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Efficient computation of Islamic yield and forward rates in sukuk market of Malaysia

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Abstract: The dynamic yield rates prevailing in the bond market determines the bond portfolio values as the yield rate is negatively correlated with the bond value. Due to economic conditions principal in the country the yield rate sometimes goes up which cause the bond portfolio values to go down. This value loss is to be contained by risk management, which requires accurate yield and forward rates. The future yield rates are determined by term structure methods and published for almost 30 years. The English published are not at regular intervals. They have a lot of gaps this gap stops to be filled to get yield rates at regular intervals of every six months. The interpolation technique and spline methods were applied to get the missing yield rates. These methods produce larger errors which cause miscalculation of expected losses, defeating the objective of risk management. In this article to overcome this problem, we apply Nelson Siegel Svensson (NSS) method to compute the missing yield rates by minimizing the errors through non-linear optimization. We take the sukuk yield rates provided by the Bank Negara Malaysia and apply Microsoft Excel salver function and compute all yield rates once in every six months. These computed NSS regular yield rates are applied to get forward rates. These forward rates are essential to compute value at risk accurately. Once the value at risk is quantified accurately it is easier to hedge the portfolio value so as to avoid the value at risk. We prove that forward rate computed for 2021 and 2022 are converging well with the yield rates given by Bank Negara. The method we explain will be useful for asset managers and also the portfolio risk managers.

Keywords: Sukuk, Forward Rates, Yield Rates, Shariah

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1. Introduction

The Government of Malaysia and private sector organizations issue financial instruments such as Sukuk and acquired by several types of investors and compose them into financial asset portfolios (Siddiqui, 2012). To make an effective risk management, the portfolio managers who manage portfolios in the form of mutual fund, and institutional investors like Tabung Haji, Takaful, etc (Ahmad et.al, 2017). Require yield rates and forward rates because has gaps and inefficiencies in the form of inaccurate yield, forward rates, etc. (Heng et.al, 2005).

The yield rates are computed by several agency like Bank Negara Malaysia (BNM), fully automated System Tendering and Issuing (FAST) and Bond Pricing Agency of Malaysia. Inaccurate estimation of value at risk occurs along with sub optimal hedging when yield rates given are discontinues and lead to the problem of missing yield rates and the forward rate is discontinued automatically (Hung & Lee ,2006). IAS international accounting standard 21–standard mandate that hedge should be 80% effective however when forward rate inaccurate will not result in 80% effectiveness (Nesuf,2013). Nelson Seigal Svennsson (NSS) model is proved to be effective in estimating the discontinues yield rates. The forward rate computed will help the investors to mitigate risks and assist in hedging decisions (Minina & Vellekoop , 2010).

Sukuk is an Islamic bond in Islamic debt market instrument which is an asset-based security that represents ownership of tangible assets which is related to Syariah law (Essia Ries Ahmed, Fathyah Hashim,2020). All activities which are related to Sukuk must be 'halal' (Rafisah Mat Radzi 2018). According to Islamic Finance Development Indicator, Malaysia is known as the most developed Islamic finance market in the world. Islamic scholars believe that there should be no risk management in Islamic finance as the sukuk itself is risk free and not to sell intangible products in the market (Agha & Sabirzyanov, 2015). However, the Islamic sukuk portfolios also lose value when Islamic yield rate increase in the sukuk market (Alim et al.,2021).

According to Hanif(2011), the Bai Salam contract are equivalent to conventional market forward contracts and used to manage the sukuk portfolios it is carried out in Islamic finance whereby the seller undertakes to supply some specific commodity to the buyer at a future date in exchange for advance price fully paid on spot. The price paid in cash but the delivery of the good is in future in which the commodity sold in seller physical possession or existence. Bai Salam is not permitted in Syria if commodity is already for sale, further the sale has performed either on Bay' Bithaman Al-Ajil or Bai-Murabaha investment (Shuib &Noor, 2018). Basically, agricultural and industrial products are performing in advance purchase based on Bai Salam mode. Due to funds shortage, production is not delayed through investment to infuse finance from seller collateral security is attained and claimed in order to perform secure investment. It has been done through commodity supply in partial or low-quality products or hazards' non supply. From third party it is permissible to attain personal guarantee or mortgage as security before or at the time of agreement signing.

2. Literature Review

Usmani (2002) raised the issue of Riba in Islamic finance, known that collection of Riba is cruel ,because the Riba is paid interest by the borrower to the lender and doesn't have risk to lenders. Since, suggested a profit sharing between the borrower and the lender. The lenders sometimes get losses from the borrower. It doesn't worry him why because the years of profit the profit rate will be higher. This will reduce the burden on the part of the businessman.Businessman's are the borrower which will encourage more people to come and start businesses are entrepreneurs by borrowing money. Thus, Islamic

finance encourages the business and entrepreneur activity by profit sharing ratio suggestion.

Bank Negara (National Bank of Malaysia) supervise Islamic banks with healthy banking system, Basel three rules are applied in Malaysia (Zainudin et al.,2019). Now Basel four has come being gradually implemented in Malaysian banking system to protect the environment and also to assist the society in general and poor in particular and also to implement corporate governance principal in banking the environmental social governance (ESG) system(Atan et al.,2016).The environmental issues and social issues are now a days given importance's in bank lending. Other banks sector also strictly follow principal of lending and borrowing including financial Islamic system (Kaleem & Wajid, 2009).

According to Melzatia & Doktoralina (2018), the yield rate is computed by several organization which are associated with the banks, also investment market specifically in bond market. The short-term interest rate and long-term interest rate are arranged in order and its used in computing the term structure of yield rates (Hladíková & Radová,2012). Terms structure of yield rates are not given in every six months. There are given: three months yield rates, six-month yield rate, one yield rate, three years yield rate, seven years yield rate, fifteen years yield rate, twenty years yield rate like that yield rates are given. Any investment manager who wants to fix the future rates of interest and also anyone who wants to borrow or lend money in the future market require forward rates. So, the continues yield rate are needed, but they are not available (Awaludin & Masih, 2019). The available information is only in the not in the order but only in several gaps. Several techniques which were use earlier is computing the forward rates, but these forward rates are very inaccurate produce larger error. When they produce larger error, definitely the risk management is not efficiently done. Provide this problem every six months yield rates need to be computed and every six months rates when try to compute. There are several models and this model discussed below.

In 1996 Nelson Siegal method was improved by Nelson Svenson. Since interpolation technique are inefficient based on Nelson and Siegal model in 1987. Nelson Siegal Svenson method, the error level is minimized and the expected yield rate and the given yield rate both are converging and it gives the researchers all six months yield rates and contributing to compute the forward rates, which is supportive in risk management (Garcia et al., 2018). The errors produced by the interpolation model is very large, sometimes, it defeats the purpose of finding accurate forward rates. Researchers developed many models to overcome this problem.

According to Waluyo & Rozza (2020),Bai Salam contracts are forward contracts which trading commodities has changed in advance as money paid in advance. The contracts they have to be valued the forward rate here the forward rate places value. Forward rates cannot value the forward contract as such this is important in Bai Salam meanwhile important in Islam, they use forward rate for pricing. Expectation theory explains what

the investors except from the market. There are two possibilities the investors may have except that the financial asset may increase in the future. The financial assets maybe falling into prices using this opportunity investors can take long position or short position to make profits in the long position involved to buy some assessed in the financial market on the except on prices increases in future.If an investors buy share or bond it may increase to x plus y the y is capital gain money price increase. If the share is sold to some it will give profit of y because is buying price so here called long position. It senses wait for sometimes and sell. Sometimes short position take place the short place is exception price will fall near future. if the prices are going to fall, the investor will do certain activities to make the profit. He will go to the broker and he will do share promising that he will return at sometimes and the borrow share will be sold to investor in the share market are similarly are the bond market and sell it to higher price (Nawalkha & Zhuo, 2022). Prices will fall when the prices fall the buyer are the investor at the borrower will buy the share at the lower prices and return the securities to the brokers at sometimes so this borrow and sell and buy give back the broker this short contract which is giving profit to the investors in the short-term contract will be shown the balance sheet as liability as the share is borrower that is paid his liability places central role and balances of securities.

3. Materials and Methods

Forward rates are helpful in risk management and quoting rates for a future loan. Forward rates grow geometrically. Hence there are to be computed in powers. There are sixty taus in this framework. It is as follows.

Forward Rate Time Periods

where

τ_1 = First six months
τ_2 = Second six months
T = time for which forward rate needed
S = Maturity of the instrument

For each Tau, one forward is to be calculated, but for the first Tau, the yield rate will be the forward rate. The algebra formula and process are as follows.

$$FR\ \tau_2 = \frac{(1+YR_2)^2}{(1+YR_1)^1} - 1 \ldots\ldots\ldots\ldots$$

$$FR\ \tau_3 = \frac{(1+YR_3)^3}{(1+YR_2)^2} - 1 \ldots\ldots\ldots\ldots$$

$$FR_{\ T} = \frac{(1+YR_T)^T}{(1+YR_{T-1})^{T-1}} - T \ldots\ldots\ldots\ldots$$

where
T = time for which forward rate needed
S = Maturity of the instrument

Thus, the forward rate for all sixty taus will be calculated. All sixty tau forward rates will be available. The managers who handle the risk can use this forward rate to compute future losses and hedged them to avoid portfolio value loss (Kumar,2022).

Nelson Siegel applied four parameters to optimize and compute every six-monthly data of yield rates. As an improvement, Svenson introduced two more parameters in the optimization model to compute every six months' yield rates, and the model is as follows.

$$r(t) = \beta_1 + \beta_2\left(\frac{1-\exp\left(\frac{-t}{\lambda_1}\right)}{\frac{t}{\lambda_1}}\right) + \beta_3\left(\frac{1-\exp\left(\frac{-t}{\lambda_1}\right)}{\frac{t}{\lambda_1}} - \exp\left(\frac{-t}{\lambda_1}\right)\right) + \beta_4\left(\frac{1-\exp\left(\frac{-t}{\lambda_2}\right)}{\frac{t}{\lambda_2}} - \exp\left(\frac{-t}{\lambda_2}\right)\right)$$

where
r(t) = Yield Rate as per NSS Model at time t
β_1 = Shift
β_2 = Slope
β_3 = Curve
β_4 = Absorption
λ_1 = Hump 1
λ_2 = Hump 2

4. Results

The coupon interest rates change from lower rate to higher speed or higher rate to lower rate based on the Bank Negara's,Negara's Based lending rate (BLR) adjustment. This BLR is specifically used to control inflation and demand. In times of difficulties, the same BLR will create more demand by reducing it. When the BLR increases, the money will be followed from the public to banks. This is happening due to the higher interest rates given by the banks. In addition, this will create a situation where the public will have less money, reducing the consumption of goods and services. Therefore, inflation will be controlled. Similarly, when the Economy is dull and in recession, to create employment and increase production, the Bank Negara will reduce the BLR. The cash will flow from the banks to the public. The public will have more money to spend, increasing demand, creating production opportunities, and ultimately generating employment. This activity of Bank Negara will result in a shifting of interest rates. This is captured by Beta 1.

The companies will increase interest rates in the short term to attract more funds. Similarly, when funds are available abundantly, the companies will slowly reduce the interest rates. A slope will capture this increase or decrease in interest rates addressed in the NSS model as Beta 2. Economic downturns will frequently occur due to natural courses such as the economic and financial crisis in 2008 and the pandemic covid crisis from 2020 to 2022. Even changes in the Government and the ministers in essential portfolios when they change the Economy will take a turn which will affect the economic activities of a nation. This will create curves in interest rates as the Economy is affected due to natural courses. This curvature effect is captured by Beta 3.

Several factors influence the economic activities of a nation simultaneously. Actions like exports, imports, current accounts balance, etc., affect the Economy sometimes positively and sometimes negatively. These positive and negative effects will absorb interest rate shocks up and down. This effect is captured by Beta 4. The parabola curve is

like a "U" shape curve. In the Economy, the "U" shape curve will occur due to multiple factors which affect the Economy and pulls the Economy in different directions. All these forces culminate into a "U" shaped curve (Moorad Choudhry, 2018). In curve projection, there are three curves: Normal Yield Curve, Inverted Yield Curve, and Humped Yield Curve. The inverted yield curve is captured by Lambda 1(MẀ nch, 2008) .

4.1 Findings and Discussion

As discussed in the previous section, different economic forces will pull the yield curve in different directions. The cumulative effect of all these factors will provide the inverted U-shaped curve captured by Lambda 2. Under the NSS model, the above six forces are incorporated to capture the yield rate possibilities in the blank cells where the data is unavailable. These six parameters will change during optimization, reducing errors between the given and computed yield rates. Thus, the NSS model calculates error-free (minimum error) yield rates every six months.

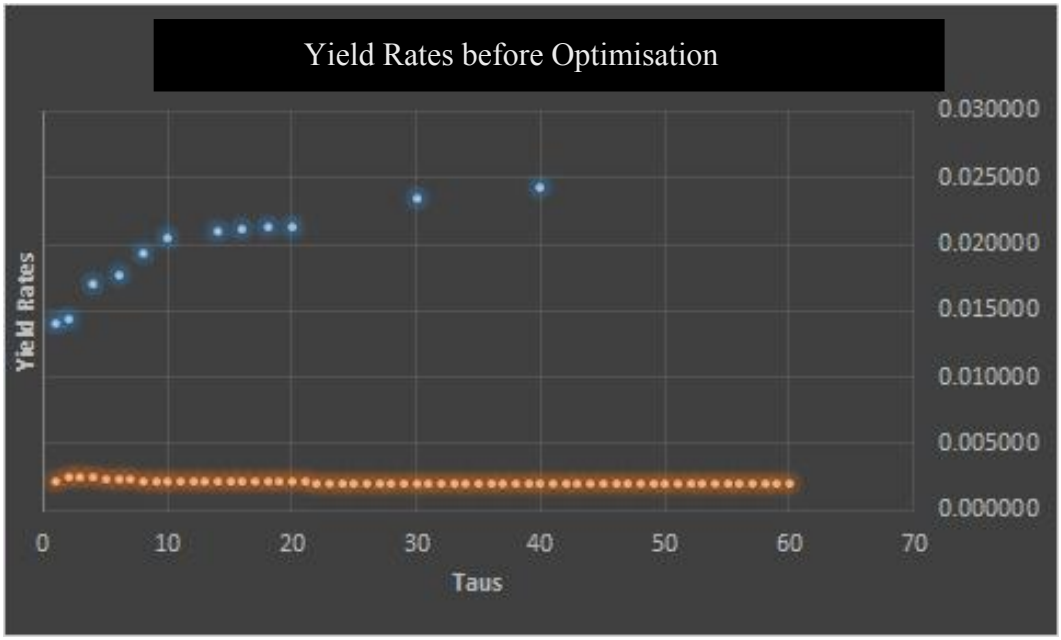

Figure 1: *Given yield rates and NSS yield rates before optimization*

The chart above shows error is to be minimized by non-linear optimization. The data given in fast is not continuous and unavailable for every Tau. The NSS model fields up this gap. There are not converging with each other due to the more significant error between FAST yield rates and NSS yield rates. The optimization process will achieve convergence. The optimization process will reduce the total error iteratively. This brought into a scatter graph to determine whether FAST yield rates and NSS yield rates merge. This will validate the efficiency of the NSS model in estimating the yield rates.

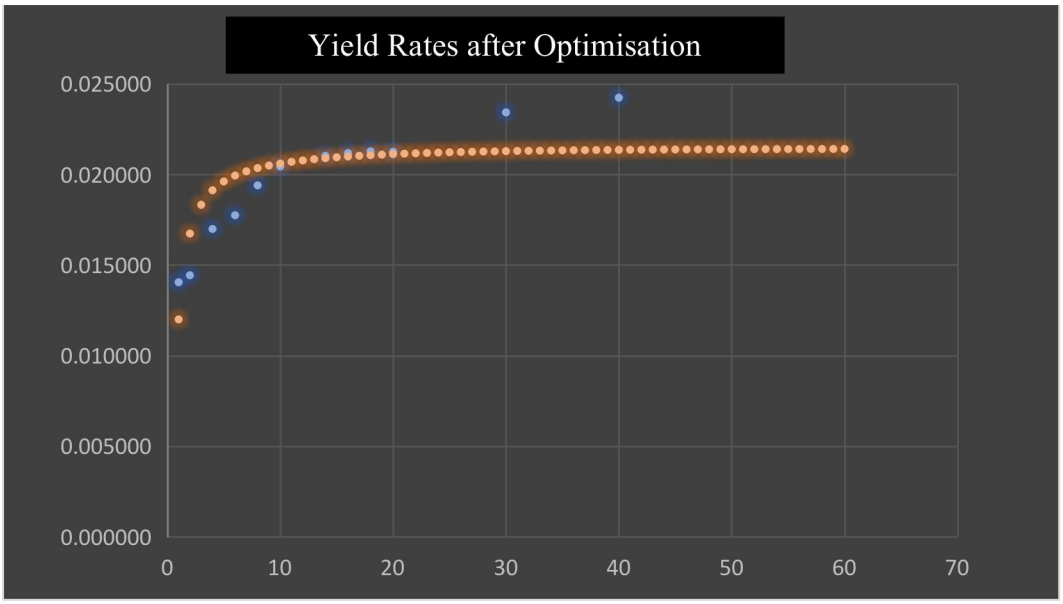

Figure 2: *Converged Yield Rates after optimization*

The blue dots and orange dots converge on each other. For 2022 data, the FAST yield rates show blue dots. The orange dots are NSS yield rates. Even after error minimization, both the dots are not perfectly converging. Still, there are some gaps, but the gaps are not significantly more significant. At the list of square errors, two drops fall above the orange dots of NSS yield rates. This shows that the NSS model satisfactorily interpolates the missing yield rates for every Tau.

4.1.1 Islamic Forward Rates computed from NSS yield rates

The NSS model computes yield rates for every Tau from one to sixty; thus, it gives 60 data representing 30 years. These yield rate data are to be applied in finding forward rates which are essential not only for risk management but also to quate future interest rates for future borrowings.

The first 16 taus increase at a greater rate and peak at 16 taus. It later declines at the decreasing rate for the next 34 taus—the forward rate declines from the initial tau rate from the 52nd Tau. The line intersects at 52nd Tau and declines. The forward rates line is a parabola curve, and it is not an increasing trend line.

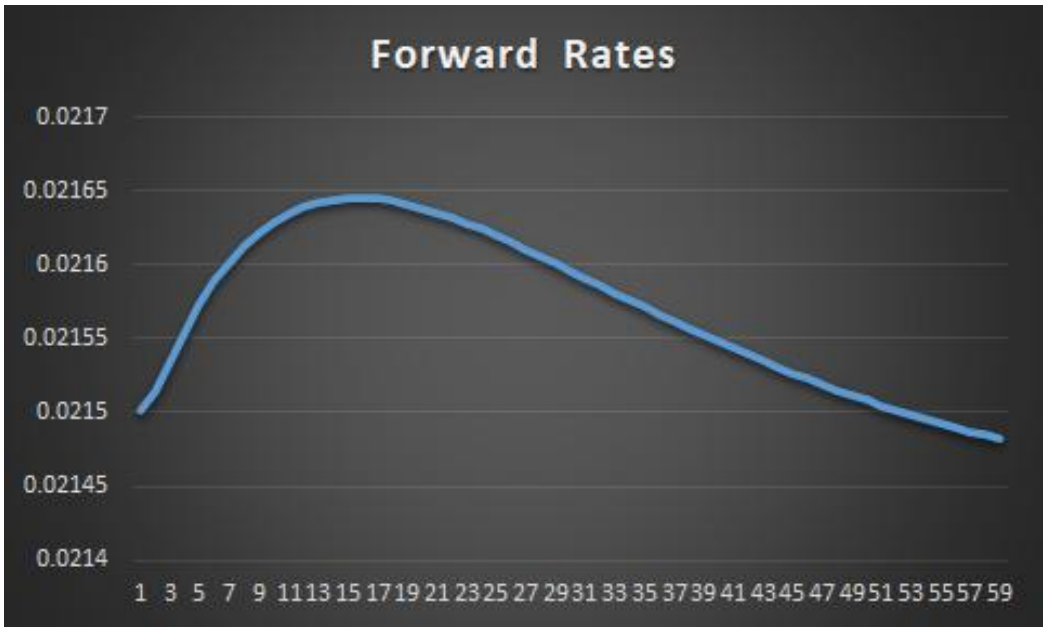

Figure 3: *Islamic Forward Rates*

5. Conclusion

In this article the missing yield rates for several taus are found by nonlinear optimization, the forward rates are computed by using the above optimized yield rates. The yield rates which are computed by the NSS model is producing minimum errors. As it is producing minimum errors or almost zero error, it is efficient and highly reliable forward rates. The forward rates are very useful for hedging financial asset portfolios through derivative contracts. Hedging is to be effective to apply hedge accounting, which is beneficial to the companies, if hedging is not effective hedge accounting cannot be applied in the books of accounts. If hedging is effective the cost of hedging will come down. This article will be useful for the risk managers who constantly and dynamically hedging their portfolios. Forward rates are applied to quantify future losses accurately, in turn sufficient number of forward contracts or option contracts can be purchased and can be held in the portfolio. Thus, the asset managers avoid losses at minimum costs. This article will immensely be useful to risk managers and policy makers. This article will contribute not only to the literature but also will be helpful for the risk managers.

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