB) for each firm. Therefore, this screening excludes non-ethical sectors such as alcohol, pornography, pork-related activities, tobacco, gambling, etc.

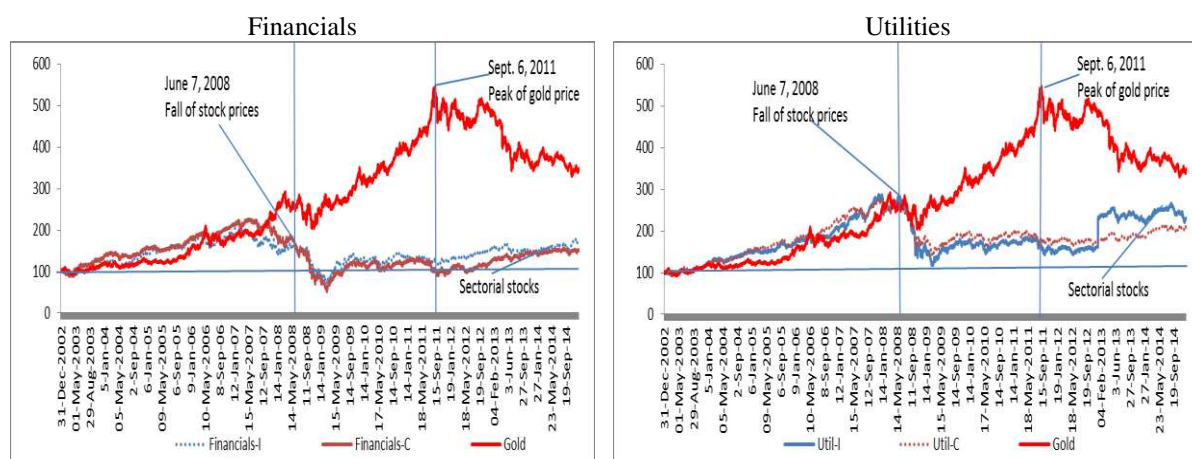
As for the quantitative screen, it is conducted using financial ratios. Indeed, after removing firms with unacceptable primary business activities, the remaining stocks are evaluated according to several financial ratio filters. The filters are based on criteria set up by the Dow Jones Islamic Market (DJIM) Index Sharia Supervisory Board to remove firms with unacceptable levels of debt or impure interest income. According to the guidelines of the DJIM indices (Dow Jones, 2015), all of the following must be less than 33%:

1. Total debt divided by trailing 24-month average market capitalization,
2. the sum of a firm's cash and interest-bearing securities divided by trailing 24-month average market capitalization, and
3. accounts receivable divided by trailing 24-month average market capitalization.

Firms passing the qualitative and quantitative screens are included as components of the DJIM World Index and all its sub-indexes (regional, sectoral and capitalization-weighted indexes). Since the screening is very tough, it is interesting to study whether the performance of the Islamic indexes (obtained by using the Sharia compliance criteria) is different from that of the conventional indexes, as studied in this paper.

As an example, we plot indexes of the Financials and Utilities sectors as well as gold prices in Figure 1. To save space, the figures of the other sectors are presented in the Appendix file.

**Figure 1: Islamic and conventional stock indexes vs. gold, 31/12/2002-31/12/2014**



*Note:* For an easier comparison, the base of 100 is fixed at the beginning of the study period. The letter “I” indicates Islamic and “C” indicates “Conventional.”

Gold prices reached their peak on September 6, 2011, at 1,895 USD per ounce. In general, Islamic indexes and their counterparts evolve very closely, each experiencing a tendency to increase between 2002 and 2008, a tendency to decrease in 2008, and again, a tendency to increase from 2009 to 2014. To take into account this time-varying characteristic, a robustness check will be performed to test whether the study period has an impact on the results. To do so, we divide the whole period into three different sub-periods:

- The first one, from December 31, 2002, to June 7, 2008, is characterized by the tendency of both stock and gold prices to increase;

- The second one, from June 8, 2008, to September 6, 2011, is characterized by the financial crisis period with a tendency for both stock and gold prices to decrease at the beginning of the crisis, followed by a tendency for gold prices to increase and peaked on September 6, 2011;
- The third one, from September 7, 2011, to December 31, 2014, is characterized by the tendency of stock prices to increase and gold prices to decrease.

For simplicity, we call sub-period 1 the “bull market for all assets,” sub-period 2 the “bull market for gold,” and sub-period 3, the “bear market for gold.” Table 1 presents the basic descriptive statistics.

[Insert Table 1 here]<sup>7</sup>

Overall, the gold’s rate of return is the highest (about 11% annually). Stock returns range between almost 3% and 9%, and the higher returns include stocks of the following sectors: Consumer Goods, Consumer Services, Health Care, Industrials, and Technology. The lowest ones concern the Financials and Telecommunication sectors. There is not a great gap between Islamic and conventional stock indexes. In most cases, the Islamic indexes’ rates of return are lower than the conventional ones (for 6 over 10 sectors). The sectors for which Islamic stocks are more profitable are Consumer Services, Financials, Industrials, and Utilities. The standard deviation is the lowest for the Consumer Goods and Health Care sectors (about 13%). The highest ones are for Basic Materials and Oil & Gas (about 24%). The one for gold is close to 20% per year. Once again, we do not find a great gap between Islamic and conventional stocks, except for the Utilities and Financial sectors (21% vs. 15%, and 25% vs. 21%, respectively). For the Utilities sector, this gap can be explained by the fact that most of the firms in this sector are related to energy activities that depend on the oil market, which is, in turn, greatly related to Islamic countries (such as the Gulf countries). As for the Financials sector, this gap can be explained by the fact that the activities in this sector diverge the most between Islamic and conventional firms. As for the skewness coefficients, they are significantly negative, indicating that the distributions of returns are skewed to the left. The kurtosis excess coefficients are significantly positive, indicating that the distributions of returns are leptokurtic. All normality tests show that the distributions are not normal.

To summarize, basic descriptive statistics show that there is not a significant gap between Islamic stocks and conventional stocks, except for the Utilities and Financial sectors. In this case, would their relationship with gold be different? The next section will focus on the methodology that allows answering this question.

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<sup>7</sup> Please refer to the Appendix file for all tables of results.

## 4. Methodology

To study whether gold is different with Islamic and conventional stocks, we follow 4 steps:

- First, we constitute four portfolios: PF1 (100% stocks),<sup>8</sup> PF2 (50% stocks and 50% gold), PF3 (Markowitz minimal-variance portfolios), and PF4 (CCC-GARCH portfolios). As we mentioned above, there is a double comparison: (1) between Islamic and conventional portfolios, and (2) between portfolios with gold and those without gold.
- Second, the double comparison is made through mean-risk (MR) criteria (mean-variance and mean-MVaR) in distinguishing between risk-averse and risk-seeking investors.
- Third, to circumvent the limits of the MR approach, the stochastic dominance (SD) approach is used in distinguishing between risk-averse and risk-seeking investors. Indeed, this method allows us to compare the entire distributions of returns and not only the first few moments of the distribution, such as the mean, variance, skewness and kurtosis. Moreover, Lean et al. (2008) show that the SD approach is robust to non-i.i.d. data, including heteroscedastic data, which is usually the case with financial data.
- Fourth, for a robustness check, we will conduct the above analysis in three sub-periods to test whether the results are time-dependent.

All of the above-mentioned methods are detailed in the following sub-sections. The first one is devoted to the optimal weight of gold in PF4 following the Kroner and Ng (1998) method. The second and third sub-sections focus on the mean-risk analysis (mean-variance and mean-MVaR) from which the optimal weight of gold in PF3 can be calculated. The fourth sub-section is dedicated to the stochastic dominance method.

### 4.1. Bivariate-GARCH models and the optimal weight

To determine the optimal weight of gold and stocks in PF4, we employ the method proposed by Kroner and Ng (1998) model<sup>9</sup> as follows:

$$w_t^G = \frac{h_t^S - h_t^{SG}}{h_t^G - 2h_t^{SG} + h_t^S}$$

where  $w_t^G$  is the optimal weight of gold in the portfolio,  $h_t^P$  is the conditional variance of the stock-only portfolio  $S$ ,  $h_t^{SG}$  is the conditional covariance between the stock-only portfolio and gold, and  $h_t^G$  is the conditional variance of gold. The optimal weight is thus calculated for each date under the condition that:  $w_t^G = 0$  if  $w_t^G < 0$ ,  $w_t^G = w_t^G$  if  $0 \leq w_t^G \leq 1$ , and  $w_t^G = 1$  if  $w_t^G > 1$ . The optimal weight used is thus the average value over our study period.

We base our study on the bivariate CCC-GARCH(1,1) model of Bollerslev (1990) to estimate the conditional variances and covariance. We choose the CCC representation because it provides more economic significance in estimating conditional correlation rather than the conditional covariance (as in the BEKK-GARCH model of Engle and Kroner (1995),

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<sup>8</sup> In the composition of these portfolios, stocks are referred to as the indexes (Islamic or conventional).

<sup>9</sup> For another application of this method, please refer to Arouri et al. (2011).

for example). For each pair of returns of the stock-only portfolio and gold, the bivariate VAR(1)-GARCH(1,1) has the following specification:

$$\begin{cases} R_t = \mu + \Phi R_{t-1} + \varepsilon_t \\ \varepsilon_t = H_t^{1/2} \eta_t \end{cases}$$

where  $R_t = (R_t^S, R_t^G)'$  is the vector of returns of the stock-only portfolio and gold, respectively,

$\Phi$  refers to a (2 x 2) matrix of coefficients  $\Phi = \begin{pmatrix} \phi_1 & 0 \\ 0 & \phi_2 \end{pmatrix}$ ,  $\varepsilon_t = (\varepsilon_t^S, \varepsilon_t^G)$  is the vector of the error

terms of the conditional mean equations for the stock-only portfolio and gold, respectively,  $\eta_t = (\eta_t^S, \eta_t^G)$  refers to a sequence of independently and identically distributed (*i.i.d.*) random

errors with  $E(\eta_t) = 0$  and  $Var(\eta_t) = I_N$ , and  $H_t = \begin{pmatrix} h_t^S & h_t^{SG} \\ h_t^{SG} & h_t^G \end{pmatrix}$  is the matrix of conditional

variances of returns of the stock-only portfolio and gold.

The CCC-GARCH(1,1) model specifies the  $H_t$  matrix as follows:

$$H_t = D_t K D_t$$

with  $D_t = diag(\sqrt{h_t^S}, \sqrt{h_t^G})$ , and  $K = (\rho_{ij})$  is the (2 x 2) matrix containing the constant conditional correlations  $\rho_{ij}$  with  $\rho_{ii} = 1$ ,  $i = S, W$ . The conditional variances and covariance are given by:

$$\begin{cases} h_t^S = C_S + \alpha_p (\varepsilon_{t-1}^S)^2 + \beta_S h_{t-1}^S \\ h_t^G = C_G + \alpha_G (\varepsilon_{t-1}^G)^2 + \beta_G h_{t-1}^G \\ h_t^{SG} = \rho \sqrt{h_t^S h_t^G} \end{cases}$$

To estimate this model, the maximum likelihood method is used.

#### 4.2. Mean-variance analysis for risk-averse and risk-seeking investors

The classical mean-variance portfolio optimization (MVPO) model introduced by Markowitz (1952), and improved later by Bai et al. (2009), Leung et al. (2012), and others, can be used to determine the asset allocation for a given amount of capital through the efficient frontier. To present the MVPO model formally, we assume that there are  $n$  assets and let  $x_i$  ( $i=1, \dots, n$ ) be the fraction of the capital invested in asset  $i$  of portfolio  $P$  in which the average return  $R_p$  is maximized, subject to a given level of its variance  $\sigma_p^2$ . We denote  $R_i$  to be the expected return of asset  $i$  and  $\sigma_{ij}$  the covariance of returns between assets  $i$  and  $j$ , for any  $i, j = 1, \dots, n$ . The general MVPO model is presented as follows:

$$\text{Max } R_p = \sum_{i=1}^n R_i x_i, \text{ subject to: } \sum_{i=1}^n \sum_{j=1}^n \sigma_{ij} x_i x_j = \sigma_p^2 \text{ and } \sum_{i=1}^n x_i = 1.$$

From this efficient frontier, we will use the minimal-variance portfolio (PF3) which the lowest point on the curve. As for the mean-variance (MV) comparison, we consider the returns of any two portfolios  $Y$  and  $Z$ , with means  $\mu_y$  and  $\mu_z$  and standard deviations  $\sigma_y$  and  $\sigma_z$ .  $Y$  is said to dominate  $Z$  by the MV rule for risk-averse (Markowitz, 1952) if  $\mu_y \geq \mu_z$  and  $\sigma_y \leq \sigma_z$ .  $Y$  is said to dominate  $Z$  by the MV rule for risk-seekers (Wong, 2007) if  $\mu_y \geq \mu_z$  and  $\sigma_y \geq \sigma_z$  and if the inequality holds in at least one of the two conditions.

#### 4.3. Mean-MVaR analysis for risk-averse and risk-seeking investors

It is well-known that downside risk is a major factor in measuring financial risk. In the mean-variance (MV) context of Markowitz (1952), the variance or standard deviation is adopted to measure the risk exposure of financial assets. Nonetheless, it cannot capture the downside risk of an asset. To circumvent this limitation, Jorion (2000) proposes using the Value-at-Risk

(VaR); Rockafellar and Uryasev (2000) recommend using the conditional-VaR (CVaR); while Gregoriou and Gueyie (2003) suggest using the modified VaR (MVaR). The limitation of the traditional VaR is the use of a symmetrical distribution function, which is not the case for our series (see Section 3). Thus, to compare the risk of different portfolios, we choose to use the MVaR (Gregoriou and Gueyie, 2003), which takes higher moments of the distribution of returns into account (skewness and kurtosis). Moreover, this measure is appropriate to our portfolios because of their weak skewness, as pointed out by Caporin et al. (2014).

The MVaR is defined by:  $MVaR_{1-\alpha} = \mu - \sigma Z_{CF,\alpha}$  where  $1-\alpha$  is the confidence level of the MVaR,  $\mu$  and  $\sigma$  are the mean and standard deviation of the asset returns, and  $Z_{CF,\alpha}$  is the Cornish-Fisher approximation of the  $\alpha\%$  quantile of the distribution:

$$Z_{CF,\alpha} = Z_\alpha + \frac{1}{6}S(Z_\alpha^2 - 1) + \frac{1}{24}K(Z_\alpha^3 - 3Z_\alpha) - \frac{1}{36}S^2(2Z_\alpha^3 - 5Z_\alpha)$$

where  $Z_\alpha$  is the  $\alpha\%$  quantile of a standard normal distribution,  $S$  is the skewness, and  $K$  is the excess kurtosis. In our paper, we use the conventional quantile  $\alpha\% = 5\%$ .

Ogryczak and Ruszczyński (2002) show that under the expected-utility principle, the VaR criterion is equivalent to the first-order SD (FSD) for risk-averse, while Ma and Wong (2010) prove that the CVaR criterion is equivalent to the second-order SD (SSD) for risk-averse. If  $Y$  dominates  $Z$  in the sense of the FSD and SSD, then it is well known that the mean of  $Y$  is higher than that of  $Z$ . On the other hand, Levy (2015) shows that under some conditions (for example, equal mean), the order of SSD for risk-seekers is reversed from that of the SSD for risk-averse. Chan et al. (2012a) find that in some situations, the second and third order SD for risk-seekers is the same as that for risk-averse. In some other situations, the second and third order SD for risk-seekers is reversed from that for risk-averse. While the order of the MVaR is consistent with that of the CVaR under some conditions, we make the following rules:

- 1) If  $\mu_Y \geq \mu_Z$  and  $MVaR(Y) \leq MVaR(Z)$ , then risk-averse prefer  $Y$  to  $Z$ ,
- 2) If  $\mu_Y \geq \mu_Z$  and  $MVaR(Y) \geq MVaR(Z)$ , then risk-seekers prefer  $Y$  to  $Z$ .

We call (1) the mean-MVaR rule for risk-averse and (2) the mean-MVaR rule for risk-seekers.

#### 4.4. Stochastic dominance analysis for risk-averse and risk-seeking investors

The choice to include the SD approach is motivated by various reasons. First, it can be used to draw inferences on the expected utility maximization for different types of investors. It then allows investors to appropriately rank portfolios without any assumption on the distribution of returns, and only a few very simple assumptions on utility functions.<sup>10</sup> Indeed, the SD method incorporates information on the entire distribution of returns, rather than only the first few moments. Second, the SD method requires no precise assessment as to the specific form of investors' risk preference or utility functions. Thus, in our study, we employ the SD approach to compare the cumulative distribution functions of returns for the portfolios under study. If one portfolio stochastically dominates another, then an investor would prefer the dominating portfolios to maximize his or her expected utility and/or wealth, following the order of the SD, as explained below (Sriboonchitta et al., 2009; Levy, 2015).

To apply the SD approach, we let  $Y$  and  $Z$  be the return series of two portfolios with a common support of  $[a, b]$  ( $a < b$ ), cumulative distribution functions (CDFs),  $F$  and  $G$ , and corresponding probability density functions (PDFs),  $f$  and  $g$ , respectively, and we define:

---

<sup>10</sup> The first and third derivatives of the utility function are positive, while the second one is negative for risk-averse and positive for risk-seekers.

$$H_0 = H_0^R = h, H_j(x) = \int_a^x H_{j-1}(t)dt, \text{ and } H_j^R(x) = \int_x^b H_{j-1}^R(t)dt \quad (1)$$

for  $h = f, g$ ;  $H = F, G$ ; for any integer  $j$ . We call the integral  $H_j$  [ $H_j^R$ ] the  $j^{\text{th}}$ -order [reversed] integral for  $H = F$  and  $G$ . We note that the  $j^{\text{th}}$ -order [reversed] integral defined in (1) corresponds to the  $j^{\text{th}}$ -order [reversed] SD for risk-averters [-seekers], which is defined as follows:  $Y$  dominates  $Z$  by FSD (SSD, TSD) [FRSD (SRSD, TRSD)],<sup>11</sup> denoted by  $Y \succ_1 Z$  ( $Y \succ_2 Z$ ,  $Y \succ_3 Z$ ) [ $Y \succ_1^R Z$  ( $Y \succ_2^R Z$ ,  $Y \succ_3^R Z$ )] if and only if  $F_1(x) \leq G_1(x)$  ( $F_2(x) \leq G_2(x)$ ,  $F_3(x) \leq G_3(x)$ ) [ $F_1^R(x) \geq G_1^R(x)$  ( $F_2^R(x) \geq G_2^R(x)$ ,  $F_3^R(x) \geq G_3^R(x)$ )] for all possible returns  $x$ , and the strict inequality holds for some values of  $x$ , where FSD (SSD, TSD) denotes first- (second-, third-) order traditional SD, and FRSD (SRSD, TRSD) denotes first- (second-, third-) order reversed SD, respectively. We note that Levy (2015) calls the SD theory for risk-seekers the “risk seeking SD theory” and denotes it as RSSD. In this paper, we follow Levy (2015) and call it risk-seeking SD, but we denote it as RSD (instead of RSSD).

For any integer  $j$ , SD corresponds to three broadly defined utility functions,  $U_j$ , for risk-averters, and RSDs correspond to three broadly defined utility functions,  $U_j^R$ , for risk-seekers.  $U_j$  is the set of utility functions such that  $U_j = \{u : (-1)^{i+1} u^{(i)} \geq 0, i = 1, \dots, j\}$ .  $U_j^R$  is the set of utility functions such that  $U_j^R = \{u : u^{(i)} \geq 0, i = 1, \dots, j\}$ , where  $u^{(i)}$  is the  $i^{\text{th}}$  derivative of the utility function  $U$ . It is well-known that for any integer  $j$ ,  $Y \succ_j Z$  ( $Y \succ_j^R Z$ ) if and only if  $E[u(X)] \geq E[u(Z)]$  for any  $u$  in  $U_j$  ( $U_j^R$ ) (Li and Wong, 1999; Guo and Wong, 2016). Thus, risk-averse investors exhibit FSD (SSD, TSD) if their utility functions  $u$  belong to  $U_1$  ( $U_2, U_3$ ). On the other hand, risk-seeking investors exhibit RFSD (RSSD, RTSD) if their utility functions  $u$  belong to  $U_1^R$  ( $U_2^R, U_3^R$ ).

In practice, the above definitions imply that risk-averters prefer portfolios that have a lower probability of loss (lower CDF or lower risk), whereas risk-seekers prefer portfolios that have a higher probability of gain (higher reversed CDF). In other words, to make a choice between two portfolios, risk-averters will choose the one with a lower CDF, since it has a lower probability of loss (e.g.,  $F_1(x) \leq G_1(x)$ ). On the other hand, risk-seekers will choose the one with a higher reversed CDF, since it has a higher probability of gain (e.g.,  $F_1^R(x) \geq G_1^R(x)$ ). To date, SD tests have been well developed (e.g., Davidson and Duclos, or DD, 2000). Since the DD test was found to be powerful, less conservative in size, and robust to non-i.i.d. and heteroscedastic data (Lean et al., 2008), we employ the DD test and its extension as presented in the following subsections.

### A. Stochastic dominance test for risk-averters (SD)

Assume the data  $\{(f_i, g_i)\}$  for  $i = 1, 2, \dots, N_h$  are observations drawn from any two returns of portfolios  $Y$  and  $Z$  with CDFs  $F$  and  $G$ , respectively. For a grid of pre-selected points  $x_1, x_2, \dots, x_k$ , Bai et al. (2015) modify the statistic developed by Davidson and Duclos (2000) to obtain the following  $j^{\text{th}}$ -order SD test statistic,  $T_j(x)$  ( $j = 1, 2$ , and  $3$ ), for risk-averters:

<sup>11</sup> In these definitions, F denotes First Order, S denotes Second Order, T denotes Third Order and R denotes Reversed. Readers may refer to Chan et al. (2012a) and Guo and Wong (2016) for more details on the definitions.



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

where

$$\begin{aligned} \hat{V}_j(x) &= \hat{V}_{F_j}(x) + \hat{V}_{G_j}(x) - 2\hat{V}_{FG_j}(x); \\ \hat{H}_j(x) &= \frac{1}{N_h(j-1)!} \sum_{i=1}^{N_h} (x-h_i)_+^{j-1}, \\ \hat{V}_{H_j}(x) &= \frac{1}{N_h} \left[ \frac{1}{N_h((j-1)!)^2} \sum_{i=1}^{N_h} (x-h_i)_+^{2(j-1)} - \hat{H}_j(x)^2 \right], H = F, G; h = f, g; \\ \hat{V}_{FG_j}(x) &= \frac{1}{N_h} \left[ \frac{1}{N_h((j-1)!)^2} \sum_{i=1}^{N_h} (x-f_i)_+^{j-1} (x-g_i)_+^{j-1} - \hat{F}_j(x)\hat{G}_j(x) \right], \end{aligned}$$

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

It is empirically impossible to test the null hypothesis for the full support of the distributions. Thus, Bishop et al. (1992) propose testing the null hypothesis for a pre-designed finite number of values  $x$ . Specifically, for all  $i = 1, 2, \dots, k$ , the following hypotheses are tested:

$$\begin{aligned} H_0 &: F_j(x_i) = G_j(x_i), \text{ for all } x_i; \\ H_A &: F_j(x_i) \neq G_j(x_i) \text{ for some } x_i; \\ H_{A1} &: F_j(x_i) \leq G_j(x_i) \text{ for all } x_i, F_j(x_i) < G_j(x_i) \text{ for some } x_i; \\ H_{A2} &: F_j(x_i) \geq G_j(x_i) \text{ for all } x_i, F_j(x_i) > G_j(x_i) \text{ for some } x_i. \end{aligned}$$

We note that in the above hypotheses,  $H_A$  is set to be exclusive of both  $H_{A1}$  and  $H_{A2}$ , such that if either  $H_{A1}$  or  $H_{A2}$  is accepted, this does not mean that  $H_A$  is accepted. Bai et al. (2015) suggest using a simulation approach to generate the simulated critical values. In this paper, we follow their recommendation.

The SD test compares the distributions of  $Y$  and  $Z$  at a finite number of grid points, and various studies have examined the choice of these points. Too few grids will miss information on the distributions between any two consecutive grids (Barrett and Donald, 2003). To make more detailed comparisons, we follow Fong et al. (2008), and others, to make eleven equal-spaced major grids (10 partitions) and nine equal-spaced minor grids (10 partitions) within any two consecutive major partitions. We then have a total of 101 grids with 100 equal-spaced partitions in each comparison. Bai et al. (2015) improve the SD test by deriving the limiting process of the SD statistic  $T_j(x)$  so that the SD test can be performed by  $\max_x |T_j(x)|$  to take care of the dependency of the partitions. We follow their recommendation in our analysis.

## B. Stochastic dominance test for risk-seekers (RSD)

We follow Bai et al. (2015) to use the SD test statistic for risk-seekers and call it the risk-seeking SD (or RSD) test statistic. Let  $\{(f_i, g_i)\}$  for  $i = 1, 2, \dots, N_h$  be observations drawn from  $Y$  and  $Z$ . For a grid of pre-selected points  $x_1, x_2, \dots, x_k$ , Bai et al. (2015) modify the statistic developed by Davidson and Duclos (2000) to obtain the following  $j^{\text{th}}$ -order RSD statistics  $T_j^R$  for risk-seekers ( $R$  denotes risk-seeking behavior) such that:

$$T_j^R(x) = \frac{\hat{F}_j^R(x) - \hat{G}_j^R(x)}{\sqrt{\hat{V}_j^R(x)}} \quad (3)$$

where  $\hat{V}_j^R(x) = \hat{V}_{F_j}^R(x) + \hat{V}_{G_j}^R(x) - 2\hat{V}_{FG_j}^R(x)$ ;

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

$$\hat{V}_{H_j}^R(x) = \frac{1}{N_h} \left[ \frac{1}{N_h((j-1)!)^2} \sum_{i=1}^{N_h} (h_i - x)_+^{2(j-1)} - \hat{H}_j^R(x)^2 \right], H = F, G; h = f, g;$$

$$\hat{V}_{FG_j}^R(x) = \frac{1}{N_h} \left[ \frac{1}{N_h((j-1)!)^2} \sum_{i=1}^{N_h} (f_i - x)_+^{j-1} (g_i - x)_+^{j-1} - \hat{F}_j^R(x) \hat{G}_j^R(x) \right];$$

and the integrals  $F_j^R(x)$  and  $G_j^R(x)$  are defined in (1) for  $j=1,2,3$ . For  $i=1,2,\dots,k$ , the following hypotheses are tested for risk seekers:

$$H_0 : F_j^R(x_i) = G_j^R(x_i), \text{ for all } x_i;$$

$$H_R : F_j^R(x_i) \neq G_j^R(x_i) \text{ for some } x_i ;$$

$$H_{R1} : F_j^R(x_i) \geq G_j^R(x_i) \text{ for all } x_i, F_j^R(x_i) > G_j^R(x_i) \text{ for some } x_i;$$

$$H_{R2} : F_j^R(x_i) \leq G_j^R(x_i) \text{ for all } x_i, F_j^R(x_i) < G_j^R(x_i) \text{ for some } x_i.$$

We construct grid points for the RSD test (for risk-seekers) in the same way as for the SD test (for risk-aversers) to get 101 grids with 100 equal-spaced partitions in each comparison. We also follow the approach recommended by Bai et al. (2015) to obtain the simulated critical values for the RSD test.

Not rejecting either  $H_0$  or  $H_A$  or  $H_R$  implies: (1) there is no SD between  $Y$  and  $Z$ ; (2) there is no arbitrage opportunity between these two portfolios, and thus, no portfolio is preferred to the other. If  $H_{A1}$  ( $H_{A2}$ ) [ $H_{R1}$  ( $H_{R2}$ )] of order one is accepted,  $Y$  ( $Z$ ) stochastically dominates  $Z$  ( $Y$ ) at the first order for risk-aversers [-seekers]. In this situation, and under certain regularity conditions,<sup>12</sup> an arbitrage opportunity exists and investors will be better off switching from the dominated to the dominant portfolio. These results imply that neither the market efficiency nor the market rationality holds in these markets (Chan et al., 2012b; Qiao et al., 2013). On the other hand, if  $H_{A1}$  ( $H_{A2}$ ) [ $H_{R1}$  ( $H_{R2}$ )] is accepted at order two (three), a particular portfolio stochastically dominates the other at the second (third) order. In this situation, an arbitrage opportunity does not exist, and switching from one portfolio to another will only increase the expected utility of risk-aversers [-seekers], but not their expected wealth (Jarrow, 1986; Falk and Levy, 1989; Wong et al., 2008). These results imply that both market efficiency and market rationality could still hold in these markets.

In order to minimize Type II errors and to accommodate the effect of almost SD,<sup>13</sup> we follow Gasbarro et al. (2007), among others, and use a conservative 5% cut-off point in checking the proportion of test statistics for statistical inference. Using a 5% cut-off point implies that one prospect dominates another only if at least 5% of the statistics are significant.

<sup>12</sup> Please refer to Jarrow (1986) for the conditions.

<sup>13</sup> Readers may refer to Leshno and Levy (2002) and Guo et al. (2014, 2016) and the references therein for more information. Leshno and Levy (2002) use an example of 1% violation to state the problem of almost SD.

## **5. Results and discussions**

As mentioned in Section 4, we build 4 types of portfolios: PF1 (100% stocks), PF2 (50% stocks+50% gold), PF3 (Markowitz minimal-variance portfolios), and PF4 (CCC-GARCH portfolios). In this section, we will first present the results on the weights of gold in PF3 and in PF4. Once all the portfolios are built, we will then conduct the double comparison between Islamic portfolios and conventional portfolios (for both with and without gold) and between portfolios with and without gold (for both Islamic and conventional portfolios). The MR results are presented first, followed by SD results.

### **5.1. The weight of gold in portfolios PF3 and PF4**

As explained in Section 4.1, PF3 is the minimal-variance portfolio (Markowitz, 1952) for each sectorial stock portfolio (either Islamic or conventional) diversified by gold. The weights of gold in these portfolios are presented in Table 2.

[Insert Table 2 here]

As mentioned in Section 4.1, we use the CCC-GARCH model to calculate the optimal weight of gold in PF4 (either Islamic or conventional). Table 3 presents the results.

[Insert Table 3 here]

In both PF3 and PF4, the weight of gold is higher in Islamic portfolios than in conventional ones. However, this difference is not very high (between 1% and 5%). Nevertheless, for the Utilities sector, there is a very high difference: 53% for Islamic and 33% for conventional portfolios in PF3, while the numbers are 50% and 33% in PF4, respectively. These high weights of gold in portfolios minimizing the risk (measured by the variance in PF3 and conditional variance in PF4) confirm the results of previous studies about the positive role of gold in the diversification of portfolios (e.g., Choudhry et al., 2015; Nguyen et al., 2016).

As we now have the composition of the four portfolios, the following sections will focus on the double comparison between Islamic and conventional portfolios and between portfolios with gold and those without gold

### **5.2. Mean-risk comparisons**

#### **5.2.1. Mean-risk comparisons between Islamic and conventional portfolios**

The tables below present the results on mean-variance and mean-MVaR analyses to compare the performance of both Islamic and conventional portfolios for the four kinds of portfolios (PF1, PF2, PF3, and PF4) defined in Section 4. Table 4 presents results on PF1, Table 5 on PF2, Table 6 on PF3 and Table 7 on PF4.

[Insert Tables 4, 5, 6, and 7 here]

From Table 4 (PF1, 100% stocks), the MV results show that the average returns are not significantly different in all sectors. However, for half of the sectors (Basic Materials, Consumer Services, Financials, Telecommunications, and Utilities), the variances of Islamic stocks are significantly greater than those of the conventional ones. For the other half, the variances are not significantly different. The two highest differences are for the Utilities and Financial sectors (20% vs. 14% and 25% vs. 21%, respectively, with a p-value less than 1%). The conclusion drawn from the mean-MVaR is similar to that from the mean-variance analysis. Table 5 (PF2, 50% stocks+50% gold) shows that there is no significant difference in the average returns of all the Islamic and conventional portfolios, while the difference in variances is not significant for almost all sectors, except two: Financials and Utilities. For these latter, the variance is higher with Islamic portfolios than with the conventional ones. This result thus suggests that investors in these two sectors prefer conventional portfolios if they are risk-averse and Islamic portfolios if they are risk-seeking. From Table 6 (PF3, minimal-variance portfolios), we find that the results are the same as those for PF2 in Table 5. This means that there is no significant difference in the mean returns, while there are significant differences for the variances in the Financial and Utilities sectors. The results from Table 7 (PF4, CCC-GARCH portfolios) are also consistent with those from Tables 5 and 6.

Thus, the MR analysis, on the comparison between Islamic and conventional portfolios, leads to the following conclusions. First, we find that for the portfolios without gold (PF1), risk-averse investors prefer conventional portfolios (with the same return and smaller risk), while risk-seeking investors prefer the corresponding Islamic portfolios (with the same return and higher risk) in five sectors (50%). However, in the other five sectors, both risk-averse and risk-seeking investors are indifferent between the Islamic and conventional portfolios over the entire period. Second, the inclusion of gold in these portfolios following different strategies (PF2, PF3, and PF4) results in more indifference between the Islamic and conventional portfolios. There are only two sectors (Financials and Utilities) in which risk-averse investors would be better off choosing the conventional portfolios, while risk-seeking investors would be better off choosing Islamic. Regarding these sectorial differences, Charles and Darné (2015) find that the Islamic indexes outperform their conventional counterparts in the Basic Materials, Consumer Goods and Services, Health Care, Industrials, Technologies and Telecommunications sectors. They argue that Islamic screens lead to a higher concentration in some sectors, especially Basic Materials, Industrials and Technology in most DJ Islamic indexes. In addition, within the four diversification strategies under study, the equal-weighted portfolio (PF2) gives the highest rate of return confirming the finding of De Miguel et al.

(2009). However, the portfolios that follow the Markowitz approach (PF3) provide the lowest variance.

The following section presents the results on the second comparison, between portfolios with gold (PF2, PF3, PF4) and those without gold (PF1), using the MR method.

### **5.2.2. Mean-risk comparisons between portfolios with and without gold**

The results on conventional portfolios are presented in Panel A and those on Islamic portfolios in Panel B of Table 8.

[Insert Table 8 here]

We first focus on the conventional portfolios, with and without gold. From Panel A, the results of the t-test show that there is no significant difference in the average returns between the portfolios with gold (PF2, PF3, PF4) and the portfolio without gold (PF1). However, the results from the F-test show that the variances of returns of portfolios with gold are significantly lower than that of portfolios without gold in all sectors. This means that in the conventional portfolios, gold helps to reduce the volatility of returns. This result is consistent with the findings in Hoang et al. (2015a) and Hoang et al. (2015b) for French and Chinese conventional portfolios, respectively. The results for Islamic portfolios (Table 8, Panel B) remain the same, meaning that risk-averse investors prefer Islamic portfolios with gold and risk-seeking investors prefer Islamic portfolios without gold. The conclusion drawn from the mean-MVaR is similar to that from the MV analysis.

Overall, the MR analysis on the comparison between portfolios with and without gold leads to the following conclusions. Regardless of the diversification strategies (PF2, PF3, and PF4), portfolios with gold dominate portfolios without gold for risk-averse investors, while it is the reverse for risk-seekers. This conclusion holds for both the Islamic and the conventional portfolios and for any sector. This implies that following the MR analysis, the impact of gold remains the same either for conventional or Islamic portfolios. This evidence supports the argument by Sadorsy (2014) in distinguishing between conventional stocks and socially responsible stocks. The results regarding risk-averse investors are consistent with those of previous studies, such as Hoang et al. (2015a), Kumar (2014), Baur and Löffler (2015), and Choudhry et al. (2015), among others. As for risk-seeking investors, very few studies have investigated this kind of investors, so it is hard to establish a consistent comparison with previous studies. We also notice that the decrease of the variance is higher for PF3 (minimal-variance portfolios) and PF4 (CCC-GARCH portfolios) than for PF2 (50% stocks and 50% gold). This suggests that the strategies minimizing the variance of returns are more efficient

than the naïve strategy (equal-weighted portfolios, PF2). This finding is consistent with the findings from Hoang et al. (2015b) in the Chinese context.

### **5.3. Stochastic dominance comparisons**

We first compare between Islamic and conventional portfolios (section 5.3.1) and follow by the comparison between portfolios with gold and those without gold (section 5.3.2).

#### **5.3.1. SD comparisons between Islamic and conventional portfolios**

Table 9 shows the comparison between Islamic and conventional portfolios within each strategy (PF1 to PF4). There is no first-order stochastic dominance relationship between the Islamic and conventional portfolios for any diversification strategy and for any sector. This implies that there is no arbitrage opportunity for Islamic and conventional portfolios. This supposes that Islamic and conventional markets are efficient (see Section 4). In addition, similar to the results obtained from the MR analysis, there is no second- or third-order SD relationship in some sectors while it is the case in some other sectors. However, different from the MR analysis, there are more dominance relationships when applying the SD approach, as detailed in the following paragraphs.

[Insert Table 9 here]

In the first portfolio (PF1, 100% stocks), the conventional portfolios second- and third-order stochastically dominate their Islamic counterparts for risk-averse investors. As for risk-seeking investors, the preference is reversed in most sectors (seven over ten), except the Consumer Goods, Health Care and Telecommunications sectors for which there is no SD. This result can be explained by the fact that Islamic stocks are more volatile than their conventional counterparts (see Table 1). That is why risk-averse investors prefer conventional portfolios to Islamic ones, while the reverse is true for risk-seeking investors.

For the second portfolio (PF2, 50% stocks+50% gold), there is the same number of sectors for which there is no SD relationship and 3 more sectors for which there is no RSD relationship, compared to PF1. This suggests that including 50% gold in the portfolio may significantly change the relationship between Islamic and conventional stocks. The sectors for which there is no SD include Financials, Health Care and Industrials. For most of the other sectors, the principal result is: risk-aversers prefer conventional portfolios, while risk-seekers prefer Islamic portfolios. However, the preferences are reversed in the Consumer Goods sector such that risk-aversers prefer Islamic portfolios, while risk-seekers prefer conventional portfolios. The Consumer Services sector is different because there is no SD relationship for risk-seekers but risk-aversers prefer Islamic portfolios. The same mixed result is also found

for the Telecommunications sector, for which there is no SD for risk-seekers, while risk-averse investors prefer conventional portfolios. Overall, the results on PF2 lead to the conclusion that including gold can significantly change the relationship between the Islamic and the conventional portfolios. In most sectors, risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer Islamic portfolios.

For PF3 and PF4 (minimal-variance and CCC-GARCH portfolios), the results are similar to those for PF2: There are more sectors in which there is no SD and/or RSD relationship than in PF1. But different from PF2, both PF3 and PF4 have more sectors in which there is no SD relationship when comparing with PF2, but there are fewer sectors in which there is no RSD relationship when comparing with PF1. Furthermore, for PF3 and PF4, risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer the Islamic counterparts in four sectors out of ten (Basic Materials, Technology, Telecommunications and Utilities). In other sectors, including Consumer Services, Financials, Health Care and Oil & Gas, there is no SD relationship. For the two remaining sectors, Consumer Goods and Industrials, the results are a bit different: There is no SD for risk-averse investors, while for risk-seeking investors, the conventional portfolios dominate in the Consumer Goods sector and the dominance is reversed in the Industrials sector.

Overall, the SD comparison between Islamic and conventional portfolios leads to the conclusion that in most sectors, risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer Islamic portfolios. The next sub-section will focus on the SD comparison between portfolios with gold and those without gold (PF2, PF3 and PF4 to PF1).

### **5.3.2. SD comparisons between portfolios with and without gold**

Table 10 shows that similar to the findings on the comparison between Islamic and conventional portfolios, there is no first-order SD. This suggests that there is no arbitrage opportunity between portfolios with and without gold and markets with and without gold are efficient (see Section 4). For both Islamic and conventional portfolios, those with gold stochastically dominate those without gold for risk-averse investors. On the contrary, risk-seekers prefer portfolios without gold to those with gold in almost all sectors. This result is true for all strategies with gold (PF2, PF3 and PF4) and for nearly all sectors. This thus confirms the theory that risk-averse investors prefer more diversified portfolios to reduce their risk, while risk-seeking investors prefer less diversified portfolios, which provide higher risks. This result also shows that it is important to distinguish between risk-averse and risk-seeking investors when studying gold investments.

[Insert Table 10 here]

Overall, the SD analyses on the above-mentioned double comparison lead to the following conclusions: First, there is no arbitrage opportunity. Second, the efficient market hypothesis may hold in these markets. Third, as with the findings from the MR analysis, risk-averse investors prefer investing in portfolios with gold, while risk-seekers prefer portfolios without gold for all strategies, for both Islamic and conventional portfolios, and for nearly all sectors. Fourth, in most sectors, the conclusion drawn from the SD analysis is consistent with the MR analysis: risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer the corresponding Islamic portfolios. Fifth, the diversification strategies with gold can significantly change the relationships between Islamic and conventional portfolios. Sixth, the sectorial effect is significant and in most sectors, risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer Islamic portfolios. In other sectors, the preference is reversed or there is no SD relationship. Seventh, in most cases, adopting the strategy proposed by Markowitz (1952) or Kroner and Ng (1998) does not change the preference of investors. Eighth, there are differences between the naïve strategy (equal-weighted portfolios or PF2) and risk-minimizing strategies (PF3 and PF4).

The above conclusions are for the entire period (2002-2014). However, do these results remain true in different periods? It is the robustness check that we perform in the next section.

## **6. Robustness check: Are results time-dependent?**

As in previous sections, we also conduct a double comparison (between Islamic and conventional portfolios and between portfolios with and without gold) in three different sub-periods defined in Section 3. We recall that the first sub-period (bull market for all markets) is from December 31, 2002, to June 7, 2008; the second one (bull market for gold and bear market for stocks) is from June 8, 2008, to September 6, 2011; and the third one (bear market for gold and bull market for stocks) is from September 7, 2011, to December 31, 2014.

### **6.1. Comparisons between Islamic and conventional portfolios in sub-periods**

#### **6.1.1. Mean-risk comparisons<sup>14</sup>**

Overall, the results of the MR analysis in each sub-period are similar to those for the entire period. For example, the average returns are not significantly different, between the conventional and Islamic portfolios for PF1, in all the three sub-periods. The variances of

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<sup>14</sup> The tables reporting the MR analysis for the double comparison (between Islamic and conventional portfolios, and between portfolios with gold and without gold, next sub-section) in the three sub-periods contain many panels. Thus, we only report the results and skip exhibiting the tables in the Appendix file. They are available upon request. The tables for SD comparisons are still reported in the Appendix file.



Islamic portfolios are either significantly higher than those of conventional portfolios or not significantly different for PF1 in all three sub-periods. Thus, the sub-period analysis confirms our first conclusion from the MR analysis for the entire period: Risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer the corresponding Islamic portfolios in some sectors, while there is no preference in other sectors. As for portfolios with gold (PF2, PF3, PF4), the results are similar to those for PF1. However, it remains that including gold changes significantly the relationship between Islamic portfolios and conventional ones.

### **6.1.2. Stochastic dominance comparisons**

Table 11 shows that in the 1<sup>st</sup> sub-period for PF1 (100% stocks), risk-averse investors prefer conventional portfolios; while risk-seeking investors prefer Islamic portfolios for almost all sectors (except the Consumer Goods sector). The situation changes in the 2<sup>nd</sup> and 3<sup>rd</sup> sub-periods for different sectors: either the preferences of risk-averse and risk-seeking investors change or there is no longer a SD relationship between the Islamic and conventional portfolios. We illustrate this by looking at the Health Care sector for which risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer Islamic portfolios in the 1<sup>st</sup> sub-period. However, in the 2<sup>nd</sup> sub-period, the preference is reversed. Furthermore, in the 3<sup>rd</sup> sub-period, risk-averse investors prefer conventional portfolios, while risk-seekers are indifferent. This finding shows that the relationship between Islamic and conventional portfolios is time-dependent.

[Insert Table 11 here]

## **6.2. Comparisons between portfolios with gold and without gold in sub-periods**

In this sub-section, we will analyze the impact of time on the comparison between portfolios with gold (PF2, PF3 and PF4) and those without gold (PF1) in the three sub-periods. We first apply the MR approach and follow with the SD approach.

### **6.2.1. Mean-risk comparisons**

First, the results of the t-test show that the average returns are not significantly different between portfolios with gold and those without gold in each sub-period in all cases. This is thus similar to the results of the whole period. Second, the results of the F-test show that the variances of returns for portfolios without gold are significantly greater than those of portfolios with gold (for all strategies, all sub-periods and both Islamic and conventional portfolios). Thus, similar to the whole period, the inclusion of gold helps to reduce the volatility of returns of portfolios. However, there are exceptions in some sectors, such as

Consumer Goods, Consumer Services, Financials and Utilities. For example, in sub-period 1, for Islamic portfolios in the Utilities sector, there is no significant difference in the variances of returns between PF1 and PF2, PF3, and PF4. These exceptions can change in different sub-periods and in different sectors. Thus, we conclude that the time period can have an impact on some sectors. As for the MVaR, the finding is the same as that for the variance. These results are similar for conventional portfolios and Islamic portfolios. This suggests that following the MR approach, the impact of gold on Islamic and conventional stocks is not significantly different. In most cases, risk-averse investors prefer portfolios with gold, while risk-seeking investors prefer portfolios without gold. This result is similar to that for the whole period for most cases. Finally, this result leads us to suggest that based on the MR approach, the impact of the time period on the comparison between portfolios with and without gold is not significant in most cases, but it can be significant for certain sectors, especially for the Financial and Utilities sectors.

### **6.2.2. Stochastic dominance comparisons**

Last, we present the results obtained by using the stochastic dominance approach in Table 12 to compare portfolios with gold (PF2, PF3, PF4) to those without gold (PF1) (for both Islamic and conventional portfolios in each sector and in each sub-period). The table reveals that the results for sub-periods 1 and 2 are very similar to those for the whole period. This means that in the first two sub-periods, for most cases, risk-averse investors prefer portfolios with gold, while risk-seeking investors prefer portfolios without gold. On the other hand, the results of the third sub-period are very different for risk-averse investors, since, in most cases, there is no SD relationship between portfolios with gold and those without gold. For risk-seeking investors, the results remain the same as those for the whole period in almost all cases. This may suggest that the tendency of gold prices to decrease from 2011 to 2014 may have changed the behavior of risk-averse investors but not that of risk-seeking investors. Finally, these results show that following the SD approach, the results are time-varying. These findings on sub-periods also suggest that gold can be considered as a safe haven asset for risk-averse investors in the first two sub-periods when the price of gold was on an upward trend. However, it is not the case in the third sub-period when gold was on a downward trend. In the latter case, both risk-averse and risk-seeking investors prefer to invest in portfolios without gold to those with gold.

[Insert Table 12 here]

## 7. Conclusions

Through this research, we have found that it is important to use the stochastic dominance (SD) method to compare between Islamic and conventional portfolios. Indeed, the mean-risk (MR) approach (mean-variance and mean-MVaR) leads to the conclusion that the difference between them is not significant (except for the Financials and Utilities sectors). However, following the SD approach, we find that there is a SD relationship between Islamic and conventional portfolios in most sectors. Regarding the impact of gold, the MR results show that including gold does not change the relationship between Islamic and conventional portfolios, while the SD approach shows the contrary. These findings thus suggest that it is important to use a robust method, such as stochastic dominance, to compare Islamic to conventional stocks and to compare portfolios with gold to those without gold.

Following the MR results, risk-averse investors prefer conventional portfolios, while risk-seeking investors prefer the corresponding Islamic portfolios in only two sectors (Financials and Utilities). However, following the SD results, this is the case in most sectors. This result suggests that Islamic portfolios represent a higher risk and thus correspond more to investors being risk-seeking. As for the benefit of gold in the diversification of portfolios, the comparison of PF2, PF3, PF4 (with gold) to PF1 (without gold) shows that, in most cases, risk-averse investors prefer portfolios with gold, while risk-seeking investors prefer portfolios without gold. This is true for both Islamic and conventional portfolios. This finding thus confirms the theory that risk-averse investors prefer more diversified portfolios in order to reduce the risk. Our robustness check shows that these results are time-dependent and gold tends to be more profitable in down-trending periods for stocks. This thus confirms the role of gold as a safe haven highlighted in numerous past studies. Furthermore, there are significant sectorial differences, especially with the Financials and Utilities sectors when comparing Islamic to conventional stocks. Finally, as expected, the equal-weighted portfolio (50% stocks+50% gold) has different characteristics compared to the minimal-variance portfolio (Markowitz, 1952) and CCC-GARCH portfolio (Kroner and Ng, 1998). These results reveal interesting managerial implications in terms of portfolio diversification regarding investors' beliefs and risk-aversion levels.

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