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PROBABILITY APPROACH IN ESTIMATING VALUE AT RISK OF BOND PORTFOLIOS FOR EFFECTIVE HEDGING

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ABSTRACT

Bond portfolios are growing as the investors like banks, fund managers and institutional investors are more interested in Malaysian Bond market comprises conventional and Islamic (Sukuk) Bonds. The Malaysian Sukuk market has provided greater diversification especially catering to the needs of investors such as Islamic pension funds and Islamic insurance companies which can only invest in Shariah-compliant instruments. As the Sukuk and conventional bonds complement each other in Malaysia, we have chosen from real portfolios framed by popular mutual funds to study the risk management practices adopted by these portfolios and to observe the differences and the reasons for them. The link between duration and price volatility is widely used for managing risk positions and portfolio value protection due to the market volatility which can cause huge losses on large exposures. We have applied standard risk measures of bond portfolios, portfolio duration and portfolio convexity to assess the Value at Risk (VaR) accurately and this will lead to minimum cost of hedging. Fair value hedging requires accurate expected loss, which is arrived at by applying these estimates of duration and convexity. We used Bond funds which invest more than 74% of funds in Islamic Bond or Conventional Bond which are designed and implemented by popular Banks and Mutual funds. These results helped in computing the VaR which subsequently could be hedged with the available financial instruments such as interest rate futures in Bursa derivative market effectively.

Contribution/ Originality: This study contributes to the existing literature in the bond market area specifically in terms of bond valuation, bond risk estimation and management. This study is one of the very few studies to have investigated the risk estimation of convexity with the real data which is very intensive and complex.

1. INTRODUCTION

Malaysia has proven to be strong in Islamic finance with more than thirty years experience with two full pledged Islamic Banks and eight Conventional Banks with Islamic Window and has established operations in the Islamic capital market. Comprehensive regulatory and Shariah governance framework are in shape and active secondary market for trading in Islamic securities with well-equipped technology.

The first Sukuk was issued in Malaysia by Shell Middle Distillate Synthesis (Shell MDS) and a syndicate of financiers had participated for the issuance of RM75 million for a tenure of five years. The Malaysian Sukuk market is the quickest rising and most favourable division of Islamic finance and it is progressively popular worldwide in countries such as Malaysia, United Arab Emirates (UAE) and Saudi Arabia (Fitriya, 2012). Since 2001, the global sukuk market has grown on the compounded annual growth rates of 27.8% (Naveed, 2015). The amount of sukuk outstanding globally reached US$281.3 billion at the end of 2013 from just US$14.8 billion in 2001 and Malaysia is the largest sukuk market having 58.1% of total outstanding sukuk (Naveed, 2015).

According to Tahmoures (2013) conventional bonds (CB) are long term debt securities issued by corporations and government which generates cash flows for issuers for investment and for bondholders in terms of coupon rate (paid to bondholders annually/ semi-annually) and the face value paid to the bondholders when the bond is matured. Sukuk are Syaria-compliant financial instruments known as "Islamic Bonds" (Sukuk) and it is defined as certificates of equal value that represents an undivided interest in an ownership of an underlying asset both tangible and intangible, usufruct and services or investment in particular project or special investment activity (El Mosaid & Boutti, 2014). There a few types of Islamic-based structures of Islamic bonds: such as Mudaraba (profit sharing), Musharaka (loss-sharing), Murabaha (cost-plus sale), Ijarah (project finance), Salam (seller finance) and Istisna (project finance).

Mudaraba refers to types of joint venture or partnership, where two parties will have a contractual relationship in investing in a commercial, pre-determine initiative. Musharaka in Islamic finance refers to the sharing of profit and also the loss of the joint enterprise. In Musharaka banking, the Islamic bank contributes the capital from the depositors to a joint enterprise (Mansoor & Ishaq, 2008). Murabaha is also known as the cost-plus financing where a contract sale transaction occurs between the bank and the client for goods or commodity with a price after adding a profit margin. Ijarah in Islamic financing refers to the lease financing of assets such as land, property or equipment that is quite similar to conventional bank leasing. In Islamic finance, Bai Salam is a forward sale contract with which the delivery date is at a specified future date and the seller has to pay the price of goods in advance. In order to satisfy the Shariah principle, the terms and condition in a Bai Salam contract such as the price and quantity of goods must be specified clearly without any interest. Bai Istisna is also another forward sale contracts option. Basically, Istisna refers to a sale by ordering of goods or assets to be constructed and then delivered at a specified future date.

Conventional bonds include the public sector and also the private sector: government bonds and corporate bonds. The government debt securities are Malaysian Government Securities (MGS), Malaysian Treasury Bills (MTB), Government Investment Issues (GII), Bank Negara Monetary Notes (BNMN), Khazanah bonds. The other types of corporate bonds that are issued on the Malaysian capital market are convertible, bonds with warrants, floating rate, zero coupon, mortgage bonds, Islamic bonds, secured and unsecured bonds, and guaranteed bonds.

One of the main factors as to why investors invest in Sukuk and CB is for diversification purposes. Investors can diversify their portfolio to complement their investments other than equities and unit trust. The other reason that motivates investors' especially institutional investors is the source of additional stable and reliable income streams. Sukuk and CB provide a steady income stream through regular coupon payments.

Accounting standards insist that the bonds are to be valued at mark to market or at fair values to be stated in balance sheet. Sukuk and CB are both known for being a safe investment instrument but, are these both financial instruments being valued according to the investment standards? The investors specifically look at various financial market crises and assess risk to hedge effectively. In addition, the risks posed by these bonds individually and collectively (in portfolios) are to be assessed accurately to provide revaluation reserves. This information will be useful to hedge the bond portfolios and avoid losses. This not only satisfies the company objectives but also fills the mandatory requirements imposed by the accounting standards and the various laws enacted at different times such as Sarbanex Oxly Act 1991.

The problem here is whether both these financial instruments will be able to continue to provide low risk and steady income to the investors in the foreseeable future. Therefore, it is important to study the practices followed in Malaysia regarding the bond valuation and bond risk assessment so that it boosts the investors' confidence.

The duration, convexity in bond portfolio context will help the investors to correctly assess expected loss. This research will be significant to portfolio managers and to the regulators such as Securities Commission. It will give them the methods to manage the risk and protect the value of their portfolios efficiently. As for the regulators, it gives an insight on whether the current practices are sufficient to protect the investors' interest in bond investments. The Federal Government, Bursa Malaysia, and Bank Negara Malaysia also regulate the bond market and directly oversee them (Bursa Malaysia, 2015). The society should also be taught about these developments in share, bond, mutual funds and derivative markets to create knowledgeable manpower in near future.

This paper is organized into four sections; Section one describes Islamic bonds and conventional bonds. Section two highlights the important concepts theories on duration, modified duration, convexity, Daily Earnings at Risk (DEAR) and Value at Risk (VaR) and related literature. Section three discusses the methodology and techniques used in risk assessment of bonds and their portfolios. This will help in effective hedging of Sukuk and conventional bond portfolios. Section four deals with the selection of portfolios for analysis and the profiles of each selected portfolio. Section five discusses the results of analysis and interpretation. Section six concludes the paper.

2. LITERATURE REVIEW

In order to optimize the bond portfolio to maximize the yield and at the same time minimize the risk, portfolio theories are used. Harry Markowitz publishes the widely used portfolio theory in the article Portfolio selection in Journal of Finance 1952. A Modern Portfolio Theory (MPT) by Markowitz (1952) provides method to determine the efficiency of a given portfolio based the means and the variance of the rate or returns contained in the portfolio. Markowitz (1952) published a paper on portfolio selection in 1952 in which he addresses portfolio theory as a mathematical problem and by introducing a method to analyse a given portfolio based on only means and the variance of the returns of the assets contained in the portfolio. However, variance of a portfolio is not a complete measure of risk and Value at Risk should be considered to measure risk based on the 95% confidence level and 99% confidence level (Marling & Emanuelsson, 2012).

Portfolio managers, finance managers and traders should understand how to assess exposure and how to hedge positions in fixed income securities due to the market volatility. The main motive behind this risk management is due to the movements in interest or profit rates. Rates and bond value move in opposite directions to the fair value forecast on which an active strategy is based. So, managers need to assess the possible loss and if it is unacceptably high, they need to manage and explore methods to reduce exposure by hedging.

Duration is one of the key risk management tools and was introduced by Macaulay (1938). It gives the slope of the yield rate and price of the bonds. The duration increases with maturity but decreases with yield because a bond with higher yield rate pays a higher percentage of its present value prior to maturity. Hence, such a bond has greater weights on payments and thus a shorter duration (Smith, 2010). The Macaulay formula simplifies duration analysis and uses a bond's yield to maturity to calculate all the present values that interest rates are the same for all maturities.

The duration model gives accurate approximations of percentage price changes for small shifts in yields, however as the yield shifts become larger, the approximation becomes less accurate (Paroush & Prisman, 1997). According to Crack and Nawalkha (2001) the shifts in rates are more complicated as duration is highly accurate for small shifts in yield rates only. Hence, if interest rates increased by hundreds of basis points in one day, the price changes predicted from the duration formula are only approximations. This is caused by the convexity of the price

yield curve because the true relationship between change in bond price and change in the discount factor is signified by a convex function.

Convexity sometimes called as an insurance against yield rate fluctuation, it is good when rates fall as the true price gain is greater than predicted by duration formula. However, when the opposite happens, the true percentage loss is smaller than predicted by the duration formula. When cash flows depend on rates, duration can shift and convexity no longer applicable. It is a challenge for many managers to assess this complexity and this results in large losses for banks and investment dealers (Kanchu & Kumar, 2013).

However, duration and convexity do not consider the real behaviour of the interest rates by means of historical or simulated data (Babbel, Merrill, & Panning, 1997). Given this limitation in the portfolio optimization, modern measures try to solve this issue. VaR assesses risk which is a loss of portfolio value and has become a benchmark for measuring and estimating risk in diverse portfolios and other complex instruments (Cakir & Raei, 2007). Asset managers and portfolio managers actively implement their asset allocation and the primary benefits of VaR for asset managers is that it facilitates the consistent and regular monitoring of market risk (Bhat, 2015).

3. METHODOLOGY

The periodic interests and redemption value were discounted at yield rate to find the fair value, duration and convexity. The procedure for computing duration and convexity are the same as in conventional bonds (Ramasamy, Munisamy, & Helmi, 2011). Below are the formulas that were used in computing duration, modified duration, convexity, DEAR (daily earnings at risk) and VaR (value at risk) for all the individual bond and subsequently as a portfolio (Saunders, 1999). However, all the algebra method was computed in MATLAB software. Firstly, below is the interest or cash flow in algebraic:

$$C = FV * Cr \tag{1}$$

Where

C = Interest.

FV = Face Value.

Cr = Coupon rate.

Equation 1 estimates the cash flow of any bond which is part of bond portfolio with face value and coupon rate. The cash flows after the redemption value will be

$$C1, C_2, \ldots..C_n+RV; \quad \text{where} \quad \ldots..k = 1,\ldots.., n \tag{2}$$

Where

RV = Redemption value.

k = Remaining life of the bond.

Equation 2 takes all the cash flow estimated in Equation 1 and the final redemption value (RV) also taken into account in the maturity year.

In Equation 3 all the cash flows are to be discounted at a yield rate to maturity and added to get the price of the bond.

$$\eta = \frac{C_1}{(1+y)} + \frac{C_2}{(1+y)^2} + \ldots\ldots + \frac{C_n + RV}{(1+y)^n} \tag{3}$$

$$\eta = \sum_{k=1}^{n} \frac{CR_k}{(1+y)^k} + \frac{RV}{(1+y)^n} \tag{4}$$

Where

η = Total discounted cash flow or fair value of the bond.

Y= Yield rate.

In Equation 4 it gives the total present value of the discounted cash flows.

Next, in Equation 5 to calculate the duration, the present values of the cash flows are multiplied by the time and added.

$$\xi = \frac{C_1 * t_1}{(1+y)} + \frac{C_2 * t_2}{(1+y)^2} + \ldots\ldots + \frac{(C_n + RV) * t_n}{(1+y)^n} \quad (5)$$

Where

t = 1,…..,n

ξ = Total discounted price and time

$$\xi = \sum_{k=1}^{n} \frac{c_k * t_k}{(1+y)^k} + \frac{RV * t_n}{(1+y)^n} \quad (6)$$

In Equation 6 all the cash flows scaled by time including redemption value is added to get total time adjusted cash flow.

So, the duration is weighted average life of the bond.

$$D = \frac{\xi}{\eta} = \frac{Total\_discounted\_value\_and\_time}{Fair\_price} \quad (7)$$

Where

D= duration

Equation 7 computes the duration by dividing the total time adjusted present value by the value of the bond as estimated by Equation 4.

Next, the modified duration is calculated to identify the price lose or gain and it is a direct measure.

$$MD = \frac{D}{(1+y)} \quad (8)$$

Where

MD = Modified duration normally expressed in the negative.

Equation 8 computes the Modified Duration by discounting again the duration itself.

Equation 9 computes the price loss or gain can be easily computed by using the modified duration multiply with increase/ decrease delta in the yield rate as below:

$$\frac{\partial p}{p} = -MD * \partial Y \quad (9)$$

Where

P = Price of the bond.

MD = Modified duration of bond in years.

∂ = Delta.

Duration is the slope of price yield curve and it is the first order effect of an interest rate change on the bond's price.

Kritzman (1992). However, in reality there is curvature in the price yield curve which is known as the convexity. In Mathematics, it is the Taylor series expansion of the second order effect which measures the change in the slope of the price yield curve.

Equation 10 calculates convexity present in the price-yield curve as follows:

$$CX = \frac{\lambda}{p*(1+y)^2} \tag{10}$$

Where

CX= convexity

The convexity effect is the degree to which the capital gain affects more than the offsets the capital loss effect for an equal increase and decrease in interest rates at the current interest rate level.

Equation 11 computes the convexity adjusted Daily Earnings at Risk (DEAR) which can indicate the loss in value of the bond or sukuk as follows:

$$\Delta p = [-MD*\Delta y + 0.5*CX*(\Delta y)^2]*P_0 \tag{11}$$

Finally, Value at Risk (VaR) can be computed as follows:

$$\text{VaR} = \Delta p * \sqrt{n} \tag{12}$$

Where

Δp = Convexity adjusted DEAR.

$\sqrt{n}$ = Number of bad days in a year (Basel II).

Equation 12 computes VaR and if there is some number of bad days in a year in the future, the loss is to be increased by the indicated value derived from Equation 11.

4. SAMPLING AND DATA

The main focus of this research was to compute the standard risk measures of Islamic and Conventional bond portfolios, which are portfolio duration and portfolio convexity to assess the Value at Risk (VaR) accurately so that the losses can be hedged accurately to minimize cost. This research was conducted during 2015. All the data for this research were collected from BondInfo Web and Fund supermart Web for the year 2014. In total, four bond portfolios consisting of 57 individual bonds were used: 27 were Islamic sukuk and the two Islamic bond portfolios were RHB-OSK Islamic Bond and Eastspring Investments Dana Wafi while the Conventional bond portfolios were CIMB Principal Strategic Bond Fund and Kenanga Bond Fund.

Table-1. Profiles of Portfolios selected.

Portfolios	Principle	Inception	Fund size in RM (m)	Invested in bonds	NAV unit (RM)	PT Ratio (times)	Mgt Exp Ratio (%)	Annual return (%)
CIMB Principal	Conv	2004	63.99	15	1.11	0.12	0.57	4.21
Kenanga Bond	Conv.	2002	14.31	15	0.68	1.96	1.56	2.58
RHB-OSK Islamic	Islamic	2000	33.84	17	1.30	0.42	0.97	4.45
Eastspring Dana	Islamic	2005	30.19	10	0.53	0.37	0.69	2.43

Note: 1. Conv = conventional, 2. NAV = net asset value, 3. PT = portfolio turnover, 4. Mgt Exp = management expenses.

Each portfolio had an allocation of 74% and more in Islamic bond or sukuk. The profiles of each portfolio were tabulated and discussed as set out below in Table 1. It is worthwhile to understand the background of each portfolio to interpret how the portfolios are being managed in Malaysia and the risk and return differences in terms of properties between Islamic and Conventional Bonds.

RHB-OSK Islamic Bond has been in existence for the last fifteen years, followed by the Kenanga Bond Fund for thirteen years, CIMB Principal Strategic Bond Fund eleven years and the youngest fund is Eastspring Investments Dana Wafi with ten years. In term of fund size, CIMB Principal Strategic Bond Fund stands first with RM63.99 million, followed by RHB-OSK Islamic Bond with RM33.84 million and Eastspring Investments Dana Wafi with RM30.19 million. The smallest fund is Kenanga Bond Fund with RM14.31 million. Even though Kenanga Bond Fund has the smallest size it has invested in fifteen individual bonds which can be considered as over diversified compared to other portfolios. Although the CIMB Principal Strategic Bond Fund has the largest fund, it has only invested in fifteen individual bonds. The highest diversification is RHB-OSK in seventeen bonds and the lowest diversification is Eastspring Investments Dana Wafi with only ten bonds.

The portfolio turnover ratio measures the value of securities sold and purchased from the portfolio in a year divided by the assets managed by the fund. A high ratio indicates that the manager is active in selling and reinvesting the bonds in the portfolio. Kenanga Bond Fund had the highest turnover ratio at 1.96 times compared to the other three portfolios which were lesser than 0.5 times. The lowest was CIMB Principal Strategic Bond Fund at 0.12 times only.

If there is high turnover ratio it doesn't indicate that Kenanga Bond Fund was performing greatly and CIMB Principal was performing badly. This ratio looks at the efficiency of the portfolio manager and it may not be effective in terms of managing expenses. The managers are being cautious and will only attempt to sell and reinvest if there are huge capital gains that can offset the transaction costs. So, it only makes sense that Kenanga Bond Fund had the highest management expense ratio at 1.56% compared to CIMB Principal which had the lowest expenses ratio at 0.57%. The CIMB-Principal Fund could be said to be prudent and ethical in managing their fund. However, the RHB-OSK Islamic Fund had a high management expense ratio at 0.97% despite having lower portfolio turnover ratio.

5. RESULTS AND DISCUSSION

As mentioned earlier, with the above methodology and data on the four real portfolios of bonds, the duration, modified duration, convexity, daily earnings at risk (DEAR), convexity adjusted DEAR and Value at Risk (VaR) were computed for each individual bond in the four portfolios. The results are given below.

Table-2. CIMB Principal Strategic Bonds and their risk parameters.

Bonds	Duration	Mod. Dur	Convexity	DEAR	Con.Adj	VaR
CIMB Bank	7.67	-7.35	66.49	-0.15	-0.13	-0.42
Genting Capital	6.90	-6.59	53.80	-0.13	-0.12	-0.38
Nur Power	6.17	-5.92	43.42	-0.12	-0.11	-0.35
GB Services	5.31	-5.09	32.73	-0.10	-0.10	-0.30
AMMB Hldg	5.39	-5.14	33.07	-0.10	-0.10	-0.30
Bumitama Agri Ltd	4.53	-4.33	23.94	-0.09	-0.08	-0.26
Perbadanan Kemajuan N.Selangor	4.58	-4.39	24.44	-0.09	-0.08	-0.26
Gamuda	4.61	-4.42	24.69	-0.09	-0.08	-0.26
Golden Assets Intl Fin Ltd	4.56	-4.34	24.01	-0.09	-0.08	-0.26
Golden Assets Intl Fin Ltd	3.75	-3.58	16.74	-0.07	-0.07	-0.22
MUMTALAKAT	3.70	-3.52	16.31	-0.07	-0.07	-0.21
Hyundai Capital Services	2.88	-2.76	10.46	-0.06	-0.05	-0.17
Sports Toto Malaysia	2.87	-2.75	10.36	-0.05	-0.05	-0.17
Sabah Development Bank	1.96	-1.88	5.35	-0.04	-0.04	-0.12
Jimah Energy Ventures	1.93	-1.86	5.30	-0.04	-0.04	-0.11

Note: 1. Mod. Dur = modified duration, 2. Con.Adj = convexity adjusted DEAR, 3. VaR= value at risk.\

The findings in Table 2 are tabulated as below in six figures for easier discussion.

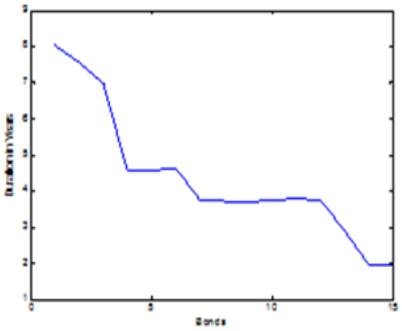

Figure-1.1. Duration.

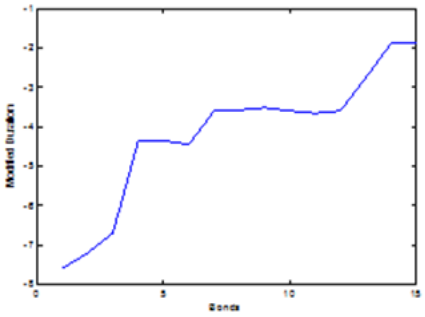

Figure-1.2. Modified Duration.

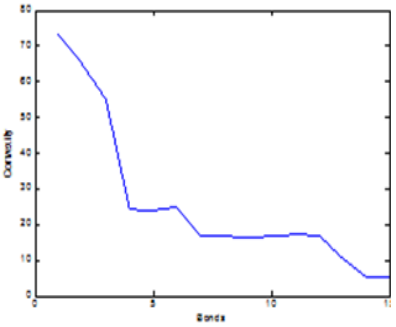

Figure-1.3. Convexity.

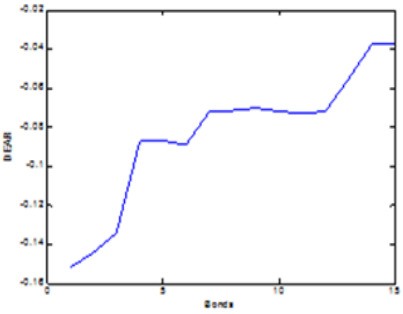

Figure-1.4. DEAR.

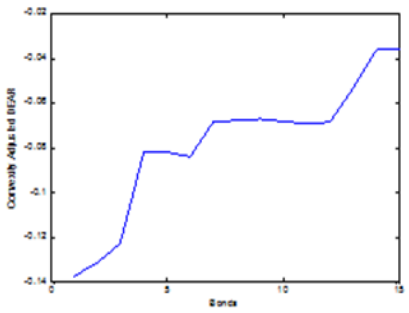

Figure-1.5. Con. Adj. DEAR.

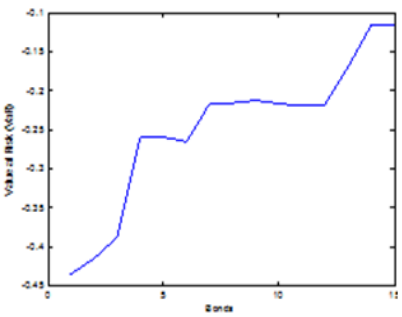

Figure-1.6. VaR.

Based on the first Figure 1.1, the first four bonds duration declined steeply to 5 but from bond 5 to bond 9 the duration stabilizes. Then the duration declined at a slower rate. Figure 1.2, showed a modified duration which is diametrically opposite to duration. The first three bonds increased steeply, and then it increased at a consistent rate. Convexity at Figure 1.3 shows the first four bonds declined steeply to 32 points then from bond 5 it declined at a lower rate. DEAR looked very similar to modified duration. Figure 1.5 was also similar to DEAR but the values were slightly lower. The final figure of expected loss in the individual bond which is technically known as VAR, also followed the path of DEAR. This was due to multiplication effect of the number of days after taking the square root for 10 days as suggested in BASEL II (Bank For International Settlement, 2009).

Table-3. Kenanga Fund's bonds and their risk parameters.

Bonds	Duration	Mod. Dur	Convexity	DEAR	Con.Adj	VAR
Jati Cakerawala	8.03	-7.61	73.25	-0.15	-0.14	-0.43
Malaysia Airports Capital	7.55	-7.22	64.82	-0.14	-0.13	-0.42
Syarikat Prasarana	6.97	-6.69	55.08	-0.13	-0.12	-0.39
Cagamas	4.54	-4.36	24.30	-0.09	-0.08	-0.26
DRB-Hicom	4.56	-4.34	24.02	-0.09	-0.08	-0.26
Manjung Island Energy	4.63	-4.45	24.98	-0.09	-0.08	-0.27
Sarawak Energy	3.74	-3.59	16.82	-0.07	-0.07	-0.22
Westports Malaysia	3.73	-3.57	16.68	-0.07	-0.07	-0.22
Bahrain Mumtalakat Holding	3.71	-3.52	16.26	-0.07	-0.07	-0.21
Golden Assets International Finance	3.75	-3.58	16.74	-0.07	-0.07	-0.22
Celcom Networks	3.79	-3.64	17.19	-0.07	-0.07	-0.22
First Resources Limited	3.75	-3.60	16.86	-0.07	-0.07	-0.22
Perbadanan Kemajuan Negeri	2.88	-2.76	10.43	-0.06	-0.05	-0.17
UniTapah	1.96	-1.87	5.31	-0.04	-0.04	-0.11
ADCB Finance (Cayman) Limited	1.95	-1.88	5.37	-0.04	-0.04	-0.12

Note: 1. Mod. Dur = modified duration, 2. Con.Adj = convexity adjusted DEAR, 3. VaR= value at risk.

Based on the Figure 2.1 below, up to the third bond the duration declined steeply to 3.5 but from bond 7 to bond 12 the duration stabilized. Then from bond 12 the duration declined at a slower rate and showed a stable pattern. Figure 2.2, the modified duration pattern looked diametrically opposite to duration. Convexity at Figure 2.3 shows the first seven bonds declined steeply to 16 points then from bond 8 it declined at a lower rate and then stabilized. DEAR looked very similar to modified duration. Figure 2.5 was also similar to DEAR but the values were slightly lower. The final figure, of expected loss in the individual bond, also followed DEAR but at larger amount. This, again was due to the multiplication effect of the number of days after taking the square root for 10 days as suggested in BASEL II.The findings in Table 3 are tabulated as below in six figures for easier discussion.

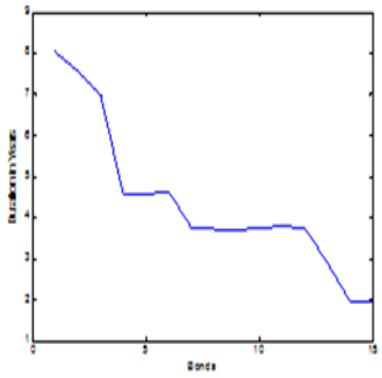

Figure-2.1. Duration.

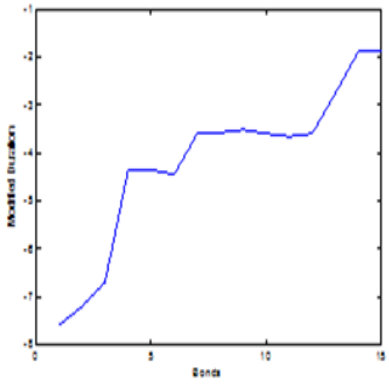

Figure-2.2. Modified Duration.

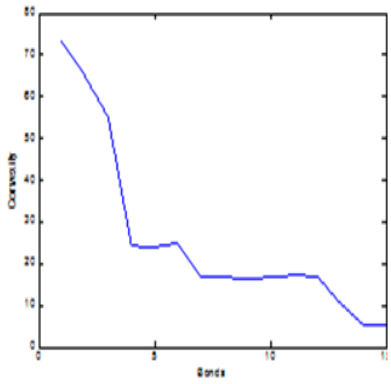

Figure-2.3. Convexity.

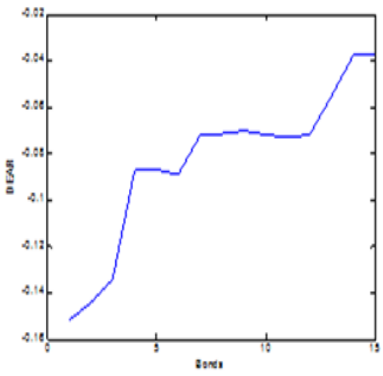

Figure- 2.4. DEAR.

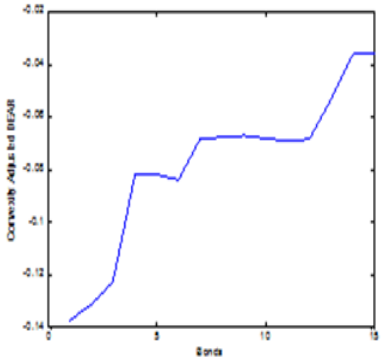

Figure-2.5. Con. Adj. DEAR.

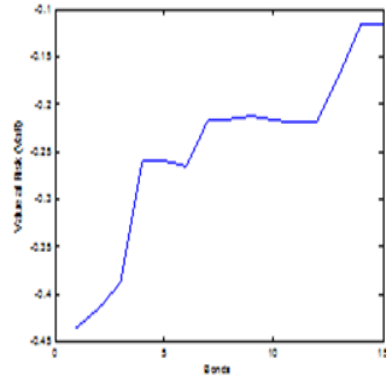

Figure-2.6. VaR.

Table-4. RHB-OSK Islamic Bonds and their risk parameters.

Bonds	Duration	Mod. Dur	Convexity	DEAR	Con.Adj	VAR
TNB Northern Energy	13.29	-12.58	219.46	-0.25	-0.21	-0.66
Konsortium ProHAWK	12.24	-11.59	184.77	-0.23	-0.19	-0.62
Tanjung Bin Energy	11.53	-10.91	164.58	-0.22	-0.19	-0.59
ANIH	10.11	-9.63	121.52	-0.19	-0.17	-0.53
Gulf Investment Corp	9.77	-9.30	111.55	-0.19	-0.16	-0.52
Westports Malaysia	9.42	-8.98	101.88	-0.18	-0.16	-0.50
Westports Malaysia	8.86	-8.45	89.46	-0.17	-0.15	-0.48
Bright Focus Bhd IMTN	8.05	-7.66	74.15	-0.15	-0.14	-0.44
BGSM Management	7.96	-7.57	72.94	-0.15	-0.14	-0.43
Kimanis Power	6.11	-5.84	42.61	-0.12	-0.11	-0.34
BGSM Management	6.05	-5.77	41.82	-0.12	-0.11	-0.34
Weststar Capital	6.02	-5.72	41.23	-0.11	-0.11	-0.34
Alpha Circle	6.03	-5.72	41.21	-0.11	-0.11	-0.34
Bumitama Agri Ltd	4.53	-4.33	23.94	-0.09	-0.08	-0.26
Weststar Capital	4.54	-4.33	23.94	-0.09	-0.08	-0.26
Edaran SWM	3.72	-3.54	16.42	-0.07	-0.07	-0.21
Edaran SWM	2.86	-2.73	10.24	-0.05	-0.05	-0.17

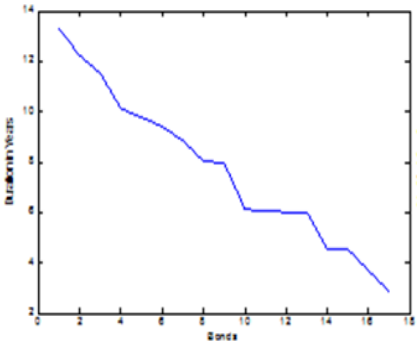

Figure-3.1. Duration.

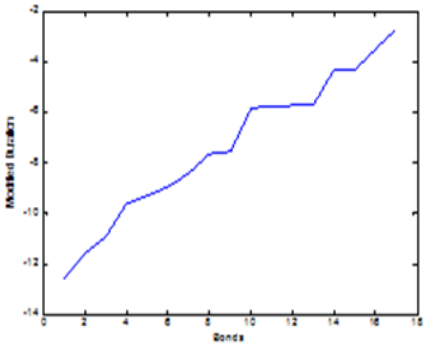

Figure-3.2. Mod Duration.

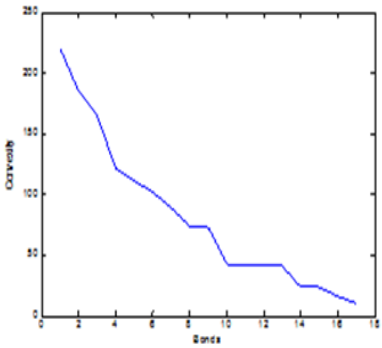

Figure-3.3. Convexity.

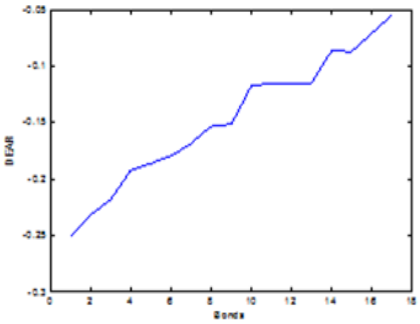

Figure-3.4. DEAR.

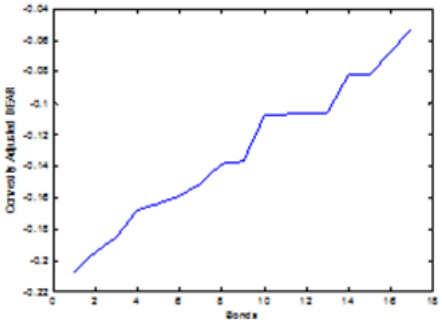

Figure-3.5. Con. Adj. DEAR.

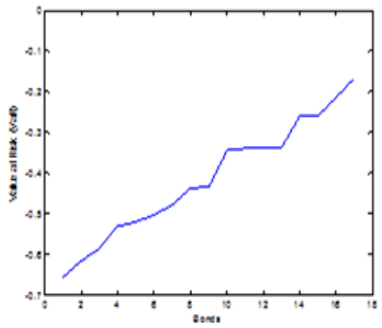

Figure-3.6. VaR.

The findings in Table 4 are tabulated as above in six figures for easier discussion. Based on the first Figure 3.1, this portfolio had the largest number of bonds. , The duration declined steadily for the bond 1 to bond 8, but declined steeper from bond 9 to bond 12. Then bond 13 it declined at a slower rate and stabilized again. In Figure 3.2, the modified duration was diametrically opposite to duration. Convexity at Figure 3.3 shows the first seven bonds declined steeply to 16 points. Then from bond 8 the convexity declined at a lower rate and then stabilized. DEAR looked very similar to modified duration. Figure 3.5 was also similar to DEAR but the values were slightly lower. The final figure of expected loss (VaR) in the individual bond, also followed DEAR but at a larger amount. This was due to the multiplication effect of the number of days after taking the square root for 10 days.

Table-5. Eastspring Investments Dana Wafi and their risk parameters.

Bonds	Duration	Mod. Dur	Convexity	DEAR	Con.Adj	VAR
Kimanis Power	8.71	-8.30	87.18	-0.17	-0.15	-0.47
Public Islamic Bank	8.20	-7.83	76.66	-0.16	-0.14	-0.45
RHB Islamic Bank	8.14	-7.77	75.79	-0.16	-0.14	-0.44
AmIslamic Bank	8.11	-7.73	75.19	-0.15	-0.14	-0.44
Tanjung Bin Energy	7.99	-7.58	73.01	-0.15	-0.14	-0.43
Tanjung Bin Energy	7.39	-7.03	62.23	-0.14	-0.13	-0.41
MukahPower	5.06	-4.83	30.30	-0.10	-0.09	-0.29
Jimah Energy Ventures	4.31	-4.12	22.41	-0.08	-0.08	-0.25
Bumitama Agri Ltd	4.53	-4.33	23.94	-0.09	-0.08	-0.26
Malakoff Power	4.56	-4.35	24.08	-0.09	-0.08	-0.26

Note: 1. Mod. Dur = modified duration, 2. Con.Adj = convexity adjusted DEAR, 3. VaR= value at risk.

The findings in Table 5 are presented as below in six figures for easier discussion.

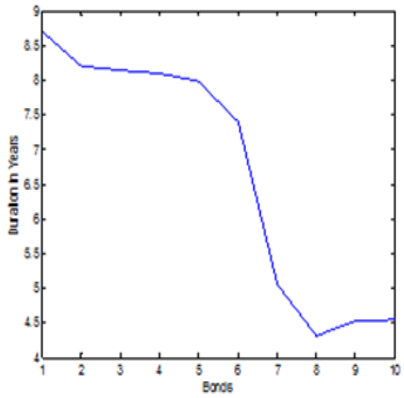

Figure-4.1. Duration.

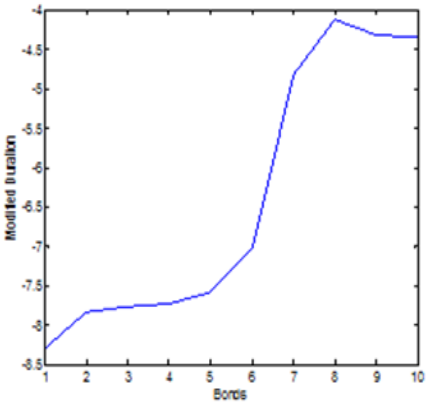

Figure-4.2. Modified duration.

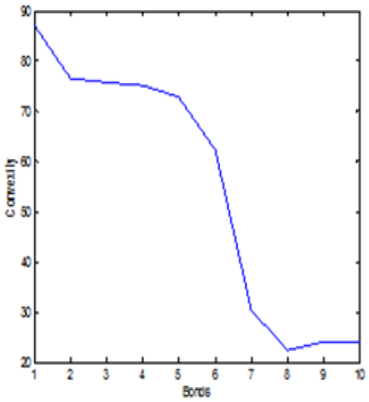

Figure- 4.3. Convexity.

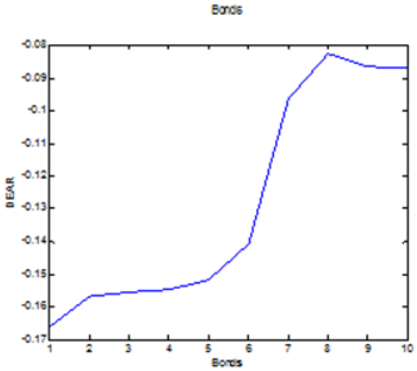

Figure-4.4. DEAR.

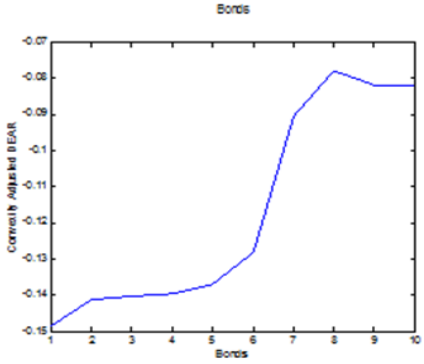

Figure-4.5. Con.Adj.DEAR.

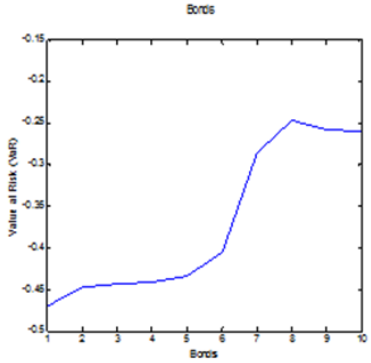

Figure-4.6. VaR.

Based on the first Figure 4.1, the first five bonds the duration declined but from bond 6 to bond 8 the duration declined steeply to 1.5 and stabilized for the next bonds. Figure 4.2, shows modified duration which was diametrically opposite to duration. The first 6 bonds increased slightly, but from bond 6 to 8, the modified duration increased very steeply and stabilized from bond 8 onwards. Convexity at Figure 4.3 showed similarity to the duration pattern. DEAR looked very similar to modified duration. Figure 4.5 was also similar to DEAR but the values were slightly lower. The final figure of expected loss in the individual bond which is technically known as VAR, also followed the path of DEAR. This was due to the multiplication effect of the number of days after taking the square root for 10 days as suggested in BASEL II.

5.1. Portfolio Comparison

After comparing the risk parameters for each bond in each portfolio, the next step was to compare all these parameters across the portfolios. This would give a distinction between the risk parameters used in Islamic and Conventional bonds.

Table-6. Inter portfolio comparison and their risk parameters.

Risk Parameters	CIMB Principal	Kenanga	RHB	Eastspring
Portfolio Duration	4.61	4.11	7.64	6.71
Portfolio Mod. Duration	-4.41	-3.93	-7.26	-6.40
Portfolio Convexity	27.63	22.80	76.40	55.18
Portfolio DEAR	-0.09	-0.08	-0.15	-0.13
Portfolio Con.Adj. DEAR	-0.08	-0.07	-0.13	-0.12
Portfolio VaR	-0.26	-0.23	-0.41	-0.37

Note: Conventional portfolio- CIMB Principal and Kenanga, Islamic portfolio- RHB and Eastspring.

Based on Table 6, the portfolio VaR for RHB-OSK fund was highest which means for every RM1 invested the expected loss was 41 cents if there is one bad day next year, followed by the Eastspring fund where for

every RM1 invested the expected loss was 37 cents. Both the conventional portfolios had lower expected loss, with CIMB at 26 cents and Kenanga at 23 cents for every RM1 investment.

However, based on the Basel II guidelines, in calculating the VaR, a 99th percentile, the one tailed confidence interval is to be used which was 2.33 in terms of standard deviation. In calculating VaR, a price shock equivalent to a 10 day period was to be used, in other words in a year 10 bad days will occur based on Basel II. This is a minimum regulatory capital needed to protect against market risk. After calculating 99% confidence, the portfolio VaR was larger and more accurate. Based on 99% confidence, Eastspring had the highest expected loss which means that for every RM1 invested the expected loss was 70 cents if there were 10 bad days the next year, followed by the RHB fund at 66 cents expected loss. The lowest portfolio VaR at 99% confidence was Kenanga at 27 cents for every RM1 investment.

Mutual funds and asset management companies have grown in size and volume in recent years. Deeper knowledge on risk management should be quantified precisely; or else over hedging and under hedging will lead to high cost and inefficient bond portfolio management. This mathematical result will be highly useful in understanding and managing bond portfolios.

6. IMPLICATIONS

The household savings should move to the industry to finance important projects which ultimately lead to economic development of a nation. This activity utilizes different financial products to tap into household savings. Therefore, bonds play a vital role in supporting and complementing the shares. The risk prevalent among the bonds was captured through duration and convexity is not as familiar as share risk captured by standard deviation and correlation.

Disseminating the information, the tools and the algorithms pertaining to bond risk will provide the stakeholders to quantify, manage and hedge the bond risk which is otherwise called as VaR. The regulators such as Securities Commission, Finance Ministry will be able to effectively control and reduce the risk prevalent in different kinds of bond which ultimately lead to a healthy bond market in a country.

7. CONCLUSION

The bond portfolio parameters of conventional and sukuk showed contrasting results. In the two conventional portfolios the values of parameters were less than the Sukuk by nearly 50%. The duration was almost half in conventional bonds than the sukuk. The duration was affected by life, coupon rate, yield rate and the proportion of funds invested in each constituent bond. As such, the comparison may not be of equal size. Still, the results showed that the sukuk are riskier than conventional bond portfolios. This may be due to the additional rules imposed on them in the form of Shariah compliance such as avoiding haram businesses, projects which are undertaken with this sukuk money should adhere to Shariah etc. When more conditions are imposed the risk of earning adequate returns increases which ultimately lead to higher VaR.

The profit sharing principle applied on sukuk may be yet another reason for the higher VaR as it is not concrete like the coupon rate in conventional bonds. The profit sharing ratio is fixed but the profit is volatile and it imposes additional burden on the sukuk holders. All the above result in higher VaR for sukuk, leading to higher hedging costs. This should be further tested with more data and more portfolios before any generalisation is made.

These results are comparable with another article published in Global Journal of Management and Business Research by (Ramasamy et al., 2011), regarding bond risk in term of duration and convexity for individual bonds. Our results are comparable with the previous results in all aspects. However, in this paper, the duration and convexity are extended to the bond portfolio level.

8. LIMITATIONS OF THE STUDY

The portfolio duration and other risk parameters were computed based on the linear method which is by finding the weights of each bonds in the portfolio and multiplied by the duration of each bonds and then divided by the total weights. So, the interaction among the bonds in a portfolio was neglected. The bond price also does not change frequently as share price, so some of the bonds showed low or zero standard deviation and zero return. However, this is the nature of the bond and bond market.

9. SCOPE FOR FURTHER RESEARCH

This article addressed the VaR with limited portfolios. Future researchers can increase the number of bond portfolios and also include several years' data which would be more helpful in generalisation. In addition, the bond portfolios could be classified in terms of size, industry, purpose of fund collection that will add to the contribution.

In this paper, covariance was omitted, which is one of the important parameter in risk assessment especially in portfolio context. The future researchers may include this parameter in estimating VaR in portfolio context.

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REFERENCES

Babbel, D. F., Merrill, C., & Panning, W. (1997). Default risk and the effective duration of bonds. *Financial Analysts Journal*, *53*(1), 35-44.Available at: https://doi.org/10.2469/faj.v53.n1.2054.

Bank For International Settlement. (2009). *Revisions to the Basel II market risk framework*. Basel, Switzerland: Bank for International Settlements.

Bhat, A. P. (2015). A test of alternative value-at-risk models during volatile periods. *Indian Journal of Finance*, *9*(8), 19-33.

Bursa Malaysia. (2015). Exchange traded bonds and sukuk (ETBS). Retrieved from: http://www.bursamalaysia.com/market/securities/bonds/products/exchange-traded-bonds-and-sukuk-etbs/. [Accessed March 21, 2015].

Cakir, S., & Raei, F. (2007). Sukuk vs EuroBonds: Is there a difference in value-at -risk? IMF Working Paper. WP/07/237. IMF Working Papers.

Crack, T. F., & Nawalkha, S. K. (2001). Common misunderstanding concerning duration and convexity. *Journal of Applied Finance*, *11*(1), 82-92.

El Mosaid, F., & Boutti, R. (2014). Sukuk and bond performance in Malaysia. *International Journal of Economics and Finance*, *6*(2), 226-234.Available at: https://doi.org/10.5539/ijef.v6n2p226.

Fitriya. (2012). *The impact of Islamic debt on firm performance*. PhD Thesis,Waikato University.

Kanchu, T., & Kumar, M. M. (2013). Risk management in banking sector–an empirical study. *International Journal of Marketing, Financial Services & Management Research*, *2*(2), 145-158.

Kritzman, M. (1992). What practitioners need to know… About duration and convexity. *Financial Analysts Journal*, *48*(6), 17-20.Available at: https://doi.org/10.2469/faj.v48.n6.17.

Macaulay, F. (1938). *The movement of interst rates, bond yields and stock prices in United Dtates since 1856*. New York: National Bureau of Economic Research.

Mansoor, K. M., & Ishaq, B. M. (2008). Development in Islamic banking: A financial risk-allocation approach. *The Journal of Risk Finance*, *9*(1), 40-51.Available at: https://doi.org/10.1108/15265940810842401.

Markowitz, H. (1952). Portfolio selection. *Journal of Finance*, *7*(1), 77-91.

Marling, H., & Emanuelsson, S. (2012). The Markowitz Portfolio Theory. 1-6.

Naveed. (2015). Islamic finance in the global finance system. Retrieved from: http://www.islamicfinance.com.

Paroush, J., & Prisman, E. Z. (1997). On the relative importance of duration constraints. *Management Science*, *43*(2), 198-205.Available at: https://doi.org/10.1287/mnsc.43.2.198.

Ramasamy, R., Munisamy, S., & Helmi, M. H. (2011). Relative risk of Islamic sukuk over goverment and conventional bonds. *Global Journal of Management and Business Research*, *11*(6), 4-12.

Saunders, A. (1999). *Financial institutions management: A risk management approach* (6th ed.). New York: Mc-Graw Hill.

Smith, D. (2010). Bond portfolio duration, cash flow dispersion and convexity. *Applied Economics Letters*, *17*(17), 1669-1672.Available at: https://doi.org/10.1080/13504850903251249.

Tahmoures, A. A. (2013). Compare and contrast Sukuk (Islamic Bonds) with conventional bonds, are they compatible? *The Journal of Global Business Managemnt*, *9*(1), 44-52.