

# VALUE AT RISK FOR ASIAN EMERGING MARKET EQUITY PORTOLIOS

Value at Risk is becoming a standard risk management tool for institutions worldwide, and is enjoying rapid and wide-ranging success. Its main appeal lies in its simplicity; a single number offers information about what a firm may expect to lose over a time horizon, uncovers uncertainties of the firm, and provides crucial information of the overall firm's risk profile to senior management, traders, shareholders, investors, auditors, rating agencies, and regulators.

However, institutional investors, and international equity investors in particular, have not embraced the Value at Risk methodology with particular enthusiasm, and few of them actively use it for portfolio and risk management purposes.

The severity of the Asian financial crisis has stressed the importance of understanding the assumptions and weaknesses of the different risk management methodologies, as managers that were implementing them without a thorough understanding of them, found that their losses were larger than the ones estimated by their quantitative systems.

The main purpose of this article is to show how the VaR methodology can be effectively applied for risk measurement and management of Asian emerging market equity portfolios. We suggest an alternative way to address the problem of dealing with the risk aggregation problem of international equity portfolios by grouping individual positions in the corresponding industry sectors.

Every major stock market usually publishes several indices for clearly-defined sectors representing different areas of the country's economy. By grouping positions in individual stocks through sector indices, we can solve the aggregation problem, and we can obtain more detailed information about the risk profile of the portfolio than using the stock market index as the only risk factor.

One of the main criticisms of VaR is that it is an unidirectional analysis and, in the process of aggregating and simplifying the portfolio risk, we lose essential information that could be very useful to manage a portfolio actively. The real value of the VaR approach is not arriving at a single number. It is the process of identifying, quantifying, and managing risks that heretofore been ignored. The "drill-down" capabilities are an essential part of any VaR system, as they offer crucial insights to determine the main sources of risk of the portfolio ("hot spots"), and which components of the portfolio act as a natural hedge.

Initial VaR theory seems to permit to estimate only (1) diversified portfolio VaR or (2) undiversified VaR of a portfolio or component (e.g. a trade). These are non-additive, and reports that show the VaR by sub-components of a portfolio treating them in isolation, are not taking into account the diversification effects. With the VaRdelta and Component VaR technology, developed by Garman (1996, 1997) we can take an entire portfolio's diversified VaR and additively allocate it to the individual components comprising the portfolio.

Fund managers are starting to implement VaR systems, and use VaR not only for risk measurement, but also for risk management purposes. In this article we are going to outline some the uses of VaRdelta and Component VaR to break down the risk of an international equity portfolio. We will show that VaR is a very powerful tool to measure and manage risk, but not a goal in itself. It is the process that leads to the calculation of the VaR figures which really adds value to the risk management function, not just the VaR numbers themselves.

VaR encourages fund managers to think of the portfolio as a set of assets exposed to several sources of risk. Once the exposures to several risk factors have been identified and quantified, it is possible to analyze how those risk exposures interact with each other, which trades are acting as a natural hedge to the portfolio, and which exposures represent the largest sources of risk for the firm. With VaR it is possible to minimize the variability of portfolios P&L's, decide which risks are worth taking, and hedge those which may cause "too much" variability to portfolio returns.

In this article we use a new methodology that enables us to break down the VaR of an emerging markets portfolio in its components and determine the contribution to risk of each component or position in the portfolio. Through this methodology we can, therefore, expand the use of VaR from risk measurement to an active risk management tool.

As firms are moving to sector-based equity trading, especially in Europe during the period leading up to Europe's single currency, it is important to introduce the different market sectors as risk factors in the VaR analysis.

In this article, we analyse the risk profile of an Asian equity portfolio with positions in equities from 4 different countries (Malaysia, Singapore, Taiwan, and Thailand), and 3 industry sectors (Banking, Industry, Construction). We have decided to keep the number of countries and industries low for simplicity purposes.

## **PROBLEMS WITH RISKMETRICS™ DATASETS FOR EQUITY PORTFOLIOS**

Riskmetrics™ provides a set of volatilities and correlations matrices calculated on a daily basis for a set of core risk factors ("vertices"), and can be downloaded from the web. It is important to point out that Riskmetrics™ matrices have a limited number of risk factors, mostly foreign exchange, interest rate, and equities. One of the main problems of calculating VaR for international equity portfolios is that the Riskmetrics datasets only cover a stock market index for each country included in the datasets. The methodology is based on the systematic risk principle, by which only the systematic portion of risk matters in large, well-diversified portfolios.

To calculate the VaR of an international equity portfolio using Riskmetrics™ datasets, we have to express all the individual positions in terms of the general stock market index through their betas, beta - which measures the extent to which the price of a security moves with general market index as a whole

The problem with this approach is three-fold:

1. The method assumes that the beta of each security with the general stock market index captures the risk appropriately. For portfolios that are not well diversified in each country, the assumption no longer holds, and therefore the use of betas exclusively is incomplete. (maybe cite BIS or CNMV)
2. The assumption of the stability of betas over time rarely holds for emerging or developed equity markets.
3. The use of only one risk factor per country's equity markets does not allow the fund manager to determine the main components of the portfolio's diversified VaR. After the cashflow mapping process is completed, it assumes that we only hold a particular position in the stock market general index, and consequently, the exposure to the stock market index is all the information provided by the analysis. In the process of aggregation we lose information regarding the specific risk of the individual positions, and the interactions between them.

We suggest a different approach to implement VaR for international equity portfolios. Fund managers should use volatility and correlation datasets customized to their own needs, and have the capabilities to perform a drill-down analysis on their main sources of portfolio risk. In order to do that, it is necessary to count with historical price series for the stock market sectors of each country (maybe individual equities) in their portfolios, and exchange rate series. Once the data is available, it is possible to create correlation and volatility datasets from that historical data following commonly accepted methodologies. An ideal VaR system must accept arbitrary asset codes, and therefore deal with a wider range of vertices for the analysis of equity positions.

Individual equities introduce too many factors, but treating the different market sector indices as the risk factors for each country, adds a reasonable number of risk factors for which we can collect volatility and correlation information on a regular basis.

## NEW ADVANCES IN VALUE AT RISK: COMPONENT VAR AND VARDELTA

Two of the most recent developments in VaR are the VaRdelta and Component VaR methodologies, developed by Garman (1996, 1997)<sup>1</sup>, which allow the breakdown analysis of the diversified portfolio VaR.

The information gathered to provide the VaR numbers, can be analysed and studied to determine the main sources of portfolio risk, and the main marginal exposures ("hot spots").

### DESCRIPTION OF PORTFOLIO.

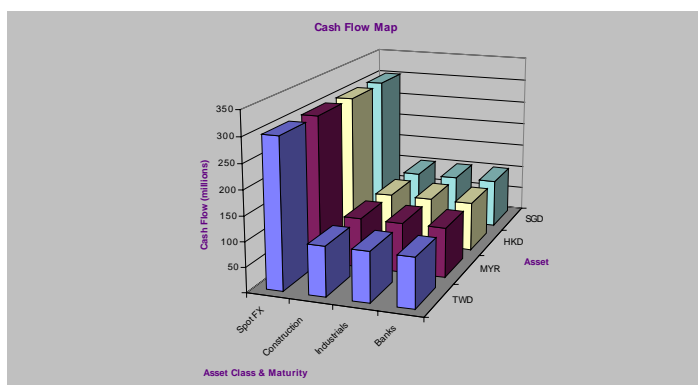
Let's assume that we have a portfolio composed of equally weighted positions in equities in Malaysia, Singapore, Taiwan, and Thailand. The portfolio only invests in three specific market sectors; Banking, Industry, and Construction, and it has equal weightings in each sector.

### DEFINE SECTOR

If we did not have any other information we could conclude that the portfolio is correctly diversified as the exposure to each of the risk factors (sector indices) is similar.

- Cashflow map:

Raw cashflow maps can be thought of as a "pre-covariance analysis", which employs neither volatilities nor correlations. The cashflow map shows the exposure to fluctuations in each of the sectors and currencies involved in the analysis. All the cashflows are normally expressed in the same currency ("numeraire", here USD).



- Undiversified VaR:

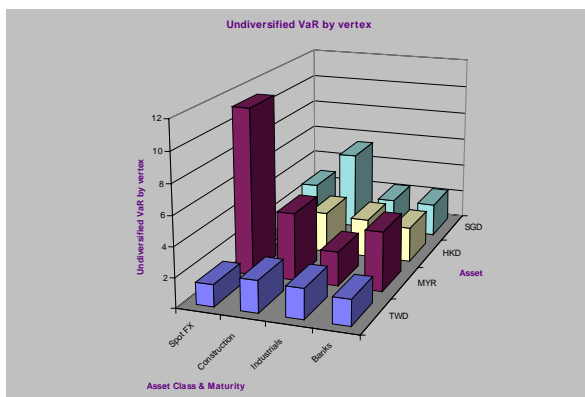
Having only the cash flow map and volatilities, we can analyze the risk of the portfolio by examining the undiversified VaR for the set of risk factors in the analysis (i.e. without considering the correlations among them). We can obtain the undiversified VaR by multiplying each casflow allocated to each vertex by the volatility of that risk factor adjusted by the horizon and confidence interval chosen.

We can observe how the greatest risk comes from our positions in construction index of the Singapore stock exchange, as well as the Malaysian construction and bank indices, and foreign exchange risk. In this analysis we are just looking at the volatility of each exposure, and looking at them in isolation. Therefore we are looking at VaR by vertices. From the analysis of the undiversified VaR by vertex, we can also conclude that the risk arising from our positions in the construction sector is considerably higher than the other sectors, and that the risk from our the position in Malaysia is higher than in the other countries.

<sup>1</sup> Garman, M. B., "Improving on VAR," *Risk*, May 1996, pp. 61-63.

Garman, M. B., "Making VAR more flexible," *Derivatives Strategy*, April 1996, pp. 52-53.

This type of risk analysis is however very narrow and limited, as we are not taking into account the interaction among the different sectors and the possible benefits of diversification within the portfolio.



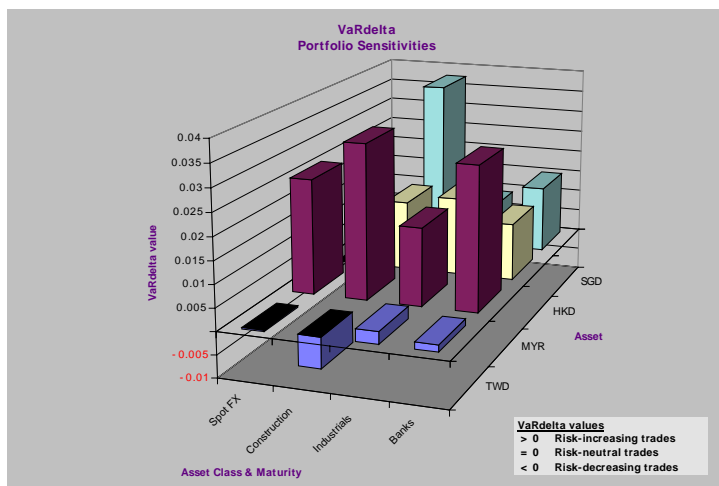
If we were to make portfolio decisions based only on the analysis of individual risks (volatilities), we would be looking only at one side of the picture. Before reaching the conclusion that a certain position is considerably increasing our portfolio risk, and therefore we should reduce our exposure to that particular risk factor, it is important to introduce the analysis of diversified VaR, which can be accomplished, as we have mentioned, through VaRdelta and Component VaR.

- VaRdelta:

VaRdelta tells us the marginal exposure of our current portfolio, posterior to correlation and volatility information. In other words, it answers the question of how VaR will change if we inject another (numeraire) unit of a vertex cashflow, given the covariance matrix (market) information. It is always measured in percentage terms (usually in basis points for short horizons). The incremental VaR calculation via VaRdelta is extremely fast, and may be conducted in real time (it involves only a few microseconds of computer time).

The VaRdelta approach offers a more economical means for evaluating any new proposed trade in terms of its effect on institutional VaR, without the extensive recalculation of total VaR. This permits the realisation of rapid evaluation of candidate trades, so that real-time VaR trading limits become practical. Besides, it becomes possible to determine not just whether certain trades will increase or decrease VaR but, indeed, what relative ranking those trades should enjoy for VaR reduction purposes.

VaRdelta allows us to estimate the incremental effect of a new trade via the previous calculation of the VaRdelta vector, which represents the VaR gradient; that is, the cashflow direction in which the VaR varies at the greatest speed. It measures the sensitivity of VaR to an additional unit in cash flow in each risk factor.



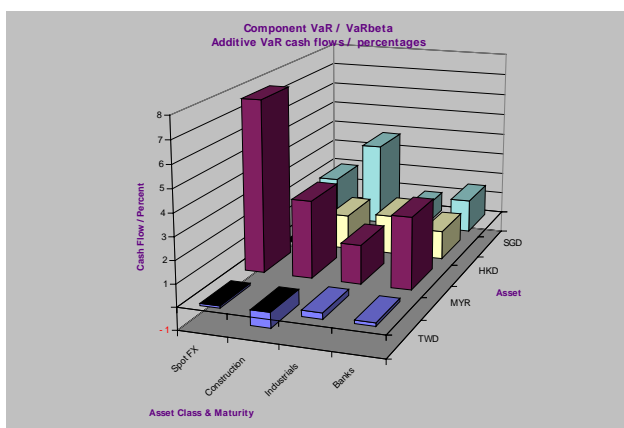
The analysis of the VaRdelta vector tentatively indicates that the market "hot spots" are the Singapore construction index and the Malaysian construction and bank indices, as they have the highest VaRdeltas. In other words, if we were to increase (decrease) our position in these indices, we would obtain the largest gain (reduction) in diversified VaR.

The low and negative VaRdeltas from the vertices of the exposures in Taiwan indicates that if we were to increase our positions in those risk factors, our portfolio VaR would hardly increase, or even decrease. The VaRdelta analysis is telling us that those risk factors are acting as a natural hedge to our portfolio. In particular, the negative sign in the Taiwan construction index, indicates that it acts as a hedge to our portfolio, and therefore it reduces its global risk. If we increase our position in this factor, the diversified VaR would in fact decrease.

If we wanted to decrease our portfolio risk, for example, we could shift our position in the Malaysian construction and banks sectors, and increase our positions in those sectors in Taiwan. Without the need to recalculate the whole portfolio VaR, the approximate reduction would be USD 12.37 MM.

- Component VaR

An application of VaRdelta is "Component VaR", which allows us to break down the diversified VaR into its main sources or components as well as to identify the trades that act as a hedge with respect to total portfolio risk.



From the component VaR we can observe that the main single factor contributing to the portfolio's diversified risk is the exposure to Malaysian ringgit foreign exchange risk.

With Component VaR and VaR-Beta (Component VaR divided by Diversified VaR), we can create risk management reports drilling down into portfolio VaR multiple ways, in terms of traders, trades, market sectors, countries, counterparty, etc.

Sector	Cash Flows	Component VaR	VaR-Beta
Construction	\$100 MM	\$ 8.0967 MM	28.5%
Industry	\$100 MM	\$ 4.6635 MM	16.4%
Banking	\$100 MM	\$ 6.1081 MM	21.5%
Spot FX	\$1200 MM	<u>\$ 9.5344 MM</u>	<u>33.6%</u>
Diversified VaR		\$ 28.403 MM	100%

Country	M-T-M	Component VaR	VaR-Beta
Taiwan	\$100 MM	\$ -0.3638 MM	- 1.3%
Malaysia	\$100 MM	\$ 16.066 MM	56.6%

Singapore	\$100 MM	\$ 8.1364 MM	28.6%
Hong Kong	\$100 MM	<u>\$ 4.5639 MM</u>	<u>16.1%</u>
Diversified VaR		\$ 28.403 MM	100%

We can see how the foreign exchange risk is the main contributor to overall VaR (33.6%). The sector with lowest Component-VaR is the industry sector, which contributes only to 16.4% of overall diversified VaR. If we decompose risk by country, we can see how the positions in Malaysian equities are contributing to more than half of the portfolio's diversified risk, while the positions in Taiwanese equities are actually acting as a natural hedge of the portfolio.

#### **Summary and conclusion:**

The use of VaR in the fund management industry is still in its infancy, and it is growing due in part of a regulatory effort as it gains acceptance and popularity as a legitimate and effective tool for market risk management.

The way the fund managers have looked at diversification traditionally requires rethinking. Component VaR offers a way to determine the contributions of the different portfolio's components to overall risk after taking into account variance and covariance effects. Those effects are completely ignored in the way managers report the positions that a particular fund may hold at any point in time.

There is little doubt among risk managers and regulators that VaR is here to stay, and it is very likely that VaR will become universal practice within a few years, not only for financial institutions, but also for all corporations facing market price risks. Investment management companies are still in the process of learning about the applications of VaR to manage equity portfolio risks, and it is expected to change the way portfolio managers deal with risks. Recent rulings by regulators all over the world, like Spain's Comisión Nacional del Mercado de Valores, etc.), which allow fund managers to use VaR to determine derivatives limits, will reinforce the trend towards making VaR a standard form to measure and manage portfolio risk.