Global Economy and Finance Journal
Vol. 9. No. 1. March 2016 Issue. Pp. 56 – 66

Emerging Markets and Value-at-Risk: The Case of Multinational Enterprises

Kashi Khazeh[1], Leonard Arvi[2], Eugene D. Hahn[3]

This study focuses and compares the efficacy of two approaches of the transaction exposure (value at risk "VaR" and modified value-at-risk "MVaR") for multinational enterprises (MNEs) conducting business in one and/or up to seven specific emerging markets for the duration of 2011-2014. The significance of this study is that it provides the optimal currency portfolio of emerging market currencies. These two approaches (VaR and MVaR) are compared with the ex-post results. The maximum 1-day loss is assessed, matched across the two aforementioned approaches, but also paralleled with actual results. These comparisons afford realistic evidence to assist MNEs to determine the level of their tolerance with respect to each version of value-at-risk over time. Moreover, these outcomes will present MNEs useful information in defining if hedging this risk is warranted. If they decide to hedge (due to the reversal of risk reduction at some point), MNEs need to contemplate as to which hedging technique (i.e., forward/futures, money market, and or option) to use given that the real cost of hedging could be positive.

1. Introduction

The continuing growth of world trade and the increasing integration of the world's capital markets have, over the last few decades, created new and exciting opportunities for multinational enterprises (MNEs). But these new opportunities come with additional risks such as adverse exchange rate movements. Such movements have the potential to damage profitability and, in the extreme, even undermine the firm's solvency. MNEs have sought ways to estimate these risks. Successively, they have identified techniques to minimize and/or eliminate these risks.

The most popular approach in estimating the transaction risk is referred to in the literature as "value-at-risk" (VaR). VaR attempts to place a specific (e.g., dollar) value on the maximum likely loss the MNE will experience over a specific time period at a particular confidence level.

Since VaR results in a specific dollar amount and has a straightforward interpretation, it is favored by many financial and risk managers. It should be noted that "modified value-at-risk" (MVaR) accomplishes the same with higher confidence level. Due to its relative computational simplicity, VaR and MVaR have gained significant footing and are widely used.

[1]Dr. Kashi Khazeh, Department of Economics and Finance, Salisbury University, MD, USA.
Email: kxkhazeh@salisbury.edu
[2]Dr. Leonard Arvi, Department of Economics and Finance Salisbury University, MD, USA.
Email: lxarvi@salisbury.edu
[3]Dr. Eugene D. Hahn, Department of Information & Decision Sciences, Salisbury University, MD, USA. Email: edhahn@salisbury.edu

These two approaches employ four years of most recent daily data (2011-2014) on the variability of individual exchange rates as well as their covariance, to make probabilistic statements about the maximum amount an MNE is likely to lose over a specific time period. While VaR in general assumes that the variables involved are normally distributed and that future trends can be extrapolated based on recent, empirical relationships, the MVaR considers skewness and/or excess kurtosis to remedy non-normal distribution in many financial variables.

Appropriately, VaR and MVaR approaches are utilized, in this study, to assess international transaction exposure for MNE conducting business in up to seven specific emerging markets for the above mentioned time duration (2011 – 2014). The currencies of seven specific emerging markets include: the Taiwan dollar (TWD), the Thailand baht (THB), the South Africa rand (ZAR), the India rupee (INR), the South Korea won (KRW), the Brazil real (BRL), and the Mexico peso (MXN). All of these aforementioned currencies are considered as emerging markets' currencies, which are allowed to float (Madura, 2015).

This study not only estimates and evaluates VaR and MVaR for various emerging market currencies, but also considers multiple-currency portfolios as well. Data for one-day holding periods are included in the analysis. The significance of this study is that it provides the optimal currency portfolio of emerging market currencies. It also offers MNEs and other firms, with respect to emerging markets, as to how they are impacted and how the inclusion of additional currencies affects value-at-risk. The results provide a clear framework on how to minimize hedging costs that will positively impact the net income of MNEs. Moreover, these findings may also inform MNEs regarding possible entry or exit strategies as they seek a footprint in the emerging markets if warranted. The focus of all previous studies is only on developed countries' VaR and MVaR.

This paper is organized as follows. Section 2 is the statement of purpose, which gives the background and rationale/motivation for the study. Section 3 is the literature review. Section 4 describes the methodology. Sections 5 describe the results of the analysis. Section 6 provides the conclusions and also discusses limitations and future research.

2. Statement of Purpose

In order to take advantage of the numerous prospects around the world, purely domestic firms evolve into multinational enterprises with the determination of netting larger market shares coupled with higher rates of return. With higher return comes higher risk. Therefore, any responsible financial manager will consider a full review of the situation they are operating in (i.e., exposure to economic, political, and exchange rate conditions/risks). The extent of the impending prospects and the appraisal of apparent risk, in any structures and methods, compel the implementation of a correct hedging strategy. Proficient managers will counter these complexities and thrive to have a clear lead over competitors. In the context of multinational enterprise, exchange rate risk is an inescapable fact of life. More than forty years ago, when gold ceased to serve as the backbone of U.S. dollar, the era of freely floating exchange rate regime was born. Consequently, high volatility of exchange rates in the foreign exchange market paired with high trading volume is the new standard. Table 1 shows the reported level of daily foreign exchange transaction around the world in trillions of dollars. In the relentless progression toward globalization, exchange rate risk is increasingly viewed as

harmful to business entities that conduct global business. Thus, this type of risk needs to be managed effectively in order for an MNE to flourish.

Table 1: Daily foreign exchange transaction around the world

Year	Volume (in $ trillion)
1985	$ 0.14
1995	$ 1.00
2006	$ 2.00
2010	$ 4.00
2014	$ 5.00

As an optimum strategy (OS), the "Value-at-Risk" (VaR) and "modified value-at-risk" (MVaR) approaches are utilized to control and/or mitigate the exchange rate risk. The attractiveness of these approaches are due to the quantification of the maximum likely loss related to conducting an open position in one or more emerging market currencies for a specific time period (holding period) at a particular confidence level (99%). Indisputably, the flexibility of VaR and MVaR approaches is one of its greatest traits. Accordingly, this study affords a hands-on illustration of engaging the two approaches, by assessing up to seven currencies of abovementioned emerging markets for the duration of most recent four years (January 2011 – December 2014). The justification for selecting the most recent four years is to provide a better estimate of the rolling standard deviations averages, which is essential for VaR approach. The study includes a total of 1005 daily observations of each individual currency's data obtained from the Federal Reserve database. To that end, the riskiness of each individual currency as well as the riskiness of multiple-currency portfolios are assessed and matched for the duration of aforesaid time period.

The evidence attained could be of practical importance to MNEs or other businesses entities in the development of an optimal risk management strategy in those markets. This is similarly true when the real cost of hedging is positive (more expensive to hedge than not to hedge). Moreover, this study also accentuates how the empirical findings could advise an MNE's entry and exit strategies in certain emerging markets.

The literature review (presented below) reveals the plausible pros as well as an apparent weakness of the two approaches; it also provides evidence of wide range of functionality of the two approaches. However, the existing literature comprises of very few applied articles to provide explicit, actionable facts with which MNEs and other enterprises can forge an effective exchange rate risk management strategy. The thrust of this article is, to some extent; fill this vacuum in the current literature.

3. Literature Review

VaR became a standard tool for measuring market risk after the creation of the Basel Committee on Banking Supervision. The capital requirements of most commercial lenders with trading activities are based on VaR estimates. Since then, this simple metric is widely used and adopted by financial institutions to measure their trading risk and capital adequacy. Darryll Hendricks of the Federal Reserve Bank of New York (Hendricks, 1996) details the use of

historical data in evaluating VaR models. (Jorion, 1996) study show that VaR is popular because of ability to summarize the downside risk in a single number.

Value-at-Risk is employed to estimate the likely losses associated with fluctuating exchange rates. Recent examples include (Berkowitz et al, 2009), (Cayton et al, 2010), (Escanciano, Olmo, 2012), (Lu et al, 2010), (Mabrouk and Chaker, 2011), (Khazeh and Winder, 2010), (Khazeh et al, 2011), and (Khazeh et al, 2013), (Khazeh et al, 2014).

Khazeh et al (2014) show, in the case of developed countries, that traditional VaR may significantly underestimate transaction risk. In order to better measure the risk exposure, modified value-at-risk is used. MVaR is used when the distribution is non-normal and when variables display excess kurtosis. Employing VaR on fat tailed data distributions will underestimate risk and is less accurate. Many studies have dealt with the issues of fat tailed distributions. Such recent studies include (Pant and Chang, 2001) comparing three common approaches considering fat tailed probability distributions into VaR computation. Other studies that examine fat tails issues include those done by (Jaworski, 2008), (Wong, 2009), and (Huang et al, 2011).

(Bormetti, 2007) highlight the limitations that VaR does not quantify the loss when the confidence threshold is exceeded. (Lin and Kao, 2008) show in the data of Dow Jones Industrial Average futures log returns that the distribution is asymmetric if there are series of negative values for skewness. Also, if the kurtosis values are greater than 3, then there is presence of fat tails in the distribution. (Wong, 2009) uses a variety of VaR models to back test the tail risk to financial institutions and others of holding the U.S. dollar. (Sirr et al, 2011) use VaR risk factor mapping technique, under the variance–covariance VaR approach, to decompose portfolio risk in Argentina, Brazil, China, India, Mexico and Russia. The data used is from 2004-2010 and they do not use MVaR in their study.

Modified Value-at-Risk concept was introduced by (Favre and Galeano, 2002). They use the Cornish-Fisher expansion to include additional moments to existing value-at-risk to account for skewness and kurtosis in the distribution. (Signer and Favre, 2002) show that excluding skewness and kurtosis in the value-at-risk calculation leads to an underestimation of actual risk by twenty-eight percent.

Kooli et al (2005) study highlights the need to modify the VaR using the Corning-Fisher expansion. They show that for institutional investors in Canada when hedge funds are in the portfolio, MVaR is preferable over both the traditional (variance-covariance) approach to VaR or historical VaR. The results are in line with the expectation, as hedge funds tend to exhibit both excess kurtosis and negative skewness. (Su and Hung, 2011) in their comprehensive study of global stock market indexes, during the period of the sub-prime mortgage crisis, test the impact of skewness, kurtosis, and jump dynamics on the accuracy and efficiency of VaR. They find that the role of excess kurtosis is of paramount importance at the 99 percent confidence level.

Cavenaile and Lejeune (2012) study show that if the data exhibit excess kurtosis then MVaR may be inaccurate at confidence levels below the 96 percent confidence level. Hence, we use the 99 percent confidence level in our computations for both VaR as well as the MVaR. (Natarajan et al, 2008), propose an approximation method for minimizing the VaR of a portfolio

using Asymmetry-Robust VaR (ARVaR). Their optimization results in lower realized portfolio VaR, and lower maximum realized portfolio loss than alternative approaches for quintile-based portfolio risk minimization.

The motivation for this study is to provide a pragmatic solution to MNEs to minimize their foreign currency risk by minimizing their hedging costs. The recent studies have focused only on VaR and MVaR in developed markets (Khazeh et al, 2014). All previous studies did not address the issue of what will be the optimal currency portfolio for a multinational enterprise that operates in emerging markets and/or developed markets. This study explicitly addresses this issue in emerging markets.

4. Methodology

The most popular approaches in measuring transaction risk (VaR), and to some degree its variations (MVaR), are commonly used to estimate the prospective maximum 1-day loss of MNEs' ongoing cash flows that are denominated in emerging market currencies.

Accordingly, the results for the maximum 1-day holding period loss for an individual currency *i* or for a portfolio of currencies *p* is estimated using equation 1:

$$E(e_t) - (Z) \times (\sigma_{i \text{ or } p}) \qquad (1)$$

where:

The expected percentage change in the currency's value for the relevant period = $E(e_t)$

The *z*-score corresponding to the desired confidence level used (i.e., 99%) = 2.326.

The standard deviation of the percentage change in the currency's or portfolio of currencies value over previous period = $\sigma_{i \text{ or } p}$

The results for the modified maximum 1-day holding period loss for an individual currency *i* or for a portfolio of currencies *p* is estimated using equation 2:

$$E(e_t) - (ModZ) \times (\sigma_{i \text{ or } p}) \qquad (2)$$

where:

The expected percentage change in the currency's value for the relevant period = $E(e_t)$

The Modified *Z*-score corresponding to the desired confidence level used (i.e., 99%) = 2.326. In this case *Mod Z* is computed as

$$ModZ = \left(z + \frac{Skew\left(z^2-1\right)}{3!} + \frac{Kurt\left(z^3-3z\right)}{4!} + \frac{Skew^2\left(2z^3-5z\right)}{36}\right)$$

where *z* is the normal *z*-score corresponding to the desired confidence level

Skew is the skewness of the population

Kurt is the excess kurtosis or absolute kurtosis -3

The standard deviation of the percentage change in the currency's or portfolio of currencies value over previous period = $\sigma_{i \text{ or } p}$

The values of standard deviations for an individual exchange rate, as well as for a portfolio of currencies, are shown in Equations 3 and 4 (respectively), below. Additionally, Equation 5 constitutes an application of Equation 4 for a two-currency portfolio.

$$\sigma = \sqrt{\frac{\sum(x - \bar{x})^2}{N}} \qquad (3)$$

where:

σ = *standard deviation*

$\bar{x}$ = *the mean of the values*

N = the number of values (the population)

$$\sigma_p = \sqrt{\sigma_p^2} \qquad (4)$$

$$\sigma_p^2 = \sum_i w_i^2 \sigma_i^2 + \sum_i \sum_{j \neq i} w_i w_j \sigma_i \sigma_j \rho_{ij}, \qquad (4A)$$

where:

σ_p = *standard deviation of weekly percentage changes in currency portfolio*

σ_P^2 = *variance of weekly percentage changes in currency portfolio*

w_i = *proportion of total portfolio value denominated in currency i*

w_j = *proportion of total portfolio value denominated in currency j*

σ_i = *standard deviation of weekly percentage changes in currency i*

σ_j = *standard deviation of weekly percentage changes in currency j*

ρ_{ij} = *correlation coefficient of weekly percentage changes between currencies i and j*

$$\sigma_P = \sqrt{W_X^2 \sigma_X^2 + W_Y^2 \sigma_Y^2 + 2 W_X W_Y \sigma_X \sigma_Y CORR_{XY}} \qquad (5)$$

where:

σ_p = *the standard deviation of the two-currency portfolio*

W_X = *proportion of the total portfolio in currency X*

W_Y = *proportion of the total portfolio in currency Y*

σ_X = *the standard deviation in the weekly percentage changes in currency X*

σ_Y = *the standard deviation in the weekly percentage changes in currency Y*

$CORR_{XY} = \rho_{XY}$ = *the correlation coefficient of the weekly percentage changes between currencies X and Y*

In finding the optimal portfolio, unavoidably we must use optimization methods. These methods are deterministic as opposed to stochastic, hence, statistical hypothesis testing cannot be performed. In fact hypothesis testing would be orthogonal to the goals of this study, which is to find the optimal currency portfolio (versus examining the existence/non-existence of causal effects for which hypothesis testing is designed and which we do not consider in this paper). In this study, the generalized reduced gradient algorithm for non-linear optimization is utilized. The goal of the optimization analyses provided below is to minimize VaR or MVaR. The optimization algorithm uncovers the portfolio weights that achieve this goal. Separate optimization runs are needed to examine VaR as opposed to MVaR since the computation of the two metrics is different. Conversely, results for VaR and MVaR are organized into Tables 4-7 below for ease of comparison.

5. Results

While Table 2 specifies the descriptive statistics of the aforementioned currencies from the highest to lowest risk, measured by standard deviation, Table 3 presents the correlation coefficients among them.

Table 2: Descriptive Statistics of the Seven Currencies (2011-2014)

	ZAR	BRL	MXN	INR	KRW	THB	TWD
Mean	-0.0528%	-0.0461%	-0.0168%	-0.0330%	0.0030%	-0.0087%	-0.0085%
Median	-0.0129%	-0.0246%	-0.0053%	-0.0166%	0.0125%	0.0000%	0.0000%
Standard Deviation	0.9024%	0.7957%	0.6403%	0.6180%	0.4824%	0.3135%	0.2331%
Skewness	-0.1413	-0.0309	-0.4744	-0.0021	-0.4131	0.3378	-0.3307
Kurtosis	2.0744	3.3712	4.0904	5.8844	3.4172	2.9871	4.1595

Table 3: Correlation Coefficient Matrix of the Seven Currencies

	BRL	INR	KRW	MXN	ZAR	TWD	THB
BRL	**1.0000**	0.3092	0.3185	0.6051	0.5499	0.3212	0.3716
INR	0.3092	**1.0000**	0.3507	0.4404	0.4044	0.3455	0.4259
KRW	0.3185	0.3507	**1.0000**	0.4399	0.4139	0.5549	0.4056
MXN	0.6051	0.4404	0.4399	**1.0000**	0.7025	0.4087	0.4680
ZAR	0.5499	0.4044	0.4139	0.7025	**1.0000**	0.3678	0.4320
TWD	0.3212	0.3455	0.5549	0.4087	0.3678	**1.0000**	0.3693
THB	0.3716	0.4259	0.4056	0.4680	0.4320	0.3693	**1.0000**

The assessments of the two approaches (VaR) and (MVaR), as well as ex-post outcomes for each individual currency are presented in Table 4.

Table 4: VaR, MVaR and Ex-post Outcomes for each Individual Currency (on Average)

Currency	$(S_1 - S_0)/S_0$	VaR @ 99%	MVaR @ 99%
BRL	0.0020%	-1.8970%	-2.5058%
INR	-0.0100%	-1.4705%	-2.3191%
KRW	-0.2806%	-1.1191%	-1.3887%
MXN	0.0225%	-1.5062%	-1.9490%
ZAR	0.0024%	-2.1519%	-2.5022%
TWD	0.0165%	-0.5419%	-0.7212%
THB	0.0025%	-0.7378%	-1.0478%
Average	-0.0350%	-1.3476%	-1.7775%

Since all the seven emerging market currencies have positive correlations, it shows there is some but not much of a risk reduction when we create the currency portfolio.

Table 5 on the other hand provides the average for VaR and MVaR based on the order of entry of the currencies (ranked alphabetically based on country name) as well as ex-post outcomes for an equally weighted portfolio. While the VaR continuously decreases with the first four currencies, the inclusion of South African Rand increases the VaR and MVaR due to its high correlation to the Mexican Peso. However, adding the Taiwan Dollar and Thai baht reduces both the VaR and MVaR of the seven-currency portfolio.

Table 5: Average VaR, MVaR and Ex-post Outcomes based on the order of entry of Equally Weighted Portfolio of Seven Currencies

Avg $(S_1 - S_0)/S_0$	Avg VaR @ 99%	Avg MVaR @ 99%	Portfolio Composition
0.0020%	-1.8970%	-2.5058%	BRL
-0.0040%	-1.6837%	-2.4125%	BRL, INR
-0.0962%	-1.4955%	-2.0712%	BRL, INR, KRW
-0.0665%	-1.4982%	-2.0407%	BRL, INR, KRW, MXN
-0.0527%	-1.6289%	-2.1330%	BRL, INR, KRW, MXN, ZAR
-0.0412%	-1.4478%	-1.6573%	BRL, INR, KRW, MXN, ZAR, TWD
-0.0350%	-1.3464%	-1.5702%	BRL, INR, KRW, MXN, ZAR, TWD, THB

Table 6 provides VaR and MVaR based on the order of entry from the least to most risky (measured through standard deviation) respectively.

Table 6: VaR, MVaR based on the order of entry ranked from the Least to Most Risky Currency to an Equally Weighted Portfolio of Seven Currencies

# of currencies	Portfolio Std. Dev	VaR @ 99%	MVaR @ 99%	Portfolio Composition
1	0.23297%	-0.54198%	-0.72121%	TWD
2	0.22713%	-0.52839%	-0.67132%	TWD, THB
3	0.27610%	-0.64231%	-0.78121%	TWD, THB, KRW
4	0.31034%	-0.72195%	-0.92856%	TWD, THB, KRW, INR
5	0.33940%	-0.78957%	-1.05911%	TWD, THB, KRW, INR, MXN
6	0.37196%	-0.86531%	-1.19038%	TWD, THB, KRW, INR, MXN, BRL
7	0.41903%	-0.97481%	-1.30435%	TWD, THB, KRW, INR, MXN, BRL, ZAR

The average maximum 1-day holding period loss comparison, under both approaches, and the simple mean/average of additional currencies (as more and more currencies are added) is higher than the portfolio of those emerging market currencies (Tables 5 and 6). However, at some point, the addition of extra currencies does not impact the risk reduction due to higher correlations among those currencies. In fact, it may even reduce the efficacy of the impact and/or reverse that impact by increasing the risk of the portfolio. This reversal is noticed in Tables 5 and 6, once the last two or three currencies are added respectively (which is more pronounced in MVaR than VaR). This reversal could potentially guide the MNEs with their entry or exit strategies. However, it should be noted that kurtosis values in Table 2 attest to the viability of MVaR versus VaR (given that five of the currencies are valued by MVaR due to kurtosis being more than 3).

Further analysis, under a different order of entry, could reveal an optimum set of portfolios that could provide MNEs not only with an optimal market penetration strategy but also at a well-reduced level of risk.

Table 7 reveals a quick test of optimality based on the two approaches.

Table 7: Optimal Portfolio based on VaR, MVaR that has the Lowest Risk

Portfolio SD	VaR @ 99%	Currency	Weights	Portfolio SD	MVaR @ 99%	Currency	Weights
0.21611%	-0.50274%	TWD	72.27%	0.21688%	-0.64167%	TWD	66.45%
		THB	27.73%			THB	33.55%

It is evident, from Table 7 compared with Table 6, that the optimal portfolio should consist of only two countries' currencies (given the appropriate weights as opposed to being equally weighted). Under both methods, the risk is cut in half when an optimum strategy is implemented. Therefore, as an entry strategy, MNEs should consider these two countries first, once they wish to expand their market penetration beyond developed countries.

6. Conclusions, Limitations and Future Research

An important insight derived from this research indicates that multinational enterprises need not hedge all the seven emerging market currencies in which they operate. The optimization

results show that hedging just two currencies (Thai baht and the Taiwanese dollar) out of the seven would reduce the currency portfolio's risk in half. Since real cost of hedging is positive and hence expensive, our findings show that firms can minimize the cost of hedging to achieve superior risk reduction in their currency portfolios.

These results provide a clear framework on how to minimize hedging costs that will positively impact the net income of MNEs. Moreover, these findings may also inform MNEs regarding possible entry or exit strategies as they seek a footprint in the emerging markets (if warranted). All previous studies had focused only on developed countries VaR and MVaR.

This research is timely due to the latest period under consideration (2011-2014). While the Federal Reserve contemplates changing the interest rate, one can only conclude that it is bound to have a negative reaction in the emerging market currencies. Since sixty percent of all earnings of S&P 500 firms occur outside the U.S., a good hedging strategy to minimize foreign currency exposure (transaction exposure) is indispensable. Henceforth, our research is useful and timely as the results is applicable to benefit multinational enterprises.

The limitation of the study is the assumption that the MNEs operate only in the seven emerging markets analyzed in this study. It is worth noting that the level of actual risk (in currency fluctuation) vs. perceived risk (VaR and MVaR) is much lower, on average, during 2011-2014. It would be interesting to see if the same scenario would hold on a disaggregated basis. Also, as most MNEs operate in both developed and emerging markets, it would be meaningful to study a currency portfolio that includes countries from both categories.

References

Bormetti, G, Cisana, E, Montagna, G, Nicrosini, O 2007, 'A non-Gaussian approach to risk measures', *Physica A*, vol. 376, pp. 532-542.

Berkowitz, J, Christoffersen, P, Pelletier D 2009, 'Evaluating Value-at-Risk models using desk level data', *Management Science,* vol. 57, no 12, 2213-2227.

Cayton, JA, Mapa, DS & Lising, MT 2010, 'Estimating Value at Risk Using TIVEX-POT Models', *Journal of Advanced Studies in Finance,* vol. 1, no. 2, pp. 152-161.

Cavenaile, L & Jejeune, T 2012, 'A Note on the Use of Modified Value-at-Risk', *The Journal of Alternative Investments,* vol. 14, no. 4, pp. 79-83.

Escanciano, C, Olmo, J, 2012,'Backtesting parametric value-at-risk with estimation risk', *Journal of Business and Economic Statistics,* vol. 28, no. 1, pp. 36-51.

Favre, L & Galeano, J 2002, 'Mean-Modified Value-at-Risk Optimization with Hedge Funds', *Journal of Alternative Investments,* vol. 6, pp. 21-25.

Hendricks, D, 1996, 'Evaluating VaR models using historical data', *Federal Reserve Bank of New York Economic Policy Review,* vol. 2, pp. 40-69.

Huang, S, Chien, Y & Wang, R 2011, 'Applying GARCH-EVT-Copula Models for Portfolio Value at R on G7 Currency Markets', *International Research Journal of Finance and Economics,* Issue 74, pp. 136-151.

Jorian, P 1996, 'Risk and turnover in the foreign exchange market', in Frankel, JA, Galli, G, and Giovanni, A. (eds), *The Microstructure of Foreign Exchange Markets,* the University of Chicago Press, Chicago, IL.

Jaworski, P 2008, 'Bounds for Value at Risk – The Approach Based on Copulas with Homogeneous Tails', *Mathware and Soft Computing,* Issue 15, pp. 113-124.

Kim, SJ, Ryu D 2015, 'Are the KOSPI 200 implied volatilities useful in value-at-risk models', *Emerging Markets Review,* vol. 22, pp. 43-64.

Khazeh, K & Winder, R 2010, 'An Inter-Temporal Comparison of Transaction Exposure and Value at Risk', *The Journal of Current Research in Global Business,* vol. 13, no. 20, pp. 15-25.

Khazeh, K, Winder, R, Arvi, L 2014, 'A Comparison of Value-at-Risk approaches for multi-national enterprises', *International Review of Business Research Papers,* vol. 5, no.1, pp. 25-38.

Khazeh, K, Winder, R & Salimian, F 2013, 'Assessing Transaction Exposure Utilizing Value at Risk: The Holding Period Effect', *The Journal of Current Research in Global Business,* vol. 16, no. 25, pp. 50-63.

Khazeh, K, Winder, R & Salimian, F 2011, 'Measuring Transaction Exposure Using Value at Risk: Lexicographic Permutation of a Five-Currency Portfolio', *Journal of Business and Behavior Sciences,* vol. 23, no. 3, pp. 35-43.

Lin, CH, Kao, TC 2008, 'Multiple structural changes in the tail behaviour: evidence from stock index futures returns', *Nonlinear Analysis: Real World Applications,* vol. 9, pp. 1702-1713.

Lu, X, Kawai, K & Maekawa, K 2010, 'Estimating Bi-variate Garch-Jump Models Based on High Frequency Data: The Case of Revaluation of the Chinese Yuan in July 2005', *Asia-Pacific Journal of Operational Research*, vol. 27, no. 2, pp. 287-301.

Mabrouk, S & Chaker, A 2011, 'GARCH-class Models Estimations and Value-at-Risk Analysis for Exchange Rate', *International Journal of Monetary Economics and Finance,* vol. 4, no. 3, pp. 254-278.

Natarajan, K, Pachamanova, D, Sim, M 2008, 'Incorporating Asymmetric Distributional Information in Robust Value-at-Risk Optimization', *Management Science,* vol. 54, no. 3, pp. 573-585.

Pant, V & Chang, W 2001, 'An Empirical Comparison of Methods for Incorporating Fat Tails Into Value-at-Risk Models', *Journal of Risk,* vol. 3, no. 2, pp. 99-119.

Sirr, G, Garvey, J, Gallagher L 2011, 'Emerging markets and portfolio foreign exchange risk: An empirical investigation using a value-at-risk decomposition technique', *Journal of International Money and Finance,* vol. 30, pp. 1739 -1777.

Su, J & Hung, J 2011, 'Empirical Analysis of Jump Dynamics, Heavy Tails and Skewness on Value-at-Risk Estimation', *Economic Modelling,* vol. 28, no. 3, p. 1117.

Wong, W 2009, 'Backtesting the Tail Risk of VaR in Holding U.S. Dollars', *Applied Financial Economics,* vol. 19, no. 4, pp. 327-337.