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A VALUE AT RISK APPROACH TO MEASURING EQUITY TRADING RISK EXPOSURE IN EMERGING STOCK MARKETS

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ABSTRACT

The attempt of this article is to fill a gap in the equity trading risk management literature and particularly from the perspective of emerging and illiquid financial markets, such as in the context of the Moroccan stock market. This paper provides real-world risk management techniques and strategies that can be applied to equity trading/investment portfolios in emerging markets. In this work, we divulge a proactive approach for the measurement/management of risk exposure for financial trading portfolios that contain illiquid equity securities. This approach is based on the renowned concept of Value At Risk (VAR) along with the creation of a software tool utilizing matrix-algebra technique. The recommended feasible analytical/quantitative techniques and procedures can be utilized in almost all-emerging economies, if they are tailored to match-up with each market's initial level of complexity. In order to exemplify the appropriate use of VAR and stress-testing techniques, real-world examples and attainable reports of risk management are presented for the Casablanca Stock Exchange (CSE). To this end, some case studies are accomplished with the intent of creating a realistic framework of equity trading risk measurement and control reports.

Keywords: emerging markets, financial engineering, financial risk management, financial markets, Morocco, portfolio management, stress testing, Value At Risk

INTRODUCTION

Trading of financial securities – stocks (equities), bonds (fixed income instruments), derivative products, and structured products, etc. has been on

uninterrupted expansion in emerging economies. While these emerging-markets share some similarities in development patterns, it is often their individual differences that create unique expected return opportunities and embedded risks, which may be addressed through art and science risk management techniques. The role of trading risk management and its proper implementations are essential factors in the success of emerging-markets' financial trading activities.

After all, what is most needed is a better understanding of the trading risk management process. This can be accomplished by striking a number of institutional changes that will help reduce the uncertainties in the trading of securities. In the rapidly changing and increasingly integrated financial markets, better management and closer supervision of the trading positions being taken (and their trading units) will better ward against hidden risks than formal regulations that focus on particular instruments, markets or participants. Naturally this has to be accompanied with clearer legal environment, risk management and accounting standards, in addition to greater disclosures of trading transactions. Accordingly, this will make users, dealers, and regulators better off and can improve their assessments of all kinds of risks they may encounter.

In the 1950s, Markowitz (1959) described the theoretical framework for modern portfolio theory and the creation of efficient portfolios. The solution to the Markowitz theoretical models revolves around the portfolio weights, or the percentage of asset allocated to be invested in each instrument. Sharpe (1963) developed the single-index model, which relates returns on each security to the returns on a common index – abroad market index of common stock returns such as S&P 500 is generally used for this purpose. The concepts of Value At Risk (VAR) and other advanced risk management techniques are in fact not new and are based – with some modifications – on modern portfolio theory. Thanks to J. P. Morgan, RiskMetrics^{TM} (1994) document, the concept of VAR and other modern risk management techniques and procedures are popularized. Since then the VAR concept is widespread and several specific applications are adapted to credit risk management and mutual funds investments.

For a comprehensive survey, and the different VAR analysis and techniques, one can refer to Jorion (2001). For the most part, VAR analyses in the public domain have been limited to comparing different modeling approaches and implementation procedures using illustrative portfolios (Pritsker, 1997). In their paper Berkowitz and O'Brien (2001) question how accurate VAR models are at commercial banks. Due to the fact that trading accounts at large commercial banks have considerably grown and become increasingly diverse and complex, the authors presented statistics on the trading revenues from such activities and on the associated VAR forecasts internally estimated by banks.

According to Culp, Mensink, and Neves (1998), VAR can be adapted for the use in asset management and for the estimation of market risk in the long-term horizon. In their study, they explore the application of VAR to asset management and with particular attention on the importance of VAR for multi-currency asset managers. In another relevant study, Dowd, Blake, and Cairns (2004) tackle the problem of the estimation of VAR for long-term horizon. In their paper they offer a different; however a rather straightforward, approach that avoids the inherited problems associated with the square-root of time rule, as well as those associated with attempting to extrapolate day-to-day volatility forecasts over long horizons.

In his research papers, Al Janabi (2007a; 2007b; 2005) establishes a practical framework for the measurement, management and control of trading risk. The effects of illiquid assets, that are dominant characteristics of emerging markets, are also incorporated in his models. The established models and the general framework of risk calculations are mainly based on matrix-algebra techniques. Moreover, in his latest research paper, Al Janabi (2007a), the robust quantitative measurements and procedures of market risk are applied to emerging markets' equity trading portfolios that are combined with foreign exchange trading portfolios. Market risk management models, which are implemented in his latest work, are applied to both the Mexican foreign exchange and stock markets.

Set against this background, the objective of this paper is to define key equity trading risk management methods, rules and procedures that financial entities, regulators and policymakers should consider in setting-up their daily equity trading risk management objectives and then to adapt it to the specific needs of emerging-markets. The suggested analytical/quantitative methods and procedures can be implemented in almost all-emerging economies, if they are adapted to correspond to each market's initial level of sophistication. In order to illustrate the proper use of VAR and stress-testing (scenario analysis) methods, some practical reports of equity trading risk management are presented for the Casablanca Stock Exchange (CSE).

To this end, the parameters required for the construction of appropriate and simplified VAR and stress-testing methods are reviewed from previous work and adapted the specific applications of these methods to emerging-markets. The theoretical mathematical/analytical models that are applied herein are based on matrix-algebra approach. The latter approach can in fact simplify the programming process in EXCEL^{TM} worksheets and can also permit easy incorporation of short selling of assets in the equity trading process. Moreover, a simplified approach for the incorporation of illiquid asset, in daily trading risk

management practices, is defined and is appropriately integrated into the VAR and stress-testing models.

Trading risk management models, which are developed in this work, are applied to the CSE. Firstly, several tests of abnormal (asymmetric) distributions of returns are performed. To this end, various tests of skewness, kurtosis and Jarque-Bera statistics are implemented. This is followed by a study of daily volatilities along with the calculations of betas of the sample stocks. Furthermore, various case studies are carried out with the objectives of calculating VAR numbers under various market scenarios. The different scenarios are performed first with distinct asset allocation percentages, second by studying the effects of liquidity of trading assets (unwinding period of assets) and finally by taking into account the possibilities of short selling in daily trading operations.

Our case studies demonstrate VAR numbers under normal market condition along with severe crisis condition (stressed or abnormal market conditions) and with different liquidation horizons. Moreover, all VAR numbers are calculated and presented (under normal and severe market conditions) with three different correlation factors (+1, 0 and exact (empirical) correlations between the various risk factors). Under correlation +1, one is assuming 100% positive relationships between all risk factors (risk positions) all the times, whereas for the zero-correlation case, there is no relationships between all positions at all the times. The last correlation case takes into account the empirical correlations between all positions and is calculated via variance/ covariance matrix.

TRADING OF SECURITIES IN EMERGING-MARKETS AND PRUDENTIAL REGULATIONS

Trading consists of the proprietary positions in financial instruments which are held for resale (available for sale) and/or which are taken on by the financial entity with the intention of benefiting from actual and/or expected differences between purchase and sale prices or from other price variations (such as spread differentials). Trading risk is defined as the risk that the trading income will decrease due to an adverse price change in the traded financial instrument.

Trading Risk Management is a unit within global risk management that is responsible for monitoring all risks related to "proprietary trading" of the financial institution. Trading risk deals with risk within short-term time horizon positioning, where all trading positions are marked-to-market and risk is re-evaluated on a daily basis and performance is measured via daily profit and loss and impacts immediately the financial institution's income statement. The trading

risk management unit is responsible for the measurement and management of several categories of risks, which include:

- Market risk
- Event risk
- Issuer risk
- Counterparty risk
- Country risk
- Liquidity risk
- Legal and compliance risk
- System and operational risk

The demands for risk management instruments and processes by emerging countries are now large and it will continue to grow throughout the 21st century. This will put more burden on banking regulators and supervisors to ensure the safety and soundness of their respective financial systems through effective regulations. This, of course, is a difficult task, as evidenced by the variety of financial crises over the last century. Looking forward, the task is likely to get harder, given the likely increase in the complexity of financial instruments and the magnitude of cross border financial flows. Originating and demanding compliance of rational "rules-of-the-game" is a challenging endeavor for any financial/banking regulator.

The regulatory challenge is even more difficult and more important to meet in emerging-market economies for several reasons (Al Janabi, 2006):

- Market structure of banking and financial activities is concentrated in just few major institutions, on which the stability of the whole macroeconomy depends. Local financial markets are often characterized as thin, illiquid, lacking information technology infrastructures, and severely volatile, making them even more difficult for local institutions to manage their risks effectively. In some countries, banks and other financial intermediary's functions are conducted and interlined with other corporate entity shareholders, creating severe moral hazard problems.

- The political structure and government policies of ensuring stability of the financial system are weak and less developed. These markets are characterized with frequent government interventions to stabilize the short-term impact of current events. Banks and other financial institutions may have a high degree of political influence in their countries, but only a limited understanding and acceptance of the needs for independent regulations and supervisions.

- Financial sophistication for the valuations of complex instruments and reporting of exposure are weak and less stringent than advanced economies. Additionally, accounting standards vary widely from market to market. Financial entity management and regulatory body supervisors are less trained in advanced methods for the identification, measurement, management and control of financial risks.

- Lack of adequate historical and current databases for most of these countries macroeconomic variables can complicate the logistics of an effective and integral risk management proceeding. Little real progress can be made without good databases and it will take considerable efforts to assemble them. Risk management systems are expensive to create and to run without adequate current and historical databases of most of the markets' main indicators.

PERFORMING VALUE AT RISK ANALYSIS WITH THE VARIANCE/COVARIANCE (PARAMETRIC) APPROACH

After a series of big losses in some of the world's largest financial and non-financial institutions, the vital importance of a systematic approach to trading risk management, control and reporting is established. One of the key concepts of modern risk management is VAR which represents an attempt to quantify, with a specified confidence interval, the maximum potential loss for a given trading position over a short period under "normal" market conditions.

Calculating the VAR numbers is progressively becoming a standard procedure for risk management worldwide. In 1994, VAR techniques are used mainly by a handful of international banks and brokerage firms to manage risks on their trading desks, but now, the use of VAR is expanding in other dimensions. Currently, it is being used for risks other than market movements, such as the risk of default, and also it is being used by more market participants other than traders, including mutual funds managers and even CFOs at non-financial entities.

What are new with the development of the VAR method are the quantification of firm-wide, cross-products risk exposures and the extensive use of modern statistical techniques and concepts in the risk measurement process. These new developments make the VAR approach more powerful than conventional ones. One of the primary benefits of VAR analysis as opposed to other risk assessment tools is that it can measure the price (market) risks across all types of markets and then distil them down to a single number. This enables those who manage or oversee portfolios containing, for example, both fixed

income and equity securities, to examine the price risk in all positions simultaneously because the same methodologies are used across all markets.

In order for this method to perform properly, accurate trading positions should be gathered and correspondingly, historical database of these positions should be built. Once the position data are centralized, the overall risk has to be calculated by aggregating the risks from individual contracts across the whole portfolio. This is done by working out the effect of moves in individual "risk factors" (e.g. equities, money market instruments, foreign exchange rates) across the portfolio, which may involve large currencies and, with each currency, different asset classes. VAR is worked out from the relationships between the individual risk factors and the effect on the portfolio of moves in each risk factor.

To calculate VAR using the variance/covariance (parametric) method, the volatility of each risk factor is extracted from a pre-defined historical observation period. The potential effect of each component of the portfolio on the overall portfolio value is then worked out. These effects are then aggregated across the whole portfolio using the correlations between the risk factors (which are, again, extracted from the historical observation period) to give the overall VAR value of the portfolio with a given confidence level.

Many financial institutions have chosen a confidence interval of 95% (or 97.5% if we only look at the loss side (one-tailed) to calculate VAR. This means that once every 40 trading days a loss larger than indicated is expected to occur. Some banks use a 99% (one-tailed) confidence interval, which would theoretically lead to larger loss once every 100 trading days. Due to fat tails of the probability distribution, such a loss will occur more often. Some financial institutions feel that the usage of a 99% confidence interval would place too much trust on the statistical model and, hence, some confidence level should be assigned to the "art–side" of the risk measurement process.

A simplified calculation process of the estimation of VAR risk factors (using variance/covariance method) for a single and multiple assets' positions is illustrated (Al Janabi, 2007b; 2005) as follow:

From elementary statistics it is well known that for a normal distribution, 68% of the observations will lie within 1σ (standard deviation) from the expected value, 95% within 2σ and 99% within 3σ from the expected value, thus the VAR of a single asset in dollar terms is:

$$VAR_i = \alpha \times \text{Value of position}_i \text{ in dollars} \times \sigma_i.$$

Where α is the confidence level and σ_i is the standard deviation (volatility) of the security that constitutes the single position. The value of the position, is the amount of investment in dollars, of instrument *i*.

For multiple assets or portfolio of assets, VAR is a function of each individual security's risk and the correlation factors between the returns of the individual securities, detailed as follows:

$$\mathrm{VAR}_P = \sqrt{\left| \mathrm{VAR} \right| * \left| \rho \right| * \left| \mathrm{VAR} \right|^{\mathrm{T}}}.$$

This is a general formula for the calculation of VAR for any portfolio regardless of the number of securities. It should be noted that this formula is presented in terms of matrix-algebra – a useful form to avoid mathematical complexity, as more and more securities are added. This approach can in fact simplify the programming process in EXCEL^{TM} worksheets and can also permit easy incorporation of short selling in the market risk management process.

This means, in order to calculate the VAR (of a portfolio of any number of securities), one needs first to create a matrix of the individual VAR's positions, a transpose matrix (indicated above by the letter "T" on top of the matrix) of the individual VAR's positions and finally a matrix of all correlation factors. Once one multiplies the three matrices and then takes the square root of the result, he ends up with the VAR_P of any portfolio with any *n*-number of securities. This simple number summarizes the portfolio's exposure to market risk. Investors and senior managers can then decide whether they feel easeful with this level of risk. If the answer is no, then the process that led to the estimation of VAR can be used to decide where to reduce the redundant risk. For instance, the riskiest securities can be sold, or one can use derivative securities such as futures and options to hedge the undesirable risk.

Illiquid securities such as equities are very common in emerging-markets. Customarily these securities are traded infrequently (at very low volume). Their quoted prices should not be regarded as a representative of the traders' consensus *vis-à-vis* their real value but rather as the transaction price that arrived at by two counterparties under special market conditions. This of course represents a real dilemma to anybody who seeks to measure the trading risk of these securities with a methodology which is based on volatilities and correlation matrices. The main problem arises when the historical price series are not available for some securities or, when they are available, they are not fully reliable due to the lack of liquidity. Since this situation is very common in emerging-markets, it becomes essential to develop a methodology/procedure that will permit the estimation of the risk parameters of illiquid securities. The methodology which is discussed herein can be adapted to all emerging markets

where some traded assets are liquid and others are having liquidity-related problems.

The choice of the "time-horizon" or number of days to liquidate (unwind) a position is a very important factor and has big impact on VAR numbers, and it depends upon the objectives of the portfolio and the liquidity of its positions. For a bank's trading portfolio invested in highly liquid currencies, a one-day horizon may be acceptable. For an investment manager with a monthly re-balancing and reporting focus, a 30-day period may be more appropriate. Ideally, the holding period should correspond to the longest period for orderly portfolio liquidation. In order to perform the calculation of VAR under illiquid market conditions, one can define the following (Al Janabi, 2007b; 2005):

$$\text{VAR}_{adj} = \text{VAR} * \sqrt{\frac{t+1}{2}}.$$

Where t is the number of liquidation days (t-day to liquidate the entire asset fully), VAR is under liquid market conditions and VAR_{adj} is VAR under illiquid market conditions.

A linear liquidation procedure of the asset is assumed in the above formula, i.e. selling equal parts of each asset every day till the last trading day (t), where the entire asset is sold. The above approach can also be used to calculate the VAR for any time horizon. Consequently, the difference between VAR_{adj} – VAR should be equal to the residual market risk due to the illiquidity of any asset under illiquid markets conditions.

The number of days required to liquidate a position (of course, depending on the type of security) can be obtained from the various publications of "capital markets" and can be compared with the assessments of the individual traders of each trading desk. Hence, one can create some simple statistics of the volume which can be liquidated on a daily basis of each instrument (fixed income, equities, FX, derivatives, etc.) and the necessary total number of days to unwind the whole volume. This will permit the trading risk manager to segment the market's instruments into categories or groups according to specified criteria that will be different in each case and will depend on the asset type.

As described earlier, VAR method is only one approach of measuring market risk and is mainly concerned with maximum expected losses under normal market conditions. For prudent risk management and as an extra management tool, firms should augment VAR analysis with stress testing and scenario procedures. The VAR methodology gives a probabilistic measure of loss that is exceeded, say 2.5% of the time. From a risk management perspective,

however, it is desirable to have an estimate for what potential losses could be under severely adverse conditions where statistical tools do not apply.

Stress-testing estimates the impact of unusual and severe events on the entity's value and should be reported on a daily basis as part of the risk reporting process. For emerging countries with extreme volatility, the usage of stress-testing should be highly emphasized and full description of the process should be included in any policy and procedure manual. Stress-testing usually takes the form of subjectively specifying scenarios of interest to assess changes in the value of the portfolio and it can involve examining the effect of past large market moves on today's portfolio.

A BROAD FINANCIAL RISK MANAGEMENT – CASE ANALYSIS OF THE CSE

The market risk of a trading position is the risk of experiencing unexpected changes in the value of the position due to unexpected changes in the market variables or factors that affect the valuation of the position. Such market factors may be the level of equity markets or individual equity prices. These market variables that affect the value of a trading position are customarily called market-risk-factors. Specifically, a trading risk manager is interested in the likelihood of unexpected losses (rather than gains) and their magnitude for a trading position over a given time horizon. The interest in possible future losses in a trading operation is obvious as every trading house has only limited capital. In order to continue operating as a going concern even in the most adverse conditions, the allocated trading capital must be able to absorb the "maximum" loss at any given time.

In measuring the market risk of a trading position, the first step is to identify the market risk factors that affect its mark-to-market value. For certain trading positions, the identification of the market risk factors is quite straightforward. For instance, for a trading position in cash equities, the prices of the individual stocks determine the value of the position and, therefore, the equity prices could be taken as the market risk factors. There is, however, a problem with this approach – for a large and diversified trading book the number of risk factors becomes very large and the risk measurement and aggregation becomes unmanageable. Fortunately, financial theory and related empirical research provide ways of simplifying the number of market risk factors for equity positions.

In the study reported herein, database of the most liquid stocks that are traded in the Moroccan financial markets is gathered from the CSE. These liquid

stocks – 11 stocks in total – are the constituents of a local index that is called MADEX (Moroccan Most Active Shares Index, which is a capitalization weighted index). Thus, these most active 11 stocks are (their respective industrial sectors are included in parentheses):

- SAMIR (Oil refinery)
- MANAGEM (Mining)
- ONA (Conglomerate)
- SONASID (Steel)
- LAFARGE (Cement)
- WAFA ASSURANCE (Insurance)
- SNI (Conglomerate)
- HOLCIM (MAROC) (Cement)
- BCM (Banking)
- BMCE (Banking)
- WAFABANK (Banking)

The analysis of data and discussions of most of the relevant findings and results of this research will be organized and explained as follows:

Statistical Analysis of Volatility, Beta, Skewness, Kurtosis and Jarque-Bera (JB) Test

In this section, the analysis of the particular risk of each stock (daily volatility), the stock's returns relationship with respect to the MADEX index (beta or the sensitivity market (systematic) risk factor) and finally a test of normality (symmetry) are performed on the sample stocks and the market index.

Table 1 illustrates the daily volatility of each of the sample stocks under normal market and severe (crisis) market conditions. Crisis market volatilities are calculated as the maximum negative returns (losses), which are witnessed in the historical time series, for the stocks and market index. As evidenced in Table 1, the stock with the highest volatility is WAFA ASSURANCE whereas BMCE stock has the lowest volatility. An interesting outcome of the study of betas (systematic risk) is the manner in which the results are varied across the sample stocks as indicated in Table 1. MANAGEM stock appears to have the highest beta (1.56) *vis-à-vis* the MADEX index (i.e. the highest systematic risk) and BMCE stock seems to have the lowest beta (0.20). Moreover, WAFABANK stock (with a beta of 0.97) is the best candidate of the entire sample stocks that appears to move very closely with respect to the market index.

Table 1
Descriptive Statistics: Daily Volatility, Beta, Skewness, Kurtosis and Jarque-Bera Test for Normality

Stocks	Daily volatility (normal market) (%)	Daily volatility (crisis market) (%)	Beta	Skewness	Kurtosis	Jarque-Bera (JB) test
SAMIR	2.13	9.53	1.44	–0.27	2.67	8.22
MANAGEM	1.96	6.27	1.56	–0.28	1.62	44.46
ONA	1.30	6.10	1.31	0.14	4.54	49.30
SONASID	1.22	12.90	0.77	–2.48	29.87	14962.48
LAFARGE	1.15	6.17	0.30	–0.28	8.47	604.88
WAFA ASSUR.	2.57	6.43	1.34	0.00	0.26	150.13
SNI	1.34	6.06	1.16	–0.21	3.43	7.20
HOLCIM (Maroc)	1.16	5.34	0.47	0.06	5.67	142.80
BCM	1.33	6.17	0.91	–0.35	4.45	52.02
BMCE	0.71	4.53	0.20	0.35	10.02	998.13
WAFABANK	1.38	4.14	0.97	0.84	3.23	58.09
MADEX	0.77	2.85	1.00	0.35	3.29	11.25

In another study, the measurements of skewness and kurtosis are achieved on the sample stocks and MADEX index. The results are also depicted in Table 1. It is seen that in general all stocks have shown asymmetric behavior (both positive and negative values). Moreover, kurtosis studies have shown similar patterns of abnormality (i.e. peaked/flat distributions). At the upper extreme, SONASID stock has shown the greatest negative skewness (–2.48) which is combined with a very high Kurtosis – peakedness of (29.87). Other stock, such as SNI, has shown a close relationship to normality (skewness of –0.21 and kurtosis of 3.43). Likewise, the MADEX index has also indicated some signs of normality with 0.35 and 3.29 of skewness and kurtosis respectively. As evidenced in Table 1, the above results of the general departure from normality are also confirmed with the JB test. The JB statistics is calculated as follows:

$$\mathrm{JB} = n/6\left[S^2 + \left(K-3\right)^2/4 \right] \approx \chi^2\left(2\right)$$

Where S is the skewness, K is the kurtosis, and n is the number of observations. The JB statistics reassembles an approximately Chi-squared distribution $[\chi^2(2)]$ with 2 degrees of freedom. The 95% and 99% percentage points of the Chi-squared distribution with 2 degrees of freedom are 5.99 and 9.21, respectively, thus, the lower the JB statistics, the more likely a distribution is normal. Nonetheless, the JB test shows an obvious general deviation from normality and, thus, rejects (in general terms) the hypothesis that the CSE's time series returns are normally distributed. The interesting outcome of this study suggests the necessity of combining VAR calculations – which assumes normal distributions of returns – with other methods such as stress testing and scenario analysis to get

a detailed picture of other remaining risks (such as fat-tails) that cannot be captured with the simple assumption of normality.

Sample of Equity Trading Risk Management Daily Reports

In this section, several case studies are carried out to emphasize the importance of equity trading risk management reports for daily risk taking practices. In the calculations reported herein, the effects of different portfolio combinations, various liquidation periods (unwinding horizons of stocks holdings) and short selling of stocks, are all investigated.

Table 2 illustrates a practical sample report for the coverage of equity trading risk management activities of a hypothetical equity portfolio consisting of the most active stocks in the CSE. In this first case study, total portfolio value is MAD160 millions with different asset allocation percentage and a liquidity horizon of one trading day – i.e. one day to unwind all trading positions. Table 2 depicts the effects of stress testing (VAR under severe market conditions) and different correlation factors on daily VAR calculations. The VAR report depicts also the overnight (daily) volatilities (that are calculated as the volatility of the percentage price changes (daily returns) of these stocks) and in addition their respective betas.

The VAR results are calculated under normal and severe market conditions by taking into account different correlation factors (+1, 0 and exact (empirical) correlations between the various risk factors). Under correlation +1, one is assuming 100% positive relationships between all risk factors (risk positions) all the times, whereas for the zero-correlation case, there is no relationships between all positions at all the times. The last correlation case takes into account the empirical correlation between all positions and is calculated via variance/covariance matrix.

As one might expect, the case with correlation +1 gives the highest VAR numbers (MAD4, 432,692 and MAD21, 497,252), owing to the fact that under these circumstances the total VAR of the portfolio is the weighted average of the individual VAR of each trading position. It is essential to include various correlation factors in any stress-testing exercise, based on the fact that current trends in correlations may break down with severe market movements, caused by unexpected financial or political crises. The degree of diversification of this hypothetical trading portfolio can also be displayed as the difference in the value

Table 2

Equity Trading Risk Management Report (Analysis of Case Study 1)

Asset Allocation and Value At Risk (VAR) Report

Stocks	Market Value in MAD	Asset Allocation Percentage	Daily Volatility (Normal)	Daily Volatility (Severe)	Beta
SAMIR	$ 10,000,000	6.3%	2.13%	9.53%	1.44
MANAGEM	$ 10,000,000	6.3%	1.96%	6.27%	1.56
ONA	$ 20,000,000	12.5%	1.30%	6.10%	1.31
SONASID	$ 20,000,000	12.5%	1.22%	12.90%	0.77
LAFARGE	$ 10,000,000	6.3%	1.15%	6.17%	0.30
WAFA ASSUR.	$ 10,000,000	6.3%	2.57%	6.43%	1.34
SNI	$ 10,000,000	6.3%	1.34%	6.06%	1.16
HOLCIM (Maroc)	$ 10,000,000	6.3%	1.16%	5.34%	0.49
BCM	$ 20,000,000	12.5%	1.33%	6.17%	0.91
BMCE	$ 20,000,000	12.5%	0.71%	4.53%	0.20
WAFABANK	$ 20,000,000	12.5%	1.38%	4.14%	0.97
MADEX	$ -	0.0%	0.77%	2.85%	1.00
		100%			
Total Value in Moroccan Dirhams	$ 160,000,000				

Daily Value At Risk (VAR) in Moroccan Dirhams [Normal Market Conditions]

Correlation – Exact	Correlation – 1	Correlation – 0
2,364,490	4,432,692	1,396,157
1.48%	2.77%	0.87%

Diversification Benefits	
$ 2,068,202	87.47%

Daily Value At Risk (VAR) in Moroccan Dirhams [Severe (Crisis) Market Conditions]

Correlation – Exact	Correlation – 1	Correlation – 0
11,632,656	21,497,252	7,463,020
7.27%	13.44%	4.66%

Diversification Benefits	
$ 9,864,596	84.80%

Beta of the Overall Portfolio
0.912

of the two greatest VARs, i.e. the VAR of correlation = +1 case versus the VAR of the exact correlation case (MAD2,068,202 or 87.47% for the normal market condition case). The overall beta of this portfolio is also indicated in this report as 0.912, or in other words, the total portfolio value, with the actual asset allocation percentage, moves very closely with the main market indicator (MADEX index).

Since the variations in daily VAR are mainly related to the ways in which the assets are allocated in addition to the liquidation period of assets and the effects of short selling, it is instructive to examine the way in which the VAR figures are influenced by changes in such parameters. All else equal, Table 3 illustrates the drastic changes to the VAR numbers when the liquidation period is increased to 10 trading days for all stocks within the portfolio.

The effects of short selling (albeit short selling is currently not permitted in the CSE) are depicted in Table 4. One of the interesting results of this study is the way in which the VAR numbers have decreased. This behavior might be explained by the way in which the overall portfolio is funded – in other words, some of the long positions have been funded with the short selling of other stocks and consequently have led to the reduction in the overall risk. This also is evidenced by the fact that the overall portfolio beta (sensitivity factor) is very close to zero and that VAR number under correlation +1 has became less than the VAR number with the exact correlation case (or in other words, the correlation benefits due to diversification has switched signs due to the short selling effects).

In fact, one of the best advantages of the calculation of VAR within the matrix-algebra framework is the ability in which one can incorporate the effects of short selling without complex mathematical analysis.

CONCLUDING REMARKS AND FINAL THOUGHTS

There are many methods and ways to identify, to measure and to control trading risk, and trading risk managers have the task to ascertain the identity of the one that suits their needs. In fact, there is no right or wrong way to measure/manage trading risk; it all depends on each entity's objectives, lines of business, risk appetite and the availability of funds for investment in trading risk management projects. Regardless of the methodology chosen, the most important factors to consider are the establishment of sound risk practices, policies and standards and the consistency in the implementation process across all lines of businesses and risks.

Table 3
Equity Trading Risk Management Report (Analysis of Case Study 2)

Asset Allocation and Value At Risk (VAR) Report

Stocks	Market Value in MAD	Asset Allocation Percentage	Daily Volatility (Normal)	Daily Volatility (Severe)	Beta
SAMIR	$ 10,000,000	6.3%	2.13%	9.53%	1.44
MANAGEM	$ 10,000,000	6.3%	1.96%	6.27%	1.56
ONA	$ 20,000,000	12.5%	1.30%	6.10%	1.31
SONASID	$ 20,000,000	12.5%	1.22%	12.90%	0.77
LAFARGE	$ 10,000,000	6.3%	1.15%	6.17%	0.30
WAFA ASSUR.	$ 10,000,000	6.3%	2.57%	6.43%	1.34
SNI	$ 10,000,000	6.3%	1.34%	6.06%	1.16
HOLCIM (Maroc)	$ 10,000,000	6.3%	1.16%	5.34%	0.49
BCM	$ 20,000,000	12.5%	1.33%	6.17%	0.91
BMCE	$ 20,000,000	12.5%	0.71%	4.53%	0.20
WAFABANK	$ 20,000,000	12.5%	1.38%	4.14%	0.97
MADEX	$ -	0.0%	0.77%	2.85%	1.00
		100%			
Total Value in Moroccan Dirhams	$ 160,000,000				

Daily Value At Risk (VAR) in Moroccan Dirhams [Normal Market Conditions]

Correlation = Exact	Correlation = 1	Correlation = 0
5,545,221	10,395,585	3,274,278
3.47%	6.50%	2.05%

Diversification Benefits	
$ 4,850,364	87.47%

Daily Value At Risk (VAR) in Moroccan Dirhams [Severe (Crisis) Market Conditions]

Correlation = Exact	Correlation = 1	Correlation = 0
27,280,995	50,415,524	17,502,333
17.05%	31.51%	10.94%

Diversification Benefits	
$ 23,134,529	84.80%

Beta of the Overall Portfolio
0.912

Table 4
Equity Trading Risk Management Report (Analysis of Case Study 3)

Table (4) Equity Trading Risk Management Report (Analysis of Case Study 3)

Asset Allocation and Value At Risk (VAR) Report

Stocks	Market Value in MAD	Asset Allocation Percentage	Daily Volatility (Normal)	Daily Volatility (Severe)	Beta
SAMIR	$ (10,000,000)	-25.0%	2.13%	9.53%	1.44
MANAGEM	$ 10,000,000	25.0%	1.96%	6.27%	1.56
ONA	$ (20,000,000)	-50.0%	1.30%	6.10%	1.31
SONASID	$ 20,000,000	50.0%	1.22%	12.90%	0.77
LAFARGE	$ 10,000,000	25.0%	1.15%	6.17%	0.30
WAFA ASSUR.	$ 10,000,000	25.0%	2.57%	6.43%	1.34
SNI	$ (10,000,000)	-25.0%	1.34%	6.06%	1.16
HOLCIM (Maroc)	$ 10,000,000	25.0%	1.16%	5.34%	0.49
BCM	$ 20,000,000	50.0%	1.33%	6.17%	0.91
BMCE	$ 20,000,000	50.0%	0.71%	4.53%	0.20
WAFABANK	$ (20,000,000)	-50.0%	1.38%	4.14%	0.97
MADEX	$ -	0.0%	0.77%	2.85%	1.00
		100%			
Total Value in Moroccan Dirhams	$ 40,000,000				

Daily Value At Risk (VAR) in Moroccan Dirhams [Normal Market Conditions]

Correlation = Exact	Correlation = 1	Correlation = 0
1,127,705	904,538	1,396,157
2.82%	2.26%	3.49%

Diversification Benefits	
$ (223,167)	-19.79%

Daily Value At Risk (VAR) in Moroccan Dirhams [Severe (Crisis) Market Conditions]

Correlation = Exact	Correlation = 1	Correlation = 0
6,471,616	7,069,141	7,463,020
16.18%	17.67%	18.66%

Diversification Benefits	
$ 597,525	9.23%

Beta of the Overall Portfolio
0.071

The VAR concept is the focus for establishing information on position risks. VAR gives the maximum acceptable potential loss arising from the impact of adverse price changes or changes in other market risk factors (e.g. volatilities) on open positions over a given time horizon. The maximum acceptable loss is usually calculated with a 97.5% confidence interval (2σ) and with a standard time horizon of one day. In addition VAR limits are usually set on overnight risk exposures.

Under special conditions when changes in market risk factors are normally distributed, the VAR can be calculated using the variance/covariance approach. For daily trading risk measurement purposes, these assumptions are made for the sake of simplifying the calculation process. However, for an emerging-market environment, one needs to supplement the variance/covariance approach with other analysis such as stress testing and simulation analysis. This is done with the objective of estimating the impact of assumptions that are made under the VAR approach. Likewise, the effects of illiquidity of trading assets in emerging-markets must be dealt with more wisely and should be brought into existence within the VAR framework.

In this document a simplified and practical method for calculating portfolios' trading risk is presented and analyzed. Matrix-algebra approach is used to derive the necessary mathematical/quantitative trading risk management methods. This approach has

several advantages owing to the fact that it can facilitate the programming process in EXCEL™ worksheets and can also permit easy incorporation of short selling of trading assets into the equity trading process. The effects of illiquidity of trading assets are also incorporated into the VAR quantitative approach. For that purpose a simplified and practical model for the measurement of the effects of illiquid assets (unwinding of trading assets), in daily trading risk management practices, is defined and is appropriately integrated into the VAR and stress-testing models.

Equity trading risk management models, which are developed in this work, are applied to the CSE. Thus, our analyses are carried out for the most active shares on the CSE and the local MADEX index. The analyses that are performed include volatility, skewness, kurtosis and JB tests along with beta calculations. Our results suggest that in almost all tests, there are clear asymmetric behaviors in the distribution of returns of the sample stocks and the main market indicator. A number of case studies are carried out with the objectives of calculating VAR numbers under different normal and severe (crisis) market condition scenarios. The different scenarios are performed with distinct asset allocation percentages in addition to analyzing the effects of liquidity of trading assets (unwinding horizon period of assets) and moreover including the possibilities of short selling.

Based on the fact that our approach can handle effectively the outcome of short selling, it is suggested for future research to incorporate and quantify the end result of short selling with different liquidation horizons and with various asset allocation proportions. Likewise, the same approach can be used to set optimum trading limits (of different proposed equity portfolio) so that trading units can use such maximum authorized limits as a guide for their daily position-taking.

REFERENCES

Al Janabi, M. A. M. (2005). Trading risk management: Practical applications to emerging-markets. In Motamen-Samadian S. (Ed.). *Risk management in emerging markets* (91–136). UK: Palgrave/MacMillan.

_____. (2006). On the inception of sound derivative products in emerging markets: Real-world observations and viable solutions. *Journal of Financial Regulation and Compliance, 14*(2).

_____. (2007a). A practical approach to market risk analysis and control: Empirical test of the Mexican foreign exchange and stock markets. *International Journal of Risk Assessment and Management.* Special issue on: Financial Risk Management (forthcoming).

_____. (2007b). Equity trading risk management: The case of Casablanca stock exchange,. *International Journal of Risk Assessment and Management, 7*(4), 535–568. Special issue on: Flexibility and Risk Management.

Berkowitz, J., & O'Brien, J. (2001). *How accurate are Value-At-Risk models at commercial banks?* (Working paper of US Federal Reserve Board's Finance & Economic).

Culp, C., Mensink, R., & Neves, A. (1998). Value-At-Risk for asset managers. *Derivatives Quarterly*, Winter Issue.

Dowd, K., Blake, D., & Cairns, A. (2004). Long-term Value-At-Risk. *The Journal of Risk Finance*, Winter/Spring Issue.

Jorion, P. (2001). *Value-At-Risk: The new benchmark for controlling market risk.* Chicago: McGraw-Hill.

Markowitz, H. (1959). *Portfolio delection: Efficient diversification of investments.* New York: John Wiley.

Morgan Guaranty Trust Company. (1994). *Risk metrics-technical document.* New York: Morgan Guaranty Trust Company, Global Research.

Pritsker, M. (1997). Evaluating value at risk methodologies: Accuracy versus computational time. *Journal of Financial Services Research, 12,* 201–242.

Sharpe, W. (1963). A simplified model for portfolio analysis. *Management Science, 9*(2), 277–293.

www.casablanca-bourse.com (Casablanca Stock Exchange Website). Retrieved 2006.