Emerging Markets Risk Model: G4-Denominated Fixed Income Securities

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This paper describes the new risk model for G4-denominated emerging markets' fixed income securities in POINT. It illustrates some applications of the model and discusses its main building blocks and general methodology. We detail the integration with local currency models and with other asset classes available in our Global Risk Model. The model is a significant improvement over the current methodology and part of our effort to develop a new generation of risk models that provide more responsive conditional risk forecasts. It performs well out-of-sample and is fully integrated with all other components and functionalities of POINT (e.g., the optimizer). It can therefore be a powerful tool for portfolio managers.

Introduction[1]

The Barclays Capital Global Risk Model allows a portfolio manager to quantify the expected volatility of performance deviation ("tracking error volatility") between a portfolio and a benchmark, as well as the severity of extreme events ("tail risk"). It helps portfolio managers understand their portfolios and find optimal transactions to reflect specific views. These tools are increasingly important in today's complex environment, where the need to manage global portfolios, monitor adequate levels of diversification, and search for investment opportunities outside the core increases the complexity of managing fixed-income portfolios. Moreover, the events over the past year clearly highlight the need for risk models that adjust quickly, but in a robust way, to changes in the market environment. It is in this context that Barclays Capital enhances its Global Risk Model to include a new-generation risk model for emerging markets debt[1].

The new model significantly increases the set of countries that have dedicated risk factors, therefore allowing for a better characterization of exposures and diversification. It builds on the DTS concept (see Dor, Dynkin et al. 2005), in which the forecasted volatility of bonds depends directly on the current level of its duration and spread. This concept makes volatilities more responsive and proved to be a robust mechanism for risk measurement across asset classes (e.g., credit) during the recent credit crisis.

The model performs well out-of-sample and integrates effortlessly with the current models available for local debt. The integration is seamless with the other asset classes in POINT, namely credit and emerging market equities. This careful integration of models across asset classes and currencies is a hallmark of our Global Risk Model.

We would like to thank Joe Kogan and Anthony Lazanas for their comments and suggestions. Gary Wang, Jerome Hauser, and Chandra Koppella contributed to the development and implementation of the risk model in point.

[1] For more details about our models please see the Portfolio Modeling publications on our webpage.

The amount of data available for EM fixed income securities is relatively scarce, which predisposes us to a relatively parsimonious model. Throughout our research, we are cautious in treating the available data fairly and not overextending what can be delivered. The result is a simple, robust, yet complete risk model that covers all three components of risk traditionally found in our models: systematic, idiosyncratic and default risk.

The risk model report may substantially enhance the analytical view managers have of their portfolios, contributing to their better understanding and therefore more informed decisions about rebalancing. The report is very flexible, allowing clients to tailor the output along the dimensions that are of most interest to them. Moreover, the risk model is fully integrated into the other components of POINT, such as the optimizer and scenario analysis. This holistic approach to risk, performance, and portfolio construction delivers a powerful tool for portfolio managers.

We begin with an illustration regarding the usefulness of the risk model and how the risk report can quickly enhance the manager's view of his portfolio. Section 2 describes the emerging market debt market and recent developments. Section 3 emphasizes the major assumptions and building blocks of our model. Section 4 details the overall framework. Sections 5 and 6 examine the interaction between the emerging markets risk model and the local currency markets and other asset classes in general. Section 7 presents the historical back-testing of our model for different types of portfolios. Section 8 concludes.

1. Why We Need a Risk Model: An Illustration

Most emerging market portfolio managers like to understand the return and risk exposures of their portfolios by looking at their country exposure. Specifically, they tend to calculate "betas" of their portfolios to understand their sensitivity to a specific benchmark. The use of such metrics allows the portfolio manager to formulate an educated view regarding questions such as:

- Will I outperform the benchmark if USD interest rates go up?
- If the index spread widens, what is the expected change in Mexican spreads?
- What happens if I extend the average maturity of my Russian portfolio?

However, there are many other related and important questions the portfolio manager may have trouble addressing, such as:

- What is my risk exposure to a flattening of the USD curve?
- Is my portfolio riskier under that scenario? What is the risk impact of the flattening on my spreads?
- How much diversification do I get from adding an extra country to my portfolio? And what about expanding to a core plus strategy?
- I think my portfolio is too volatile: Where should I begin to rebalance? Where do I get the most "bang for the buck"?
- What are the major active positions in my portfolio? Is it Asia or Venezuela? Or is my imbalance on the 10y point of the EUR yield curve? How to rank them?
- How much risk am I taking for being long maturity in Brazil? How well is that hedged by my short maturity exposure to Mexico?

- What is the extra volatility associated with default events that come from my exposure to distressed bonds?
- Is my security selection risk diversified?

To answer this second set of questions, we need to translate "directional" views one may have into numbers. Of course, the more complex the portfolio, the harder the task. The Barclays Capital Global Risk Model quantifies and integrates all the different risk exposures of the portfolio and the benchmark by taking into account the effect of correlations between all these different effects. The result is a risk report that details and quantifies the characteristics and imbalances of the portfolio, allowing clear answers to all these and other questions.

To illustrate such an application, we turn to a very simple example. Suppose we are managing a portfolio of Brazilian bonds. For simplicity, assume the portfolio is actually the Brazilian component of the Barclays Capital USD Emerging Market Index. Suppose our benchmark is composed of sovereign Brazilian bonds. More precisely, suppose it is the Brazilian component of the Barclays Capital USD Emerging Market Sovereign Index. Figure 1 shows the risk estimates when we run this portfolio against its benchmark in POINT, as of May 2009. As you can see, we forecast the portfolio to have higher volatility than the benchmark (534 versus 500bp/month). We forecast the volatility of the return difference between the two (TEV) to be about 79bp/month. Finally, we forecast the beta of the portfolio return to the index return to be 1.06. This beta is calculated based on our forecasts for volatility and correlations.

Figure 1: Risk Estimates from the POINT Emerging Market Risk Model, May 2009

Statistic	Portfolio	Benchmark
Name	US EM Brazil	US EM Brazil Sovereign
Number of Positions	30	19
Volatility Estimate (bp/month)	534	500
Tracking Error Volatility (TEV in bp/month)	79	
Portfolio Beta	1.06	

Source: Barclays Capital

However, the risk report gives a wealth of other useful information. For instance, in terms of betas, the report can disaggregate the portfolio beta based on any partition the user creates. One may use an issuer partition to get betas for each one of the issuers in the portfolio or a rating partition to get the beta for each rating bucket. Figure 2 shows these betas. As expected, the sovereign "issuer" has a beta of one to the benchmark. More interestingly, we see that PetroBras also has a low beta, probably due to its government-related nature. Other more independent issuers do have higher betas, as one would expect. Regarding the analysis for the rating buckets, it is interesting to note that betas increase systematically with the decreasing quality of the bonds. Although these results might be expected, this example report exemplifies how the risk model quantifies these expectations with no effort.

Figure 2: Risk Estimates from the POINT Emerging Market Risk Model, May 2009

BY ISSUER	Beta
Brazil (Fed Rep Of) - Global	1.00
Petrobras Intl Finance	1.08
Vale Overseas Ltd - Global	1.73
GTL Trade Finance Inc	1.44
Braskem Finance Ltd	1.48
BY RATING	**Beta**
BAA3	1.02
BAA2	1.42
BA1	1.48
B1	1.67

Source: Barclays Capital

The other reports from the risk model help to significantly complement this analysis on many different levels. For instance, Figure 3 shows that the source of the TEV is spread out among all the three sources that our risk model recognizes (more details in section 4). Specifically, because the portfolio is relatively small in terms of the number of issuers (not necessarily issues), both the idiosyncratic risk and the default risk are relatively large (34 and 42bp/month, respectively).

Figure 3: Detail on the Predicted Tracking Error Volatility (TEV) in bp/month, May 2009

Total TEV	79
Systematic TEV	57
Idiosyncratic TEV	35
Default TEV	42

Source: Barclays Capital

The systematic risk in this portfolio is clearly driven by the higher spreads (and therefore higher betas) of the portfolio, as it includes (riskier) corporate issuers the benchmark does not. Therefore, for this particular example, let's explore the other components of risk. Figure 4 shows the idiosyncratic and default risk per ticker. Comparing this with Figure 2, one can see that higher betas do not lead to higher contributions to risk. In particular, the sovereign sub-portfolio with a beta of one does have the highest contribution to both idiosyncratic and default risks. This is due to the large underweight we have for that issuer in the portfolio. More interestingly, let's focus on the risk from PetroBras and Vale Overseas. Both have relatively the same overweight in the portfolio (9% and 10%, respectively). However, the latter contributes more significantly to idiosyncratic risk and especially default risk (In this case, these numbers are aligned with the betas – Vale Overseas is riskier along all dimensions - but that is not always the case. For instance, JBS and Braskem have similar betas, but very different default risk). This seems to suggest, that other things equal, we would have this kind of holding in our portfolio only if we are more bullish regarding Vale Overseas than PetroBras.

Figure 4: Detail on the Predicted Tracking Error Volatility (TEV) in bp/month, May 2009

Ticker	Net weight (%)	Idiosyncratic TEV	Default TEV
Brazil (Fed Rep Of)-Global	-24	26	40
Vale Overseas Ltd-Global	10	20	23
Petrobras Intl Finance	9	11	4
Gtl Trade Finance Inc	3	5	5
Jbs Usa Llc/Jbs Usa Finance	1	3	11
Braskem Finance Ltd	1	2	3

Source: Barclays Capital

This simple example suggests the breadth of information the risk model can provide to portfolio managers. In particular, this illustration touches only a small part of the information available in the risk report. The analysis can be conducted in a multi-country, multi-currency, multi-portfolio and multi-asset class level. They are also highly customizable to the specific portfolio analysis clients are used to perform. The following sections detail the elements behind this analysis.

2. Fixed Income Emerging Markets

The history of emerging markets debt after the Second World War may be described in three distinct phases. Until the early 1990s, the market was small and the majority of developing countries tended to borrow directly from banks or other international institutions. During the 1990s, the number of countries accessing the international public bond markets increased substantially, as the effects of the emerging markets debt crisis of the 1980s faded away. In particular, the last years of the 1990s brought two important developments to this market. One regards the steady increase of local denominated (instead of G4 – USD, EUR, GBP and JPY) offerings – mainly Treasuries. The other is the expansion of issuance from the corporate sector. The last decade reinforced these developments.

To document these trends, we start by looking at the data from some countries with large and strong traditions in emerging market debt issuance. Countries are chosen just for illustration purposes. From the Americas, we pick Brazil and Mexico; from Europe, Russia and Turkey; from Asia, the Philippines.

Figure 5 shows the total amount of debt outstanding from these countries. Issuance increased substantially, from about $238bn in December 1999 to $809bn in May 2009. The data also show that the increase was substantial for all major countries. In relative terms, the asset class also became more relevant. For instance, the numbers above represented about 20% of the amount outstanding of the Barclays Capital USD Investment Grade Credit Index in 1999. Now they represent approximately 37% of that index.

Figure 5: Emerging Market Total Debt Outstanding in USD - Major Countries (USD bn)

	31-Dec-99	31-May-09
TOTAL	238	809
Brazil	79	272
Mexico	78	189
Russia	52	162
Turkey	14	137
Philippines	15	49

Source: Barclays Capital

Figure 6 shows the total local denominated debt outstanding for the same major emerging markets countries. For all countries shown, the increase in local issuance is impressive. For instance, Brazil had about $1.3bn of debt outstanding at the turn of the decade. This value increased to $203bn as of May 2009.

Figure 6: Emerging Market Local Government Debt Outstanding - Major Countries (USD bn)

	31-Dec-99	31-May-09
TOTAL	18.3	491
Brazil	1.3	203
Mexico	14.3	117
Russia	0.5	60
Turkey	2.2	90
Philippines	0	21

Source: Barclays Capital

Numbers around corporate issuance are a bit harder to obtain. This is in part due to the fact that in the earlier periods the distinction between corporates and government-related issuers is harder to establish. However, if we focus on the Barclays Capital USD Emerging Market Index, the percentage of the amount outstanding from the corporate sector goes from virtually zero in 1999 to 15% in May 2009[2].

Barclays Capital USD Emerging Market index

Focusing now on the Barclays Capital USD Emerging Market Index, Figure 7 shows some information regarding the composition of the index as of May 2009. Specifically, the majority of the issuance is rated Baa/Ba, which has been the historical pattern. Given that sovereigns in this index are, by definition, rated below BAA, this pattern is not surprising. Note that the distressed market (Caa or below) is quite small, especially in market value terms. The figure also shows Russia as the biggest issuer on the index, both in terms of number of issues and current market value. Brazil and Mexico are also robust issuers. Although it has a significant amount of debt outstanding, Argentina is not on the list given the low current valuations of its bonds.

Figure 7: Composition of the Barclays Capital USD Emerging Market Index, May 2009

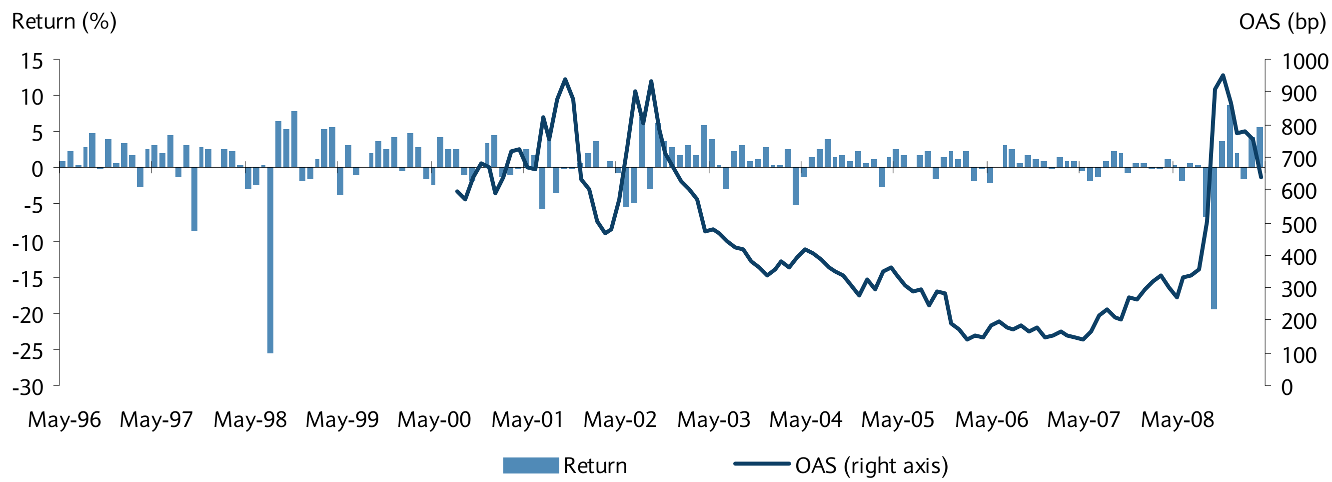
	Number of Issues	Market Value ($bn)
Total	262	321.6
Per Rating		
A	6	3.9
Baa	111	168.6
Ba	86	108
B	47	36.5
Caa	5	2.5
Ca-D	7	2.1
Per Country (top 5 per market value)		
Russia	49	64
Brazil	30	53
Mexico	32	41.7
Turkey	17	31.4
Philippines	15	22.4

Source: Barclays Capital

[2] The issuer classification along these lines is available only after January 2003.

Figure 8 shows the historical monthly total returns and level of OAS for this index[3]. The return series shows an asset class that occasionally experiences episodes of extreme negative returns. Specifically, during the 1998 and the 2008 crisis, the monthly return for this index reached levels of -20%. Another interesting pattern is the unprecedented low volatility the index showed for the period from 2005 to the crisis of 2008. During that period, OASs tightened to levels close to 1%, extremely low by historical standards. This reflects the age of the decoupling theory, which argued that these markets would not be affected by a crisis in the developed world. The month of October 2008 showed otherwise, with the index returning -19% for that month and OASs reaching values close to 10%. These are values close to what we saw in previous crisis, namely during 2001 and 2002.

Figure 8: Total Returns from the Barclays Capital USD Emerging Market Index



Source: Barclays Capital

Figure 9 illustrates the statistical properties of the index returns. The returns show very strong kurtosis and negative skewness – characteristics far from a normal distribution. These characteristics help explain why traditional models may not adequately capture the dynamics of this asset class. As documented below, our risk model, using state-dependent variables, such as the current OAS, adapts fast and in a robust way to this changing environment, producing conditional distributions closer to normal.

Figure 9: Properties of the Total Return of the Barclays Capital USD Emerging Market Index

Summary Statistics	
Mean	0.84
Median	1.22
Standard Deviation	3.84
Kurtosis	18.31
Skewness	-3.13
Minimum	-25.56
Maximum	8.69

Source: Barclays Capital

[3] OAS levels for the index are available only after August 2000.

3. The Model's Building Blocks

Data and Analytics

Our model is calibrated mainly using data from the Barclays Capital Global Emerging Markets Index. The use of the index – scrutinized by hundreds of clients worldwide – guarantees the integrity of the data, a pre-requisite for a valuable model. This data is proprietary to Barclays Capital and one of the distinguishable advantages our models can offer. For the estimation of the model, we use monthly data starting in January 1999.

There are three main components of our data retrieval process. First, we use the index prices at the end of each month to compute monthly returns. The accuracy of the risk depends clearly on its ability to represent the behavior of the markets. Good pricing data guarantee that the returns used are aligned with the markets' behaviour. Although trivial, this issue can not be understated, as less liquid bonds may produce stale prices that contaminate the analysis. This is especially true for emerging market bonds. Second, we use the indicative information to look for systematic patterns of return behavior across different sets of bonds (e.g., country). Finally, these characteristics, as well as prices, are fed into our pricing model to return a set of analytics that are used as inputs by the risk model. It is important to note that our pricing model accounts for the possible optionality of the bond. Also, the pricing model assigns a particular constant OAS to the bond assuming no credit risk to the cash flows. Therefore, the spread contains all the risk premia associated with the credit (and other) risk of the bond. We discuss below how we introduce default risk into the model.

Another important observation regarding this asset class is the lack of high-quality, higher-frequency data (e.g., daily data)[4]. This imposes limitations on the set of econometric approaches we can use while developing the model.

Country as Major Driver of Risk

The emerging market asset class is characterized above all by country risk. Virtually all research done in this area has *country* as the starting point of the analysis. The local economic conditions of each country – such as the current accounts, inflation, economic growth, public sector spending and debt – are usually the starting point of any fundamental analysis of emerging markets and their risks. There are certainly themes common to the asset class – state of the world economy, trade, price of commodities, etc – and that also play a role in determining the local conditions for many countries, but in the end, countries with similar exposures to these themes may behave very differently.

Emerging market debt issued in major world currencies (such as USD or EUR) is also sensitive in a more direct way to the economic environment in these major economic blocks. For instance, the level of interest rates, the business cycle and inflation in the US have a direct impact on the cost of borrowing for emerging market countries. That is why actions from the US Federal Reverse Board are closely followed by these markets. Also, a lot of the investors in this debt are domiciled in these blocks and therefore are affected by their conditions.

It is extremely hard to find an economic model that can integrate all these different macro variables to explain the movements we observe in emerging market countries. This fact leads emerging market portfolio managers to rely on a set of portfolio statistics to measure the characteristics of their portfolios and their sensitivity to the different economic variables. They

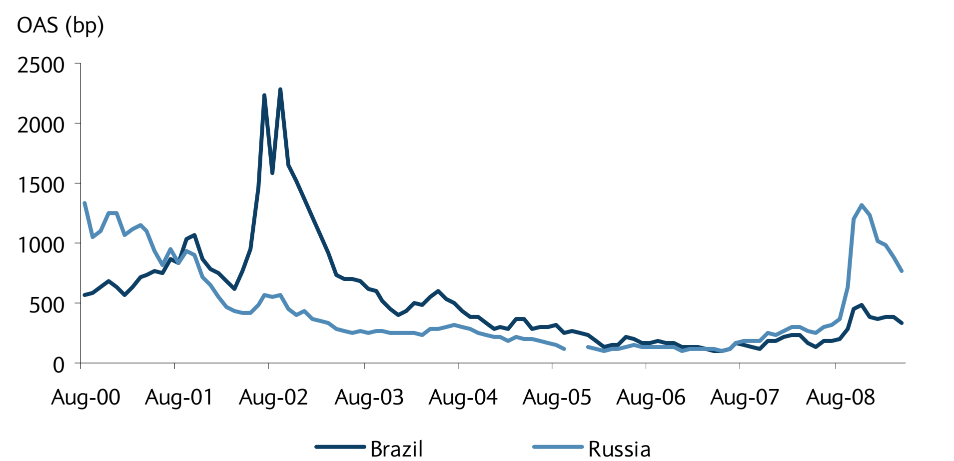
[4] CDS data for emerging markets are available and somewhat more liquid than the cash markets. However, they are not available for a significant portion of the historical period we are using for calibrating this model. Moreover, the cash and CDS markets may behave significantly different (e.g., during the 2008 crisis) making CDS a potential weak proxy for the cash market.

monitor exposure to the yield curve (e.g., the EUR yield curve for EUR-denominated bonds). They also examine the different country's "betas" – the relative volatility of the country spreads against a benchmark – to understand the country's sensitivity to general news regarding growth, inflation or commodity prices. In the end, country is widely used as the fundamental unit of analysis. In our model, we also adopt this view.

The next step is to decide on the level of granularity of the model, that is, the number of countries with dedicated country factors. Those outside this list are still modeled, but through more generic risk factors (e.g., regional risk factors). This decision depends on the trade-off between having a detailed model and having a robust model.

On one hand, one would like to keep in the model all the nuances of the market, specifically, the fact that countries do move in different patterns over time. If we do not allow for that granularity, we are missing an important characteristic of this asset class. Figure 10 makes that case. It shows the OAS level for the Brazilian and Russian components of the Barclays Capital USD Emerging Market Index. Although there are periods of common behavior – like the spread tightening following 2003 – investments in these two countries did generate significantly different risk profiles. Risk models that do not accommodate this level of granularity may introduce significant biases in the analysis. For instance, the volatility seen in Brazilian spreads through 2002 and 2003 are very specific to that country. They come from the uncertainty around the Brazilian presidential election that brought to power president Lula da Silva. While this was happening, we saw negligible impact in the Russian market. The opposite happened during the current financial crisis. Russia's spreads jump from 3% to 15%, while the Brazilian ones increased by much less, to about 5%.

Figure 10: OAS Index Levels for Brazil and Russia



Source: Barclays Capital

On the other hand, one needs to be careful with the data available for the different countries. In order to estimate risk well at a country level, we need to have liquid pricing data for that country and for a significant time period.

In our risk model, we decided to include specific countries and exclude some others using a soft threshold. The decision was reached by extensively looking at data and time patterns from both index and trading data, in consultation with our emerging markets research team. It is also important to note that the universe of emerging market countries we start with comes directly from our index, with very few deviations. In our framework, emerging market countries are those with sovereign index ratings of BAA or below. The exceptions are a few countries that, although not emerging markets – by the current index definition – have a significant amount of outstanding debt denominated in G4 currencies. The majority of these countries were emerging markets in the recent past. For this reason, we decided to include them in this model, but with a different categorization: "Other G4-denominated issuers". In what follows, we model these two groups in a similar fashion.

The resulting set of countries included explicitly in the model is displayed in Figure 11. For each country, we show the amount outstanding as given by our database. For reference, the table also shows which countries have their own dedicated FX, local treasury factors and equity factors in our Global Risk Model. Specifically, the new risk model has 17 emerging market country factors, as well as seven other country factors. As one can see, the model complements the coverage available in both our local and equity risk models. This approach allows clients to have an integrated view of their country exposures across these different asset classes.

Figure 11: List of Countries in the Emerging Market Model, May 2009

	G4- Denominated Amt Outstanding (USD bn)	FX & Local	Equity
Emerging Markets			
Russia	102.3	Yes	Yes
Mexico	72.1	Yes	Yes
Brazil	69.8	Yes	Yes
Argentina	55.2	Yes	Yes
Turkey	46.9	Yes	Yes
Venezuela	33.9	Yes	Yes
Philippines	27.9	Yes	Yes
Kazakhstan	21.6	No	No
Indonesia	21.3	Yes	Yes
India	16.4	Yes	Yes
Lebanon	16.1	No	No
Colombia	14.0	Yes	Yes
Peru	10.8	Yes	Yes
Ukraine	9.1	Yes	No
Panama	7.5	No	No
Uruguay	6.1	No	No
Ecuador	4.1	No	No
Other G4-denominated issuers			
Poland	38.2	Yes	Yes
S.Africa	17.2	Yes	Yes
China	15.2	Yes	Yes
Malaysia	14.3	Yes	Yes
Chile	11.5	Yes	Yes
Israel	10.7	Yes	Yes
Thailand	4.7	Yes	Yes

Source: Barclays Capital

Note that all other emerging market countries not specifically listed in this table (e.g., Lebanon) are still fully supported in this model, as explained later in this paper. The difference is that they are supported through more aggregated regional block factors, instead of dedicated country factors.

Evidence of Log-normal Spread Returns and DTS

Future volatility of the spread returns of a bond have been shown to be well predicted by its current level of spread (e.g., Dor, Dynkin et al. 2005). The reasoning is intuitive: bonds with higher spreads tend to be more volatile because the spread represents, to a large degree, uncertainty concerning future payoffs. What is interesting is to note that the relationship between these two variables is, in general, remarkably linear and similar across many different asset classes (see Gabudean 2009 for evidence in US ABS bonds, Staal (2009) for evidence in US municipal bonds). For instance, the spread return volatility of a bond with spreads of 200bp/month tends to be half of the volatility of a bond with spreads of 400bp/month given a similar spread duration. This is important as it suggests that a linear factor model may be enough to capture the bulk of the relationship between volatility and level of spreads. We use this line of research extensively in the new model (see section 4). For now, we illustrate the strong evidence for the linear relationship between level of spreads and future spread volatility in the emerging markets, keeping the notation to a minimum.

A simple duration approximation to the spread return for bond *i* is:

$$SpreadR_{i,t} = -OASD_{i,t-1} \times \Delta LOAS_{i,t} \tag{1}$$

Where *OASD* stands for option-adjusted spread duration, *LOAS* for the Libor option-adjusted spread and Δ for change. We further decompose the changes in *LOAS* into a systematic component – the risk factor $\widetilde{F}$ – and an idiosyncratic component - $\widetilde{\varepsilon}$:

$$\Delta LOAS_{i,t} = \widetilde{F}_t + \widetilde{\varepsilon}_{i,t}$$

Note that $\widetilde{F}$ represents here the systematic component in *changes in spreads*. In light of the research referred to above, we normalize this expression:

$$\Delta LOAS_{i,t} = LOAS_{i,t-1} \times \left[F_t + \varepsilon_{i,t}\right]$$

Where now F represents the systematic component in the *percentage change in spreads*. We can rewrite (1) as:

$$SpreadR_{i,t} = -OASD_{i,t-1} \times OAS_{i,t-1} \times \left[F_t + \varepsilon_{i,t}\right]$$

If we define *DTS* (Duration Times Spread) as $DTS_{i,t-1} = -OASD_{i,t-1} \times OAS_{i,t-1}$, then:

$$SpreadR_{i,t} = DTS_{i,t-1} \times \left[F_t + \varepsilon_{i,t}\right] \tag{2}$$

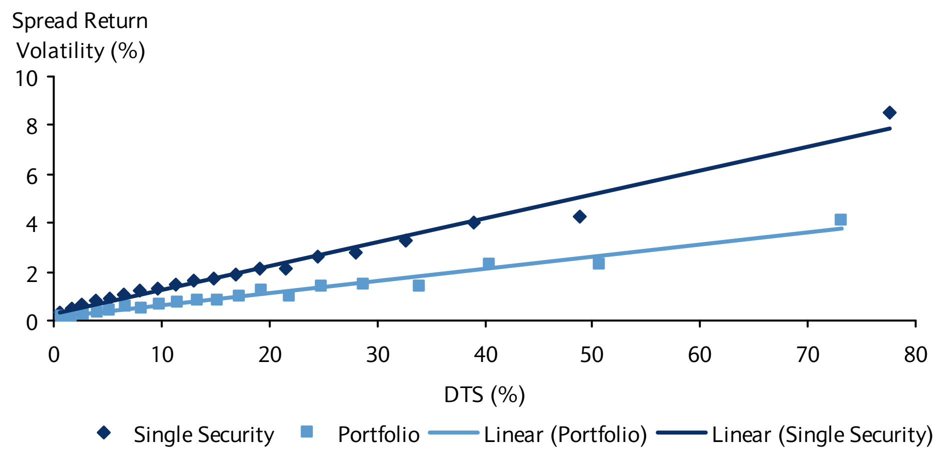
Let's define σ_R^2 , σ_F^2 and σ_ε^2 as the variance of spread return, factor and idiosyncratic returns, respectively. Finally, assume idiosyncratic risk to be independent of systematic. Then:

$$\sigma_R = DTS \times \sqrt{\sigma_F^2 + \sigma_\varepsilon^2} \tag{3}$$

If this specification is correct, we should expect spread volatilities for individual bonds to be linear with respect to their DTS (with slope $\sqrt{\sigma_F^2 + \sigma_\varepsilon^2}$) and spread volatilities for portfolios to be also linear in their DTS, although with slope σ_F (assuming idiosyncratic risk is diversified away).

To investigate this specification, we want to compare DTS levels with realized volatilities, both for single securities and portfolios. To do that, we perform the following exercise: at the beginning of every month, from 19998 to 2008, we group all bonds in our sample into 20 equally populated groups, sorted by increasing level of DTS. This guarantees that the different groups span the bulk of the DTS range available in the sample. Then, we compute the realized volatility of both the portfolio (whole group, equal weighted) and a typical security in each of the groups across all time periods. We also compute the average level of DTS for each of the groups. Figure 12 shows the result of such an experiment. It is quite striking to see how the volatility of both portfolio and single securities relate so linearly to the level of DTS. We can see that this conclusion holds even for very large levels of DTS (remember the sample does include distressed securities), suggesting a quite robust relationship.

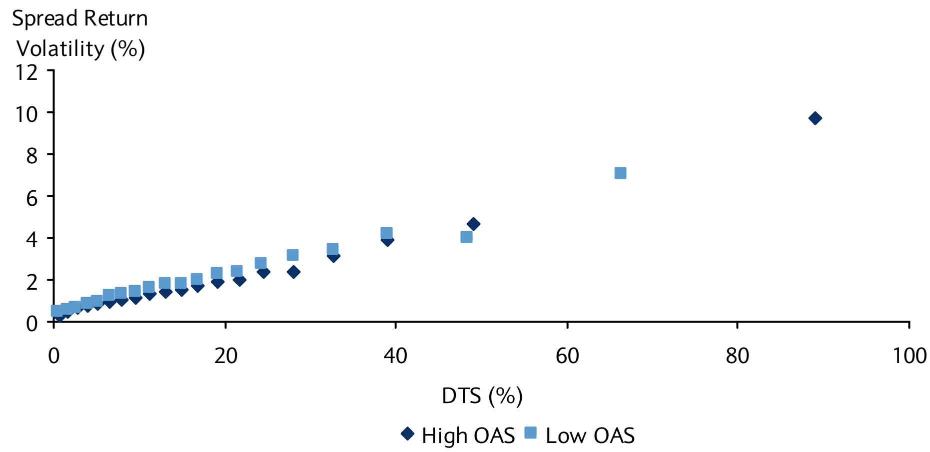
Figure 12: Realized Spread Return Volatility across Different DTS Levels (1998-2008)



Source: Barclays Capital

We conducted several robustness tests on this observation. They all confirm the generality of this behavior in EM. This comes as no surprise, as the same behavior was extensively documented in the research for our risk models for other asset classes (e.g., global credit, US ABS HEL and US CMBS, US municipal bonds). In one of our tests, we performed the same exercise as described above, but further separated each of the 20 groups in half, by level of OAS. Because all securities in the same group have similar DTS by construction, this exercise separates the bonds with high LOAS and low OASD from those bonds with low LOAS and high OASD. This segregation allows us to understand whether it is the DTS or instead only one of its components that is driving the relationship. Figure 13 shows this to be not the case. In particular, note that for each level of DTS, the volatility of the securities on both portfolios is quite similar, suggesting that it is the product of the two analytics that explains spread volatility, not either one in isolation.

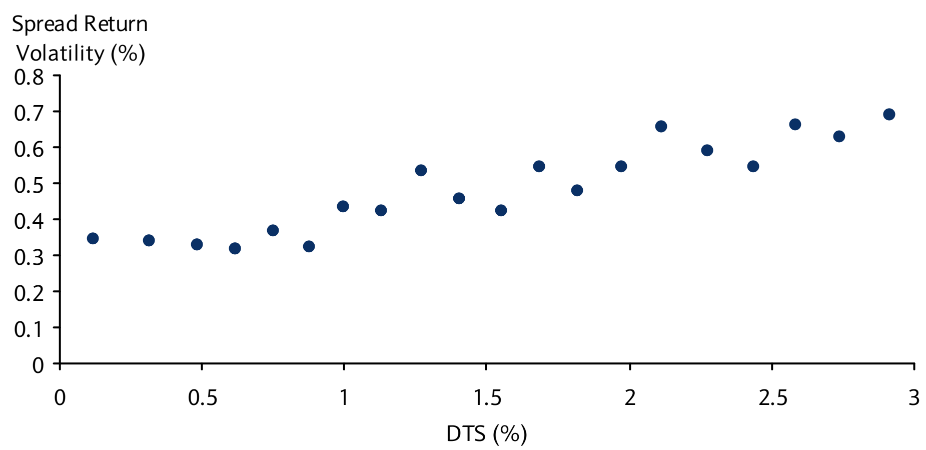
Figure 13: DTS Slope for Single Securities with High and Low LOAS



Source: Barclays Capital

Although the previous figures describe well the general relationship between volatilities and DTS, it is interesting to focus on low DTS portfolios. Specifically, we want to understand the behavior of volatility as DTS approaches zero. In Figure 14 we repeat the initial exercise but limit the sample to DTS levels of up to 3%. We note that for very low levels of DTS (about 0.5%-0.75%) the relationship becomes flat, indicating a floor on volatility at about 30bp/month. This observation is not surprising: even very high quality bonds do present some spread volatility, driven by issues such as demand, liquidity, or other technical factors. We use this observation in our model, where we also impose a floor to a bond's volatility (see Section 4).

Figure 14: DTS Slope for Small DTS Values



Source: Barclays Capital

Overall, the evidence presented confirms the presence of a DTS effect that helps explain the cross-section differences in spread return volatilities for emerging market's bonds. This evidence is the major building block behind our risk model.

4. Model Specification

The previous section detailed the main characteristics of our model: relatively scarce data, a set of countries with dedicated risk factors, and strong evidence for DTS in this market. The emerging markets risk model is also a part of the larger Barclays Capital Global Risk Model. There is therefore a consistent framework for risk analysis across all asset classes that we want to maintain. As a result, it is not surprising that the search for the correct specification for the emerging markets' risk model starts by analyzing the specifications chosen for the other asset classes. In one way this is already done, by including DTS – widely used in other models – as a fundamental component of the emerging markets risk model. Readers familiar with our credit model will recognize some of its components in the description below[5].

General Framework

The emerging markets risk model starts by postulating that emerging market bonds have two major sources of risk: (1) market risk that reflects investors' continuous assessments of interest rate, credit and liquidity risks of the bond; and (2) default risk that captures the risk of an outright default over the short term. To capture these two kinds of risk, we describe the monthly return from bond *i* as:

$$R_{it} = (1 - I_{it}) R_{it}^{Market} + I_{it} R_{it}^{Default}$$

Here *I* is an indicative random variable for a default event – it has a value of 1 if issuer *i* defaults during period t, and 0 otherwise. If there is no default during the period, the return for the bond is driven by market factors - R_{it}^{Market}. However, if the issuer does default, the return is driven instead by the default process - $R_{it}^{Default}$.

Market Risk

In the model, market return is decomposed as follows:

$$R_{it}^{Market} = R_{it}^{Carry} + R_{it}^{YC} + R_{it}^{SS} + R_{it}^{Spread}$$

Where the carry return is known in advance (e.g., coupon payments), and the remaining three are not. Return from carry captures coupon accrual and the return due to the passage of time. The yield curve (*YC*) return measures returns associated with changes in the respective treasury curve and the swap spread (*SS*) return capture returns owing to the changes in swap spreads. Finally, the spread return captures the return due to changes in spreads over swap rates. Specifically, for emerging markets, the spread should capture all market information regarding the prospects of the country and specific issuer under consideration. Because these may change abruptly (Figure 10), it is especially important to be able to incorporate these dynamics in our spread model. We detail our approach for the spread component later in this section. Note that the spread risk is further split into a systematic and an idiosyncratic spread risk component.

Default Risk

The return process described above can be presented as:

$$R_{it} = R_{it}^{Market} + I_{it} (R_{it}^{Default} - R_{it}^{Market}) \tag{4}$$

Therefore, the direct return impact driven by the default component is given by:

[5] See Silva (2009) and Chang (2003) for a more complete description of the credit models.

$$I_{it}(R_{it}^{Default} - R_{it}^{Market})$$

Where the return given default is modeled as:

$$R_{it}^{Default} = (recovery_{i,t} - price_{i,t-1}) / price_{i,t-1}$$

We can show that the volatility of the default component is mostly a function of three variables: default probability, recovery rates, and default correlations (when looking at portfolios). Our risk model addresses all these three components separately.

Bond returns in our model are therefore explained by three types of risk: systematic, idiosyncratic and default. We use this rich specification to model the risk of emerging market bonds. Next, we detail the treatment of each of these components.

Systematic Risk

We defined market risk as having three sources of systematic risk: yield curve, swap spread and spread risk. For the first two sources, we have a set of risk factors that are common to the generality of fixed income products. These are factors that proxy the volatility of the yield curve and the swap spreads across different points of these curves. The risk factors associated with spread risk are the ones developed specifically for each asset class, to include the major risk characteristics of that class. We next focus on this last source of risk.

A defining characteristic of emerging markets is their volatile nature. Underlying conditions can change abruptly and with no warning. For instance, Figure 8 shows how in a couple of months during the fall of 2008, spreads for the emerging market index went to 9% from 3%. This sudden change creates a big challenge from a modeling point of view. A typical approach would be to model spread return as a function of some bond characteristics, like its duration and rating. However, the reliance on ratings has significant limitations: first, all emerging market bonds tend to have ratings very concentrated in the Baa/Ba range (Figure 7). Investors may have problems estimating factors out of this rating range. Moreover, ratings implied by the market may significantly diverge from institutional ratings. Because volatility tends to be more driven in the short-run by market conditions, using ratings may significantly misrepresent the market risk of the portfolio. Finally, models based on relatively "static" characteristics of bonds tend to react very slowly to sudden market shifts. They tend to underestimate risk long after a shock hits the system and overestimate it long after a crisis passes. Again, these limitations are particularly relevant given the volatile nature of emerging markets.

Our approach is instead based on DTS. In particular, we make no use of ratings in our model. The staring point is given by equation (2), which we repeat here for convenience:

$$R_{i,t}^{Spread} = DTS_{i,t-1} \times \left[F_t + \varepsilon_{i,t}\right]$$

Which in terms of volatility is represented by (3):

$$\sigma_R = DTS \times \sqrt{\sigma_F^2 + \sigma_\varepsilon^2}$$

Note that independently of the volatility forecast for both the systematic factor (F) and idiosyncratic return (ε), the forecast volatility for the spread return of the bond changes instantaneously with the level of its spread, through the DTS. This dynamic specification ensures that the volatility forecast adapts quickly to changing market conditions as spread levels change. Our research suggests also that the systematic factor realizations coming out of this specification behave better – their distribution is more invariant – than the one coming out from more standard approaches (namely where the systematic factor represents changes in spreads, instead of percentage changes in spreads). Therefore, volatility estimates from the DTS specification tend to perform better out-of-sample.

The general starting point defined by equation (2) can be developed to incorporate other systematic behavior in the market. In our case, as previously discussed, we decided to have different DTS systematic risk factors for different countries. Focusing on the systematic component of (2), this means

$$R_{i,C,t}^{Spread,SYS} = DTS_{i,t-1} \times F_{C,t}$$

for all bonds belonging to country *C*. Figure 14 conveys the evidence that we need to further adapt this specification for bonds with low DTS. Our approach is to impose a floor on the DTS level used as loading to the country DTS risk factor. Let: $DTS_{it}^{+} = \max(DTS_{i,t}, \underline{DTS})$, where $\underline{DTS}$ is the lower bound on DTS. Then we can represent the spread return as:

$$R_{i,C,t}^{Spread} = DTS_{i,t-1}^{+} \times F_{C,t}$$

Under this specification, the systematic risk is captured by 17 emerging market countries, plus 7 other G4 denominated issuer countries (Figure 11). The model, however, also covers other emerging market countries through three additional regional risk factors: Americas, Asia, and EMEA (Europe, Middle East and Africa). These three DTS risk factors are estimated using the bonds from all countries in these regional blocks. For instance, a bond from Sri-Lanka (a country that has no dedicated risk factor) will load into the Asian DTS factor.

The specification described in (4) is the one used in our emerging markets risk model. It is a parsimonious specification, limited by the small amount of intra-country cross-section data available for the large majority of countries. In what follows we go through other variables tested and the reasoning for not including them as risk factors. Generally, the relatively small set of bonds for each particular country does not allow us to estimate more than one risk factor with them. For the largest countries, this is not the case – we could actually estimate more than one factor. However, the potential benefits of adding one extra factor would be made at the expense of having an asymmetrical treatment of the different countries in the model. After extensive research, we decided not to take that route. The alternative would be to estimate these factors on a more aggregate level (e.g., regional level). We usually get poor results with this approach. The differences in behavior across countries are too significant, so imposing common systematic behavior across them does not work well out-of-sample. Some of the variables are directly suggested by their use in our other models; others are relevant for emerging markets only. Note that the exclusion of the variables does not mean that we do not capture differences in risk across these dimensions. We capture them, as long as they are also reflected in the cross-section by systematic different levels of DTS.

- Ultra high grade factor: in the global credit model, we use this factor to estimate the floor in spread volatility. For emerging markets this factor would be ill suited: If we choose to have one such factor per month, we find that specific countries have no bonds with low volatility for a large number of months, blurring the interpretation of the factor. If we estimate one such factor for a large number of countries (e.g. regional blocks), this factor tends to have very high volatility, because along every time period, we can always find examples of bonds and countries with low spreads being hit by extremely large negative returns. Therefore, the volatility of that factor would be large, and we would impose an artificially high floor across all countries.

- High yield factor: in the global credit model, we use this factor to proxy for different behaviors between the investment grade vs. the high yield worlds. There are systematic institutional differences between these two markets in global credit. This distinction is much weaker for emerging markets. Moreover, as referred before, issues in this market tend to be clustered around the Baa/Ba ratings, diminishing significantly the relevance of this market segmentation.

- Maturity factors: these risk factors tend to proxy the volatility of changes in the slope of the spread curve. This is a perfect example of a factor that cannot be estimated on the aggregate level (very different behaviors in the cross-section).

- Non-sovereign factor: this risk factor would capture the additional risk usually associated with non-sovereign bonds (e.g., G4-denominated bonds issued by corporates in emerging market countries). For a number of countries, this population is very thin. Moreover, this is a typical dimension where we would expect the extra risk to be incorporated into higher OASs and therefore higher DTSs. If this is the case, the country DTS risk factor would capture this different volatility level. Also, the model does have a different treatment for non-sovereign bonds, in what regards the default risk (see discussion later in this section). This differentiation implies higher risk for corporates, with all else being equal. We therefore believe that the proposed specification has enough differentiation across this dimension.

Idiosyncratic Risk

The estimation of the idiosyncratic risk for the emerging markets' model comes directly from (2). Specifically, focusing on the idiosyncratic part of the model, we have:

$$R_{i,t}^{Spread,Idio} = DTS_{i,t-1} \times \varepsilon_{i,t}$$

That is, the specification for idiosyncratic returns also assumes a DTS-based parameterization for the idiosyncratic risk. As with the systematic component, we model this risk component in a very parsimonious way. Specifically, we postulate that the idiosyncratic volatility of a bond is given by the product of its DTS with a country specific parameter:

$$\sigma_{\varepsilon,i,C,t}^{2} = DTS_{i,t-1} \times \varphi_{C,t}$$

The parameter $\varphi_{C,t}$ is estimated monthly using the actual residual returns from each country that come out of our calibration process. This specification was hinted already in Figure 12. If we attribute the difference in slopes to the idiosyncratic risk, it becomes clear that this is also linear in DTS. Other tests performed confirm this assumption.

Default Risk

Portfolio default volatilities in our model are driven by three factors: the default probability and recovery rate for each bond in the portfolio and the correlation of default events among them. To illustrate this point, we begin with equation (4). Assuming that the market risk component is small compared with the return from default we get:

$$R_t^i \approx I_i R_{Default,t}^i$$

Furthermore, and for illustration purposes only, we assume that the loss given default is deterministic, (*R*), that all bonds have the same default probability (*p*), and default correlation is constant at ρ [6]. Then, for a single bond portfolio, the standard deviation of the return owing to default (DTEV) is given by:

$$DTEV \approx \sqrt{(1-p)p}\,|R|$$

And for a portfolio with two equally weighted bonds the DTEV comes as:

$$DTEV \approx \sqrt{0.5p(1-p)(1+\rho)}\,|R|$$

And as the number of bonds increase:

$$DTEV \to \sqrt{\rho p(1-p)}\,|R| \qquad (5)$$

Note that the *DTEV* is increasing in the probability of default (for relatively low levels of default), the correlation and the loss upon default. In what follows, we analyze in more detail each of these three variables.

The default probability of a given bond is driven by the financial situation of its issuer. We assume that once the default occurs for one issuer, it occurs for all its bonds. Therefore, the default probability of a bond is independent of its subordination, and all bonds from the same issuer have the same probability of default. Currently, we attribute the default probability to a particular issuer based on the implied rating for its senior unsecured debt. The implied rating is based on a state-of-the-art proprietary model that delivers individual corporate default probabilities (CDP) for thousands of issuers. Please refer to Asvanunt and Staal (2009) for more information about this model. As of May 2009 the (weighted) default probabilities used in the emerging market model are displayed in Figure 15:

Figure 15: Default Probabilities per Rating, May 2009

Rating	Default Probability
AAA	0.01%
AA	0.02%
A	0.03%
BAA	0.57%
BA	2.27%
B	11.72%
CAA/C	28.72%

Source: Barclays Capital

The procedure used to attribute recovery rates to a particular emerging market bond has to be necessarily parsimonious. The number of defaults is extremely small. So in our model, we set recovery rates for emerging markets bonds based on historical trends: recovery rates tend to be relatively higher for sovereign bonds than their corporate counterparts. Given these trends, we set the recovery rates to 25% for emerging markets sovereigns bonds and 10% for emerging markets non-sovereign bonds. These numbers are conservative estimates. Their historical averages are somewhat higher, but there is great uncertainty about them, given the small number of actual defaults.

[6] Although in general the recovery rate is stochastic at the beginning of the period, we treat it as deterministic here, for the sake of tractability. For the large majority of portfolios this assumption is innocuous.

Finally, the default volatility depends also on the default correlation. This is the component that gives a systematic nuance to default risk. Because defaults are correlated – distressed credit conditions tend to propagate across firms – investors can never fully diversify away this risk, as they can with the idiosyncratic risk. Equation (5) confirms that as long as correlations are not zero, DTEV will always be positive. The interested reader is referred to Chang (2003) for a discussion on the implementation of this feature in our risk models.

Putting It All Together

Emerging market bonds in our risk model are exposed to three different kinds of risk:

1. **Systematic risk** – every bond loads on four types of systematic risk factors: Foreign exchange (if currency is different than the base currency), G4 treasury and swap spread factors (for the underlying currency of the bond), and the country-specific DTS-spread factor (or regional factor if the country has no dedicated spread factor).

2. **Idiosyncratic risk** – the bonds specific risk that is associated with the bonds' DTS level and the idiosyncratic volatility of its country.

3. **Default risk** – where default probabilities are based on the implied rating of its issuer, and recovery rates on broad bond's sector classification (sovereigns vs. corporates).

All these sources of risk are well summarized in POINT risk reports. In section 1 of this paper, we presented some examples of the information contained in our risk model reports. Here, we present another example, now with more details on the systematic risk report.

Figure 16 shows the summary risk numbers for the Barclays Capital USD Emerging Markets Index, as of May 2009. As shown, the three components of risk can be aggregated into a single volatility estimate – tracking error volatility (TEV). For the index, our volatility forecast was 5.68% as of May 2009. The majority of the risk comes from the systematic component, given the diversified nature of the index.

Figure 16: Components of the Total Tracking Error Volatility (TEV) for the Barclays Capital USD Emerging Markets Index, May 2009

Total	567.9
Systematic	564.7
Idiosyncratic	33.7
Default	49.9

Source: Barclays Capital

Figure 17 shows in detail the systematic risk factors the Brazil component of the index loads into, with its loadings and contributions to total risk. Because the analysis is done with USD as the base currency, there is no risk coming from the FX component. However, you see all the other sources of risk detailed above: Yield curve and swap spreads risk factors – with detailed key rate exposures for different points in the curves – and emerging market spreads captures by a single Brazil DTS factor. Note that as expected, the spread factor is the major contributor to risk, with about 75% of the risk coming from the country's exposure.

Figure 17: Systematic Risk Description for the Barclays Capital USD Emerging Markets Brazil Index, May 2009

	Exposure		Contribution to TEV (%)
Factor name	Description	Value	
KEY RATES AND CONVEXITY			
USD 6M key rate	KRD (Yr)	0.044	-0.08
USD 2Y key rate	KRD (Yr)	0.323	-0.10
USD 5Y key rate	KRD (Yr)	1.575	1.35
USD 10Y key rate	KRD (Yr)	2.646	8.62
USD 20Y key rate	KRD (Yr)	1.791	5.23
USD 30Y key rate	KRD (Yr)	0.833	2.34
USD Convexity	OAC (Yr^2/100)	0.832	0.35
SWAP SPREADS			
USD 6M swap spread	SSKRD (Yr)	0.043	0.09
USD 2Y swap spread	SSKRD (Yr)	0.320	0.34
USD 5Y swap spread	SSKRD (Yr)	1.608	0.75
USD 10Y swap spread	SSKRD (Yr)	2.556	-1.43
USD 20Y swap spread	SSKRD (Yr)	1.692	-1.11
USD 30Y swap spread	SSKRD (Yr)	0.774	-0.58
EMERGING MARKETS SPREAD			
EMG Fixed Income Brazil	DTS (Yr*%)	19.633	75.27

Source: Barclays Capital

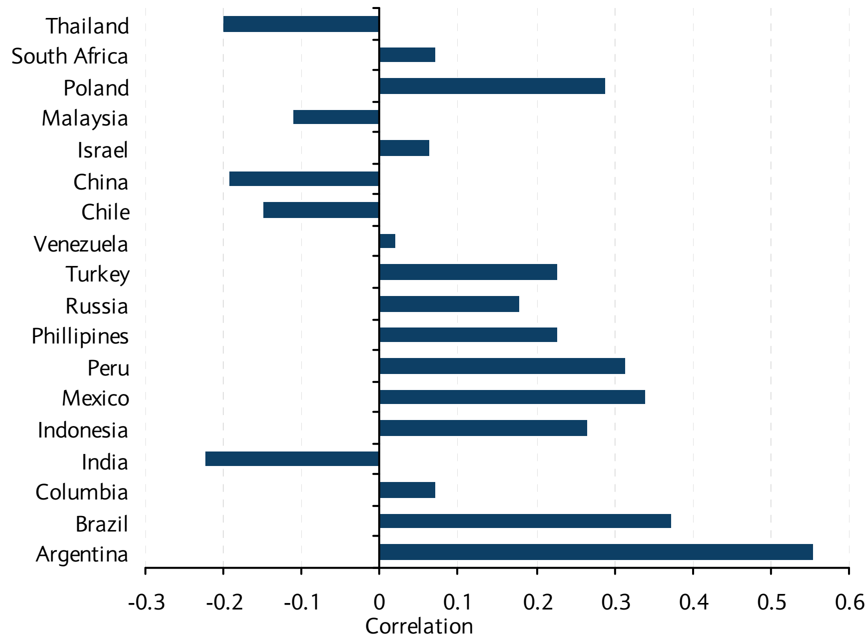
5. Relationship with Local Debt

A significant number of investors that participate in the G4-denominated emerging market follow and invest in local-denominated issues from the same countries. The rationale is that both kinds of securities have similar country exposures. For instance, once one becomes expensive, portfolio managers may choose to buy the other instead to gain country exposure. Or they may choose to hedge one exposure with the other.

This rationale has clear limitations: First, the base of investors tends to be different, with international investors more focused in G4-denominated debt and local investors in local denominated one. Although for significant periods of time – usually calm market periods – the distinction may be smaller, the segmentation tends to rise in periods where investors least want it. In general, during emerging market crisis, international investors tend to flee the local denominated debt first. The segmentation invariably leads to potential disconnect between the two markets, making them less appealing as equivalent investments. Second, for international investors, local denominated issues carry the extra foreign exchange risk. This may be a significant differentiator between the local and G4-denominated issues. Take the example of a solid company (e.g., with a strong operation outside their country) domiciled in a country where the outlook has become uncertain. Suppose the company issues both in local and USD-denominated debt. If its currency starts devaluating, this brings automatic losses to international investors of local issues, while the USD-denominated debt may not react too much if the credit risk of the issuer did not change significantly. Investors may try to hedge their exposure to this FX component, but that may not be cheap or easy. Third, countries that default choose in the past to treat differently these two types of issues. This perception creates a further segmentation between these two types of issues.

Even with these limitations, we expect to see some relationship between local and G4-denominated spread risk factors. Figure 18 shows that the correlations are by in large positive, but relatively small. They tend to be larger for the major emerging market issuers such as Argentina, Brazil, or Mexico (about 40%). Interestingly, the correlation is less clear for the more “developed” list of countries, like South Africa, Chile, or Malaysia.

Figure 18: Correlation between G4 and Local Denominated Country Risk Factors (May 2009)



Source: Barclays Capital

The reason for the lower correlations shown above can be found on the limitations of this comparison. In particular, for international investors, the comparison is only complete when we overlay to the analysis the FX component.

To accomplish this, we propose the following exercise. Suppose we have two bonds from a particular country, one denominated in USD the other on the local currency. Moreover, suppose the bond has 5 years of duration, a spread of 5% and that our potential investor has the USD as the base currency. Then:

- The USD-denominated bond is exposed to two systematic risks (we ignore idiosyncratic risk in this exercise): USD yield curve and the bond's spread over this curve, captured by our G4 DTS country factor. The systematic return from our risk model point of view would be:

  $$R^{USD} = OAD \times F^{YC-USD} + DTS \times F^{DTS} = 5F^{YC} + 25F^{DTS}$$

  Where F^{YC-USD} is the (USD) yield curve risk factor and F^{DTS} the DTS country factors.

- From the point of view of our investor, the local denominated bond is also exposed to two systematic risk factors: The foreign exchange risk (FX) and the local curve risk. In terms of our risk model:

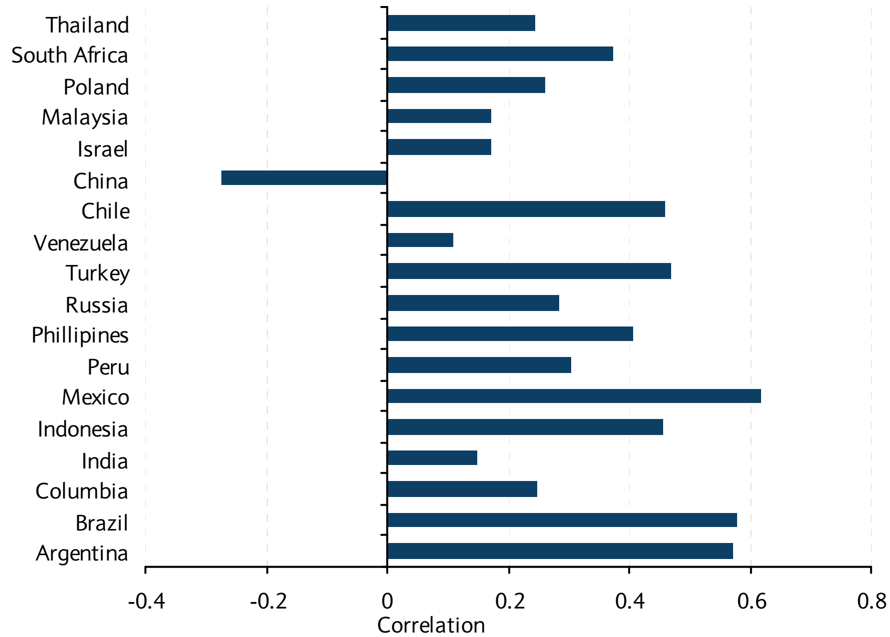
  $$R^{local} = F^{FX} + OAD \times F^{YC-local} = F^{FX} + 5F^{YC-local}$$

  Where F^{FX} is the foreign exchange risk factor.

Note that these two return series are somewhat related to what is shown in Figure 18. In particular, in this figure we show the correlation between F^{DTS} and $F^{YC-local}$. We now complete the analysis by showing the correlation between R^{USD} and R^{local}. This is done in

Figure 19. Note that the correlations are now higher, on average, and the pattern is also much cleaner than what we had in Figure 18. We have now correlations that average 30% and that are significantly higher for major issuer countries. The only exception seems to be China, where the relationship is actually negative. This may be due to currency management or trading restrictions put in place by the Chinese authorities.

Figure 19: Correlation between G4 and Local Denominated Country Risk Factors (May 2009)



Source: Barclays Capital

The evidence presented suggests that our risk model does capture in a meaningful way the correlations across risk factors relevant to the emerging market world. Up to now, the analysis included only the systematic risk component. However, the integration does not stop here. Both idiosyncratic and default risk are also fully integrated within issuer, independently of the type of debt it is issuing.

With regard to idiosyncratic risk, our risk model does consolidate all issues from the same issuer into one single issuer risk number. Specifically, we assume the idiosyncratic risk of bonds from the same issuer that are denominated in different currencies to be correlated. Therefore, investors are not fully diversifying away their idiosyncratic risk by adding issues from emerging market issuers they already have in their portfolio, independently of currency of issuance.

The default risk of two bonds from the same emerging market issuer is also fully integrated and reported in a single number. Here again, we assume that the correlation of defaults within bonds from the same issuer is one, independently of currency of issuance. In short, we assume that once an issuer defaults in one bond, defaults in all bonds[7].

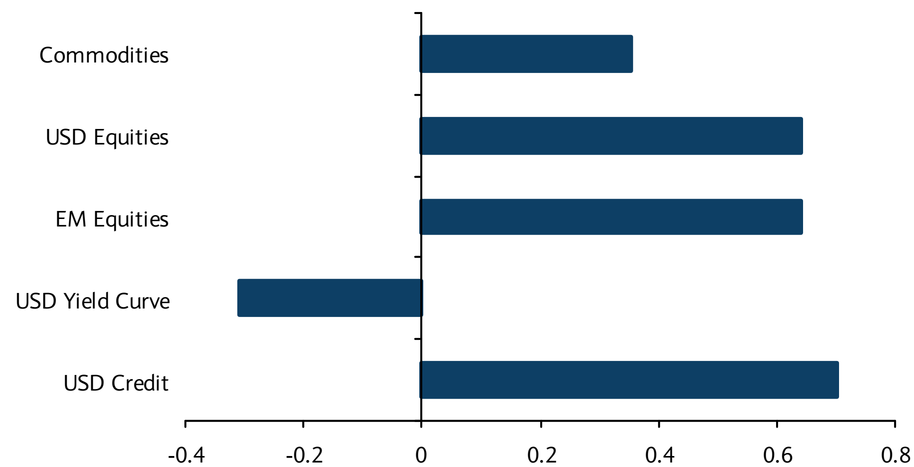
[7] As discussed above, countries may choose to default only on a partial set of bonds. This is uncommon and virtually impossible to anticipate. Therefore, we assume that once defaulted in one bond, the issuer defaults on all.

6. Correlation with Other Asset Classes

In the Global Risk Model (GRM) in POINT, all the different asset classes are fully integrated to deliver a consistent, aggregate picture of risk exposures. The integration works with the different dimensions of risk, namely systematic and idiosyncratic. In this section, we illustrate how the new emerging markets risk model interacts with other major asset classes covered by the GRM.

Figure 20 shows the correlation between the DTS regional factor for the Americas and factors from other major asset classes. The results from the regional factors for Asia and EMEA (Europe, Middle East, and Africa) are similar. The figure shows that correlations are very high for both USD and emerging market equities and also for USD credit. The high numbers are somewhat driven by the crisis in the fall of 2008, but are still high (though about 5 to 10 percentage points lower) when we exclude that period (not shown). The negative correlation with the USD yield curve is very much in line with what we see for other USD-denominated spread products, like USD credit. The correlation with commodities is also high, at about 35%. This may seem intuitive, as a number of emerging market countries are major producers of commodities. However, a closer look at the relationship shows that the high correlation is a recent phenomenon, exacerbated by the sharp decline of these two asset classes during the crisis of 2008. If we exclude this period, correlations are driven down close to zero.

Figure 20: Correlations between the America's Regional DTS Factor and Factors from other Major Asset Classes (May 2009)



Source: Barclays Capital

7. Back-testing Our Model

In this section we present the results from the back-testing of our model. Our back-testing covers the period from December 2002 to May 2009.[8] This is an interesting period to use, as it covers very different market conditions (Figure 8). In the beginning of the sample period, we have the high volatility associated with the 2001/02 crisis. This environment is repeated at the end of the sample. In the middle, we have a period of exceptionally low levels of volatility and spreads.

[8] December 2002 is the first date for which the covariance matrix is available fully integrated with the other asset classes.

Emerging markets debt is an especially hard asset class to model, given the abrupt nature of the changes in its market conditions. Moreover, there is limited availability of historical data: good pricing data on a reasonable cross-section of countries is available only from the late 1990s. These two conditions make it especially hard to conduct extensive out-of-sample testing of our model: it is generally hard to reject the hypothesis that our model produces unbiased risk forecasts, even if the point estimates from the bias test (see below) seem significantly off target, In light of these considerations, we decided to limit the tests presented here to the broad market portfolio. In particular, we look into the behavior of the Barclays Capital US Emerging Markets Index monthly total return. The analysis of this index allows us to understand the broad fit of our volatility model. Then, we analyze the excess returns of the index – its spread return – to test directly the spread DTS risk factors in our model. This example is potentially closer to the setting portfolio managers usually work in. Before doing that, we briefly describe the framework used to conduct the tests.

The Framework

The general framework we use to evaluate the performance of the model is quite standard, and is generally known as the ratio/bias test. For each period *t* and portfolio *p*, we construct a standardized return - u_p^t - that is the ratio of the actual return during that period - r_p^t - to the predicted volatility of that portfolio for that period - $\sigma_{p,forecast}^t$. Specifically:

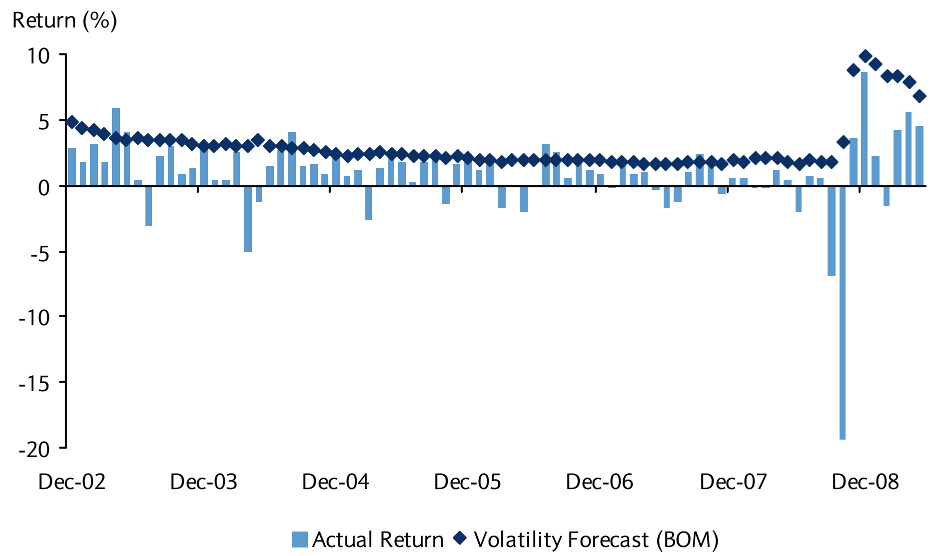
$$u_p^t = \frac{r_p^t}{\sigma_{p,forecast}^t}$$

If the forecast is good on average, the volatility of this ratio should be close to 1. The test statistic is somewhat less revealing if the distribution of the standardized returns is fat-tailed. Unfortunately, this is the case for the majority of the tests we performed within this asset class. As we show, the bootstrapped intervals of confidence regarding some of these ratios can be substantially wide. In what follows, we therefore try to complement the analysis of this statistic with other observations.

Barclays Capital USD Emerging Markets Index

Our first test focuses on the forecasted volatility for the Barclays Capital USD Emerging Markets Index. In particular, Figure 21 shows both the actual return and the forecasted volatility (the two inputs used to calculate the standardized return) for the testing period.

Figure 21: Actual Returns and Forecasted Volatility (BOM: Beginning of Month) for the Emerging Market Index – December 2002 to May 2009

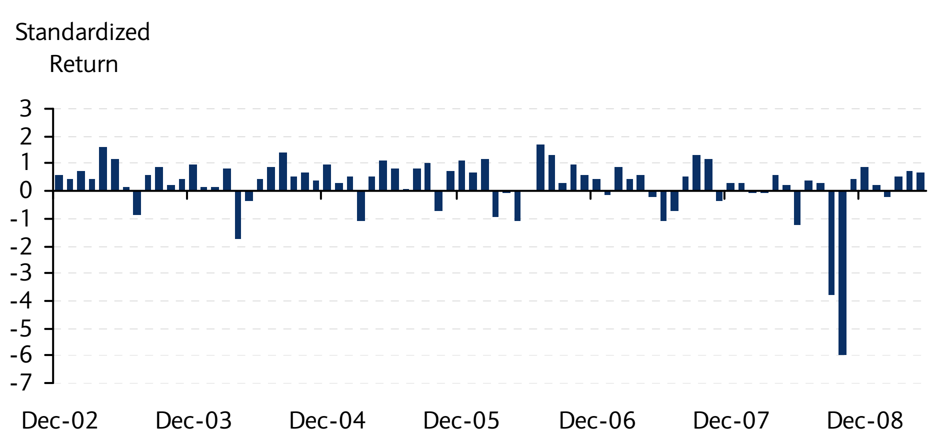


Source: Barclays Capital

The figure illustrates some interesting points. First note that the model reacts fast to changes in underlying conditions. For instance, forecasted volatility jumps to 8.8% from 3.2% during October 2008, driven by an extreme realization of -20% in the index. Second, the forecasted volatilities seem to reach a floor at about 1.5%-2%, during the very calm period of 2007 and beginning of 2008. The analysis on excess returns we perform later in this section seems to suggest that this floor is driven by the interest rate risk associated with the index.

Figure 22 shows the ratio of the two series presented in Figure 21 – the standardized returns. In particular, it is interesting to note how violent the events from last year were. Although not unprecedented (Figure 8) these events cannot be fully accounted for by our model, resulting in returns 4 to 6 times their ex-ante prediction. Part of this behavior is explained by the long period of extremely calm markets that precede the current crisis.

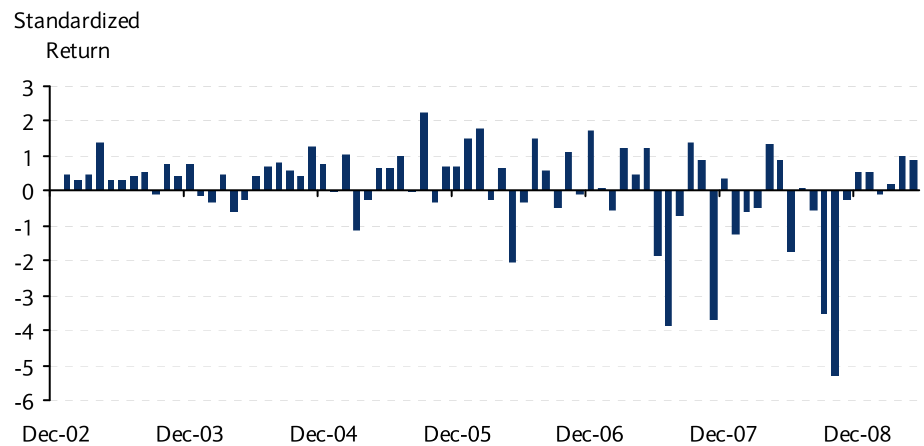
Figure 22: Standardized Returns for Emerging Market Index – December 2002 to May 2009



Source: Barclays Capital

In Figure 23 we take a look at the standardized returns but applied to the excess (not total) returns. We can see that observations are more extreme. This is mainly driven by the fact that forecasted volatilities are significantly lower for excess return.

Figure 23: Standardized Excess Returns for Emerging Market Index – December 2002 to May 2009



Source: Barclays Capital

We can now calculate the statistics for these two standardized series and compare their properties. Figure 24 shows the results, illustrating the difficulty in evaluating forecasts for this asset class, even at a very aggregate level. Let's start with the standard deviation of the standardized returns. The discussion above suggests this value should be close to one. Figure 24 shows that the forecasts for both series easily pass this test. However, this happens because of the high uncertainty we have for this statistic. The intervals of confidence – constructed from bootstrapping the standardized returns – are quite wide. The picture is better when we exclude the observation from October 2009, but the general uncertainty remains.

Figure 24: Summary Statistics for the Standardized Returns of the Emerging Market Index – December 2002 to May 2009

	Standardized Returns	
Statistic	Total Return	Excess Return
Standard Deviation	1.07 [0.62-1.54]*	1.26 [0.89-1.62]*
Standard Deviation (without October 2008)	0.81 [0.59-1.09]*	1.10 [0.82-1.40]*
Skewness	-3.27	-1.76
Kurtosis	15.58	5.40
5% Percentile	-1.08	-2.07
95% Percentile	1.31	0.73

Note: * Numbers in the squared brackets are the bootstrapped 95% interval of confidence for the standard deviation.
Source: Barclays Capital

The other statistics also present the case for a distribution that is significantly different than normal, with extreme kurtosis and negative skewness, driven by infrequent but extreme (negative) events. Although consistent with what we see in other asset classes (e.g., credit and equities), these results are somewhat more extreme.

Overall, the new emerging market model seems to produce good volatility forecasts that adjust quickly to changing environments. This model is a significant enhancement to our quantitative model's offering. Emerging market portfolio managers now have a more flexible and comprehensive tool to help them manage their portfolios.

8. Conclusions

In this paper, we present the new emerging markets risk model available through POINT. It has a simple, yet robust framework that performs well in our back-testing. The model captures quick changes in the environment extremely well, as illustrated by its performance over the past year.

The model dedicates specific risk factors to many individual countries, thereby ensuring a good characterization of the portfolio and its diversification across countries and regions, spread or duration levels. The model is also very detailed in its treatment of idiosyncratic and default risk. These can constitute substantial portions of the risk in particular portfolios. As with all our models, the new emerging markets model is fully integrated with other asset classes, which allows POINT to give a complete picture of emerging markets risk in isolation or within the context of a portfolio that spans multiple asset classes.

We believe the risk model report can substantially enhance the analytical understanding managers have of their portfolios, contributing to better portfolio construction and more informed decisions about rebalancing. The report is very flexible, allowing clients to tailor the output along relevant dimensions. Moreover, the risk model is fully integrated with the other components of POINT, such as the optimizer and the scenario analysis, resulting in a powerful tool for portfolio managers in every step of the investment process.

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