# Testing for Predictive ability of conventional and Shariah indices of selected Gulf Countries and Economic Regions Using Neural Network Modelling

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**Abstract**

*The study employs Islamic indices along with mainstream indices and macroeconomic variables. The Indices include the Islamic and traditional Indices of the Kingdom of Saudi Arabia, Oman, UAE, GCC, BRIC's and the Euro Area. Firstly the correlations of returns between the six pairs of traditional and Shariah indices are calculated to assess their movement with respect to each other. Secondly the macroeconomic variables i.e. Price of Brent Crude and respective exchange rate of the Countries' currency with the USD are used to predict the stock prices of the traditional and Shariah indices. The results are based on the KTB MLP structure, MSE and relative error. For prediction of Stock indices of GCC, BRIC and Euro Area Elman network has been used. It is found that the macroeconomic variables used in forecasting model have been more accurate in predicting Shariah stock Indices for Saudi Arabia, Oman and UAE and the economic regions.*

***Keywords:*** *Islamic Indices, Macroeconomic variables, Artificial neural networks.*

## Introduction

The recent years have witnessed a tremendous upsurge in the Islamic financial industry, especially in the dominantly Muslim countries in Middle East and Southeast Asia. The investments in Islamic Finance has been reinforced in the wake of the 2008–2009 global financial crisis. The value of the total Islamic financial assets under management was estimated at US$1.6 trillion at the end of 2012 and US$1.8 trillion at the end of 2013, and is expected to be US$2.1 trillion at the end of 2014. These assets have been

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increasing at a CAGR of 16%.[3] The Islamic financial asset is expected to be about US$6.5 trillion by 2020.[4] The Sukuk (Islamic bond) market was expected to reach US$131.2 billion on a global level. The total amount of the Islamic banking assets, which are the main driver of the global Islamic financial industry, was estimated at US$1.27 trillion at the end of 2012.

The sectoral allocation of Islamic funds is about 46.9% equities, 22.2% money markets, 11.8% mixed assets and 9.0% real estate. The new and innovative Islamic financial industry is now being considered as an alternative portfolio diversification. From a religious point of view, Islamic investing differs from conventional investing because Muslims, as per Quran, are prohibited to receive and pay any kind of Usuary (Interest), or to invest in certain companies engaged in unethical business such as alcohol producers or to engage in speculation. The Islamic funds invest in the stock market through Islamic equity funds which are similar to conventional mutual funds, but refrain from the companies as mentioned above and comply with the Shariah law.

Islamic equity, theoretically is less susceptible to any untoward shock as they exhibit lower leverage effects due to screening of companies invested heavily in debt. The debt allowance upper limit is only about 33% as per various scholars. However, a smaller number of stock in a fund or an index, exaggerated by high concentration in few sectors, may result in multiplied effect of the crisis due to less diversification effect.

In order to help the investors achieve diversification benefits, one needs to research how the Islamic stock indices move with respect to other mainstream indices. Proponents of Islamic investment stress that the Islamic stock indices provide better diversification benefits due to the innate features of Islamic Indices such as, screening on the basis of ethical business and maximum debt threshold, exclusion of derivatives financial sectors and intensive structured financial products, limits to interest-based leverage. An Islamic stock index is argued to be more resilient to a financial crisis compared to a conventional stock index (Charles, Pop, & Darn, e, 2011; Sukmana & Kolid, 2012).

The present study attempts to assess the diversification benefit of Islamic equities (indices as proxy) in comparison to their mainstream peers. It is of importance for both Islamic institutional investors as well as Shariah-compliant firms. At present the challenge for individual or Islamic institutional investors has been a small number and lesser variety of asset class of Shariah-compliant investment options. Traditionally

3 Earnst & Young World Islamic banking competitiveness report 2013-2014.
4 Various Bloomberg research reports.

they have been dominated by traditional asset classes such as equities and Sukuk (Islamic bonds). This screening results in a lower number of investable equities, with concentration in particular sectors. In view of that, our study attempts to address this issue through assessing the returns, correlation risk and prediction using artificial neural networks. Recent research activities in artificial neural networks (ANNs) have shown that ANNs have powerful pattern recognition capabilities (Widrow et al., 1994).

With the emergence of Shariah compliant firms, various Islamic indices have been formed. This study also attempts to find if these Shariah Indices are as efficient as their Conventional counterparts. The efficiency can gauged by the predictive ability of the neural network model. The higher the accuracy the index can be predicted, lesser is its efficiency. Also since the economies in gulf are highly dependent on crude oil and their remittance is in form of US Dollars, hence it's imperative to study and predict the stock indices using these two macroeconomic variables.

**Literature Review**

Ata and Bugan (2016) in their study measured bank efficiencies with the help of Data Enveloping Analysis (DEA) and then studied factors that affect bank efficiency. They determined it using the Tobit regression model. They concluded that the factors affecting the efficiency of banks are asset size and net interest margin.

Siddiqui and Abdullah (2015) used Artificial Neural network model to predict the stock prices of CNX Nifty 500 using assorted independent variables using Artificial Neural Networks. The variables used in the study were USD-INR exchange rate, Crude oil price and major stock indices of USA (S&P 500), Euro Zone (Euro Stoxx 50), China (Shanghai Composite Index) and Japan (Nikkei 225). The Artificial Neural network model achieved a predictive accuracy of more than 85%.

Farooq and Reza (2014) applied technical analysis on leading Islamic indices and explored if these indices are apt for using same kind of analysis as is applied to conventional indices and whether technical analysis, produces distinct or superior return to fundamental analysis. They applied basic tools of Technical Analysis, i.e. moving averages, MACD and Stochastic indicators to Dow Jones Islamic Market US Index (IMUS) and compared it with major market indices: Dow Jones Industrial Average, S&P 500 Index and NASDAQ 100.

Rizvi and Arshad (2014) proved Islamic Indices have provided more risk averse alternatives. They employed DJIMI index family and covered 12 years from 3rd

January 2000 to 30th December. Multivariate GARCH DCC methods were used. The study found that Islamic indices has negative correlation with conventional indices at the time of crisis period which means Islamic indices provides better alternative for credit crunch.

Karim, Datip and Shukri (2014) enquired into the performance of Shariah stock market and their conventional counterparts of Malaysia. For their study, the period of January 2000 to October 2011 was taken. The analysis was done by using Treynor ratio, Adjusted Jensen Alpha Index, Sharpe ratio and modified Sharpe ratio, Granger Causality Test and Co-integration. The results of the study revealed that Shariah Compliant stocks earn more return, even at the time of economic crisis and the existence of significant bi-directional causality for short term between both indices

Rahman et.al (2010) compare the criteria used for Kuala Lumpur Stock Exchange Shari'ah Index (KLSESI) and the Dow Jones Islamic Market Index (DJIM) in screening a permissible company for investment purposes. The major screens used are: level of debt and level of liquidity of company. The results reveal that the KLSESI does not use the criteria set by the DJIM as its measures during the screening process. Studying the level of debt criterion, it was found that 44.07 percent of the companies listed under the KLSESI have debt higher than the threshold allowed for Islamic investments. Sukmana and Kholid (2010) studied the effect of global financial crisis on Jakarta Islamic index and Jakarta Composite index. Their study used data from 2001 to 2009 using the daily closing price. The period for the global financial crisis was considered from March 2008 to July 2009 in their study. Their study employed ARCH and GARCH models to estimate the variances of the given indices. The study concluded that the volatility of the Islamic index was less than that of traditional composite index in Malaysia during the global financial crisis period.

Kok and et al (2009) performed empirical analysis of Shariah Compliant Indices (SCIs) by evaluating the performance of various SCIs, in comparison to similar traditional mainstream indices and some ethical funds. They studied for co-integration among the SCI's and the mainstream indices to find out if there is any scope for diversification. They concluded that SCIs provide for portfolio diversification with mainstream indices and other ethical funds in UK.

Biek and Wardhana (2009) found a relationship between Jakarta Islamic Index and some selected stock market indices for the period of January 2006 to December 2008. Their study applied Unit root testing, Cointegration approach and Vector autoregressive

model (VAR) to examine the long term relationship between the selected sample indices in the study. The results attested to the fact that there is no long term relationship between Jakarta Islamic Index and other selected stock Market indices for the study period.

Majid and Yusof (2009) studied the short- and long-run dynamics between the macroeconomic variables and Islamic stock market for Malaysia using Autoregressive Distributed Lag Model (ARDL. The period in their study was post financial crisis of 1997 to 2006 by using Autoregressive Distributed Lag Model (ARDL). The study found that when interest rates rise in the domestically or international market, the Muslim investors will buy more Shariah compliant stocks; thereby escalating the Islamic stock prices.

Sadegi (2008) assessed the effect of the introduction of Bursa Malaysia Islamic index (BMII) on the financial performance and liquidity of the screening securities involved in the Islamic index in Malaysia. The study employed event study methodology to estimate mean cumulative returns of the Shariah compliant stocks in the days surrounding the event and also investigate the changes in liquidity using trade volume and bid ask spread surrounding the event days as liquidity proxies. The study found that the introduction of the Shariah index has positive and strong impact on the financial performance of the Shariah compliant stocks.

Bastaki (2008) assessed the impact of Islamic investment guidelines during security selection on investor's wealth by using 156 Dow Jones listed Shariah companies for the period of July 1986 to July 2006 in London. Using regression model, the study revealed that the Shariah-based investments may be profitable over conventional investments in companies. They also concluded that the Shariah based investments are more profitable during bear market conditions.

Hussein (2005) compared the FTSE Global Islamic Index to the FTSE All-World Index over a sample period from 1996 to 2003. His results show that the Shariah-compliant index consistently outperformed its counterpart in bull markets whilst it underperformed the FTSE All-World Index in bear markets. Moreover, this study also indicated that, by and large, the use of Islamic screens, described above, failed to adversely affect the performance of Shariah-compliant funds.

Hakim and Rashidian (2004a) in their paper, "Risk and Return of Islamic Stock Market Indexes" study the relationship between three variables i.e. DJIMI, Wilshire 5000 index, and 3-month Treasury Bill. The data for the study is for the period 1999 to 2002.

The study employs causality and cointegration analysis. The results show that DJIMI is not correlated with both the Wlishire 5000 index and 3-month T-bill. The authors concluded that the screening and omission involved in constructing Islamic indices result in formation of index with different risk-returns features from their conventional counterparts.

Hakim and Rashidian (2004b) analyzed the risk and return of the three global indices i.e. Dow Jones Islamic World Index, Dow Jones World index and Dow Jones Sustainability (DJS) World index. They used weekly closing value of the indices and LIBOR (as a proxy for the risk-free rate) for the period January 5, 2000 to August 30, 2004. Using CAPM, their study revealed that the most popular index is market competitive but underperforms in relation to another morally restricted but non-Islamic index for the study period. The study concluded that investors in the Islamic index are not significantly adversely affected for complying with the Shariah restriction laws.

Yumlu et al (2004) compared ANN with conventional autoregressive model. The authors studied 12 years of financial data (a set of ISE index closing values, USD values and two interest rates) using a modular ANN model. The authors concluded that the model outperformed the conventional autoregressive model used qfor comparison. They stated that the model introduces a powerful way to predict the volatility of financial time series data, contradicting EMH.

Egeli et al (2003) conducted study on ISE stock market values and build an ANN model that uses previous day's index value, exchange rate and simple interest rate as input to forecast ISE price fluctuations. They constructed a model with the previous day's index value, the previous day's Turkish Lira/USD exchange rate, the previous day's overnight interest rate and 5 dummy variables each representing the working days of the week. They tried three different numbers of hidden layers (1, 2 and 4) and acquired the lowest error rate and the highest accuracy using a single hidden layer. They concluded that ANN models have been superior to the 5-day/10-day moving averages model.

Ahamad and Ibrahim (2002) compared the risk and return performance of Kuala Lumpur Shariah Index (KLSI) with Kuala Lumpur Composite index (KLCI) during the period 1999 to 2002. The sample period of the study is divided into growing period, decline period and overall period. They have employed relative return technique, Standard deviation, risk adjusted performance measurement and two sample t - test to measure the performance of both indices. The study found that KLSI underperforms

during overall period and decline period but it overperform in growing period. Finally they find that there is no significant difference in performance of both indices during three sample period.

Hassan (2002) examined the market efficiency and time-varying risk return relationship for the Dow Jones Islamic Index (DJIM) from 1996 to 2000 using empirical methodology. The paper employed serial correlation, variance ratio and ADF tests to investigate the market efficiency of DJIM index. The results show that DJIM returns are normally distributed and that DJIM index returns are efficient.

Hakim and Rashidian (2002) used CAPM and found that the DJIMI performs well as compared to the Dow Jones World (DJW) Index, but underperforms the Dow Jones Sustainability (DJS) World Index. Some studies also showed that Islamic indices outperform during bull period while underperform during bear period, with the reasons for investing in growth and small-cap firms.

Sadorsky (1999) examined the relationship between occurring shocks in oil prices in U.S.A and the stock returns. The study was performed for the period 1947-1996. The study used VAR and GARCH analysis, which were applied using interest rate and industrial production output. It was concluded that oil prices and volatility in the oil prices plays a vital role in affecting the returns of stock prices. Moreover, shock volatilities occurring in oil prices have asymmetric effect on the economy.

## Research Methodology

### Data

The study employs various Islamic indices along with mainstream indices and macroeconomic variables. The Indices include the Islamic and traditional Indices of the Kingdom of Saudi Arabia, Oman, UAE, Gulf Cooperation Council (GCC), BRIC region and the Euro Area. The frequency of data is daily. The data used is the five years data from June 2010 to May 2015. Data has been matched and missing values excluded where required. The Macroeconomic variables used are the exchange rate for Saudi Arabia, Oman, UAE and the Crude oil price. The Variables used are:

- *BRIC Shariah Index (SPSHBRE)*
- *S&P BRIC 40 Index*
- *S&P GCC Investable Shariah Index*
- *Bloomberg GCC 200 Index (BGCC200)*
- *S&P Europe 350 Shariah Index.*
- *Euro Stoxx 50 Index*

- *S&P Saudi Arabia Domestic Shariah Index*
- *Saudi Arabia Tadawul TASI Index*
- *S&P Oman Domestic Shariah Index*
- *Oman MSM 30 Index*
- *S&P UAE Domestic Shariah Index (SPDJ)*
- *UAE ADX General index*
- *Saudi Arabian Riyal and USD Exchange rate.*
- *UAE Dirham and USD Exchange rate*
- *Omani Riyal and USD Exchange rate*
- *Price of Brent Crude in US Dollar.*

**Artificial Neural Networks**

Artificial neural networks are statistical learning algorithms which are akin to biological neurons in their functioning. Similar to biological neurons ANNs also have Synapse which are the connections between different neurons. Each synapse has a weight associated which determines the strength of the input signal. The activation function of input node defines the output of that node. The activation function determines the output value of a neuron on the basis of net input and bias. For the study the authors have used Hyperbolic Tangential function. The Hyperbolic Tangential function is a sigmoid function with the range (-1, 1). It can be mathematically expressed as follows:

$$\varphi(u) = \tan\frac{u}{2}$$

The domain of Hyperbolic Tangential function is (-1, 1) hence large values are scaled down to the limits of the functions. This removes the effect of outliers in the data set to a considerable extent.

$$y = F(W_\circ + \sum_{h=1}^{H} W_h Z_h$$

$$Z_h = F(\beta_{oh} + \sum_{j=1}^{n} \beta_{jh} X_j$$

**A Multilayered Perceptron** is a feed forward ANN model with a single hidden layer having H hidden units and a single output, y, which can be expressed as follows:

where $Z_h$ is the output of the hth hidden unit, $W_h$ is the weight between the hth hidden and the output unit, and $W_0$ is the output bias. There are N sensory inputs, $X_j$. The jth input

is weighted by an amount $\beta_j$ in the hth hidden unit. An MLP uses a supervised learning technique called back-propagation for training the network (Rumelhart et al., 1986). The simplest back propagation algorithm follows the direction in which the error function decreases most rapidly (negative gradient) to update weights and biases. Thus, a single iteration can be written as:

$$x_{k+1} = x_k - \alpha_k g_k$$

Where $x_{k+1}$ is the vector of weights and biases.

The back propagation algorithm looks for the minimum error function on the regressional gradient. The weights are initially assigned randomly. The output of an MLP is compared to a target output and an error is calculated. This error is back-propagated to the neural network and used to adjust the weights. This process aims at minimizing the error function between the network's prediction output and the target output. This is an iterative process which is repeated several times until the error is minimized. The most common error function is the mean squared error (MSE) which can be expressed as follows:

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(O - T)^2$$

Where O is the output of the network and T is the target value.

The present study uses Neural network package of IBM-SPSS. This software applies artificial intelligence techniques to automatically find the efficient MLP architecture. The data for the variables is fed into the neural network prediction tool in the SPSS. The MLP structure is determined automatically by the SPSS software which works on the principle of Keep the best model (KTB). In order to assess the accuracy of forecast, Mean Squared Error (MSE) has been used as measures of fit (Zhang et al. 2004).

**Elman Recurrent neural network**

Elman (1990) recurrent networks are constructed in a way so as to allow the neurons in the structure to depend on the input variables(x) as well as their own lagged values. This is similar to biological neuron functioning in which it builds "memory" as the neurons are fed through the network. Hence this network works similarly to a normal

moving average (MA) process. An example of an Elman network is given below:

$$n_{k,t} = \omega_{k,0} + \sum_{i=1}^{i^*} \omega_{k,i} x_{i,t} + \sum_{k=1}^{k^*} \emptyset_k n_{k,t-1}$$

$$N_{k,t} = \frac{1}{1 + e^{-n_{i,t}}}$$

$$y_t = \gamma_0 + \sum_{k=1}^{k^*} \gamma_k N_{k,t}$$

The estimation in Elman recurrent neural networks starts with ordinary least square method which helps to eliminate the set of lagged conditional variance terms. This neural network model uses lagged as well as current values of initial input time series. The estimation is a multistep process, which starts with initializing and obtaining the vector of lagged neuron with lagged neuron proxy (conditional variance) as done in a simple feed forward network. It is followed by estimation of coefficient and recalculation of vector of lagged neuron. The lagged hidden layer neurons feed back into the current hidden layer of neurons. These lagged neurons are feedback before the activation function is applied to them which is to say that they are input as lags in their original unsquashed state. The calculations are done recursively in a recurrent network which also takes in account the previous lagged conditional variance values. This iterative process is continued until convergence takes place and the error cannot be reduced further. Elman network is highly dynamic modelling tool for the financial markets which requires the practitioners to recognize arbitrage opportunities from high frequency data. Elman network comes in handy to model financial markets which depend on lag terms as well as the non-linear structure changes over time.

At first the correlations of returns between the six pairs of traditional and Shariah indices are calculated in order to assess their movement with respect to each other. The results are provided in Table 1. Secondly the macroeconomic variables i.e. Price of Brent Crude and respective exchange rate of the Countries' currency with the US Dollar are used to predict the stock prices of the traditional and Shariah indices. The results with the KTB MLP structure, MSE and relative error is provided in Table 2 for Saudi Arabia, Table 3 for Oman and Table 4 for UAE.

For prediction of Stock indices of GCC, BRIC and Euro Area Elman layer recurrent network of MATLAB have been used. Layer recurrent networks work similar to Autoregressive functions where the prediction is dependent on previous lag values.

**Research Gap**

The literature is replete with studies testing for efficiency of stock market, more so in the case of Islamic Indices. However major studies testing for efficiency of Islamic Indices have been mainly concentrated to Malaysia, Indonesia and United Kingdom. The studies using Indices in Gulf region have been rare. Studies on Islamic indices using ANN are even rarer. Hence, the present study makes an earnest attempt to fill this gap.

**Objectives of the study**

- *To find out the relationship between stock prices of Conventional and Shariah Indices for different countries and economic regions.*
- *To assess the difference between prediction of conventional and Shariah indices using macroeconomic variables for different countries by modelling it using Multilayered perceptron.*
- *To assess the difference between prediction of conventional and Shariah indices using Autoregressive neural networks for different economic regions by modelling it using Multilayered perceptron.*
- *To gauge the efficiency of the conventional and Shariah indices for different countries and economic regions using prediction results.*

**Research Hypothesis**

Hypothesis 1. There is no significant correlation between stock prices of the Conventional and Shariah indices of different countries and economic regions.

Hypothesis 2. There is no significant difference in prediction of conventional and Shariah indices using macroeconomic variables for different countries.

Hypothesis 3. There is no significant difference in prediction of conventional and Shariah indices using Autoregressive neural networks for different economic regions.

## Results And Interpretation

**Table 1.**
**Correlations among indices of countries and regions.**

| | |
|---|---|
| BRIC Shariah Index (SPSHBRE) and S&P BRIC 40 Index | **0.621** |
| S&P GCC Investable Shariah Index and Bloomberg GCC 200 Index (BGCC200) | **0.897** |
| S&P Europe 350 Shariah Index and Euro Stoxx 50 Index | **0.618** |
| S&P Saudi Arabia Domestic Shariah Index and Saudi Arabia Tadawul TASI Index | **0.762** |
| S&P Oman Domestic Shariah Index and Oman MSM 30 Index | **0.861** |
| S&P UAE Domestic Shariah Index (SPDJ) and UAE ADX General index | **0.527** |

Table 1 shows correlations among various pairs of conventional and Shariah stock indices for different countries and economic regions. The correlation for GCC is highest at 0.897 which maybe the result of high concentration of Shariah compliant stocks in General index as well. Similarly Oman also has a high correlation of 0.861 among the conventional and the Shariah indices.

**Table 2**
**Multilayered perceptron prediction results for Shariah and Traditional Indices of Saudi Arabia.**

| KSA Traditional Index | | | | KSA Shariah Index | | | |
|---|---|---|---|---|---|---|---|
| **MLP Structure** | **SSE** | **MSE** | **Relative Error** | **MLP Structure** | **SSE** | **MSE** | **Relative Error** |
| 2-4-1 | 0.10436476 | 9.244 E-05 | 18.59% | 2-4-1 | 14.53023 | 0.01287 | 15.23% |
| 2-3-1 | 0.10830497 | 9.04 E-05 | 15.93% | 2-3-1 | 13.01737 | 0.01153 | 13.89% |
| 2-5-1 | 0.10207289 | 9. 593 E-05 | 19.21% | 2-5-1 | 15.21892 | 0.01348 | 16.43% |

Table 2 portrays the relative predictions for Saudi Arabia's Shariah Index and Traditional Index using SAR and US Dollar exchange rate and price of the Brent crude as macroeconomic variables. The prediction error for different MLP structures for both Shariah and traditional Indices of Saudi Arabia are given. We can assess that the prediction for the MLP Structure of 2-3-1 is the best for prediction of both traditional (Relative Error=15.93%) as well as Shariah (Relative Error= 13.89%) indices of Saudi Arabia. We can see from the table that Relative error for the Shariah Index is less than that of traditional index, hence we can conclude that Shariah index in case of Saudi Arabia is less efficient than the traditional index. This gives the investors an opportunity to cash out arbitrage opportunities for the less efficient index. Also Since the correlation between the two indices is 0.762 (although high), it provides diversification benefit

for the investor. Hence we can conclude that investment in Shariah complaint stocks in Saudi Arabia provides some diversification benefits. Efficient market works in the favour of small/individual investors who cannot buy active trading resources.

**TABLE 3.**

**Multilayered perceptron prediction results for Shariah and Traditional Indices of Oman.**

| Oman Traditional Index | | | | Oman Shariah Index | | | |
|---|---|---|---|---|---|---|---|
| MLP Structure | SSE | MSE | Relative Error | MLP Structure | SSE | MSE | Relative Error |
| 2-4-1 | 0.132093 | 0.000117 | 21.43% | 2-5-1 | 10.74808 | 0.00952 | 17.89% |
| 2-2-1 | 0.136609 | 0.000121 | 22.93% | 2-2-1 | 13.31091 | 0.01179 | 19.68% |
| 2-6-1 | 0.160318 | 0.000142 | 23.78% | 2-6-1 | 15.60278 | 0.01382 | 21.12% |

Table 3 maps the relative predictions for Oman's Shariah Index and Traditional Index using Omani Riyal and US Dollar exchange rate and price of the Brent crude as macroeconomic variables. The prediction error for different MLP structures for both Shariah and traditional Indices of Oman are entered in the table. We can assess that the prediction for the MLP Structure of 2-4-1 is the best for prediction for Traditional index in Oman (Relative Error= 21.43%) and the MLP Structure of 2-5-1 is best for prediction of Shariah index of Oman (Relative Error= 17.89%). We can see from the table that Relative error is comparatively lesser for MLP structures of the Shariah Index than that of Traditional index, hence we can conclude that Shariah index in case of Oman is less efficient than the traditional index. This allows the active investors an opportunity to cash out arbitrage opportunities for the less efficient index. Also Since the correlation between the two indices is 0.861(although high), it provides diversification benefit for the investor. Hence we can conclude that investment in Shariah complaint stocks in Oman provides some diversification benefits. Efficient market works in the favour of small/individual investors who cannot buy active trading resources.

**TABLE 4.**

**Multilayered perceptron prediction results for Shariah and Traditional Indices of UAE.**

| UAE Traditional Index | | | | UAE Shariah Index | | | |
|---|---|---|---|---|---|---|---|
| MLP Structure | SSE | MSE | Relative Error | MLP Structure | SSE | MSE | Relative Error |
| 2-3-1 | 4.456163 | 0.003947 | 14.41% | 2-3-1 | 0.137738 | 0.000122 | 10.43% |
| 2-4-1 | 4.660512 | 0.004128 | 13.98% | 2-4-1 | 0.156931 | 0.000139 | 10.04% |
| 2-5-1 | 4.203267 | 0.003723 | 12.24% | 2-6-1 | 0.132093 | 0.000117 | 08.87% |

Table 4 provides the relative predictions for UAE's Shariah Index and the Traditional

Index using UAE Dirham and US Dollar exchange rate and price of the Brent crude as macroeconomic variables. The prediction error for different MLP structures for both Shariah and traditional Indices of UAE are entered in the table. It is discernable from the table that the prediction for the MLP Structure of 2-5-1 is the best for prediction for Traditional index in (Relative Error= 12.24%) and the MLP Structure of 2-6-1 is best for prediction of Shariah index of UAE (Relative Error= 8.87%). We can see from the table that Relative error is comparatively lesser for MLP structures of the Shariah Index than that of Traditional index, hence we can conclude that Shariah index in case of UAE is less efficient than the traditional index. This allows the active investors an opportunity to cash out arbitrage opportunities for the less efficient index. Also Since the correlation between the two indices is 0.527, it provides good diversification benefit for the investor. Hence we can conclude that investment in Shariah complaint stocks in UAE provides significant diversification benefits. A low correlation among Shariah and Traditional stock indices of UAE is considered to be because Shariah compliant indices don't include interest based financial sector which has much weightage in Traditional Stock index of UAE.

**TABLE 5.**
**Layer recurrent prediction results for Shariah and Traditional Indices of different economic regions.**

| Traditional index | | | | Shariah Index | | | |
|---|---|---|---|---|---|---|---|
| **Economic region** | **SSE** | **MSE** | **Relative Error** | **Economic region** | **SSE** | **MSE** | **Relative Error** |
| **Euro Area** | 1.12051 | 0.000992 | 11.54% | **Euro Area** | 4.619863 | 0.004092 | 08.21% |
| **BRIC** | 1.568309 | 0.001389 | 12.83% | **BRIC** | 2.684944 | 0.002378 | 11.08% |
| **GCC** | 1.228629 | 0.001088 | 17.52% | **GCC** | 0.151123 | 0.000134 | 15.87% |

Table 5 displays the prediction result for each of the economic area (Euro Area, BRIC region and GCC). As it is evident from the result that Shariah Indices have relatively less prediction error than their Traditional counterparts, we can conclude that the traditional indices are more efficient again in the case of these economic areas. The traditional index for the Euro area shows the least prediction error in relative error terms of 11.54% which shows that the stock market is most efficient in Euro area. BRIC region and the GCC area with relative error percentage of 12.83% and 17.52% for their traditional indices are less efficient than Euro area.

The correlation coefficient for stock indices of BRIC, GCC and Euro area is respectively

0.621, 0.897, and 0.618 which goes on to show that Investing in Shariah stocks in BRIC and Euro area may provide significant diversification benefit, whereas in case of GCC diversification benefits may not turn out to be significant due to high correlation coefficient. Moreover lesser efficiency of Shariah indices compared to conventional indices may allow investors to gain arbitrage profits.

**Conclusion**

The study has proposed ANN model using Multilayer perceptron on the basis of MSE to forecast the stock prices. The forecast on the basis of proposed models have been computed and compared. It is found that the macroeconomic variables used in forecasting model have been more accurate in predicting stock prices for Saudi Arabia, Oman and UAE. The correlation between different pairs of traditional and conventional stock indices has been mapped.

Shariah index in case of Saudi Arabia is less efficient than the traditional index, hence investment in Shariah complaint stocks in Saudi Arabia provides some diversification benefits. In case of Oman Shariah index, again is less efficient than the traditional index. High correlation among traditional and Shariah indices of Oman indicates that investment in Shariah complaint stocks in Oman provides some diversification benefits from the traditional ones. In case of UAE, again conventional index is more efficient than the Shariah index which allows arbitrage opportunities to an active investor. A low correlation among traditional and Shariah indices in UAE may provide significant diversification benefits. Continuing on the usual results, traditional indices are more efficient in the case of the three economic areas. However, low correlation between Conventional and Shariah indices of BRIC region and Euro area may provide significant diversification benefits.

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