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Abstract : Islamic bonds (sukuk) and conventional bond markets operate simultaneously in Malaysia complementing each other; the former operates on profit rates and the later on interest rates. In this paper we have analysed selected sukuks traded in Malaysia in terms of duration and convexity which are vital in deciding the market risk of fixed income bearing security. We compare these durations and convexities with that of government bonds and conventional bonds to assess the relative sensitivity of sukuk. Since the government bonds are highly liquid, without credit risk they stand better than sukuk. When compared with conventional bonds the sukuk stands better in these sensitivity measures. Interestingly the sukuk's duration and convexities fall exactly in the middle between government and conventional bonds. The sukuk investor will get a better yield rate when compared to government bonds and lower rate when compared to conventional bonds. This information conveys that the Islamic sukuk is lesser risky than conventional bonds. Our findings are significant for the investors who are not investing in pure sukuk alone. The blend of government, Islamic and conventional bonds in a portfolio will bring down market risk and in addition will provide stable income above the government bonds.

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I. Introduction

In recent times the Islamic bond (sukuk) market has registered a phenomenal growth all over the globe including non Muslim countries (Gavin James, 2010). Islamic sukuk market is very active in Malaysia (table 1) and approximately contributes 53.6% of the funds collected through sukuk issues in recent months. This could not be possible only due to the religious sentiments but there should be some sound economic merits for these Islamic sukuks when compared with conventional and government bonds. Bonds offer investors steady income, though low, often it is not in negative (loss) and less risky when compared to shares. In many jurisdictions the governments compel the institutional investors and financial institutions to invest a major portion of funds in bond market, as they are less risky, provide fixed rate of income. Therefore it becomes obligatory on the part of the financial institutions to choose best bonds issued and traded in the secondary bond market to construct bond portfolios.

Malaysia practices Shariah rules not only in day today life but also follow in economic life. The outcome is Islamic financial products like sukuks. Innovative Islamic financial products are designed and issued, acceptable to Shariah council. These sukuks differ from government bonds (GBs) and conventional bonds (CBs) in terms of rates and in adding the delayed payments (Bacha 1995). In conventional finance interest rates are charged and if the borrower fails to repay in time the interest accrued is added to the principal and thus interest earns interest based on the length of the time the funds are utilized by the borrower (Saeed 1995). In contrast the Islamic finance charges a markup (profit) over the principal and when default or delay occurs in repayment a penalty is charged (Al-Omar and Abdel-Haq 1996). In addition the delayed amount is not added to the principal and no extra amount is charged (Rose, 2010). The lender faces more risk in Islamic finance. As the risk and return are positively related the expected return (profit rate) should be higher for Islamic finance. The sukuks are issued by various Malaysian agencies under different Islamic principles. Bank Negara issues sukuks under Ijarah principles. This Ijarah sukuks brings three rights to the sukuk holder. The sukuk holder has the right not only to the cash flow of the asset and the right to posses the asset but also the right to get the proceeds from the sale of asset. It is like hire purchase in conventional finance.

Bai Bithaman Ajil, Murabahah and Istisna sukuks are issued as evidence of indebtedness arise from the sale of an asset. Normally these securities get the cash flows only and they do not have the right to possess and they cannot get the proceeding from the final sale of asset (Khoja, 1995). The rights to cash flow may be in the form of pre agreed profit sharing ratio or may be on deep discount basis. It is like any common conventional bond or zero coupon bond.Finance may be raised on partnership basis for some projects on a pre agreed profit sharing ratio. But the losses are differently treated. The losses are

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distributed in the capital ratio contributed by the partners. The partners are the owners of the undivided share of the project. The above mechanism is falling under the Musyarakak principle and any sukuk issued under this principle gives ownership of an undivided project in proportion of capital contributed by them.Mudharabah is another type of sukuk which gives equal rights to the partners and the profits are shared in a pre agreed ratio. This type of sukuk is issued on the principles of conventional equity shares.

Table 1: Top 20 Corporate Issuers as on June 2010 (RM billion)

Issuer	CBs	Sukuks	Con. MTN	Islamic MTN	Total
Cagamas	—	—	9.30	8.85	18.15
Khazanah	—	13.20	—	—	13.20
Binariang GSM	—	3.17	—	8.28	11.45
Project Lebuhraya	—	6.57	—	3.68	10.25
Prasarana	5.11	2.00	—	2.00	9.11
Maybank	6.10	2.50	—	—	8.60
Rantau Abang Capital Bhd	—	—	—	8.00	8.00
Malakoff Corp	—	1.70	—	5.60	7.30
KL International Airport	1.60	4.76	—	—	6.36
AM Bank	1.60	—	4.33	—	5.93
Value Cap	5.10	—	—	—	5.10
1 Malaysia Development Bhd.	—	—	—	5.00	5.00
Jimah Energy Ventures	—	—	—	4.77	4.77
Tanjung Bin	—	—	—	4.59	4.59
Bank Pembangunan Malaysia	1.00	—	2.60	0.90	4.50
Putrajaya Holdings	—	1.70	—	3.65	5.35
YTL Power International	2.20	—	1.70	—	3.90
Tenaga Nasional	1.50	2.15	—	—	3.65
Danga Capital	—	—	—	3.60	3.60
RHB Bank	0.60	—	3.00	—	3.60
Total	24.81	37.75	20.93	58.91	142.40
Total Outstanding	63.48	70.47	45.48	89.40	294.65
Top 20 as % of Outstanding	39.10%	**53.60%**	46.00%	**65.90%**	48.30%

Source: Bank Negara Malaysia Fully Automated System for Issuing/Tendering (FAST).

In Malaysia conventional bonds have a market share of 39% while Islamic sukuks have 54%. In the medium term notes also the sukuks enjoy a higher market share of 66%while the conventional medium term notes have only 46%.

Table 2 : Shariah compliant securities as on November 2010

	Shariah-compliant securities	Total securities	Shariah-compliant securities (%)
Consumer Products	131	141	93
Industrial Products	273	283	96
Mining	1	1	100
Construction	48	50	96
Trading/Services	170	198	86
Properties	71	88	81
Plantation	38	43	88
Technology	104	106	98
Infrastructure (IPC)	7	7	100

Finance	3	38	8
Hotels	Nil	5	Nil
Closed-end Fund	Nil	1	Nil
Total	846	961	88

Source: http://www.sc.com.my/eng/html/icm/sas/sc_syariahcompliant_101126.pdf

Almost 88% of the securities issued so far are Islamic and the remaining 12% is conventional. Though sukuks are unique in character and pricing mechanism they cannot deviate much from CBs because arbitrage opportunities will emerge. Overpricing will prevent investors in parking funds in sukuks while under pricing will attract all. Efficient fair pricing is needed to avoid arbitrage between Islamic and CBs (Al-Zoubi, Haitham Maghyereh and Aktham 2007). Pricing mechanism is intimately connected with the yield rate (YR), duration and convexity (Fournier and Elizabeth, 2010). These three measures are basic fundamental tools in any fixed income-bearing instrument assessment and evaluation whether it is sukuks or CBs. The popularity for sukuks would not only come from religious sentiments but also due to the economic benefits embedded in them. This paper examines what are those economic benefits accrue to the sukuks. The remaining part of this paper is organized into six sections. Section two explains the bond terminologies. Section three explains the methodology for computing duration and convexity while section four explains the data and its sources. In section five the duration and convexity of Islamic bonds, CBs and GBs are computed and compared through 't' tests to bring out the differences exist among the important parameters. Section six concludes the paper.

II. Bond Concepts

a) *Islamic Finance and Interest*

Riba or Usury (interest) or the time value of money destroys the soul of the human race because the provider (lender) of funds is safe (only takes rewards never bears risk) and all risks of investing the money is solely borne by the person (borrower) who takes the pain from inception of a project or venture. The borrower faces all risks of investments while the funds provider faces none. It is unfair as the risk and uncertainties are placed on one person. Islamic finance principles advocate the provider of the funds should also face uncertainties and risks which will provide a level playing field (Kahf and Khan, 1992).

b) *Coupon rate and yield rate*

Normally bond issuers pay interest to investors in regular intervals normally once in six months. This interest is computed by applying CR on the face value of the bond regularly. Except this function the CR has no role to play in bond management. This interest is based on time. Sukuks on the other hand avoid this type of computation. There are two main differences between conventional and Islamic way of calculating cash flows. Firstly the profit rate charged by the Islamic finance is not based on length of time period and secondly when delay or default occurs due to some unforeseen reasons the amount due will not be added to the principal as in conventional finance to compute compound interest.

The deep discount technique requires no payment of interest during the life of the bond to investors. The face value of the bond will be paid at maturity in full. This will increase the default risk several fold to the investor. To overcome this credit risk, both in Islamic and conventional bond investors, through indenture provisions force the issuer to set aside periodically an annuity in sinking fund (Aggarwal and Yousef, 2000). If the borrower fails to transfer the required funds to sinking fund delay or default occurs in zero coupon bonds. Though direct cash flow does not occur between borrower and lender, indirectly funds move from issuer to sinking fund.

Coupon rate (CR) is useful only for cash flow (interest) computation. The true rate of return is measured in terms of yield rate (YR) both in Islamic and in conventional investments. This YR plays a major role in all spheres of bond management. Term structure calculations, value at risk computations, hedging or swap decisions are all based on YR. Islamic finance is no exception. YR has a number of underlying assumptions, yet it is applied in all aspects of bond management.

Bond value is highly sensitive to YR changes and the YR is dependent on the economic policies of the government. YR, Duration and Convexity are the three important parameters used while analyzing bonds to compute value at risk (VaR). The zero coupon bond is also subjected to the above rigorous assessment. The individual bonds' duration and convexity are applied in assessing the individual bond's market risk and bond portfolio's market risk.

c) *Yield to Maturity*

YR is the discount rate that equates the total present value of a given bond's future cash flows to the spot market price. In other words it is the internal rate of return or Yield to Maturity. This YR is inversely related to the value of the bond. If YR increases the bond's value declines. This fall in value is the VaR which is needed for hedging decisions.

d) Duration

Duration of a bond approximates the value fall or value gain when the YR changes in either direction. In other words the duration is a sensitivity measure, which quantifies the bond's value movement for a given change in the YR. It is the first derivative of the price yield curve. The slope of the price yield line is the duration and colloquially it is the weighted average time an investor has to wait to get back his or her money. A higher duration indicates higher sensitivity of the bond's value to a given YR change and vice versa.

e) Convexity

Convexity is the sensitivity of the delta or it is the second derivative of the price yield curve. The duration approximately estimates the sensitivity of the value when YR changes. This duration is not an accurate measure because the price yield curve is not a straight line as portrayed by the duration. The slope of the price yield curve is a parabola and it is convex in shape. The duration estimate of bond's value fall is approximate and results in an error. This error component in the value change for a given yield change is measured by the convexity. In other words the error present in the value fall is corrected by convexity.

f) Convexity is desirable

The convexity estimates the change in duration for a given change in YR. Equal YR drop or increase does not produce equal amount of convexity as expected. The convexity produced by the drop of YR is more than the convexity produced by same YR increase. It is a measure of excess capital gain received by the investors. The value loss in a bond for a given change in YR upwards is less than the value gain for the same YR decrease. In other words there is more value gain than value loss for a given equal YR drop and increase. More convexity means more capital gain to the investor hence it is desirable.

In nutshell duration measures the sensitivity of the bonds' value for YR changes and the convexity measures the sensitivity of delta. Delta is the first derivative of price-yield curve and the gamma is the second derivative of the same. With the above background we try to analyze the Islamic bonds delta and gamma and compare with the conventional counterpart to assess the relative sensitivity of Islamic sukuk.

III. Methodology

The investors and portfolio managers are concerned very much about their bond portfolio value. Duration quantifies this value loss and convexity corrects error present in the quantified loss. Our interest is to compute and compare the duration and convexity of Islamic sukuks against GBs and CBs.

Bonds values are directly related to cash flows and these cash flows will be discounted at YRs to find fair value, duration and convexity of bonds. The periodical interest received is the cash flow. Interest for every year is computed by multiplying face value of the bond by the coupon rate (CR). At maturity the bondholder will get back his money invested earlier along with the final interest. The principal amount returned is known as redemption value.

In terms of algebra, the interest or cash flow will be

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

CF = Cash flow (interest)

FV = Face Value

CR = Coupon rate

For sukuks also this calculations match. Instead CR profit rate will be applied in sukuks. In the case of deep discount Bai Bithaman Ajil bonds the amount transferred to sinking fund will appear as cash flow after removing the principal portion.

Interests or profits accrue all years till maturity and in final year the redemption value is also received. Therefore the cash flows are

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

RV = Redemption Value

k = Life of the bond

The above cash flows are to be discounted at YR and added to get the fair value of a bond.

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

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

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

The total present value of the cash flows is the fair value, which could be paid for the bond while buying in the secondary market.

The present values (discounted cash flows) of cash flows are to be multiplied by the time (years) and summed up while computing duration.

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

t = 1,…..,n

ξ = Total of discounted value and time

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

Now duration can be computed with the above two totals of cash flows.

$$D = \frac{\xi}{\eta} \quad (7)$$

D = Duration (weighted average life of the bond)

Duration gives the slope of the price yield curve but not the expected drop in value of bonds. To calculate the loss or gain one has to find another parameter, which is modified duration calculated as follows.

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

MD = Modified duration

Change in bond's value is proportional to modified duration. This parameter is the direct measure, which quantifies the value fall or value increase when YR changes. The value loss or value gain could be easily calculated with the help of modified duration as stated below. As per conservative accounting principle the future losses are to be accounted while prospective profits are ignored. Hence modified duration is always quoted in minus.

$$\frac{dp}{p} = -MD * dy \quad (9)$$

dP = Change in value of the bond

MD = Modified duration

dY = Change in YR

For small YR changes this modified duration fairly estimates the value loss or value gain. The value difference resulting in a change of YR of 20 points may be accurately captured by duration. But in case of a larger YR change, say 100 points or more the duration does not estimate the value change accurately. This is due to the convexity of the yield curve.

This convexity is to be quantified and to be adjusted to the value to get value loss or gain more precisely.The same duration calculation method is to be extended by two more steps to get the convexity. The present values of cash flows obtained in equation three is to be multiplied by t^2+t as follows.

$$\lambda = \frac{C_1 * (t_1^{\ 2} + t_1)}{(1+y)} + \frac{C_2 * (t_2^{\ 2} + t_2)}{(1+y)^2} + \ldots\ldots + \frac{(C_n + RV) * (t_n^{\ 2} + t_n)}{(1+y)^n} \quad (10)$$

λ = Total discounted cash flows multiplied by time squared plus time

$$\lambda = \sum_{k=1}^{n} \frac{C_k * (t_k^{\ 2} + t_k)}{(1+y)^k} + \frac{RV * (t_n^{\ 2} + t_n)}{(1+y)^n} \quad (11)$$

With the above total of time adjusted cash flows convexity can be computed as follows.

$$CX = \frac{\lambda}{p * (1+y)^2} \quad (12)$$

CX = Convexity

This convexity is desirable in bonds. More convexity will bring more value gain than value loss for a given equal YR drop or increase. It is a partial insurance against the bond value because it minimizes the future loss. Investors will choose the financial assets in terms of risk reward ratio. For every unit of risk an investor will desire to have a higher return, ceteris paribus. To compare the sukuks with various kinds of bonds the risk reward ratio was computed using the following notation.

$$RR = \frac{YR}{\sigma} \quad (13)$$

RR = Risk Reward (Sharpe) Ratio

YR = Yield Rate

σ = Standard Deviation

An argument may arise how the models applicable to conventional bonds could be applied to Islamic Sukuk. Whether it is sukuk or conventional bonds both have yield rates. Only in coupon rates the difference exists. The coupon rate is based on time for conventional for but for sukuk it is profit based. As the yield rate measures the rate of return it is the common parameter for evaluating both sukuk and conventional bonds.

IV. Data

Our interest is to compute and compare duration and convexity of Islamic sukuk with the GBs and CBs for which we have collected data from several websites.

Bank Negara Malaysia's FAST TRANS menu, BOND INFOHUB and Bond pricing agency of Malaysia

were used to download price, coupon and YRs. We selected only the bonds, which have complete data. The zero coupon bonds and commercial papers have been excluded from analysis due to non availability of issue prices and the market prices. Our final sample consisted of 93 bonds data comprising 31 sukuks, 35 CBs and 27 GBs. With this data we applied the earlier methodology and computed duration and convexity of all 93 bonds using MATLAB software. The results were transferred to SPSS software to test the differences that may exist among the means of four important parameters in three groups of bonds

V. Results and Discussion

YRs reveal the true profitability of a financial asset like bonds whether it is government, Islamic or conventional. The duration provides information on the sensitivity of the financial assets as financial assets lose value when the YR goes up. If sensitivity (duration) is known the expected loss could be assed and hedged easily. Since the duration is not accurate the second sensitivity convexity is computed and the expected loss is corrected. This will reduce the hedging costs.

First the sukuks are compared with GBs. Comparing GBs with sukuks may draw criticism as there are differences in terms of credit risk and liquidity risk etc. But Shariah scholars argue that the sukuks follow Shariah principles hence only bonds adhere to Islamic principles are selected consequently the risks will be lower. As such the companies which rise Islamic finance morally bound to repay the money with the agreed mark up and therefore they are comparable. The descriptive statistics of the sukuks and GBs are given in the table below. The sukuks average CR, YR, duration and convexity is more than the GBs. This is due to the riskless nature of GBs. For GBs there is no default risk, there is no liquidity risk and the interest income is tax-free. But for sukuks these risks exist and hence the rates are slightly higher.

Table 3 : Descriptive statistics of Sukuks and Government Bonds

		N	Mean	Std. Deviation	Std. Error Mean	Sharpe Ratio
Coupon or Profit %	Sukuks	31	4.79	0.92	0.165	5.21
	GBs	27	3.96	1.29	0.248	3.07
Yield %	Sukuks	31	4.24	0.85	0.152	4.99
	GBs	27	3.88	0.50	0.097	7.76
Duration	Sukuks	31	2.84	1.85	0.332	1.54
	GBs	27	1.74	2.25	0.433	0.77
Convexity	Sukuks	31	14.10	14.67	2.635	0.96
	GBs	27	9.28	21.68	4.173	0.43

GBs coupons rates are more inconsistent and the standard deviation reveals the volatility of these bonds selected. The profit rates for sukuks are less volatile (0.92) as than GBs (1.29). The YRs are more volatile for the sukuks (0.85) than GBs (0.50). It implies that the sukuk prices are volatile in the market and consequently the YRs are more volatile as market prices and YRs are related. The sukuk's duration is less volatile than GBs. In convexity also the sukuks are less volatile. When return and risks are brought under a single parameter the risk reward ratio emerges. In profit rate the sukuk shows a higher ratio but in yield rate the GBs shoes 2.5% more than the sukuk. Duration and convexities are also higher for sukuks. This is due to the absence of risk in GBs while the investors perceive the sukuks as risky.

Table 4 : Sukuks and Government Bonds mean differences and t values

	Mean Difference	t	Sig. (2-tailed)	Std. Error Difference
Coupon or Profit %	0.828	2.842	0.006***	0.291
Yield %	0.360	1.930	0.059*	0.187
Duration	1.108	2.057	0.044**	0.538
Convexity	4.817	1.002	0.321	4.808

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

The 't' values are given above for four parameters. The 't' values for CR and duration are more than 2 and they are significant at 1% and 5% levels respectively. It shows that both profit rate and duration for Islamic and GBs substantially differ. Sukuks enjoy an advantage in them. The YR mean difference is 0.36% greater for sukuks when compared with GBs. The YR 't' value is 1.93 at it is significant at 10% level of significance. It implies that there are differences in YRs of Islamic and GBs. The convexity is insignificant.

After comparing with GBs the sukuks are compared with CBs. The results are presented below.

Table 5 : Descriptive statistics of Sukuks and Conventional Bonds

		N	Mean	Std. Deviation	Std. Error Mean	Sharpe Ratio
Coupon or Profit %	Sukuks	31	4.79	0.92	0.165	5.21
	CBs	35	6.79	1.82	0.308	3.73
Yield %	Sukuks	31	4.24	0.85	0.152	4.99
	CBs	35	5.53	1.19	0.202	4.65
Duration	Sukuks	31	2.84	1.85	0.332	1.54
	CBs	35	2.90	1.89	0.319	1.53
Convexity	Sukuks	31	14.10	14.67	2.635	0.96
	CBs	35	14.98	17.74	2.999	0.84

Profit rate, duration and convexity for sukuks are lower when compared with its conventional counterpart. The Sharpe ration in terms of profit rates is higher for sukuks. Even the mean YR is higher for sukuks by 0.0034%. The CR, YR differs by 2% and 1.3% approximately. The duration and convexity also differ by 0.06 and 0.88. The standard deviation (volatility) is consistently less for sukuk than CBs. The profit rate (CR), YR and duration volatilities differ in a few points between sukuk and CBs. But the convexity volatility differs substantially between sukuk (14.67) and CBs (17.74). The Sharpe ratios of durations are same which implies both the bonds have the same sensitivity. In convexity the sukuks show favourable result, a higher convexity is desirable.

Table 6 : Sukuks and Conventional Bonds mean differences and t values

	Mean Difference	t	Sig. (2-tailed)	Std. Error Difference
Coupon or Profit %	-1.999	-5.517	0.000***	0.362
Yield %	-1.289	-4.993	0.000***	0.258
Duration	-0.058	-0.127	0.900	0.461
Convexity	-0.877	-0.217	0.829	4.038

*** Significant at 1% level

Both average CR and average YR are significantly different which implies that there is substantial difference exist between sukuks and CBs. YRs are significantly less for sukuks. But there is no significant difference in duration and convexity. The duration is less by 0.058 and the convexity is less by 0.877 for sukuks but both are close to the CB's averages. These results imply that the sukuks are less risky in terms of duration but comparable in convexity.

VI. Conclusion

The governments bonds are always considered to be safe, liquid and in terms of return they provide a lower yield. The sukuks are growing fast along with the government and conventional bonds. The sukuks invest money as per Shariah principles in halal businesses as such they are safer when compared to the conventional bonds. When empirically analysed for sukuks' riskiness the results reveal that they are moderately risky than government bonds and less risky than conventional bonds. As risk and return are positively correlated the sukuks provide a lower return. These results support the popularity of the sukuks though yield is less due to their less risky nature. All these results imply that the sukuks are more apt investment for risk averters, whether they follow Islam or any other religion. Investors who choose bond market for investment will be normally risk averse else they will go to stock market which is more risky and with better YRs.

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