

Outliers in Islamic and Conventional Stock Indices: An Empirical Analysis Using Impulse Saturation Indicator

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Outliers detection and treatment is essential to avoid getting a model with less accuracy. In this paper, the primary objective is to detect outliers by utilizing an impulse indicator saturation approach (IIS) to developed and advance emerging of Islamic and conventional stock market indices. The main results revealed that there is more than 75% similarity of the outliers date in Islamic and conventional stock market indices for the four countries. Moreover, both Islamic and conventional are affected by the global financial crisis that occurs in 2008-2009. As all the stock market indices exhibited heteroscedasticity and long memory, future studies should incorporate these features with the IIS results when modeling the data.

Keywords: impulse indicator saturation; islamic stock indices; conventional stock indices; outliers

I. INTRODUCTION

Outliers are unrepresentative, spurious, rogue, or outlying observations in sets of data, as stated by Barnett & Lewis (1978) in their book. Their book provides a comprehensive overview of outliers in statistical data analysis. The book covered univariate and multivariate statistical data analysis ranging from topics such as the design of experiment, regression, and time series. Since then, the book had motivated many researchers to acquire and enhance the study of outlier's treatment.

Time series data, for example, stock market index, currency exchange rate and commodity price have always influenced by special event such as policy changes, sudden economic or financial crisis and strikes with happen unknown in point of time. These unusual or isolated events can have a significant effect on the specification of a model that leads to bias parameter estimation and poor forecasting performance. Thus, many time series books have discussed the detection and treatment of outliers and among them are Wei (2006), Box *et al.* (2015) and Palma (2016).

In recent years, many researchers have also focused on the detection and treatment of outliers in time series data. The

proposed methods among others are statistical distribution, decomposition method, machine learning, and time series models such as autoregressive integrated moving average (ARIMA) and generalized autoregressive conditional heteroskedasticity (GARCH). Liang & Cao (2018) used the normal distribution to detect outliers in high dimensional data. Then, Grane & Veiga (2010) proposed wavelet decomposition method, and Khoshrou & Pauwels (2019) suggested singular value decomposition (SVD) to identify and corrected outliers. Next, Yu *et al.* (2014) and Yang *et al.* (2004) using machine learning methods to detect outliers. Meanwhile, Arumugam & Saranya (2018) and Kamranfar *et al.* (2017) applied seasonal autoregressive integrated moving average (SARIMA) and GARCH models to detect outliers.

Recently, several studies have focused on the indicator saturation (IS) approach developed by Hendry (1999). His seminal development demonstrates the ability to detect both outliers and structural breaks using the impulse indicator saturation approach (IIS) in the US food expenditure. The applications of the IIS was extended to, for example, the exchange of market pressure (Panday,

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2015), atmospheric CO₂ (Hendry & Pretis, 2013), and volcanic eruptions (Pretis *et al.*, 2016). However, to our concern, there are limited studies that identify the outliers in high-frequency data, such as in the return of stock indices.

Thus, the aim of this paper is to identify outliers in Islamic (Shariah) and conventional stock market indices using IIS. By detecting outliers in both stock market indices, this study wants to uncover whether both stock indices are affected by similar events that contribute to the occurrence of outliers.

II. MATERIALS AND METHOD

A. Data

This study will consider Islamic and conventional stock market indices from selected developed (USA and Japan) and advance emerging countries (Malaysia and South Africa) based on data availability. The S&P 500 (SP500) and S&P 500 Shariah (SP500SH) indices represent the USA, and SP Topix 150 (SPTX) and SP Topix 150 Shariah (SPSHTX) for Japan. On the other hand, FTSE Bursa Malaysia Emas (FBMEMAS) and FTSE Bursa Malaysia Emas Shariah (FBMSHA) represent Malaysia and Johannesburg Stock Exchange (JAS) and Johannesburg Stock Exchange Shariah (JSHAS) Indices for South Africa. The daily data are collected from 30 September 2008 to 23 March 2018.

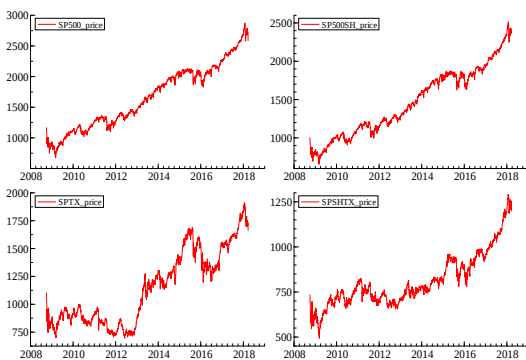


Figure 1. Closing stock indices for selected countries of developed markets

In the context of the USA (Figure 1), similar patterns were recorded in both US financial markets. It implies to us that Shariah behaves the same with their conventional counterparts. In contrast with the USA, Japan Shariah compliant indices (Figure 1) are less volatile as the display of closing prices show the lesser impact of the event in the year of 2013. Meanwhile, Figure 2 shows the closing price of both

Shariah and conventional compliant indices of Malaysia and South Africa. Shariah-compliant indices seem to behave the same with their conventional counterparts.

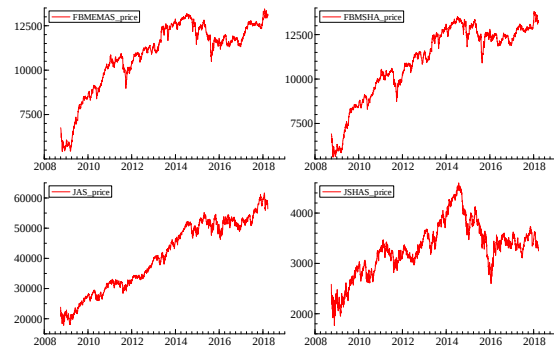


Figure 2. Closing price indices for selected countries of advanced emerging markets

B. Impulse saturation indicator (IIS)

Impulse saturation indicator (IIS) consider a general-to-specific approach according to which indicator variables were added based on the number of observations, T . Moreover, IIS provides a general procedure for analysing a model's constancy. Specifically, IIS is a generic test for an unknown number of breaks, occurring at unknown times anywhere in the sample, with unknown duration, magnitude, and functional form. Following the work of Castle *et al.* (2012), we apply IIS with the only constant as a regressor. Let $y_t = c + \varepsilon_t$ where ε_t is independent and normally distributed with zero mean and constant variance, σ^2 . Equation 1 shows the augmented block of impulse indicators.

$$y_t = c + \sum_{k=1}^{\lfloor T/2 \rfloor} \delta_{tk} I_t(k) + \varepsilon_t \quad (1)$$

where we denote $I_t(k)$ as a pulse dummy which equal to 1 for $t=k$ and 0 otherwise and $t = 1, \dots, T$.

In equation 1 the first $T/2$ parameter are analysed using the split-half approach. Any indicator with a t -value less than critical value will be deleted. In the second step, the remaining half of the impulse indicator is estimated and eliminated. The selected indicator from the terminal model is then combined and re-estimated to give the final model. IIS identifies structural breaks as a segment of impulse indicators with the same sign and magnitudes. Large outliers are detected with the impulse indicator with

different signs. In this study, we use $\alpha=0.001$ as the level of significance.

III. RESULT AND DISCUSSION

As illustrated in the previous section, Shariah-compliant indices show a similar pattern (graphically) with its conventional counterparts. Therefore, it is important to further quantify the similarity as described in the graphical display. Nonetheless, for further analysis the closing price is transformed to return with is the first difference of the natural logarithm. Table 1 and 2 presents the result of descriptive statistics for developed market and advanced emerging market. In the context of a developed market, all the indices show positive expected returns approximately equal to zero mean and negatively skewed (except for SPSHTX). The standard deviations are small and almost similar across the country. It conveys that the differences between return series Shariah and conventional are small. The Shariah version of the SP500 is less volatile as evidenced by the smallest standard deviation. The kurtosis coefficients of the return series exceed 3, suggesting the presence of fat-tailed distribution. Also, the Jarque–Bera (JB) statistics are statistically significant, indicating that all the indices are not standard normal distributed.

In terms of diagnostics testing, the residual diagnostics suggest that there is an autoregressive conditional heteroskedasticity (ARCH) effect in the series. The Ljung-Box serial correlation (Q-stats) shows the presence of serial correlation up to 20 lags. However, all the indices are stationary as indicated by Augmented Dickey and Fuller (ADF) and KPSS

tests. Besides, we also present the test for the long memory in the stock returns. We employ the semiparametric GPH test by Geweke & Porter-Hudak (1983) and Gaussian semiparametric (GSP) test by Robinson & Henry (1999). All stock index returns under study, exhibit strong evidence of long memory. It implies that the market does not immediately respond to the information flowing into the financial market, but reacts to it slowly and can be modeled by a long memory model.

In the context of advance emerging market, the conventional indices reported being less volatile than Shariah compliant indices as suggested in Table 2. This situation may arise from the presence of outliers in the data series as indicated by the higher maximum value (and lowest minimum value) in the data series. All return series under advance emerging market are negatively skewed and fat-tailed. The Jarque–Bera (JB) statistics are statistically significant, indicating that all the indices are not standard normal distributed.

Moreover, as suggested in table 2, there is a significant ARCH effect in the volatility, implying that the return series in the advance emerging market can be modeled directly from various GARCH class models. The Ljung-Box serial correlation (Q-stats) shows the presence of serial correlation up to 20 lags. All the indices are stationary as indicated by Augmented Dickey and Fuller (ADF) and KPSS tests. As reported in the advanced financial markets, all return series in advance emerging market also suggesting the presence of long memory.

Table 1. Descriptive statistics of return series of developed market

	USA		Japan	
	SP500	SP500SHA	SPTX	SPSHTX
Mean	0.0334	0.0348	0.0183	0.0209
Std. deviation	1.2465	1.1628	1.4554	1.2757
Maximum	10.957	11.583	12.865	10.918
Minimum	-9.4695	-9.5307	-10.007	-8.9735
Skewness	-0.2612	-0.0384	-0.3980	-0.0906
Excess kurtosis	11.971	13.475	8.6002	9.3454
Jarque-Bera	14274**	18688**	7214.3**	8533**
Q (20)	71.9394**	71.3727**	17.5729	78.4884**
Q ² (20)	3374.22**	3209.72**	2263.47**	3262.77**
ARCH test	99.869**	113.35**	97.195**	105.96**
ADF	-29.02**	-30.1139**	-28.6604**	-31.6768**
KPSS	0.0666	0.05815	0.1539	0.1000
GPH	0.0194**	0.0191**	0.01968	0.0195**
GSP	0.0144**	0.0142**	0.0146**	0.0146**

** denote statistical significance at 5%

Table 2. Descriptive statistics of return series of advanced emerging market

	Malaysia		South Africa	
	FBMEMAS	FBMSHA	JAS	JSHAS
Mean	0.0282	0.0277	0.0364	0.0096
Std. deviation	0.64655	0.6527	1.159	1.4413
Maximum	4.1508	3.6883	6.834	9.2904
Minimum	-4.1119	-4.3958	-7.5807	-9.6356
Skewness	-0.0140	-0.2856	-0.1049	0.0411
Excess kurtosis	3.7923	4.9373	4.5641	5.3336
Jarque-Bera	1480.2**	2399.3**	2057.9**	2805.1**
Q (20)	53.8268 **	74.1797**	62.5221**	72.1608**
Q ² (20)	640.295**	1356.93**	3525.94**	3895.91**
ARCH test	26.697**	39.107**	102.36 **	116.43**
ADF	-26.6607**	-26.9246**	-30.2198**	-30.3656**
KPSS	0.2608	0.2283	0.0413	0.0620
GPH	0.0196 **	0.0196**	0.0195**	0.0195**
GSP	0.0146 **	0.0146**	0.0145**	0.0145**

** denote statistical significance at 5%

Next, to avoid too many irrelevant variables to be retained using IIS, the level of significant used is 0.001. Table 3 and 4 present the date of an outlier in the return series for each financial market. The colour represents the same date the outlier occurs in Shariah-compliant indices as the comparison with their conventional counterparts. As expected, the numbers of outlier detected in the Shariah indices are smaller than the conventional. However, there is high similarity in the context of outlier date. It implies that the Shariah-compliant indices react with the same event that impacted the volatility of conventional indices.

In the context of a developed market, the same numbers of outliers recorded in both Shariah and conventional indices in the USA with 80% similarity. Within the past ten years, the outliers in the USA occur mainly during the global financial

crisis (2008/2009) and Black Monday (2011), which initially began in the USA. In contrast with the USA, Japan Shariah compliant indices recorded fewer outliers than its conventional counterpart, but with high date similarity (76.92%). As a developed country, the volatility of Japan stock indices also received the impact of the global financial crisis (2008/2009) started by the USA. Besides, Japan also suffers the effects of earthquake, tsunami, and nuclear disaster (2011), the Asian financial crisis (2015) and Brexit (2016). Table 3 presents the outlier data in the USA and Japan for both Shariah and conventional indices.

Table 3. Outliers detected in the developed market

	USA				Japan			
	SP500		SP500SHA		SPTX		SPSHTX	
1	07/10/2008	(-5.91)	09/10/2008	(-7.23)	08/10/2008	(-8.38)	08/10/2008	(-6.93)
2	09/10/2008	(-7.92)	13/10/2008	(11.58)	10/10/2008	(-7.36)	14/10/2008	(10.91)
3	13/10/2008	(10.95)	15/10/2008	(-9.53)	14/10/2008	(12.86)	16/10/2008	(-8.97)
4	15/10/2008	(-9.47)	16/10/2008	(4.94)	16/10/2008	(-10.00)	30/10/2008	(7.94)
5	22/10/2008	(-6.29)	20/10/2008	(5.32)	22/10/2008	(-7.30)	05/11/2008	(8.40)
6	28/10/2008	(10.24)	22/10/2008	(-6.31)	24/10/2008	(-7.82)	06/11/2008	(-7.41)
7	05/11/2008	(-5.41)	28/10/2008	(10.16)	27/10/2008	(-7.68)	13/11/2008	(-8.65)
8	06/11/2008	(-5.15)	05/11/2008	(-4.91)	30/10/2008	(7.98)	15/03/2011	(-7.04)
9	12/11/2008	(-5.32)	06/11/2008	(-4.84)	05/11/2008	(5.98)	16/03/2011	(6.58)
10	13/11/2008	(6.69)	12/11/2008	(-4.90)	06/11/2008	(-6.14)	11/01/2013	(-28.22)
11	19/11/2008	(-6.31)	13/11/2008	(7.04)	15/03/2011	(-9.95)	15/01/2013	(29.67)
12	20/11/2008	(-6.94)	19/11/2008	(-5.25)	14/03/2011	(-7.78)	09/09/2015	(6.49)
13	21/11/2008	(6.13)	20/11/2008	(-6.31)	16/03/2011	(6.42)	15/02/2016	(6.39)
14	24/11/2008	(6.27)	21/11/2008	(6.63)	23/05/2013	(-7.12)		
15	01/12/2008	(-9.35)	01/12/2008	(-8.14)	24/08/2015	(-6.03)		
16	20/01/2009	(-5.42)	10/03/2009	(5.03)	09/09/2015	(6.20)		
17	10/02/2009	(-5.03)	23/03/2009	(5.62)	15/02/2016	(7.71)		
18	10/03/2009	(6.17)	04/08/2011	(-4.84)	24/06/2016	(-7.53)		
19	23/03/2009	(6.83)	08/08/2011	(-6.04)				
20	08/08/2011	(-6.89)	18/08/2011	(-4.75)				

Note: The values in the parentheses represent the return

In the context of advance emerging market (Table 4), the outlier occurs as the result of the significant events that happened in the developed country. However, the numbers of outliers are smaller compared to the developed country. It might be due to the preventive measure taken in response to any global financial events. In the conventional indices, Malaysia and South Africa recorded 15 and 13 outliers respectively. The outliers detected for Shariah-compliant indices also similar to their conventional counterparts. 78.57% similarity recorded in Malaysia and 84.62% similarity recorded in South Africa. The outliers are detected mainly during the

global financial crisis (2008/2009).

In this study, we also further identify the common events happened across different financial markets from Table 3 and 4. It appears that the detected common outliers are negative, which is following the literature that negative outliers occur more frequently than positive ones (Jansen & De Vries, 1991). Whereas, Figure 3 and 4 represent the impact of the global financial crisis (2008/2009) that causes the outliers on both Shariah and conventional indices.

Table 4. Outliers detected in the advance emerging market

	Malaysia				South Africa			
	FBMEMAS		FBMSHA		JAS		JSHAS	
1	08/10/2008	(-2.67)	10/10/2008	(-3.16)	06/10/2008	(-7.58)	06/10/2008	(-8.56)
2	10/10/2008	(-3.83)	16/10/2008	(-3.18)	15/10/2008	(-7.24)	15/10/2008	(-9.63)
3	16/10/2008	(-3.17)	28/10/2008	(-4.39)	22/10/2008	(-4.71)	24/10/2008	(-7.94)
4	24/10/2008	(-4.11)	24/10/2008	(-3.53)	24/10/2008	(-5.99)	29/10/2008	(8.49)
5	28/10/2008	(-3.54)	30/10/2008	(3.30)	29/10/2008	(6.49)	30/10/2008	(6.20)
6	30/10/2008	(3.21)	03/11/2008	(3.58)	30/10/2008	(5.24)	10/11/2008	(7.28)
7	03/11/2008	(4.15)	05/01/2009	(3.68)	10/11/2008	(4.97)	20/11/2008	(-7.51)
8	05/01/2009	(3.06)	10/04/2009	(2.85)	20/11/2008	(-5.15)	24/11/2008	(7.50)
9	23/03/2009	(2.75)	08/08/2011	(-2.92)	24/11/2008	(4.95)	25/11/2008	(8.51)
10	10/04/2009	(2.68)	22/09/2011	(-2.69)	25/11/2008	(6.51)	01/12/2008	(-6.62)
11	22/09/2011	(-2.62)	21/01/2013	(-2.64)	08/12/2008	(6.83)	08/12/2008	(9.29)
12	26/09/2011	(-2.86)	06/05/2013	(3.24)	06/02/2009	(4.77)	10/12/2008	(6.69)
13	06/05/2013	(3.59)	01/12/2014	(-3.36)	19/03/2009	(5.60)	19/03/2009	(6.88)
14	01/12/2014	(-2.77)	15/12/2014	(-2.72)				
15	24/08/2015	(-2.91)						

The values in the parentheses represent the return

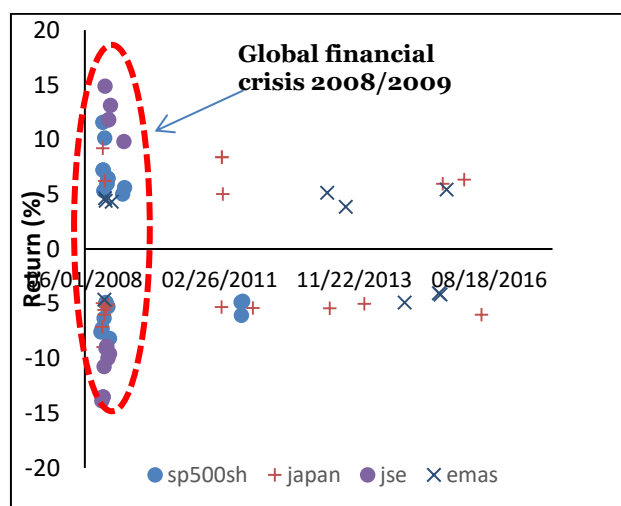


Figure 3. Outliers detected using IIS (Islamic)

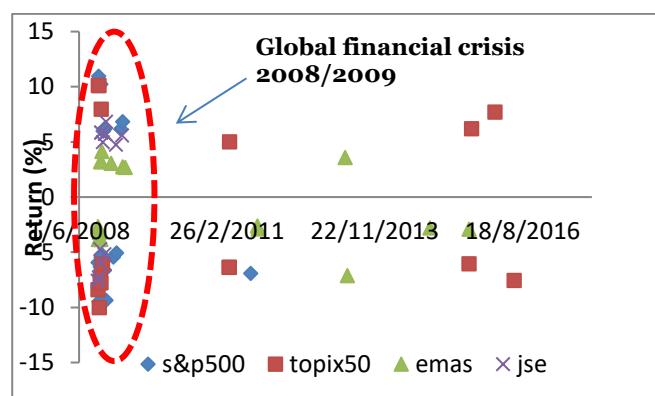


Figure 4. Outliers detected using IIS (conventional)

IV. CONCLUSIONS

The primary purpose of this paper is to detect outliers in Islamic and conventional stock market indices. Two countries from each developed and advance emerging market are chosen in this study. Time series plots exhibit a similar trend for both Islamic and conventional stock market indices. IIS disclosed that the number of outliers detected for both stock market indices is quite identical. Based on the descriptive statistics, the data have heteroscedasticity and the long memory effect. Therefore, for future research, it is recommended to use fractionally

integrated generalized autoregressive conditional heteroscedastic (FIGARCH) to consider the long memory characteristics of the stock market indices. The results of IIS can be integrated into the FIGARCH model.

V. ACKNOWLEDGEMENT

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