Management of Market Risk in Islamic Banks: A Survey

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Abstract: This study discusses the need of Islamic banking to adopt modern risk management techniques. It outlines some of the theoretical underpinning of contemporary bank risk management with an emphasis on market risk management. Value at Risk (VaR) as an accepted method for analysing market risk, and its adoption by bank regulators, is part of the evaluation of risk management. Three main methods of calculating VaR: analytical VaR, historical simulation and the Monte Carlo simulation are covered.

I. Introduction

Ribā is forbidden and profit is allowed in Islam, so a practical solution is to substitute a variable rate of return based on the economic returns to investment for the fixed rate of interest. Financial instruments based on profit-and-loss-sharing (PLS) principles have been widely studied, *e.g.* Ebrahim and Joo (2001); Khan (1999); Khan (1996); Mirakhor (1996); Ebrahim and Hasan (1993); Hameed *et al.* (1992); Hameed and Bashir (1990); Khan (1985); Uzair (1980), all of whom have advocated PLS contracts as viable alternatives to interest-based financing. *Muḍārabah* and *mushārakah* are the primary forms of long-term financing used to finance enterprises on a PLS basis. Therefore, the risk and return characteristics of the alternative financial instruments have important implications for financing as well as investment decisions.

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While sheer speculation (*bay'u al-gharar*) is forbidden any enterprise entails some degree of risk. Islamic jurists disagree over whether a specific contract is forbidden or not based on their differing assessment of whether the degree of risk is substantial or small. Occasionally prohibition is overruled in cases where clear economic benefit can only be served by a contract that includes substantial trading in risk. Islamic economic literature (e.g. El Gamal, 2000; Tahir, 2000; Al-Suwailem, 2000), indicates that trading in risk is not an integral part of the contract. However, where the contract such as *salām* and *istithnā'* is necessary to meet important economic needs the analysis will still be useful with respect to the following:

(i). risk sharing mechanisms than can reduce part of the inherent trading in risk such as financial risk versus insurance risk;

(ii). alternatives, if the secondary tools for managing the resulting risk are sought.

Many empirical studies report that the trading accounts at large Islamic banks have grown rapidly and become progressively more complex. To a large extent, this reflects the sharp growth in *over–the–counter trading* of stocks, in which Islamic banks are the principal dealers. To manage market risk, major mainstream trading institutions have developed large scale risk measurement models. While approaches may differ, all such models measure and aggregate market risk in current positions at a highly detailed level. The models employ a standard risk metric, Value-at-Risk (VaR), which is a lower tail percentile for the distribution of profit and loss (PL). VaR models have been sanctioned for determining market risk capital requirements for large banks by U.S. and international banking through the 1996 Market Risk Amendment to the Basle Accord. Spurred by these developments, VaR has become a standard measure of financial market risk, one that is increasingly used also by other financial and even non-financial firms.

The extent of market risk to which an Islamic bank is exposed must concern the risk analyst. He must also communicate this to senior management and keeping the front office in touch with the latest developments. Risk management may then comprise:

(i). understanding how the value of the Islamic banking and trading books changes in line with movements in underlying factors;

(ii). quantitative measurement of how Islamic instruments move in line with underlying factors;
(iii). defining the 'level of comfort' with regard to risk exposure, using statistical analysis to quantify comfort levels, based on market data;
(iv). constructing trading arrangements (in compliance the with Islamic mode of finance) designed to bring a portfolio back within comfort levels if at any time it has exceeded them;
(v). adding value in enhancing return on capital through 'sensible' risk taking;
(vi). communicating to management information on levels of return with respect to the level of risk taken on.

Therefore, within the framework of the Islamic banking system, as in conventional banking, risk management is very important to an investment portfolio, in order to minimize risks and maximize asset-value. Therefore, subject to the usual conditions of not violating *Sharīʿah* rules and norms, the Islamic banking system needs to replicate the many important theoretical and methodological advances made in risk management in conventional banks.

The principal objective of this study is to outline some of the theoretical underpinnings of contemporary bank risk management. We will begin with a discussion of why Islamic bank risk management is needed, then provide some of the theoretical bases for it. VaR and stress simulation will be discussed as important methods of assessing market risk, with reference to the Basle Committee on Banking Supervision's Rules. Our research will focus only on VaR for equities. The concept behind VaR for equities is almost the same as VaR for other asset classes.

II. Why Risk Management is needed in an Islamic Bank

Managing risk is a crucial determinant of an Islamic bank's profitability and shareholder added-value. Banks act as intermediaries. A priority for a modern Islamic bank is management of a whole range of unbundled risks (explained below) their operations must face. For banks, (conventional and Islamic) which concentrate on intermediation, and for the complex financial conglomerates offering a range of non-banking as well as banking services, the objective is to maximize profits and shareholder added value. Risk management is pivotal to the achievement of this goal.

The Islamic monetary authorities agree that the Islamic banking system should ideally be based on risk-return sharing. As trustees of public money (Zineldin, 1990), the authorities' first concern is with the safety of the banks, the need to avoid the possibility of insolvency and bankruptcy. It is accordingly important for Islamic banks to adopt an appropriate risk management system, in conformity with *Sharīʿah*. The Islamic banks and financial institutions also need to meet the regulatory requirements for risk measurement and capital, in order to expand their global operations.

That said, meeting the regulatory requirements is not the sole, nor even the most important, reason for creating a sound, scientific risk management system. Risk analysts in the Islamic banking sector need such a system in order to direct capital to activities with the best risk–reward ratios. Estimates by creditors, customers and regulators of the size of potential losses to stay within readily available liquidity are necessary. Mechanisms to monitor projects and create incentives for prudent risk-taking by departments and individuals need to be put in place. Risk management is the process by which bank managers meet the need to identify key risks, obtain consistent, understandable, operational risk measurers, choose which risks to reduce and which to increase by what means within the parameters of the *Sharīʿah*, and to establish procedures to monitor the net risk position.

III. Key Risks

Although risk has a broader definition as any type of uncertainty as to future outcomes, for participants in the Islamic financial markets risk is essentially a measure of the volatility of asset returns. The operational risks, to which an Islamic bank or securities house is exposed in the capital market, are broadly characterised as follows:

Market Risk: the change in net asset value due to changes in underlying economic factors such as equity, commodity prices, exchange rates, etc.

Credit Risk: the change in net asset value due to changes in the perceived ability of counter parties to meet their contractual obligations.

Operational Risk: the risk resulting from costs incurred through mistakes made in carrying out transactions such as settlement failures, failures to meet regulatory requirements and untimely collections.

Performance Risk: losses resulting from the failure to properly monitor employees or to use appropriate methods.

In this study, we focus on the theoretical underpinnings of market risk management. VaR and stress simulation will be discussed as important methods of assessing market risk.

IV. Measuring Market Risk

Internal and external views of what is a satisfactory measure of market risk differ significantly. Internally, Islamic bank managers need a measure allowing active, efficient management of the bank's risk position. Bank regulators want to be sure an Islamic bank's potential for catastrophic net worth loss is accurately measured and the Islamic bank's capital is sufficient to survive such a loss. Consider the differences in desired risk-measure characteristics that these two views engender.

4.1. Time Factors and Scope

Both managers and regulators want up-to-date measures of risk. For active trading banks, this may mean selective intra-day risk measurement as well as a daily measurement of the total risk of the bank. However, the intra-day measures that are relevant for asset allocation and hedging decisions are measures of the marginal effect of a trade on total bank risk and not the stand-alone risk-potential of the trade. Regulators, on the other hand, are concerned with the overall risk-potential of a bank and have less concern with the individual portfolio risk components. Nonetheless, given the ability of a sophisticated manager to 'window-dress' a bank's position at short notice, regulators might prefer to monitor the intra-day total risk as well. As a practical matter, they probably must be satisfied with a daily measure of total bank risk.

Measuring total risk need implies that risk measurement cannot be decentralized. For parametric measures of risk, such as standard deviation, this follows from the theory of portfolio selection (Markowiz, 1952) and the well-known fact that the risk of a portfolio is not, in general, the sum of the component risks. More generally, imperfect correlation among portfolio components implies that simulations of portfolio risk must be driven by portfolio return distribution, which will not be invariant to changes in portfolio composition. Finally, given costly regulatory capital requirements, choices among alternative assets require managers to consider risk, return or risk, cost trade offs, where risk is measured as a change in portfolio risk resulting from a given change in portfolio composition. The appropriate risk scaling measure depends on the type of change being made. For example, while the choice among proprietary transactions would involve minimizing marginal risk per unit of excess return, the pertinent choice criterion for pure hedging transactions might be to maximize the marginal risk reduction to transaction cost ratio over the available instruments.

4.2. Efficiency

Risk measurement is costly and time consuming. Consequently, bank managers compromise between measurement precision on the one hand and the cost and time factors involved in reporting on the other (Pritsker, 1996). This trade-off will bring its own problems in the cost of accurate risk measurement, which is probably one reason they have chosen to monitor and stress-test bank risk measurement systems rather than undertake their own risk measurements.

4.3. Information Content

Islamic bank regulators will have a single risk measurement goal. They want to know, to a high degree of precision, the maximum loss an Islamic bank is likely to experience over a given horizon. This then permits them to set the bank's required capital to be greater than the estimated maximum loss, and be as certain as they can be that the Islamic bank will not fail. In other words, regulators may focus on the extreme tail of the Islamic bank's return distribution and on the size of that tail in adverse circumstances. Islamic bank managers have a more complex set of risk information needs. In addition to shared concerns over sustainable losses, they should consider risk and return trade-off. That calls for a different risk measure than the 'tail' statistic, a different horizon, and a focus on more usual market conditions.

Moreover, when concerned with the level of sustainable losses, the bank manager may want to monitor on the basis of a probability of loss that can be observed with some frequency, i.e. over a month rather than over a year. This allows Islamic bank managers to use the risk measurement model to answer the following questions, for example: Is the model currently valid? In other words, if the loss probability is set at 10%, do we observe a violation once every 20 days on average?

Are traders correctly motivated to manage and not just avoid risk? How often does a trader's first position violate his risk limit relative to the likelihood of that event?

V. Market Risk Measurement Alternatives

In the risk management literature we find two principle approaches to market risk measurement, scenario analysis and VaR analysis.

5.1. Scenario Analysis

In scenario analysis, the analyst postulates changes in the underlying determinants of portfolio value (dividends, exchange rates, equity and commodity prices) and revalues the portfolio given those changes. The resulting change in value is the loss estimate. A typical procedure, often called stress-testing in conventional literature, is to use a scenario based on a historically adverse market move. This approach has the advantage of not requiring a distributional assumption for the risk calculation. On the other hand, it is subjective and assumes that future financial upsets will strongly resemble those of the past. Given the earlier discussion, it should be clear that stress-testing can provide regulators with the desired lower tail estimates, but has limited usefulness in day-to-day risk management. It should also be clear that meaningful scenario analysis is dependent on having valuation models accurate over a wide range of input parameters, a characteristic shared to a considerable extent by VaR models. Pioneering research on capital asset pricing (Sharpe, 1984), option pricing (Black and Scholes, 1973; Merton, 1973), and term structure modelling (Vasicek, 1977), have provided the basis for reliable valuation models, models becoming increasingly accurate and applied, with subsequent modification and extension, by other researchers.

5.2. Value at Risk (VaR) Analysis

It has long been recognised by bank practitioners and academics that the accurate gauging of a portfolio's exposure to different sources of risk is extremely important. VaR has gained rapid acceptance as a valuable approach to addressing and measuring market risk. VaR is defined as the maximum expected loss on a position or a portfolio of different positions, given some time horizon and confidence level. For example, a portfolio has a daily VaR of 1 million Islamic dinar (ID) with a 95% probability. Then, over the next 24 hour period, there is a 5% chance the portfolio loss will exceed ID 1 million. On the other hand, the likelihood of experiencing a 1-day loss of less than ID1 million is 95%. This single number summarizes the manager's exposure to downside market risk as well as to the probability of an adverse movement. VaR's most important strength is that it aggregates several sources of market risk into a single quantitative measure of potential value change for a portfolio. Morgan, through its RiskMetrics™, has played an important role in the increasing popularity of VaR as a risk measure. Volatilities and correlations are forecast every business day, by risk analysts, for four different markets in over thirty countries. Daily numerous investment institutions download RiskMetrics™ forecasts, implicitly assuming these estimates to be a 'true' distribution of future value changes (Johansson *et. al.*, 1999).

VaR calculations rely on estimates of the future distribution of value changes. There are three principal methods of estimating VaR; analytical VaR, historical simulation and the Monte Carlo simulation. Models calculating VaR can be sorted into two broad groups: delta valuation, where full calculation is implemented in the historical simulation, and the Monte Carlo simulation. The assumption of the distribution of return and the treatment of non-linear instruments constitutes the main difference between delta valuation and full valuation. The three techniques share the common characteristic of all relying on historical data in forecasting the pattern of expected future return. Assuming that history predicts the future accurately is the basis of such models, but often they define the past in different terms and make different assumptions about future market behaviour. Theoretically, implied risk measures from options can be used in the analytical approach, but such data are not likely to be available for all the different vertices needed. This common base is almost the only similarity among the different techniques.

VaR analysis uses asset return distributions and predicted return parameters to estimate potential portfolio losses. The specific measure used is the loss in value over *X* days that will not be exceeded more than *Y*% of the time. The Basle Committee on Banking Supervision's rule set *Y* equal to 1% and *X* equal to 10 days (Mishkin, 2001). In contrast, the standard in RiskMetrics™ is 5% over a horizon sufficiently long for the position to be unwound which, in many cases, is 1 day. The difference in probability levels reflects the differences in informational objectives discussed earlier. The differences in horizon might appear to reflect differences in the uses to which the risk measure is put, in particular the desire of regulators to set capital rules providing protection from failure over a longer period. This conclusion may be correct, but it is somewhat contradicted by the arbitrary multiplication of the resulting VaR figure by 3 to get the regulatory required capital. The Basle Committee could have obtained approximately the same result using a 1-day horizon and multiplying by 9.5. Perhaps order of magnitude arbitrariness is less palatable than single digit arbitrariness (Mishkin, 2001).

The three-principle methods for estimating VaR are the analytical method, historical simulation and the Monte Carlo simulation, each possessing advantages and disadvantages. There are implementation problems common to each method, namely choosing appropriate return distributions for the instruments in the portfolio and obtaining good forecasts of their parameters. The literature on volatility estimation is large, and seemingly subject to unending growth, especially in acronyms.

In this study we will not go to forecasting but it must be pointed out firstly that the risk manager with a large book to manage needs daily and, in some cases, intra-day forecasts of the relevant parameters. This puts a premium on using a forecasting method that can be quickly and economically updated. Secondly, forecasting models incorporating sound economic theory, including market microstructure factors, are likely to outperform purely mechanical models (Figlewski, 1997).

Modelling portfolio returns as a multivariate normal distribution has certain advantages in terms of computational efficiency and tractability. There is, however, evidence, going back to Mandelbrot (1963) and beyond, that some asset returns display non-normal characteristics. Actually, they display 'fat' tails, more extreme values than would be predicted for a normal variate, which is particularly disturbing when trying to estimate potential value loss. To some degree, these 'fat' tails in unconditional return distributions reflect the inconstancy of return volatility. The problem can be mitigated by modelling individual returns as a function of volatility as in the RiskMetrics™ model:

$$r_{i,t}=\sigma_{i,t}\varepsilon_{i,t}$$

where $\varepsilon_{i,t}$ is N(0,1).

There are other alternatives to assuming that returns follow a non-normal distribution with fat 'tails' but only if one is prepared to accept the concomitant portfolio return computation problems. Danielson and De Vries (1997) have proposed a method for explicit modelling of the 'tails' of financial returns. Since VaR analysis is intended to describe the behaviour of portfolio returns in the lower 'tail', this is obviously an intriguing approach. Again, Danielson and De Vries (1997) show that the 'tail' behaviour of data from almost any distribution follows a single limit law, which adds to the attractiveness of the method. But estimating 'tail' densities is not a trivial matter. Accordingly, while promising, there are computational issues to be resolved if this is to become a mainstream VaR method.

5.3. Analytical VaR

The analytical method for VaR uses standard portfolio theory. The portfolio in question is described in terms of a position vector containing cash flow present values representing all components of the portfolio. The return distribution is described in terms of a matrix of variance and co-variance forecasts (co-variance matrix) representing the risk attributes of the portfolio over the chosen horizon. The standard deviation of portfolio value (v) is obtained by pre- and post-multiplying the co-variance matrix (Q) by the position vector (p) and taking the square root of the resulting scalar.

$$v=\sqrt{p'Qp}$$

In order to allow the method to be manageable in terms of parameter estimation and speed of calculation, the size of the co-variance matrix can be constrained and the portfolio position vector described in terms of a subset of the actual risks being faced. For example, in the RiskMetrics™ database, equity risk appears as the variances and co-variances of 32 equity indices and a given equity position is made to correspond to this description by scaling its present values by the equity's 'beta'.

This standard deviation is then scaled to find the desired percentile of portfolio value that is the predicted maximum loss for the portfolio or VaR.

$$VaR = vf(Y)$$

where $f(Y)$ is the scale factor for percentile Y.

As for example, for a multivariate normal return distribution, $f(Y) = 1.65$ for $Y = 5\%$ or 2.33 or $Y = 1\%$.

Analytical VaR is attractive in that it is fast and not excessively demanding of computational resources. As the following algebra demonstrates, analytical VaR also lends itself readily to the calculation of the marginal risk of candidate trades (Garman 1996);

$$\Delta v_t = \frac{p'Q}{v} a_i$$

where a_i is a given candidate trade and Δv_t is its marginal risk. Given trade cash book descriptions, the information needed to calculate the marginal risk of any candidate trade can be accumulated during a single calculation of v.

There are a number of weaknesses in analytical VaR. In its simplest form, options and other non-linear instruments are delta-approximated, which is to say the representative cash flow vector is a linear approximation of a position that is inherently non-linear. In some cases, this approximation can be improved by including a second-order term in the cash-flow representation (Fallon, 1996; Morgan, 1996). However, this does not always improve the risk-estimate and can only be done with the sacrifice of some of the computational efficiency that recommends analytical VaR to Islamic bank managers.

5.4. Historical Simulation

Actual percentiles of the observation period as VaR measures are employed in the historical simulation technique. So, for an observation period of 100 trading days, the 95 percentile VaR measure for a certain portfolio is the 6th largest loss observed (Johansson *et al.*, 1999). The historical technique asks what has the value change been historically for the portfolio for which VaR will be calculated? For instance, if the past 100 trading days are used to calculate VaR, the historical technique will calculate the actual profit and loss that would have been experienced for the current portfolio during each of the last 100 trading days. Thereafter, the percentile corresponding to the chosen confidence level is used as VaR estimate. Historical VaR may be calculated as follows:

$$R_{p,\tau} = \sum_{i=1}^{N} w_{it,} R_{i,\tau} \, for \tau = 1,\ldots,t$$

The weights w_t are kept at their current values. After historical returns for the portfolio rate of mark-up or expected rate of return of equity are obtained, the procedure is straightforward. The return, corresponding to the percentile chosen, is simply multiplied by the market value of the portfolio. It is possible to forecast the future distribution of value changes by sampling actual historical returns. Depending on what assumption will be made about how the past predicts the future, different quantities of data may be used, a forecast of future distribution may be made if it is accepted that history repeats itself. The historical sample distribution may be taken as simply an estimate of the future distribution of historical returns.

5.5. The Monte Carlo Simulation

With a given a set of estimates of the volatilities, and correlations for financial instruments, the future distribution of a portfolio's return can be estimated through Monte Carlo simulation. For VaR calculations, this technique provides a method of describing the evolution of prices and rates of return on individual financial instruments and for the corresponding portfolio of the same instruments. Many possible futures for the asset are randomly chosen using statistical knowledge of the present (correlation and volatility measures). The value of the asset is measured for each of those possible futures, and the probable value of the asset is estimated by averaging over all of the future values.

It is not possible to predict the exact future value of an asset. Instead, a statistical estimate is provided by the Monte Carlo Simulation. This takes the form of a sample frequency distribution. Given this estimate of the distribution of future value-changes, calculation of VaR proceeds in the same manner as described for the historical simulation, that is, the percentile corresponding to the desired confidence level will be selected.

5.6. The Beta Method

In lieu of forecasting market risk by using historical prices for the actual securities in the equity portfolio, a simplifying technique is often applied that maps the different stocks to an equity index, using the stock's beta (correlation) to the same index. For example, if an IDB stock position has a market value of 10 million Islamic dinar (ID) and a beta of 0.80, that position is regarded as an ID8 million position in the index. If another stock position has a market value of ID5 million and a beta of 1.2, it is regarded as an ID6 million investment in the index. It is possible, therefore, to describe the equity portfolio's exposure to market risk in terms of index positions rather than as positions in the actual securities. This procedure enjoys the advantage of significantly reducing the number of historical time series needed to calculate VaR. RiskMetrics^{TM}, for instance, reports volatility and correlation forecasts for only one index per country. This technique significantly eases the VaR calculation process, but it may raise some concerns. One of these is that a stock's beta accounts for only the systematic risk of the stock, completely ignoring the firm specific risk.

In his study, Saunder's (1999) analytical VaR technique was performed using four different models, by employing the amount of historical data that were applied: 89, 261, 524 and 1,048 days of equal weighting were used. The second VaR simulation was performed using the same days of historical data. The third technique, the Monte Carlo simulation, is performed with six different models, the volatility and correlation matrix was estimated from the past 89, 261, 524, and 1,048 days using equal weighting, 0.94 decay and optimised decay. Saunder then used the analytical technique a second time, by applying the beta method. This technique is referred to as the 'analytical beta technique'; it was performed with six different models: 89, 261, 524 and 1048 days of equal weighting, decay factor of 0.94 and optimized decay. Saunder found that, for un-diversified portfolios, all beta models fail to meet the requirements imposed by the Basle Committee on banking supervision. The result showed that the firm specific risk for undiversified portfolios was captured accurately only when each stock was modelled as an individual risk factor; that is, when historical prices for the actual security were used instead of mapping the security to an index by using the stock betas.

VI. Summary

The foregoing discussion has argued that as in conventional banking, so also in the framework of the Islamic banking system, risk-management is of great importance for an investment portfolio, in order to minimize risks and maximize the value of assets. In the risk management literature we find two principal approaches to market risk measurement: scenario analysis and VaR analysis. In scenario analysis, the analyst postulates changes in the underlying determinants of portfolio value (dividends, exchange rates, equity and commodity prices) and re-values the portfolio given those changes. VaR is defined as the maximum expected loss on a position or a portfolio of different positions, given some time horizon and confidence level. VaR's chief strength is that it aggregates several sources of market risk into a single quantitative measure of potential value change for a portfolio. Daily, numerous investment institutions use RiskMetrics™ forecasts, implicitly assuming that these estimates are the 'true' distribution of future value changes. VaR calculations rely on estimates of the future distribution of value changes. There are three principal methods of estimating VaR: analytical VaR, historical simulation and the Monte Carlo simulation. Models calculating VaR can be sorted into two broad groups: delta valuation, where full calculation may be implemented in the historical simulation, and the Monte Carlo simulation. The main difference between delta valuation and full valuation lies in the assumption of the distribution of return and the treatment of non-linear instruments. The common characteristic of the three techniques is that they all rely on historical data in forecasting the pattern of the expected future return.

It is important to point out that our objective is not to find evidence for recommending any one of these techniques as superior to the analytical technique. Rather, we recommend that Islamic banks and financial institutions apply these methods, and then experience will establish which technique is better suited to their needs.

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