

A RISK ANALYSIS PROPOSITION FOR FIXED INCOME SECURITIES

Zatul Karamah Ahmad Baharul Ulum¹, Anis Suhaila Anas¹,
Azwan Abdullah¹, Zaminor Zamzamin@Zamzamin¹,
Siti Salwani Abdullah¹, Suraya Mahmood¹

¹Faculty of Entrepreneurship and Business
Universiti Malaysia Kelantan Malaysia

Email: zatulkaramah@umk.edu.my,

Abstract- Managing financial risk continues to be an integral part of assessing financial instrument performance. It is important to note that many empirical studies have looked on factors such as total risk and diversifiable risk or even beta, standard deviation and variance as risk representation. Due to the urgent need for a single risk measure, Value-at-Risk (VaR) has attained more demand in replacing standard deviation or volatility as the most widely used risk measure. However, VaR has so far not been exploited extensively in explaining fixed income financial risk within specific parameters, assumptions and data characteristics. In addition, most literature with regards to the usage of VaR has associated the measure with the assumption of normal distribution. Maintaining a normality assumption and failure to account for any financial time series imperfection will undoubtedly lead to underestimating or overestimating VaR and should the risk of heavy-tailed events fail to be quantified, the financial distress implications of trader's actions will not be captured accurately. This paper highlights the proposition to fill the gap in the knowledge of financial risk measures by adding a new parameter dimension to the quantification of VaR for fixed income securities. This will be done by extending the measure through the inclusion of several volatility models under a different assumption of return distribution. The new dimension includes associating VaR estimation based on Bayesian distribution. Within this new parameter dimension, the financial risk modelling for the fixed income securities should be able to portray the actual traits of the return thus providing more accurate financial risk estimation.

Keywords: Value-at-Risk, fixed-income securities, volatility modelling, backtesting.

1. Introduction

Since the 1980s the Malaysian economy has experienced several phases of growth and recession situations. The slowdown during the Asian crisis in 1997/1998 and global financial setback in the year 2008 without doubt have impacted the activities of securities investment. Managing financial risk continues to be an integral part of assessing financial instrument performance.

The main motivation for this research is that many empirical studies have looked on factors such as total risk and diversifiable risk or even beta, standard deviation and variance as risk representation. Due to the urgent need for a single risk measure, Value-at-Risk (VaR) is slowly replacing standard deviation or volatility as the most widely used risk measure. VaR summarizes the worst expected loss that an institution can suffer over a target horizon under normal market

conditions at a given confidence level (BCBS, 2012; Dowd, 2005; Jorion, 2002). In a basic form, VaR answers the question of “How much can an investor lose with x% probability over a given time horizon”.

In line with the motivation, this paper intends to highlight the proposition to analyze risk based on VaR using fixed income securities as the main sample. The flow of the paper covers section 2, which provides the current issues related to VaR quantifications. Section 3 and 4 outlines the research questions and literature review. Section 5 addresses the data and methodology. And finally section 6, the conclusions.

2. Issues

Most previous studies related to VaR modelling are related to determining expected losses on stocks portfolio (Berkelaar, Cumperayot & Kouwenberg, 2002; Pederzoli, 2006). VaR has so far not been exploited extensively in explaining fixed income financial risk within specific parameters, assumptions and data characteristics.

In fact, traditional VaR approaches have several shortcomings especially when VaR modelling is very much influenced by main sources of bias; heavy-tails and volatility clustering. However, the extents to which the VaR behaviours are affected by these circumstances need further clarifications. Heavy-tailed circumstances cited by Dark (2010), Obi, Sil and Choi (2010) and Yu, Li and Jin (2010) suggest that extreme outcomes will happen more frequently than would be predicted by the normal distribution (sometimes referred to as the Gaussian distribution). Most investors assume the portfolio is log-normal even though it is in actual fact illustrate otherwise for simplifying VaR calculation. Maintaining a normality assumption and failure to account for any financial time series imperfection will undoubtedly lead to underestimating or overestimating VaR (Mabrouk & Saadi, 2012; Giannopoulos, 2003; Luciano & Marena, 2002). An inaccurate VaR value can be produced when higher moments such as skewness and kurtosis are misestimated, thus influencing market users particularly the investors. This problem will be amplified when VaR measurements assimilate different underlying parameters; for instance, the length of time horizon and confidence level. Furthermore, the normality assumption may be inappropriate during market stress such as recession or economic turnover. Not only that, should the risk of heavy-tailed events fail to be quantified, Davis and Fouda (1999) warned, the financial distress implications of traders' actions will not be captured accurately. In this manner, the performance of VaR estimator can be affected by sample variation or estimation risk caused by heavy-tailed distribution or abnormalities. Thus by integrating the VaR models with Student-t and Bayesian distributions, abnormalities problems are expected to be reduced. More accurate VaR values can provide better indication of the instruments' financial risk level (Sethapramote, Prukumpai & Kanyamee, 2014; Lucas & Zhang, 2014)

Another motivation for this study is that though most major studies focused on the behavior of stocks, foreign exchange and real estate during these periods, research on financial risk of fixed income securities are found to be reported in limited numbers (Hall & Miles, 1992; Kuin, Sarma & Ramasamy, 2008). Fixed income securities, which make up to 2/3 of the market value do not merely consist of bonds or sukuk, it comprises a wider range of instrument among others the Government or Sovereign Securities, Government Agencies Issuance, Corporate Bonds and

Mortgage-backed Securities (MBS) (Fabozzi, 2000). In Malaysia since early 1970s, fund raised in the capital market can be contributed from the public sector, which comprises of MGS in particular and private sector. Prior to 1990s, most of the portions are raised from MGS while the share market contributed 12.36 percent at the end of year 1988. However after the year 1997, to assist the country in managing damaged economy due to the Asian Financial Crisis, the MGS contributed almost half of the market share and growing dominance of the Private Debt Securities (PDS). In fact post 2000, PDS continue to surpassed the stock market (Mohamed Ariff, Cheng & Neoh, 2009).

The improvement in the understanding and knowledge on Shariah-based fixed income securities would be very much relevant to identify risky portfolio or securities, reduces financial risk including speculative loss besides promoting better investment environment and better monitoring by the relevant authorities. In sum, for the benefit of both academic and policy makers, research to analyze financial risk for the Malaysian economy must be further examined.

Generally, as far as the literature is concerned, most studies only focused Sovereign securities or Bonds rather than the whole category of fixed income securities for the Malaysian market (refer to Norashikin, 2000; Norliza, Jorah & Tajul Arifin, 2009; Thillainathan, 1996). The case is in particular for Shariah-based issuance or Islamic fixed income securities. Among others is a study by Norliza et.al (2009) that highlighted multi microeconomic factor that influenced the yields for conventional bond in Malaysia which includes composite index, production index and interest rates. Even though the authors noted the popularity of bonds that continue to increase, its monitoring need to be strengthen in order to assist investor decision-making. This is in line with much earlier writing by Thillainathan (1996) that stressed on the urgent need to reform Malaysia's bond market in order to boost market liquidity and trading volume. This supported the notion that a detail research on fixed income securities especially the Shariah-based instruments in the Malaysian market has yet to be thoroughly examined. Integrating the data of Islamic fixed income securities with VaR within the framework of non-normal distributions namely the Student-t and Bayesian will address the fundamental issue for accuracy of risk measure [Danielsson, James, Valenzuela & Zer, 2014]

3. Research Questions

This study precisely embarks on the following questions:

1. How does the non-normal distribution in VaR model affects financial risk quantifications/values on different types of Islamic fixed income securities?
2. What is the most suitable/accurate model for analyzing the Islamic fixed income securities in the Malaysian market?

4. Review of Literature

Most of VaR literature is dedicated to comparing and evaluating different types of VaR approaches and methodologies. Within this context, VaR calculations can be classified into two main groups: the local valuation approach and the full valuation approach.

4.1 Local Valuation Approach

Being the first developed version, the local valuation approach is the most popular in handling VaR calculation. Three adaptations are associated with this approach namely the variance-covariance, delta-normal and delta-gamma method. Variance-covariance is the most popular and fastest method to calculate VaR, but is not suitable for portfolios containing high convexities, for example bond or options (Benninga & Wiener, 1998). Theoretically, this method will map (or decompose) financial instruments' data into delta (change) equivalent to basic market factors or financial building blocks. In other words, it decomposes the portfolio into elemental instruments each of which is exposed to only one market factor (Wirch, 1998). The delta-normal approach is one of the variance-covariance approaches to estimate VaR which handle departures from normal linearity by means of first-order (i.e. delta) approximations (Dowd, 1998). Jorion (2006) suggested that it provides a superior forecast to estimate the downside risk for portfolios especially those with a small component of options. In addition, this method is easy to implement because all that is required is the combination of portfolio positions and the forecast of variance-covariance matrix of returns (Jorion, 2006). On the other hand, delta-gamma method is best suited for portfolios which are exposed to a few sources of risk and which include substantial derivative components. For this method according to Dowd (1998), nonlinear approximation involving higher order risk factor sensitivities, for instance the gamma, can be implemented.

4.2 Full Valuation Approach

Two categories for this approach are based on simulation exercises; Historical Simulation (HS) and Monte Carlo simulation (MCS). Historical simulation is an approach that estimates VaR from the distribution of profit or loss simulated using historical returns data. In other words, it relies on a uniform distribution to sample any innovations from the past (Dowd, 1998). HS acts as the most simplistic approach of the full-valuation category (Manfredo & Leuthold, 1998). HS, also known as bootstrap simulation (Barone-Adesi & Giannopoulos 2001), allows calculation to consider nonlinearities and non-normal distributions. In contrast, Monte Carlo is used to estimate VaR from a distribution of future portfolio values, which is simulated using pseudo-random number, or, in other general term, the random walk approach (Dowd, 1998).

5. Data and Methodology

5.1 Data

The secondary data will be bought from the Thomson Bankers DataStream. It consists of daily return of Islamic fixed income securities of the Malaysian Government issuance, Corporate issuance and Mortgage Based Securities (MBS). Observation period will cover from year 2005

until 2015. The first part, from 2005 to 2012, is used to estimate the volatility. The second part which covers the years of 2013 until 2015, is used for backtesting each estimated VaR models. This research uses the time series data estimation methods, which comprise unit root tests, moment significance and normality.

5.2 Financial Risk Quantification

The financial risk quantifications will be determined based on Value-at-Risk (VaR) theoretical formula:

$$VaR_t = W_t \alpha \sigma \sqrt{\Delta t}$$

where W_t is the portfolio value at time t , σ is the standard deviation of the portfolio return and Δt is the holding period horizon (h) as a fraction of a year.

Since VaR is a function of the return volatility, the models under the Gaussian, Student-t and Bayesian distributions will be integrated with Monte Carlo Simulation (MCS). To have better generalizability, the study chooses 95% confidence level and one-day risk horizon (Dargiri, Shamsabadi, Thim, Rasiah, & Savedy, 2013; Mabrouk & Aloui, 2012)

5.3 Backtesting

In developing the most suitable risk estimation model, VaR will be accommodated with backtesting; Kupiec (1995) log-likelihood ratio test (LR). If the estimated model is correct or has high accuracy, the number of failures observation (x) will follow a binomial distribution:

$$f(x) = \binom{T}{x} p^x (1-p)^{T-x}$$

where T is the total number of trials, p is the desired coverage given by the chosen confidence level (5% for 95% confidence levels). Thus the LR test statistics is given by:

$$LR_{uc} = -2 \ln \left((1-p)^{T-x} p^x \right) + 2 \ln \left((1-\hat{p})^{T-x} \hat{p}^x \right)$$

which is asymptotically distributed Chi-square with one degree of freedom. The null hypothesis will be rejected if LR_{uc} exceeds the expected number of exceedances, x or known as critical value (Dowd, 2005).

6. Conclusion

This paper highlights the proposition to fill the gap in the knowledge of financial risk measures by adding a new parameter dimension to the quantification of VaR for fixed income securities. This will be done by extending the measure through the inclusion of several volatility models under a different assumption of return distribution. The new dimension includes associating VaR estimation based on Bayesian distribution. Within this new parameter dimension, the financial risk modelling for the fixed income securities should be able to portray the actual traits of the return thus providing more accurate financial risk estimation.

References

- Barone-Adesi, G., & Giannopoulos, K. (2001). Non-parametric VaR techniques, myths and realities. *Economic Notes by Banca Monte dei Paschi di Siena SpA*, 30(2-2001), 67-181.
- BCBS. 2012. Consultative document: Fundamental Review of the Trading Book. Basel Committee on Banking Supervision (BCBS). <http://www.bis.org/publ/bcbs219.pdf>.
- Benninga, S., & Wiener, Z. (1998). Value-at-Risk (VaR). *Mathematica in Education & Research*, 7(4).
- Berkelaar, A., Cumperayot, P., & Kouwenberg, R. 2002. The effect of VaR based risk management on asset prices and the volatility smile. *European Financial Management*, 8(2), 139-164.
- Danielsson, J, James, K, Valenzuela, M & Zet, I. 2014. Model Risk of Risk Models. Finance and Economic Discussion Series, Federal Reserve Board, Washington.
- Dargiri, M.N., Shamsabadi, H.A., Thim, C.K, Rasiah, D. & Savedy, B. 2013. Value-at-Risk and Conditional Value-at-Risk Assessment and Accuracy: Compliance in Dynamic of Malaysian Industries. *Journal of Applied Sciences*. 13(7): 974-983.
- Dark, J. G. 2010. Estimation of Time Varying Skewness and Kurtosis with an Application to Value-at-Risk. *Studies in Nonlinear Dynamics & Econometrics*. 14(2): 1-50.
- Davis, A. H. R., & Fouda, H. (1999). An augmented Value at Risk approach to risk management. *Canadian Journal of Administrative Sciences*, 16(3), 185-194.
- Dowd, K. (1998). *Beyond Value at Risk*. England: John Wiley & Sons
- Dowd, K. 2005. *Measuring Market Risk*. West Sussex, England: John Wiley & Sons.
- Fabozzi, F. J. 2000. *Bond Markets, Analysis and Strategies*. Prentice Hall.
- Giannopoulos, K. (2003). VaR modelling on long run horizons. *Automation and Remote Control*, 64(7), 1094-1100.
- Hall, S.G. & Miles. 1992. Measuring Efficiency and Risk in the Major Bond Market. *Oxford Economics Paper* 44: 599-625.
- Jorion, P. 2002. How informative are Value-at-Risk disclosure. *Accounting Review*, V77(4), 911-931

- Jorion, P. (2006). *Value at Risk: The New Benchmark for Controlling Market Risk*. (Third ed.) Chicago: Irwin.
- Kuin, K.L. Sarma, L.V.L.N. & Ramasamy, S. 2008. Mortgage-backed Securities and Financial Innovation Experience of Malaysia. *The ICAI University Journal of Derivatives Market*. 5(4), 24-34.
- Lucas, A & Zhang, X. 2014. Score Driven EWMA and Value-at-Risk Forecasting. Retrived <http://dx.doi.org/10.2139/ssrn.2470938>.
- Luciano, E., & Marena, M. (2002). Portfolio value at risk bounds. *International Transactions in Operational Research*(9), 629-641.
- Mabrouk, S. & Aloui, C. 2010. One-day Ahead Value-at-Risk Estimations with Dual Long-memory Models: Evidence from the Tunisian Stock Market. *International Journal of Financial Services Management*. 4: 77-94.
- Mabrouk, S. & Saadi S. 2012. Parametric Value-at-Risk Analysis: Evidence from Stock Indices. *Quarterly Review of Economics and Finance*. 52: 305-321.
- Manfredo, M. R., & Leuthold, R. M. (1998). Agricultural applications of value-at-risk: A perspective. *OFOR Paper number 98-04*.
- Mohamed Ariff, Cheng, F.F. & Neoh, V.H. 2009. *Bond Markets in Malaysia and Singapore*. Penerbit Universiti Putra Malaysia.
- Norashikin, A.H. 2000. *Guide to the Malaysian Bond Market*. Rating Agency of Malaysia.
- Norliza, A., Jorah, M. & Tajul Arifin, M. 2009. Factors influencing yields spread of the Malaysian Bond. *Asian Academy of Management Journal* 14 (2), 95-114
- Obi, P., Sil. S. & Choi, J. 2010. Value-at-Risk with Time Varying Volatility in South African Equities. *Journal of Global Business and Technology*. 6(2): 1-12.
- Pederzoli, C. 2006. Stochastic volatility and GARCH: A comparison based on UK stock data. *The European Journal of Finance*, 12(1), 41-59.
- Sethapramote, Y, Prukumpai, S & Kanyamee, T. 2014. Evaluation of Value-at-Risk Estimation Using Long Memory Volatility Models: Evidence from Stock Exchange of Thailand. Retrieved <http://dx.doi.org/10.2139/ssrn.2396531>.
- Thillainathan, R. 1996. Malaysia's Bond Market. The further reforms required to escape underdevelopment. *Asean Economic Bulletin*. 13(1), 95-113.
- Yu, P.L.H., Li, W.K. & Jin, S. 2010. On Some Models for Value-at-Risk. *Econometrics Review*. 29(5-6): 622-641.

Wirch, J. L. (1998). Value at Risk for Risk Portfolio. *Actuarial Research Clearing House 1*. 259-266