# MEASURING TRANSACTION EXPOSURE USING VALUE AT RISK: LEXICOGRAPHIC PERMUTATION OF A FIVE-CURRENCY PORTFOLIO

Khazeh, Kashi
Perdue School of Business, Salisbury University,

Winder, Robert C.
Luter School of Business, Christopher Newport University

Salimian, Fatollah
Perdue School of Business, Salisbury University

***ABSTRACT***

*This research paper employs the "value at risk" model to measure transaction exposure for an MNC transacting business in five specific foreign currencies. The values at risk for each currency and for every additional-currency portfolio are computed. The results for the different permutation are then compared and shown, in alphabetical as well as reverse alphabetical, to assess the consistency of the value at risk approach to measuring transaction exposure. It is found that variability in both the standard deviations of the individual exchange rates and their covariance can result, initially, in significantly different estimates of value at risk, even over relatively short periods of time.*

## INTRODUCTION AND OVERVIEW

In today's integrated global economy, different national currencies must be exchanged to conduct global business. During the era of fixed exchange rates (i.e., prior to March of 1973), the task of exchanging currencies and the level of risk associated with the prices of currencies were not of great consequence. However, over the last thirty-seven years, the system of floating exchanges rate has made the task of conducting global business a challenging one.

Multinational corporations (MNC's) operate globally by importing raw materials from some countries and then exporting the finished product around the world. Additionally, they not only produce component parts in other countries, but they also engage in manufacturing and/or assembling the final product in several countries to be marketed around the world.

With the abandonment of gold as the backbone of U.S. dollar in early 1973, and the subsequent depreciation of the dollar, the high volatility of exchange rates in the foreign exchange market has become the norm. By 1985 (just twelve years after the advent of flexible exchange rates), the level of daily foreign exchange transactions was close to $50 trillion a year (or, around .14 trillion a day). Ten years later (in 1995), the level of daily foreign exchange transactions was close to $360 trillion a year (around .99 or nearly one trillion a day). By 2006, just several years into the new millennium, the level of foreign exchange transactions surpassed $2 trillion a day. On September 1, 2010 the level of foreign exchange transactions reached/surpassed $4 trillion.

The extraordinary size of these transactions originates from several sources. The key players include the firms who engage in international trade (either importing or exporting) as well as those who participate in either foreign direct investment and/or indirect foreign investment (portfolio investment). Additionally, speculators play a key role and it is they who are primarily responsible for both the extraordinary volume of trades and the volatility in the foreign exchange markets. Ultimately, it is the volatility in exchange rates that makes this market a very risky environment for the MNC's.

MNC's face three types of exchange rate risk: 1) transaction risk; 2) economic risk; and 3) translation risk. It is the transaction exposure, generally, that is of paramount importance. Accordingly, MNC's engage in variety of hedging techniques to either reduce and/or eliminate their exposure to exchange rate risk. Conversely, an unintended consequence of hedging is that the potential benefits (of not hedging) are eliminated. Consequently, MNC's must decide if hedging is warranted. If it is, then, necessarily, they must decide which techniques to employ!

One popular approach to assessing transaction exposure is the Value-At-Risk (VAR) technique. The VAR methodology can be employed to assess the maximum likely loss on the value of the MNC's net cash flows denominated in one or more foreign currencies for a given time period. The desired time period can vary from as short as 1-day to as long as 1-week or 1-month (or even longer). The estimates of the maximum loss can then be used to assess if hedging is desirable.

In general, the transaction risk (i.e., the maximum loss) associated with net cash flows denominated in one particular foreign currency depends on the standard deviation in the percentages change in the particular exchange rate, the desired confidence level and the level of the net cash flow itself. Based on standard portfolio theory, the transaction risk (i.e., the maximum loss) for a portfolio of currencies is a function of the proportions of the total portfolio in each currency, the standard deviations of the percentage changes in each exchange rate, the correlation coefficients of the percentage changes of the relevant exchange rates, the desired confidence level and the (dollar) values of the net cash flows. [In this analysis, the net cash flows for each portfolio of currencies are assumed to be evenly split between each currency.] In both cases, above, if the value of the exchange rate (or exchanges rates) is expected to change over the relevant time period, this change is included in the value at risk calculation.

More specifically, the maximum 1-day loss for an individual currency "i" or for a portfolio of currencies can be estimated using the following equation: $E(e_t) - (1.65 \text{ X } \sigma_{i \text{ or } p})$, where

1. The expected percentage change in the currency's value for the relevant period = $E(e_t)$
2. The Z-score corresponding to the desired confidence level used (i.e., 95%, 97.5%,…) in this case at 95% = 1.65
3. The standard deviation of the percentage change in the currency's or portfolio of currencies value over previous period = $\sigma_{i \text{ or } p}$

Overall, a portfolio of currencies whose values are highly unpredictable vis-à-vis the U.S. dollar (i.e., the standard deviations in percentages changes in the dollar exchange rates are high) will have a high level of

transaction risk, ceteris paribus. Portfolios of currencies that have positive high correlation coefficients will also face more "value at risk," other things equal. By contrast, portfolios of currencies that have low (or even negative) correlation coefficients will have less value at risk due to internal (or natural) diversification effects.

This article employs the "value at risk" methodology to measure the transaction exposure for a hypothetical MNC transacting business in five specific foreign currencies (i.e., each vis-à-vis the U.S. dollar). The results provide potentially critical information informing the MNC's decision as to whether or not hedging is desirable. The five foreign currencies included in this analysis are the Canadian dollar, the Swiss franc, the Euro, the British pound, and the Japanese yen (i.e., valued in U.S. dollars). The time period February 12, 2007 through March 23, 2007 was randomly selected to form the basis for this study. This time period includes thirty consecutive daily observations on the relevant spot exchange rates.

To explore the relative risks of particular combinations of currencies (i.e., in the MNC's "portfolio" of currencies), and, even more importantly, to explore the extent of risk reduction resulting from the inclusion of additional currencies (i.e., adding additional currencies to the portfolio of currencies), the MNC's VAR is calculated under a variety of permutations.

## RELATED LITERATURE

Linsmeier and Pearson [11] provide an excellent overview of the advantages and disadvantages of the most popular approaches to estimating value at risk. Al Janabi [1] provides an excellent primer on the delta normal method. The following articles provide good overviews of VAR methodology or empirical tests: Carrada-Bravo, Hosseini, and Fernandez [4], Tardivo [14], Angelidis and Degiannakis [2], and Chong [5]. The article by Kimball [10] provides an excellent perspective as to why corporations may be prone to miscalculate risk. Platt [13] provides an excellent discussion of the increased use of value at risk resulting from globalization.

While the value at risk methodology is widely employed, there are potential shortcomings. One of these shortcomings is the possibility that the assumption the variable (or variables) in question is normally distributed is incorrect. Articles that explore the implications of nonnormal distributions, including fat tails and how to employ VAR in these cases include Bekiros and Georgoutsos [3], Novak, Dalla, and Giraitis [12], Ferreira [6], and Kaut, Vladimirou, Wallace, and Zenios [7].

This article is an extension of the authors' previous work. See Khazeh and Winder [8] and Khazeh and Winder [9].

## EMPIRICAL FINDINGS AND DISCUSSION

Table 1, below, indicates the correlation coefficients between the percentage changes in the five exchange rates for the time period being evaluated.

**TABLE 1**

| | CAD | CHF | GBP | EUR | JPY |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| CAD | 1 | | | | |
| CHF | -0.3219 | 1 | | | |
| GBP | 0.789634 | -0.04265 | 1 | | |
| EUR | 0.228513 | 0.771996 | 0.378116 | 1 | |
| JPY | -0.19294 | 0.448259 | 0.043088 | 0.27463 | 1 |

Based on the correlation coefficients (above) and the standard deviations of the percentage changes (not shown), Table 2 (below) indicates the maximum one-day loss for multiple currency exposures (i.e., as a percent of the MNC's net cash flows denominated in these currencies) at the 95-percent confidence level. The foreign currencies (i.e., vis-à-vis the U.S. dollar) were added alphabetically (i.e., from A to Z) based on each currency's symbol: CAD (Canadian Dollar), CHF (Swiss Franc), EUR (Euro), GBP (British Pound), and JPY (Japanese Yen). Of course, these risk profiles can vary based on the order of entry. Accordingly, Table 2 also shows the maximum one day loss when the currencies were added in the reverse order (i.e., from Z to A).

As can be seen from Table 2, in both cases the value at risk is reduced as the number of currencies in the portfolio expands. Of course, by the time each of the five currencies is included in the portfolio, the values at risk coincide regardless of the order of entry. One can also observe that the reduction in risk that results from additional currencies diminishes as the number of currencies in the portfolio expands.

Interesting, when the currencies are entered in reverse alphabetical order (i.e., from Z to A, that is, beginning with the Japanese yen), the value at risk starts at a much higher level and remains noticeably higher until the third and fourth currencies are added. The implication of this is clear: net cash flows denominated in Japanese yen created far more value at risk either individually, or when part of a portfolio, than the other currencies considered. While this elevated risk is reduced through diversification, its effect does not quickly or easily disappear.

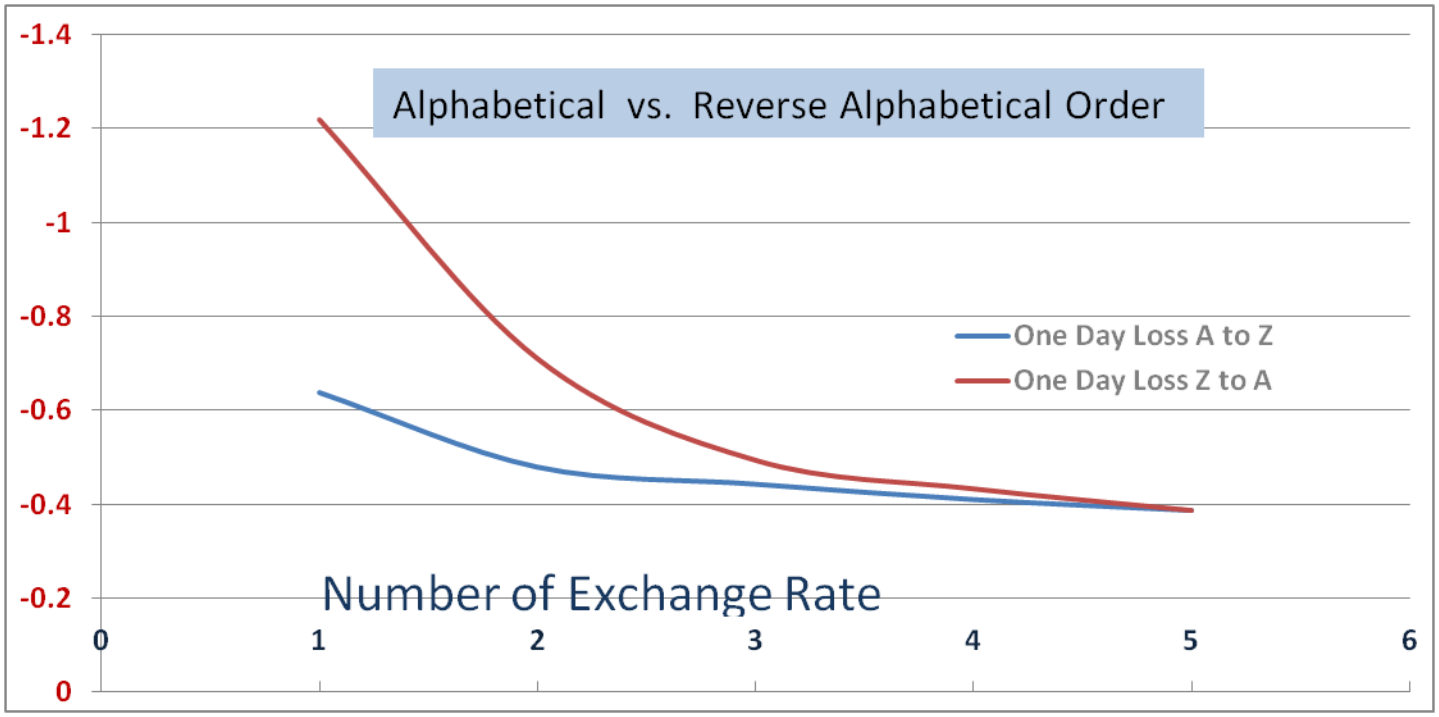
**TABLE 2**

| Number of ER | One Day Loss A to Z | One Day Loss Z to A |
|---|---|---|
| 1 ER | -0.638213339 | -1.220244709 |
| 2 ER | -0.480333794 | -0.711566805 |
| 3 ER | -0.444088183 | -0.495248256 |
| 4 ER | -0.41142049 | -0.434486831 |
| 5 ER | -0.388333251 | -0.388333251 |

The above computations were made based on a moving 15-day average of the standard deviations for each currency. This approach insures that the most recent information is used to determine the maximum likely loss. In addition, it is assumed in each case that the net cash flows denominated in the various currencies are equally weighted

Figure 1, below, is a visual representation of the data contained in Table 2. One can easily observe that the risk profiles associated with two different orders of entry differ significantly. Specifically, by combining the currencies in the first order (i.e., from A to Z, beginning with the Canadian dollar) the maximum one-day loss begins at a relatively low level and declines at a relatively modest rate. By contrast, when the currencies are added to the portfolio in the reverse order (i.e., from Z to A, beginning with the Japanese yen), the maximum one-day loss begins at a relatively higher level but then declines at a much faster rate.

**FIGURE 1**




The results shown above reveal the key relationships that form the foundation of the value at risk calculations as well the relevant portfolio theory. However, the rate at which transaction exposure is mitigated as the number of currencies increases may depend on the particular combinations of currencies. In this particular study, the standard deviations in the percentage changes of the individual exchange rates, as well as the correlation coefficients between the percentage changes in the exchange rates, differed sufficiently to have a meaningful impact on the value at risk calculations.

## FUTURE RESEARCH

Future research could evaluate alternative permutations of these same currencies. Additional time periods could also be evaluated to assess the stability of the relationships over time. These future results could also provide key insight and guidance for MNC's in their decisions for managing transaction risk.

## REFERENCES

Al Janabi, M. A. M. "Foreign Exchange Trading Risk Management with Value at Risk: Case Analysis of the Moroccan Market." *The Journal of Risk Finance*, 2006, 7(3), 273-291.

Angelidis, T. and Degiannakis, S. "Modelling Risk for Long and Short Trading Positions." *The Journal of Risk Finance*, 2005, 6(3), 226-238.

Bekiros, S. D. and Georgoutsos, D. A. "Extreme Returns and the Contagion Effect between the Foreign Exchange and Stock Market: Evidence from Cyprus." *Applied Financial Economics*, 2008, 18(3), 239-254.

Carrada-Bravo, F., Hosseini, H. K. and Fernandez, L. "Currency Risk Management: Simulating the Canadian Dollar." *International Journal of Managerial Finance*, 2006, 2(1), 77-89.

Chong, J. "Value at Risk from Econometric Models and Implied from Currency Options." *Journal of Forecasting*, 2004, 23(8), 603-620.

Ferreira, M. "Evaluating Interest Rate Covariance Models within a Value at Risk Framework." Journal of Financial Econometrics, 2005, 3(1), 126-168.

Kaut, M., Vladimirou, H., Wallace, W. and Zenios, S. "Stability Analysis of Portfolio Management with Conditional Value at Risk." *Quantitative Finance*, 2007, 7(4), 397-409.

Khazeh, K., and Winder, R., "Measuring Transaction Exposure Using Value at Risk: A Comparison of Two Different Time Periods," presented at the Annual Meeting of the Association for Global Business, Newport Beach, California, November 20-22, 2008.

Khazeh, K. and Winder, R., "Transaction Exposure and Value at Risk: A Practical Application for MNCs," presented at the Annual Meeting of the Southeast Institute for Operations Research and Management Sciences, Myrtle Beach, South Carolina, October 3-4, 2008.

Kimball, R., "Failures in Risk Management," *New England Economic Review*, 2000, Jan/Feb, 3-12.

Linsmeier, T., and Pearson, N., "Value at Risk," *Financial Analysts Journal*, 2000, 56(2), 47-67.

Novak, S. Y., Dalla, V. and Giraitis, L. "Evaluating Currency Risk in Emerging Markets." *Acta Applicandae Mathematicae*, 2007, 97(1), 163-173.

Platt, G. "Increased Volatility in Exchange Rates Spurs Adoption of Best Practices in Currency-Risk Management." *Global Finance*, 2007, 21(5), 72-75.

Tardivo, G. "Value at Risk: the New Benchmark for Managing Market Risk." *Journal of Financial Management and Analysis*, 2002, 15(1), 16-26.