



## ***CEME Fellows Research Briefing Series — Volume 1, Issue 2***

### **FX-Adjusted Local Currency Spreads**

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#### **I. INTRODUCTION**

The trend and volatility of the exchange rate as well as the operating environment of domestic firms are affected by changes in domestic and international economic conditions. As a result, in the case of local currency denominated loans or fixed income instruments, the premium associated with exchange rate changes, or currency risk premium, and that associated with default risk, or default risk premium, are not independent from each other. A common practice, however, is to consider credit risk and market risk, in this case currency risk, as independent sources of risk and to simply add the corresponding premia. This practice, that overstates the risk premium that should be charged to the issuer, is partly supported by risk management practices and regulations that require adding up economic capital charges for credit risk and market risk separately.

This paper attempts to improve current practice by proposing a simple rule of thumb, based on the joint dynamics of exchange rate changes and the spreads of credit default swaps, to determine the level of local currency spreads consistent with foreign currency credit spreads adjusting for foreign exchange effects. The rule of thumb proposed here could be useful to those engaged in pricing and investing in local currency-denominated instruments, as well as those interested in arbitraging price spread differentials between foreign currency and local currency-denominated instruments. Before presenting the rule of thumb in detail, I discuss the building blocks for determining local currency spreads.

#### **II. LOCAL CURRENCY SPREADS: BUILDING BLOCKS AND INTUITION**

From the standpoint of a foreign investor, the risk premium demanded for holding a naked long position in local currency-denominated loans and/or fixed income securities comprises two major components: a default risk premium and a currency risk premium. The default risk premium is associated with the event that the borrower may fail to repay its debt obligations and reflects the loss given default experienced by the lender. This loss depends on the exposure at default, the recovery rate, and the probability of default of the borrower. The currency risk premium is associated with future exchange rate changes as the position records profits or losses depending on the differences between the forward rate locked into the contract and the realized exchange rate.

The risk premium, in addition, depends on two other sources of risk: convertibility risk and transfer risk. Convertibility risk is associated with the possibility that, upon receipt of the payment, the lender may not be able to convert the payment to foreign currency. Transfer risk is associated

with the possibility that payments cannot be sent out of the country mainly due to capital account restrictions.

Rather than attempting to model convertibility and transfer risks separately, one common practice in industry is to embed the premia associated to these two sources of risk into the default risk premium. Specifically, the default risk premium can be decomposed into a systematic component and an idiosyncratic, issuer-specific component. This decomposition is consistent with the one-factor default risk model introduced by Vacisek [1987] and the one-factor Gaussian copula introduced by Li [2000]. As stated by Li, the intuition behind the one-factor Gaussian copula is that the default rate of a group of issuers is dependent on business cycle conditions.

Even though the systematic risk factor, or common factor, is an unobserved latent factor in the models of Vacisek and Li, it can be identified as macroeconomic risk, or macro risk. Arguably, convertibility risk and transfer risk are highly correlated with macro risk: as the macroeconomic risk of a country increases, the more likely the country will impose capital controls and convertibility restrictions to avoid a balance-of-payments crisis. This observation justifies bundling together convertibility and transfer risk into macro risk.

The discussion above can be summarized succinctly in two equations. When measured in foreign currency, the risk premium of the issuer is priced as a spread over the risk-free or funding costs of the lender:

$$(1) \quad \text{Foreign currency spread} = \text{macro spread} + \text{idiosyncratic spread.} \\ = \text{issuer spread (in foreign currency)}$$

When measured in local currency, the total spread of the issuer is the sum of the issuer spread, in local currency, plus a currency spread:

$$(2) \quad \text{Local currency total spread} = \text{issuer spread (in local currency)} + \text{currency spread.}$$

What remains to be determined are the currency spread and how to convert the issuer spread in foreign currency to an issuer spread in local currency. In regards to the currency spread, or domestic-foreign interest rate differential, it can be determined from covered interest rate parity when there are liquid currency forwards and swaps markets:

$$(3) \quad r_{D,t} - r_{F,t} = f_{0,t} - s_0,$$

where  $r_{D,t}$  and  $r_{F,t}$  are the  $t$ -periods ahead domestic and foreign risk-free interest rates,  $f_{0,t}$  is the  $t$ -periods ahead forward exchange rate, and  $s_0$  is the spot rate. Both the forward and spot rates are measured in units of local currency per foreign currency.

In some instances currency swaps and forwards may not be available but secondary markets for local currency-denominated government bonds may exist. The yields of the local currency instruments could serve as proxies for determining the domestic-foreign interest rate differential directly.<sup>2</sup> When market references are not available, practitioners can use joint econometric models of the exchange rate and the forward premium to construct a synthetic reference yield curve.<sup>3</sup> The estimation of the issuer spread in local currency is straight forward once a local currency yield curve is available by applying cross-currency swap valuation techniques, i.e. i.e. discounting the cash flows with the discount factors in each currency and ensuring that it is a zero-value transaction at inception.

What is important in this step is to decide what fraction of currency spread should be added to the local currency issuer spread to avoid double counting if the currency risk and the macro risk are not independent. A conservative approach is to assume both sources of risk are independent and to add 100 percent of the currency spread but this may overstate the total risk premium. The correct way to adjust for the dependence between the default risk of the issuer and the currency risk is to incorporate foreign exchange effects in otherwise standard default models. Some of these models are reviewed next. Because calibrating the models to real applications could be relatively difficult due to the lack of data, the paper then presents a quick-and-dirty way to determine what fraction of the foreign currency spread should be converted to local currency.<sup>4</sup>

### **III. THE CORRECT WAY TO ADJUST DEFAULT RISK FOR FOREIGN EXCHANGE EFFECTS**

The literature and availability of default risk models have witnessed an explosive growth driven partly by the rapid expansion of the credit derivatives market since the early 2000s. Default risk models can be divided into two main categories, structural models and reduced form models. Structural models link the analysis of the capital structure of the issuer to option pricing theory. Under absolute priority rules, equity shareholders are residual claimants on the assets of the firm since bondholders are paid first. Thus, equity shareholders are holding a call option on the assets of the firm, where the strike price is equal to the debt owed to bondholders. Similarly, the value of the debt owed by the firm is equivalent to a default-free bond plus a short position on a put option on the assets of the firm.

Warnes and Acosta [2002], Chan-Lau and Santos [2006] and Tasche [2007] are examples of structural default models that attempt to incorporate currency risk into structural models of default risk. Warnes and Acosta extend the Merton [1974] model to incorporate foreign currency-denominated debt, and under the assumption of constant interest rates, find closed-form solutions for debt prices. Chan-Lau and Santos [2006] propose a number of default-at-maturity and first-time passage models that allow a mix of foreign and domestic currency liabilities and different assumptions on the stochastic process governing the dynamics of the exchange rate. Tasche [2007] extends the Merton model to incorporate currency risk by combining it with the foreign exchange option pricing of Garman and Kohlhagen [1983], and also address the issue of asset correlation among different issuers by incorporating elements from the model of Vacisek [2002].

In reduced form models, also known as intensity-based models and first introduced by Jarrow and Turnbull [1995] and Duffie and Singleton [1997], the time of default is determined by an exogenous stochastic process. The default event is not linked to any observable characteristic of the firm analyzed, which raises questions on how to identify the drivers of default risk in these models. Along this line of work, Ehlers and Schonbucher [2007] introduced an affine-jump diffusion default risk model where there exists correlation between the default intensity and the exchange rate, and where the exchange rate is allowed to jump.

### **IV. THE QUICK-AND-DIRTY WAY TO ADJUST DEFAULT RISK FOR FOREIGN EXCHANGE EFFECTS**

*The nonlinear relationship between currency risk and macro risk*

One common characteristic of the models described in the previous section is that their calibration is rather complex and long time series data are needed. Another common feature of these models is that there is a linear dependence between default rates and the exchange rate, modeled by assuming that the diffusions are correlated.

Assuming that default rates and exchange rates are linearly dependent appears at odds with the empirical evidence collected on foreign exchange market microstructure studies. At the risk of oversimplification, exchange rate determinants are classified broadly into two categories: fundamental factors and technical factors. Business cycle and economic indicators fall into the first category. Technical trading rules and order flow indicators fall into the second category.<sup>5</sup>

Fundamental variables account for very little of the observed variation in exchange rates for developed countries' currencies over short-time horizons up to one year.<sup>6</sup> Dealers' order flows rather than economic fundamentals are the dominant drivers of exchange rates [Lyons, 2001]. While order flows may aggregate investors' information about the fundamental drivers of the exchange rate, they also reflect technical effects such as bandwagon effects due to the extrapolative expectations of investors in the short-run [Rosenberg, 2003].

DeGrauwe [1996] points out that the fundamental-based value of a currency cannot be known with certainty. Therefore, when the exchange rate is within certain range roughly consistent with fundamentals, or within a “band of agnosticism,” technical factors are the main drivers of exchange rate movements. When macro risk is low there is not much uncertainty about the fundamentals so the “band of agnosticism” is relatively stable, currency risk and macro risk are relatively independent from each other.

Whenever the exchange rate moves outside the band of agnosticism fundamentals-based investors have an incentive to take positions in the market. But taking positions is costly since it is difficult to assess how long it will take for the exchange rate to converge to its fundamentals-based value.<sup>7</sup> Such position taking, however, becomes less risky the greater the divergence is between the exchange rate and its fundamentals-based value, a situation typically display by countries vulnerable to a balance-of-payment crisis. As a result, when economic fundamentals are undergoing rapid deterioration they play a bigger role on exchange rate movements. Macro risk and currency risk, then, become highly dependent on each other.

Since the default risk of an issuer has been decomposed into a systematic component, macro risk, driven by fundamentals, and an idiosyncratic component, it follows that the non-linear relationship between macro risk and currency risk translates into a similar relationship between default risk and currency risk at the issuer level.

#### *A Variance Decomposition-Based Rule of Thumb*

In summary, the nonlinear dependence between macro risk, a major component of default risk, and currency risk, suggests that adjusting default risk (spreads) for foreign exchange effects needs to account for the level of macro risk. The rule of thumb proposed here captures this nonlinear dependence.

The rule builds upon a variance decomposition of a bivariate vector autoregression that includes as endogenous variables exchange rate and macro risk percentage changes. The variance decomposition permits assessing what percentage of the exchange rate variance is explained by changes in macro risk. When we perform the variance decomposition on a sample of emerging market countries, a simple relationship that relates the fraction of exchange rate variance explained by macro risk to the level of macro risk emerges.

The monthly data used in the analysis covers the period October 2000 – November 2007. Mid-quotes for 5-year credit default swap (CDS) contracts and exchange rates were obtained from Bloomberg LP. CDSs are proxies for macro risk or sovereign default risk. The countries included in the analysis are Argentina, Brazil, Chile, Colombia, Mexico and Peru in Latin America, Indonesia, South Korea, Malaysia, the Philippines and Thailand in Asia, and Bulgaria, Kazakhstan, Pakistan, Qatar, South Africa, and Turkey in Eastern Europe and Middle East region.

The percentage of the variance in exchange rates explained by changes in macro risk (CDS spreads) is determined using the long-run variance decomposition proposed by Hasbrouck [1991a,b]. Specifically, given the vector of  $n$  endogenous variables,  $Y_t=(y_{1t}, y_{2t}, \dots, y_{nt})'$ , the corresponding unrestricted VAR system of order  $p$  is:

$$(3) \quad Y_t = c + \Phi_1 Y_{t-1} + \dots + \Phi_p Y_{t-p} + \varepsilon_t,$$

where  $c$  is a  $n$ -vector of constant terms,  $\Phi_i$  ( $i=1, \dots, p$ ) are  $n$ -by- $n$  coefficient matrices, and  $\varepsilon_t$  is a vector of uncorrelated, independent and identically distributed error terms. The error terms are also serially uncorrelated. Under certain technical conditions,<sup>8</sup> the vector autoregression system in equation (1) could be represented by the following vector moving average representation (VMA):

$$(4) \quad \begin{bmatrix} y_{1t} \\ \vdots \\ y_{it} \\ \vdots \\ y_{nt} \end{bmatrix} = \begin{bmatrix} \psi_{11}(L) & \dots & \psi_{1i}(L) & \dots & \psi_{1n}(L) \\ \vdots & & \vdots & & \vdots \\ \psi_{i1}(L) & \dots & \psi_{ii}(L) & \dots & \psi_{in}(L) \\ \vdots & & \vdots & & \vdots \\ \psi_{n1}(L) & \dots & \psi_{ni}(L) & \dots & \psi_{nn}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{it} \\ \vdots \\ \varepsilon_{nt} \end{bmatrix},$$

$$\psi_{ij} = \sum_{k=1}^{\infty} \psi_{ij}^k L^k$$

where  $\psi_{ij}^k$ ,  $i, j=1, \dots, n$  are lag operators.

The coefficient  $\psi_{ij}^k$  measures the effect  $k$  periods ahead of a unit shock or innovation to variable  $y_j$  on variable  $y_i$ . Therefore, the long-term cumulative impact of variable  $y_j$  on variable  $y_i$  can be measured by adding up the coefficients associated with the lag operator  $\psi_{ij}(L)$ :

$$(5) \quad \sum_{k=0}^{\infty} \psi_{ij}^k = \text{information of } y_j \text{ on } y_i.$$

Equation (5) suggests one way to quantify the overall importance of innovations to variable  $y_j$  for explaining subsequent realizations of variable  $y_i$  vis-à-vis the other endogenous variables. Specifically, the overall importance of variable  $y_j$  is related to the relative share of the variance of variable  $y_j$  it explains:

$$(6) \quad \frac{\left( \sum_{k=0}^{\infty} \psi_{ij}^k \right)^2 \sigma_{\varepsilon_j}^2}{\sum_{m=1}^n \left( \sum_{k=0}^{\infty} \psi_{im}^k \right)^2 \sigma_{\varepsilon_m}^2}$$

where  $\sigma_{\varepsilon_j}^2$  is the variance of the innovation to variable  $y_j$ . Note that the VAR framework does not choose a particular ordering of the variables entering equation (1), and hence it is a statistical description of the dynamic inter-relations between the variables analyzed.<sup>9</sup>

Exhibit 1 presents the results per country and per region, together with some descriptive statistics of the CDS spreads per country. The percentage of the exchange rate variance explained by the CDS spreads (or macro risk) appears to be a function of the level of the spreads rather than the standard deviation, or the coefficient of variation (the ratio of the standard deviation to the mean).

Exhibit 2 captures the relationship between currency risk and macro risk graphically. If Turkey is excluded from the analysis, the non-linear relationship between macro risk and currency risk is evident from the figure. At low levels of macro risk, factors other than those affecting macro and sovereign risk explain most of the variance of the exchange rate. Interestingly, three of the countries where macro risk and currency risk appear to be independent of each other, Chile, Malaysia, and Thailand, were rated investment grade by Fitch Ratings during the sample period, and a fourth one, Mexico, was upgraded to investment grade in early 2002.

Similarly, when macro risk is high, it explains most of the exchange rate variance. In this case, adding up the default risk and the currency risk will overstate the risk charged to the issuer. The countries where macro risk and currency risk appear to be coupled are those that have been rated below-investment grade by Fitch Ratings during most of the sample period. One exception is Bulgaria that was upgraded to investment grade in mid-2004. Turkey is a notable exception: although macro risk is substantially high, the currency risk appears decoupled from it.

For practical purposes, Exhibit 2 also suggests the following rule-of-thumb for determining what fraction of the currency risk should be added to an issuer’s default risk:

$$(7) \quad \begin{array}{l} \text{Percentage of} \\ \text{currency risk} \\ \text{to be added to} \\ \text{default risk} \end{array} = \begin{cases} 100 - \frac{5\text{-year CDS spread}}{3.50} & \text{if 5-year CDS spread} < 350 \text{ bps} \\ 0 & \text{if 5-year CDS spread} > 350 \text{ bps} \end{cases}$$

In contrast to the relatively sophisticated models reviewed in section 3, Equation (7) provides a simple way to adjust default spreads for foreign exchange effects. Therefore, given the default risk of the borrower in foreign currency, information on the sovereign risk of the home country of the borrower and the local currency yield curve, investors and lenders can determine the proper spread of a local currency loan or bond. The procedure for doing so is exactly the same one explained in section 2 above but replacing equation (2) with equation (2') below:

$$(2') \quad \text{Local currency total spread} = \text{issuer spread (in local currency)} + \text{adjusted currency spread}$$

## V. CONCLUSIONS

Changes in domestic and international economic conditions affect the default risk of a firm. These changes, in turn, affect the exchange rate of the home country of the firm. As a result, if the firm borrows in local currency, the total risk compensation received by investors should factor in both default risk and currency risk. But these two sources of risk are not completely independent, so adding them up may be too conservative in some instances.

From a theoretical point of view, the “correct” way to address this problem is to adapt default risk models, either of the structural or reduced form type, to incorporate default risk. But the calibration of these models could be relatively difficult given their data requirements. Furthermore, the models need to incorporate the fact that the dependence between default risk and currency risk, which works through the systematic risk component of default risk, is nonlinear.

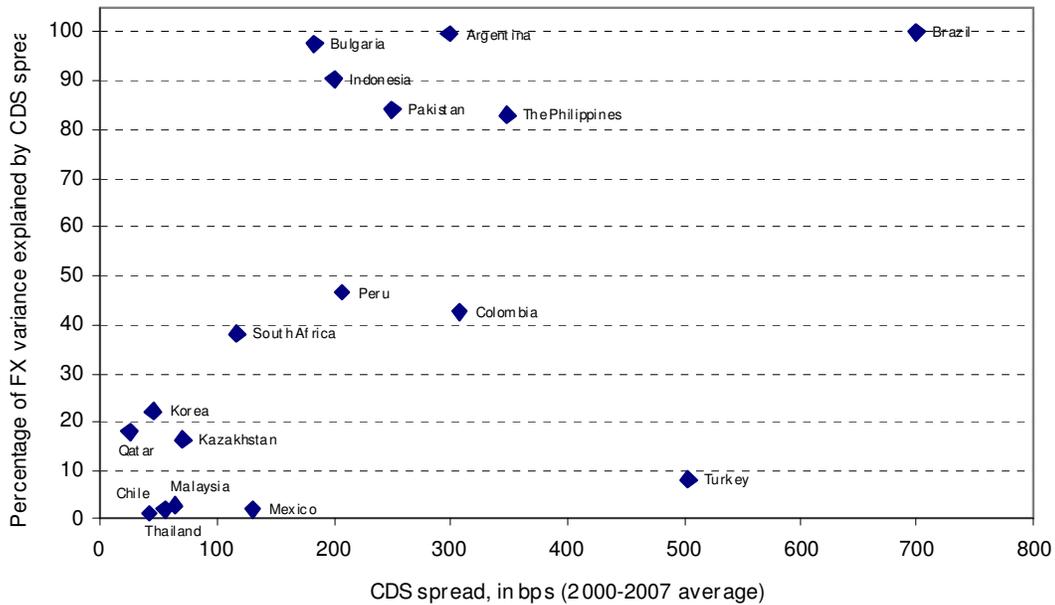
In order to address practitioner needs, this paper presents a simple rule of thumb, based on the joint dynamics of exchange rate changes and the spreads of credit default swaps, to convert foreign-currency denominated spreads to local currency-denominated spreads. The rule of thumb, while simple, captures the nonlinear dependence between default risk and currency risk, and could be very useful for investors interested in taking local currency positions or arbitraging the spreads between foreign currency and local currency-denominated spreads.

**Exhibit 1. Exchange rate variance explained by CDS spreads (in percent)**

	CDS spreads (in bps)				Exchange rate variance explained by CDS spreads (in percent)
	Mean	Minimum	Maximum	Standard deviation	
Latin America					
Argentina	300	193	476	82	99.8
Brazil	700	62	3790	813	100.0
Chile	42	13	160	38	1.4
Colombia	309	77	805	189	42.4
Mexico	132	28	392	90	1.9
Peru	207	62	571	117	46.4
Asia					
Indonesia	201	99	367	74	90.4
Korea	46	14	163	27	22.1
Malaysia	64	13	180	54	3.0
The Philippines	349	101	618	151	82.9
Thailand	57	27	150	37	2.0
EMEA					
Bulgaria	185	13	698	187	97.5
Kazakhstan	71	35	208	29	16.2
Pakistan	250	138	416	80	84.0
Qatar	26	11	39	10	17.8
South Africa	117	25	255	67	37.8
Turkey	503	123	1281	331	8.3

Source: Bloomberg LP and author's calculations.

Exhibit 2. Exchange Rate Variance Explained by Changes in CDS Spreads vs. Sovereign CDS Spreads Levels (in percent)



#### AUTHOR BIOGRAPHY

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## ENDNOTES

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<sup>2</sup> It should be bear in mind, however, that from a funding perspective, the reference rates should correspond to the funding rates in domestic and foreign currency of the institution conducting the trade. For example, the funding rates for a U.S.-based AA-rated international bank should be the U.S. Libor and the domestic interbank lending rate. The latter may not necessarily coincide with the yield of local currency government bonds.

<sup>3</sup> For the sake of conciseness, the forward premium is not discussed here. See Engel (1996), Chinn (2007) and references therein for a comprehensive discussion.

<sup>4</sup> Jiang, Jones, Halkett, and Orlandi (2008) is a recent paper that also introduces a simple way to adjust for the correlation between currency and credit risk.

<sup>5</sup> The reader should keep in the background that the default risk of an issuer has been decomposed into a systematic component, macro risk, that is driven by fundamentals, and an idiosyncratic component. The non-linear relationship between macro risk and currency risk then translates into a similar relationship between default risk and currency risk.

<sup>6</sup> See Evans (2008) and references therein.

<sup>7</sup> See Shleifer and Vishny (1997) for an intuitive explanation on why it is difficult to arbitrage price deviations from fundamentals.

<sup>8</sup> Hamilton (1994).

<sup>9</sup> While a structural VAR may offer some advantages for interpreting the data, it requires specifying *a priori* a causal ordering of the variables which we do not deem appropriate for this study given that there is little justification for imposing a particular ordering.

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