Sovereign rating transitions and the price of default risk in emerging markets*

Alena Audzeyeva[a,**] and Klaus Reiner Schenk-Hoppé[a,b]

25 May 2007

[a] Leeds University Business School, University of Leeds, Leeds, LS2 9JT, UK.

[b] School of Mathematics, University of Leeds, Leeds, LS2 9JT, UK.

ABSTRACT

This paper introduces an expected value estimator with "expert knowledge" to the robust estimation of sovereign rating transitions which are characterised by few observations. Our estimates of default premia within Mexican, Colombian and Brazilian Eurobond yield spreads provide a better fit than 'cohort' and continuous-time observation approaches. The analysis suggests that default risk accounted for a rather small share (decreasing with maturity) of the yield spreads for non-investment grade Colombian and Brazilian Eurobonds in 2003. This share increased while yield spreads fell during 2003-2005 mainly due to non-default risk factors. Default and liquidity premia for investment-grade Mexican spreads both decreased at similar rates.

JEL classification: G15, C11, F34

Keywords: Emerging markets, sovereign default, rating transitions, yield spreads, default premia

* We thank Denis Dadimov for excellent technical assistance. Financial support by the National Centre of Competence in Research "Financial Valuation and Risk Management" (NCCR FINRISK) is gratefully acknowledged.

** Corresponding author. Tel.: +44 (0) 789 99 016; fax: +44 (0) 113 343 4459.
E-mail addresses: A.L.Audzeyeva@leeds.ac.uk; K.R.Schenk-Hoppe@leeds.ac.uk.

1. Introduction

The construction of a sovereign rating transition matrix requires accurate estimators of rating transition probabilities and probabilities of default. Robust estimation is particularly hard if there is a short history of rating transitions, as is the case with emerging market sovereign borrowers (Hu, Kiesel and Perraudin, 2002). Traditional maximum likelihood estimators, which have valuable large-sample properties, can be heavily biased in small samples. These estimators maximise the probability of observing data points from the dataset used for parameter estimation and, as a consequence, might depend considerably on the characteristics of the noise in the data and inadequately describe the underlying transition process.

This paper suggests a solution to this problem based on a Bayesian approach which allows the use of a priori information in the model of sovereign rating transitions. The probability of rating transitions is estimated using the expected value estimator that takes into account the probability mass distribution of the true parameter value in contrast to the maximum likelihood estimator.

There are several approaches (some widely used in practice) to constructing a rating transition matrix. Rating agencies Moody's and Standard & Poor's employ a discrete-time 'cohort' approach which determines the probabilities of one-year rating migrations and default as the average fraction of borrowers that held a particular rating at the beginning of a period. Robustness typically fails if few sovereign ratings transitions are observed. The 110 countries rated by Standard & Poor's accumulated 1,040 annual observations over the 20 year-period 1985-2005, with only 225 rating transitions within the system of 18 fine-letter rating classes[1]. Approximately 70% of observations in this sample belong to the investment grade borrowers and only 30% to obligors classed as non-investment grade (Appendix A). In contrast, the dataset of rated U.S. industrials employed by Lando and Skødeberg (2002) includes 6,659 firms with a

[1] Source: Standard & Poor's (2006b) and authors' calculations (excluding private Standard & Poor's ratings and migrations from the state of default).

total of 11,606 transitions within the 18 fine-letter rating classes in 1981-1997. In order to enlarge the sovereign rating transition dataset, Hu, Kiesel and Perraudin (2002) develop the ordered-probit framework that allows mapping a country's macroeconomic, solvency and liquidity data into credit ratings resembling those of Standard & Poor's. Their method adds 732 observations over the period 1981-1998. Lando and Skødeberg (2002) introduce an estimation based on continuous-time observations that incorporates information on exact waiting times spent by a borrower in each rating category before a transition occurs. For sovereign borrowers this technique adds very little information due to the scarcity of rating transitions which is further exacerbated by the stability of sovereign ratings.

A Bayesian approach allowing the introduction of "expert knowledge" into the model is employed here to tackle the problem of scarcity of sovereign rating transitions. In addition, an expected value estimator is applied to find the probabilities of rating transitions. This method yields rating transition matrices with a larger number of positive off-diagonal transition probabilities than other discrete-time approaches. Empirical tests establish that our expected value estimate improves the fit provided by the maximum likelihood-type estimates when used as an indicator of default risk in the pricing of emerging market Eurobonds. A 'reality check' shows that, in contrast to the maximum likelihood-type estimates, our estimate produces realistic values of the default premium along the maturity spectrum for all countries and time periods tested. The empirical part of this paper investigates the size of the default premium within the yield spreads of lower investment grade Mexican and non-investment grade Colombian and Brazilian sovereign Eurobonds along the maturity spectrum. We also analyse the contribution of the factors determining the default premium and the residual risk premium in the fall of emerging market yield spreads during 2003-2005.

Empirical studies of the emerging market debt are based on two types of data whose dynamics differ: primary market prices of individual bonds and secondary market prices represented by the emerging market indices. Though index data are widely used, they limit the scope of the analysis because they do not allow tracking changes in the yield spreads at varying maturities as each country's index is characterised by a specific duration (the average duration of the issuer's outstanding debt instruments included in the index). Eurobond maturity at issue typically varies between 5 and 30 years, which implies that the roles of fundamentals versus global liquidity factors are likely to differ at the short and long ends of the maturity spectrum. Here secondary market prices of individual Eurobonds are employed. For each borrower, we estimate daily zero-coupon yield spreads of various maturities from May 2003 to December 2005 and decompose the yield spreads into two components: default and non-default risk premia. Our empirical analysis reveals that the default premium represented a rather small share of the non-investment quality yield spreads of Colombia and Brazil in 2003. This share increased considerably over time with the change being the most pronounced at short maturities. The fall in the Colombian and Brazilian yield spreads as well as the rise in the fraction of the default premium within the spread appear to be mainly driven by a sharp decline in the risk premia of both countries. The situation differs for investment-grade Mexican bonds in that the share of the default premium in Mexican spreads did not change significantly over the period under consideration because the yield spread and the default premium within the spread declined at roughly identical rates at most maturity horizons. An improvement in both the credit quality of Mexican Eurobonds and the non-default risk factors appears to have played a significant role in the reduction of the Mexican yield spread during 2003-2005. The fraction of the default premium tends to be consistently smaller at longer maturities for all three countries.

An on-going shift in the investor base of the emerging market bonds can explain a considerable and continuous decline in the risk premia and, hence, in the yield spreads of the emerging market Eurobonds over the period 2003-2005. Further research is needed to access directly the impact of the global liquidity factors on the risk premium within emerging market spreads of various maturities and for borrowers of different credit quality.

Section 2 presents our approach to rating transition estimation based on a small data sample. The data sample is described in Section 3. Section 4 explains the Eurobond pricing model. Our empirical test results and a 'reality check' are presented in Section 5. Section 6 offers the analysis of the default and non-default risk components of sovereign Mexican, Colombian and Brazilian Eurobonds. Section 7 concludes. The appendices contain additional figures and data. Supplementary material is available at www.schenk-hoppe.net/sovereign/.

2 A Bayesian Approach to the Estimation of Sovereign Rating Transitions

2.1 The expected value estimator of sovereign rating transitions

A Bayesian approach is used in the estimation of sovereign rating transitions with few observations. Consider a vector of transition probabilities, θ_i, where each element θ_{ij} denotes the probability that a borrower who is currently rated i will have rating j in the next period. There are K rating categories, and category K denotes the state of default. Using the multinomial distribution, the probability of observing a vector n_i of counts of observed transitions from initial rating i to each rating category j is:

$$p_i(n_i \mid \theta_i) = \frac{\left(\sum_{j=1}^{K} n_{ij}\right)!}{\prod_{j=1}^{K} n_{ij}!} \prod_{j=1}^{K} \theta_{ij}^{n_{ij}} \qquad (1)$$

Our aim is to estimate the probabilities of rating migrations θ_{ij} conditional on counts of the observed transitions n_{ij}. If there are too few observations, the probability density of the true parameter value might not be concentrated in the vicinity of the maximum likelihood estimate, i.e. such an estimate does not account for skewness and asymmetry of the probability function (e.g., MacKay (2003), p. 306). Here we apply an expected value estimator as a point estimator of rating transitions that takes into account the probability mass distribution. This will result in smoothing of the rating transitions by letting the transition probabilities to “spill out” from the states with the positive number of transitions into the states with no observed transitions. The solution is computationally feasible and can be used as an input into any asset pricing or credit risk model with exposure to the emerging market credit risk.

The Dirichlet distribution is employed as the prior distribution of the transition probabilities θ_{ij} since it is the conjugate prior for the parameters of the multinomial distribution. This prior can be interpreted as additional data. The probability density of rating migrations conditional on counts of the observed transitions and the expectation of the transitions from a given initial state are given by Gelman et al. (1995), pp. 476-477:

$$p_i(\theta_i \mid n_i) = \frac{\Gamma\left(\sum_j (n_{ij} + \alpha_{ij})\right)}{\prod_j \Gamma(n_{ij} + \alpha_{ij})} \prod_j \theta_{ij}^{n_{ij}+\alpha_{ij}-1} \qquad \text{and} \qquad E(\theta_{ij}) = \frac{n_{ij} + \alpha_{ij}}{\sum_j (n_{ij} + \alpha_{ij})}. \qquad (2)$$

Here α_{ij} are parameters of the Dirichlet distribution. The obtained expected value estimator of rating transitions takes into account the probability mass distribution of the true parameter value. Our estimator can be used in the estimation of rating transitions for any small group of borrowers such as a specific industry group within the corporate sector. [2]

2.2 Introducing "expert knowledge" into the estimation

The parameters α_{ij} are interpreted as a priori information ("expert knowledge"), which can be incorporated into the estimation of sovereign rating transitions. They describe the parts of the parameter space not covered by the observed transitions and also determine the smoothness of the estimator. Two approaches are applied to define plausible (but unrealised) transitions by assigning values to α_{ij}. A *noninformative* prior is defined by setting $\alpha_{ij} = 1, i \neq K$ for both coarse-letter and fine-letter rating transition matrices. This prior assumes a (small) positive probability that a country starting a period in any rating category can migrate into any other rating category by the end of the period. The structure of such transition matrix resembles that of the one-year corporate transition matrix estimated from continuous-time data (Lando and Skødeberg, 2002) as all elements in both types of matrices are positive. An *informative* prior is defined by $\alpha_{ij} = 1$ for $j = i, i \pm 1, i \pm 2, i + 3, i + 4$ and $\alpha_{ij} = 0$ for $i - 2 < j > i + 4$ within the

[2] Industry effects are found significant in Nickell et al. (2000).

system of 8 coarse-letter rating categories. For the rating category AAA we let $\alpha_{ij} = 1$ for $j = i, i+1, i+2$ and $\alpha_{ij} = 0$ for $j > i+2$. This prior takes into account the empirical fact that the sovereign ratings tend to be more stable over time than the corporate ones (Standard and Poor's, 2006a; Moody's Investors Service, 2006), and it limits added transition counts to near-diagonal rating categories. We observe that for a one-year period, on average, migrations up the rating scale by one coarse category are recorded for each of the rating categories in the S&P sample and there have been observed transitions down the rating scale by three coarse rating categories from at least two rating categories. During the whole sovereign rating history just one country has been downgraded by four coarse rating categories during one year. Given the small data sample, similar migrations could potentially happen from other rating categories. When estimating the fine-letter transition matrix, the *informative prior* is such that it matches the one for the coarse-letter case.

The expected value estimate of sovereign rating transitions based on the *informative* prior has a similar structure to the one-year corporate rating transition matrices, which have a greater number of positive off-diagonal transition probabilities than the sovereign transition matrices estimated using traditional discrete-time approaches. Our estimations are all based on the published S&P sovereign rating transition history for foreign currency denominated bonds from 1985 to 2005 (Standard and Poor's, 2006b). The annual cohorts are compiled on the 1st of July of each year. The coarse- and fine-letter expected value estimates of rating transitions based on the *informative* and *noninformative* priors are provided in Appendix B.

The expected value estimate of sovereign rating transitions is compared with the continuous-time approach by Lando and Skødeberg (2002). Sovereign rating transitions are re-estimated with maximum likelihood based on discrete-time annual observations because S&P rating transitions data include private ratings which are not part of the published data sample. (The one-year rating transition matrices are available at www.schenk-hoppe.net/sovereign/). A list of sovereign rating transitions estimates considered in the present study and their abbreviations follows.

Abbreviation	**Explanation**
NA	Not adjusted for default risk
S&P coar	S&P coarse-letter transition matrix (Standard and Poor's, 2006a)
HKP coar	Hu, Kiesel and Perraudin (2002) coarse-letter transition matrix
ML coar	The maximum likelihood estimate of the coarse-letter transition matrix
Cont coar	Probabilities of transitions between the coarse-letter rating categories estimated using the Lando and Skødeberg (2002) continuous-time method
EV coar inf	The expected value estimate of the coarse-letter transition matrix based on the *informative* prior
EV coar noninf	The expected value estimate of the coarse-letter transition matrix based on the *noninformative* prior
S&P fine	S&P fine-letter transition matrix (Standard and Poor's, 2006a)
HKP fine	Hu, Kiesel and Perraudin (2002) fine-letter transition matrix
ML fine	The maximum likelihood estimate of the fine-letter transition matrix
Cont fine	Probabilities of transitions between the fine-letter rating categories estimated using the Lando and Skødeberg (2002) continuous-time method
EV fine inf	The expected value estimate of the fine-letter transition matrix based on the *informative* prior
EV fine noninf	The expected value estimate of the fine-letter transition matrix based on the *noninformative* prior

3. The Data

Our data sample consists of 678 daily observations of the secondary market gross prices of each of internationally traded Eurobonds issued by three sovereign borrowers: Mexico, Colombia and Brazil. The number of each country's Eurobonds in our sample varies from 10 to 23 during the period analysed. The pricing data are from 1 May 2003 to 31 December 2005. The period is chosen to ensure that there are at least 10 straight liquid bonds of each issuer available to estimate a zero-coupon yield curve for each date in our sample. Only coupon bonds with a fixed and regular coupon payment and no options, guarantees or other special conditions attached are included. Before mid-2002 too few bonds of each issuer that satisfy these conditions were traded on the market and, in order to avoid the effects of the October 2002 Brazilian presidential elections, our sample starts in May 2003.

Eurobonds included in our sample satisfy the following conditions. They are all U.S. dollar denominated with the minimum amount at issue USD 400m to ensure the sufficient liquidity. The bond maturity varies from 1 to 30 years. The Eurobond issuers come from the same region and belong to different rating classes at the lower end of the rating scale. The sample is divided into two sub-periods of similar length, excluding a 34-day period in between. The beginning of the second sub-period coincides with an upgrade in the Brazilian credit rating to the next coarse-letter category from B+ to BB-. This avoids uncertainty related to defining the moment when the market priced the new rating into Brazilian bonds. Several empirical studies (e.g. Cantor and Parker, 1996; Reisen and von Maltzan, 1999) suggest that the market anticipates the change in a borrower's credit rating by incorporating a new rating into bond prices around one month in advance of the actual rating change. Another rating change in our sample occurred to Mexico whose sovereign rating was upgraded by 1 notch within the same coarse-letter rating category.

In the first sub-period the three countries represent three different coarse-letter rating categories: BBB, BB, and B. Mexico is rated BBB-, the lowest investment grade rating, in the first sub-period. Then it is upgraded to BBB during the second sub-period. Colombia has higher non-investment grade BB rating during both sub-periods. Brazil is rated B+ in the first sub-period, then upgraded just prior to sub-period II and rated BB- in the second sub-period.

All the emerging Eurobond prices as well as the daily gross prices of the liquid on-the-run U.S. Treasury bonds are collected from Datastream. The U.S. on-the-run treasuries include bonds with maturity of 10 years or less to ensure consistent liquidity of the U.S. sample. We also exclude prices of the emerging market and U.S. Treasury bonds that have shorter maturity than one year.

4. Empirical Bond Pricing Model and Yield Spread Decomposition

This section uses the estimates of rating transitions explained earlier as a measure of default risk in the Eurobond pricing to (a) assess the performance of these estimates and (b) to evaluate the default-risk component within the sovereign yield spreads at different maturity horizons.

At the first stage, the gross prices of U.S. treasury bonds and emerging markets Eurobonds are fitted using equation (3) to find the initial, or non-adjusted (NA) zero-coupon yield spreads, estimated as the difference between the non-adjusted zero-coupon yield of an emerging market Eurobond and U.S. zero-coupon bond yield of equal maturity. Let V_{tn} be an observed gross price of the *n*-period bond with a fixed regular coupon payment C and a par value of 100 US dollars. The gross price of a bond is equal to its market price plus an accrued interest from the next coupon payment. Following the no-arbitrage rule, the gross price of a bond can be expressed as the sum of the present values of the promised coupon payments and a par value at maturity. All are discounted by the real, as opposed to risk-neutral, discount factors that incorporate the investors' expectations about the "riskiness" of a bond.

$$V_{tn} = \sum_{s=1}^{n} CD_{ts} + 100D_{tn} \qquad (3)$$

with D_{ts} the *s*-period discount factor at time *t*. The discount factor reflects the risk of default and risk premium in the case of defaultable sovereign bonds; and it is assumed to be default risk-free when the model (3) is applied to valuation of the US Treasury bonds. Nelson and Siegel (1987)'s parsimonious function is employed for the discount factor. Following Perraudin and Taylor (2003), the risk of default is incorporated in the valuation of the emerging market Eurobonds by using the pricing model for the defaultable bonds:

$$V_{tn} = \sum_{s=1}^{n} \left[C\left(1-\widetilde{P}_s\right)+100aP_s\right]D_{ts} + 100\left(1-\widetilde{P}_n\right)D_{tn} \qquad (4)$$

Here P_s is the probability that the Eurobond will not default in periods from 1 to $(s-1)$ but defaults in period s. $\widetilde{P}_s$ is the probability that the Eurobond will default in period s or earlier.

The rate of recovery in the case of default a is assigned a constant value of 54% (an average for sovereign issuers estimated by Moody's Investors Service (2006)).

Sovereign bond ratings are used as measures of default risk in the spirit of the reduced-form of models of defaultable debt. Jarrow, Lando and Turnbull (1997) assume that the bond credit rating indicates the likelihood of default, i.e. the default rate is determined by a finite number of states associated with its credit rating. It is also assumed that a bond rating transition over a fixed period of time is governed by a finite state space Markov chain with time-homogenous probabilities. The default state is absorbing.

The probability of default at various time-horizons is calculated on the basis of the one-year rating transition matrices estimated using the two discrete-time approaches–traditional 'cohort' and Hu, Kiesel and Perraudin (2002)–together with the Lando and Skødeberg (2002) continuous observations approach and the suggested expected value approach detailed in Section 2. Then, model (4) is fitted to the gross market prices of the sovereign defaultable bonds to estimate daily zero-coupon default-adjusted yield curves for each emerging market country in our sample.[3] After the parameters of the models (3) and (4) are estimated, the yield spread on sovereign defaultable bonds can be decomposed into two components: the default premium and the residual risk premium due to non-default risk factors[4]. The default premium is estimated as the difference between the initial non-adjusted yield spread and spread adjusted for the expected loss from default of the same maturity. The yield spread adjusted for the risk of default represents the risk premium.

---

[3] Models (3) and (4) are fit using a nonlinear least squares method which employs the sequential quadratic programming procedure from MATLAB.

[4] The residual risk premium mainly reflects the global liquidity conditions and investors' attitude toward risk. See Eichengreen and Mody (1998), Kamin and von Kleist (1999), Ferrucci (2003), and Kashiwase and Kodres (2005) among others for a detail discussion of the determinants of the emerging market yield spreads.

5. Estimation Results

5.1. Ranking of sovereign transitions estimates

We estimate daily non-adjusted and default-adjusted zero-coupon yield curves for each borrower using both the coarse- and fine-letter rating transitions matrices as measures of default risk. The Kolmogorov-Smirnov test (which checks the difference in error distributions for statistical significance) is applied to the sets of daily root mean squared errors obtained as a result of the estimation procedure based on various measures of default risk. The goodness-of-fit statistics is used to judge the performance of the estimates of rating transitions. For different estimates of sovereign rating transitions in the default-adjusted yield curve fitting procedure, the fitting error is calculated as the difference between the actual and model bond prices for each bond on each date in our sample and the square root of the mean squared error (MSE) on a daily basis. Then, for each estimate, the distribution of the daily square root MSEs is compiled. The median square root MSE resulted from fitting the non-adjusted yield curves of all three countries is from \$0.83 to \$1.43 per \$100 face value of a bond. These are of a similar magnitude to the average square root MSEs of \$1.1 to \$1.6 found in the Elton et al. (2001) study for U.S. corporate BBB-rated bonds. The median root MSEs related to the fitting the default-adjusted yield curves are generally smaller.

The Kolmogorov-Smirnov test is applied to the pairs of distributions of the square root MSEs, separately in each sub-period first and then for the whole period to ensure consistency of our results. The test indicates whether these distributions are statistically different from each other at the 5% significance level and, if so, shows the sign of the difference. “0” means that, at the 5% significance level, the error distribution from the current rating transitions estimate does not differ from the one in the next row of the table, while “1” indicates that the current estimate provides a superior fit. Table 2.1 presents the results, which are robust with regard to the sub-periods chosen.

The Kolmogorov-Smirnov test shows that the *EV inf fine* estimate provides the best fitting performance. *EV inf fine* also produces the smallest median square root MSE for most countries and sub-periods considered. Only in sub-period I of the Mexican sample, the *HKP coar*, *HKP fine* and *EV noninf fine* estimates produce a superior fit to the *EV inf fine* transition matrix. However, the difference in the median square root MSEs from employing *HKP fine* and *EV inf* fine is just 8 cents in this sub-period. As a result, in the whole Mexican dataset using *HKP fine* results in the best fit and and *EV inf fine* in the second best fit with comparable median root MSEs. Also, in Brazilian sub-period I the *EV inf fine* estimate produces similar fitting results to the *S&P coar* and *ML fine* estimates according to the Kolmogorov-Smirnov test, however, it generates a smaller median root MSE than do the latter two estimates.

The *EV inf fine* estimate is the only one with consistent performance over time and for Eurobonds issued by different countries. *EV inf coar* produces slightly inferior fitting results and offers the best fitting results among the coarse-letter estimates in most periods and country samples. Both fine- and coarse-letter *EV noninf* estimates generally follow the *EV inf* estimates in the ranking of the rating transitions estimates. The *HKP fine* and *HKP coar* estimates performing well in the Mexican sample produce greater fitting errors than coarse-and fine-letter versions of both *EV inf* and *EV noninf* as well as *S&P coar* in the overall Colombian sample. In the entire Brazilian sample, both *HKP* estimates show the worst fitting performance and generate greater median root MSEs than the model that does not account for default risk (*NA*). The *S&P coar, S&P fine, Cont coar* and *Cont fine* estimates are generally on the bottom of the ranking table according to the Kolmogorov-Smirnov test and they produce considerably larger errors than the best performing estimates in most sub-periods.

Pair-wise comparison of the Kolmogorov-Smirnov test results (Table 2.1) for a coarse-letter estimate and the fine-letter estimate based on the same estimation approach shows that only *EV inf fine* consistently produces fitting results that are superior to its coarse-letter counterpart *EV inf coar*. The *EV noninf fine* estimate shows better fitting results than its coarse-letter counterpart in most of the sub-periods. For other pairs of estimates results are mixed or in

Table 2.1
Rating transitions estimates ordered in accordance with the results of Kolmogorov-Smirnov test applied to the fitting errors of the default-adjusted zero-coupon yield curve

Sub-period I			Sub-period II			Sub-periods I and II		
Median root MSE*	Rating transitions estimates	K-S test	Median root MSE	Rating transitions estimates	K-S test	Median root MSE	Rating transitions estimates	K-S Test
Mexico								
0.77	HKP coar	0	0.47	EV inf fine	1	0.67	HKP fine	1
0.78	HKP fine	1	0.51	EV inf coar	0	0.71	EV inf fine	1
0.81	EV noninf fine	1	0.51	EV noninf coar	1	0.69	HKP coar	1
0.85	EV inf fine	1	0.47	HKP fine	0	0.75	EV inf coar	0
0.96	EV inf coar	0	0.59	HKP coar	1	0.75	EV noninf coar	1
0.96	EV noninf coar	1	0.64	ML coar	1	0.72	EV noninf fine	1
1.13	ML coar	1	0.64	ML fine	1	0.86	ML coar	1
1.18	S&P coar	0	0.63	EV noninf fine	1	0.90	ML fine	1
1.17	ML fine	1	0.69	S&P coar	1	0.90	S&P coar	1
1.18	S&P fine	1	0.73	Cont coar	1	0.93	S&P fine	0
1.21	Cont coar	1	0.76	S&P fine	1	0.92	Cont coar	1
1.25	Cont fine	1	0.81	Cont fine	1	0.98	Cont fine	1
1.30	NA		0.83	NA		1.01	NA	
Colombia								
0.80	EV inf fine	1	0.67	EV inf fine	1	0.77	EV inf fine	1
0.80	EV inf coar	1	0.79	HKP coar	1	0.79	EV inf coar	1
0.80	S&P coar	0	0.69	EV inf coar	0	0.80	EV noninf fine	0
0.81	EV noninf fine	0	0.71	EV noninf fine	1	0.80	EV noninf coar	0
0.81	EV noninf coar	1	0.81	HKP fine	1	0.80	S&P coar	1
0.88	ML coar	1	0.72	EV noninf coar	0	0.84	HKP coar	1
0.96	Cont coar	1	0.73	S&P coar	1	0.86	HKP fine	1
1.00	S&P fine	1	0.80	ML coar	1	0.88	ML coar	1
0.98	HKP coar	0	0.87	Cont coar	1	0.94	Cont coar	1
1.00	HKP fine	1	0.90	S&P fine	1	0.97	S&P fine	1
1.03	ML fine	1	0.93	ML fine	1	1.01	ML fine	1
1.12	Cont fine	1	1.00	Cont fine	1	1.10	Cont fine	1
1.21	NA		1.14	NA		1.21	NA	
Brazil								
0.86	EV inf fine	0	0.51	EV inf fine	1	0.60	EV inf fine	1
0.87	S&P coar	0	0.55	S&P fine	1	0.64	S&P fine	1
0.87	ML fine	1	0.57	EV noninf fine	1	0.68	EV noninf fine	1
0.88	EV noninf coar	0	0.58	ML fine	1	0.67	ML fine	1
0.90	EV noninf fine	1	0.63	EV inf coar	1	0.74	EV inf coar	1
0.91	Cont coar	1	0.64	HKP coar	1	0.75	EV noninf coar	0
0.94	S&P fine	1	0.69	EV noninf coar	0	0.75	S&P coar	1
0.94	ML coar	1	0.69	S&P coar	1	0.84	ML coar	1
0.99	EV inf coar	1	0.78	ML coar	1	0.89	Cont fine	0
1.01	Cont fine	1	0.83	Cont fine	1	0.89	Cont coar	1
1.43	NA	1	0.88	Cont coar	1	1.51	HKP coar	1
2.21	HKP fine	1	1.25	HKP fine	1	1.36	NA	1
2.29	HKP coar		1.29	NA		1.56	HKP fine	

*The median square root MSE in this and consequent tables is expressed in U.S. dollars.

favour of the coarse-letter estimates of rating transitions. Our further analysis is therefore based on the *EV inf fine*, *EV noninf fine*, *HKP coar*, *ML coar*, *S&P coar* and *Coar cont* estimates, where one estimate represents each rating transitions estimation approach. We include the *HKP fine* estimate in the analysis of Mexican Eurobonds since it produces the best fit for Mexican Eurobond prices in sub-period I and in the entire period.

5.2 Default premia: a 'reality check'

A 'reality check' is carried out for the absolute and relative values of default premia based on various estimates of rating transitions. The default premia are analysed at four dates: 13.05.03, 09.03.04, 25.01.05 and 13.12.05. The value of the default premium is obtained as the median of the simulated sample[5] of the default premium on a given date. Estimation results are given for 5 and 10-year maturities in Table 2.2.

The absolute value of the default premium implied by the *EV inf fine*, *HKP fine*, and each of the coarse-letter rating transitions estimates is greater for bonds of lower credit quality than for bonds of higher credit quality. The estimates of the default premium incorporated in each country's yield spreads are relatively stable at two dates in each sub-period if the sovereign credit rating is unchanged.

In all periods and for all three countries, which at different times represent three lower-grade coarse-letter rating categories: B, BB and BBB and 5 fine-letter rating categories: B+, BB-, BB, BBB- and BBB, the *EV inf fine* transition matrix produces realistic default premia when used as a measure of default risk. The absolute values of the default premia of Mexico and Brazil based on the *EV inf fine* estimate declined at both maturity horizons in sub-period II

[5] The simulations are performed as follows. First, the maximum likelihood estimates of the parameters of the Nelson and Siegel (1987) model are obtained, which are used to calculate the true bond prices according to Eq. (3) and (4). Second, a random number drawn from the normal distribution is added to the true price of each bond to obtain a new price from the price sample. For each new price a separate optimization is performed to obtain the new model parameters. Finally, the simulated model parameters are employed to find the corresponding spot rates.

Table 2.2
Default premium based on different estimates of sovereign rating transitions

Date		13 May 2003		9 Mar 2004		25 Jan 2005		13 Dec 2005	
Median Root MSE	Estimate Ordering*	Basis points	% of spread	Basis Points	% of spread	Basis points	% of spread	Basis points	% of spread
Mexico		BBB-		BBB-		BBB		BBB	
				5-year maturity					
0.67	**HKP fine**	**77**	**55**	**72**	**62**	29	32	31	48
0.71	**EV inf fine**	79	56	72	62	**47**	**51**	**49**	**75**
0.72	EV noninf fine	91	65	102	87	106	115	106	163
0.86	ML coar	21	15	18	15	14	15	18	28
0.90	S&P coar	7	5	3	3	5	5	7	11
0.92	Cont coar	5	4	5	4	3	3	4	6
1.01	NA	141	100	117	100	92	100	65	100
				10-year maturity					
0.67	**HKP fine**	**101**	**49**	**107**	**62**	72	47	72	67
0.71	**EV inf fine**	88	42	93	53	**75**	**50**	**77**	**71**
0.72	EV noninf fine	100	48	78	45	123	82	126	116
0.86	ML coar	26	13	28	17	28	19	30	28
0.90	S&P coar	18	9	18	11	20	13	19	18
0.92	Cont coar	12	6	9	5	13	9	13	13
1.01	NA	209	100	175	100	150	100	109	100
Colombia		BB		BB		BB		BB	
				5-year maturity					
0.77	**EV inf fine**	**122**	**32**	**127**	**34**	**125**	**42**	**124**	**82**
0.80	EV noninf fine	105	27	108	29	108	36	104	68
0.80	S&P coar	106	27	103	27	101	34	105	69
0.84	HKP coar	219	57	268	71	259	88	265	174
0.88	ML coar	66	17	69	18	68	23	64	42
0.94	Cont coar	45	12	45	12	47	16	44	29
1.21	NA	386	100	377	100	296	100	152	100
				10-year maturity					
0.77	**EV inf fine**	**123**	**28**	**111**	**23**	**126**	**31**	**134**	**53**
0.80	EV noninf fine	103	24	94	20	111	28	112	45
0.80	S&P coar	100	23	91	19	101	25	104	41
0.84	HKP coar	215	50	213	45	247	61	255	102
0.88	ML coar	76	18	73	15	81	20	86	34
0.94	Cont coar	59	14	58	12	58	15	68	27
1.21	NA	432	100	476	100	401	100	251	100
Brazil		B+		B+		BB-		BB-	
				5-year maturity					
0.60	**EV inf fine**	**233**	**33**	**244**	**48**	**190**	**57**	**195**	**95**
0.68	EV noninf fine	157	22	169	34	153	46	154	75
0.75	**S&P coar**	**224**	**32**	**240**	**48**	103	31	104	51
0.84	ML coar	287	41	299	59	67	20	69	34
0.89	Cont coar	259	37	288	57	42	13	46	22
1.51	HKP coar	813	115	845	168	267	80	267	130
1.36	NA	707	100	504	100	333	100	205	100
				10-year maturity					
0.60	**EV inf fine**	**200**	**27**	**188**	**35**	**167**	**39**	**180**	**60**
0.68	EV noninf fine	142	20	131	24	127	29	132	45
0.75	**S&P coar**	**203**	**28**	**192**	**36**	100	23	108	36
0.84	ML coar	235	32	221	41	79	18	85	29
0.89	Cont coar	221	30	218	41	62	14	67	22
1.51	HKP coar	485	67	481	89	232	54	253	84
1.36	NA	732	100	536	100	433	100	301	100

*Rating transitions estimates are ordered in accordance with the Kolmogorov-Smirnov test for the entire country's sample. The best estimates of the default premium in each sub-period are highlighted in bold.

reflecting the upgrades in the credit ratings of Mexico and Brazil. The share of the default premium within the yield spreads of all three countries increased significantly on 13.12.05.

Other estimates, e.g. *HKP fine* and *S&P coarse*, which provide good fitting results for one country or within a specific time period, lack consistency and underperform for other countries or in different time periods. Default premia on 25.12.05, as implied by the *HKP* estimates, are greater than the corresponding yield spreads at both maturity horizons in the Colombian sample and at 5-year maturity in the Brazilian sample. *S&P coar* and *Cont coar* give unusually low default premia within the Mexican sample: 3-20 basis points (3-18% of the yield spread) for both maturity horizons at all four dates. *Cont coar* also implies the existence of very small default premia in the Colombian sample (12-14% of the yield spread on three out of four dates) and in the second sub-period of the Brazilian sample (13-22% of the yield spread) throughout which both countries have a BB coarse-letter rating. On the other hand, it overvalues the default premium of Brazilian Eurobonds when they are rated as B+. Lando and Skødeberg (2002) mention this effect in relation to CCC-C rating categories but our results highlight overvaluation of the probability of default also for a higher rating.

6. Empirical Analysis of the Default and Risk Components of Yield Spreads

The relative importance of the default versus non-default risk components within the yield spreads of Mexican, Colombian and Brazilian Eurobonds is studied in this section. Our findings offer insights into their roles in the major fall in the emerging market yield spreads during the period 2003-2005. The novelty of our study is that we are able to analyse sovereign zero-coupon yield spreads estimated from individual secondary market bond prices at various maturity horizons. We also include only straight coupon bonds with fixed coupon payments and no special conditions attached in our analysis. Previous studies of emerging market bonds use either primary market bond prices[6] or data on emerging market bond indices[7]. The emerging

[6] See, e.g., Kamin and von Kleist (1999) and Eichengreen and Mody (1998).

market bond indices tend to include a number of different instruments such as Brady bonds, loans, U.S. dollar-denominated local market bonds and Eurobonds with fixed and floating coupon payments as well as call-options and other special conditions attached. All these instruments have different structural characteristics and may adhere to altered pricing relationships. Bond indices, which are characterised by the average duration of the instruments included in the index, also do not allow studying the yield spreads of varying maturities.

The zero-coupon yield spread and its default and risk components are estimated, separately in sub-period I and sub-period II, as the median of the corresponding daily time-series at 3- to 20-year maturity horizons. The default premia are expressed in basis points and percentage points of the yield spread in Table 3.1. The plots of the time-series of default- and risk-premium incorporated into zero-coupon yield spreads for each borrower at 5, 10, 15, and 20-year maturities are provided in Figures 1-6. Our estimates of the default premium are based on the *EV inf fine* transition matrix. The only exception is sub-period I of the Mexican sample for which the *HKP fine* estimate is used (Sections 5.1 and 5.2).

Default premium

Our analysis reveals that the default premium constitutes a significant part of the investment-grade Mexican yield spread: 58-37% (decreasing at longer maturities) in both sub-periods (Table 3.1). For the non-investment grade borrowers the default premium represents a smaller fraction of the yield spread in sub-period I: 40% for Colombian and 45% for Brazilian Eurobonds at 3-year maturity coming down to around 20% at 20-year horizon. In sub-period II, the fraction of the default premium increases significantly for Colombian and Brazilian Eurobonds with the change being the most pronounced at short to medium maturities. Further in sub-period II the fraction of the default premium within the sovereign yield spread is higher for the non-investment grade Eurobonds of lower credit quality (Brazil as opposed to Colombia). This is in line with findings by Huang and Huang (2003) and Longstaff, Mithal, and Neis (2005)

[7] See, e.g, Ferrucci (2003) and Kashiwase and Kodres (2005).

for U.S. corporate bonds. However, this fraction is lower for investment-quality Mexican bonds only at 5-year maturity horizon, see Table 3.1. The share of the default premium within the yield spread tends to decline at longer maturity horizons for all three countries.

As in the case of non-adjusted yield spreads, the absolute value of the default premium is higher for bonds of inferior credit quality. The exceptions are default premia of Mexican and Colombian Eurobonds in sub-period I, in which the Mexican default premium is slightly higher at 13 to 20-year maturity horizons despite a superior credit quality of Mexican Eurobonds. This is related to the upward-looking default premium term-structure of BBB-quality bonds as opposed to the humped-shaped default premium term-structures of BB and B-rated bonds, see Figures C.1-C.6 in Appendix C and cf. Elton et al. (2001) who discuss this phenomenon in detail.

Change in default premia between sub-periods I and II

The change in the non-adjusted spread is the most significant for the non-investment grade Eurobonds. From sub-period I to sub-period II the Brazilian yield spread shows the most significant fall among the three countries for all maturities both in terms of absolute value and the rate of change. Its absolute value dropped by 322 basis points (55%) at 4-year maturity horizon and by a smaller value at longer horizons: 161 basis points (25%) at the 20-year maturity (Table 3.2). The Colombian yield spread shows the second biggest absolute decrease: by 136 basis points (37%) at 4-year maturity horizon and 52 basis points (10%) at 20-years maturity. Its relative change at medium maturities is comparable to that of the Mexican yield spread even though Colombia remained rated as BB, whereas Mexican credit rating was upgraded by 1 notch in sub-period II. The absolute change in the Mexican spread is the smallest among the three countries. It fell by 34 basis points (30%) at 4-year maturity with the absolute change rising to 54 basis points (30%) at 8-year maturity and gradually declining to 45 basis points (17%) at 20-year maturity.

The relative contributions of the default versus non-default risk factors throughout 2003-

Time-series of the default premia and risk premia within Mexican, Colombian and Brazilian zero-coupon yield spreads at 5, 10, 15 and 20-year maturity horizons estimated over the period 1 May 2003 – 31 December 2005

Figure 1. Mexican default premia

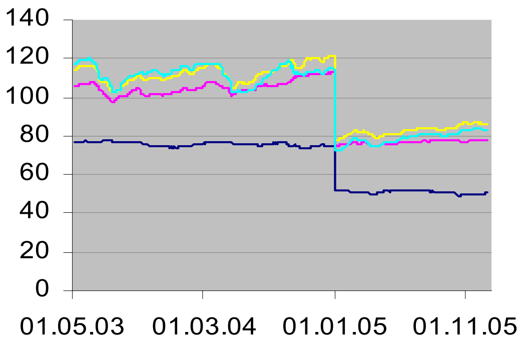


Figure 2. Colombian default premia

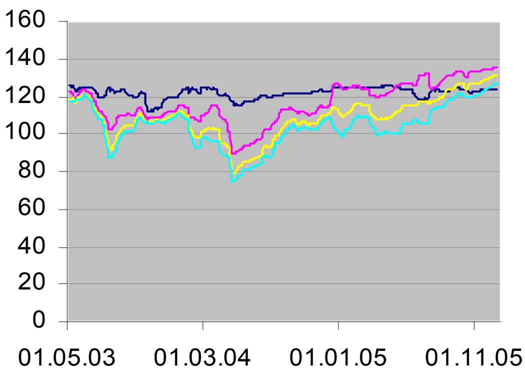


Figure 3. Brazilian default premia

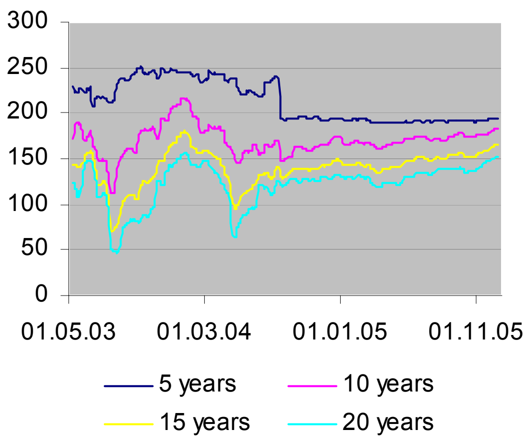


Figure 4. Mexican risk premia

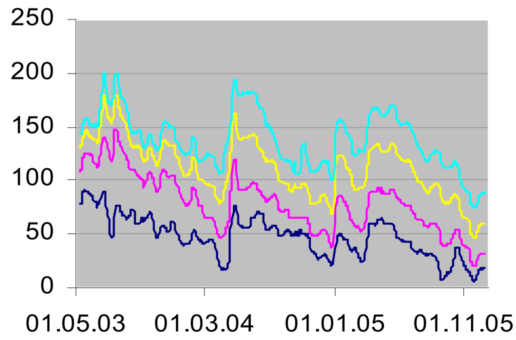


Figure 5. Colombian risk premia

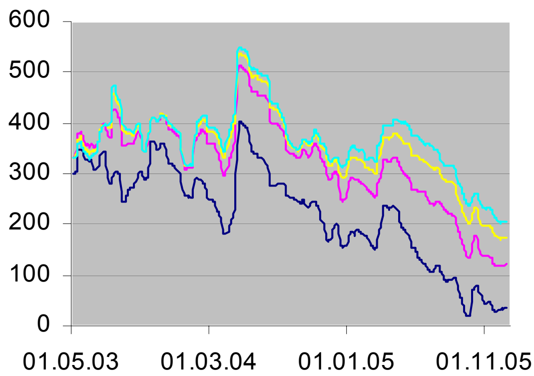


Figure 6. Brazilian risk premia

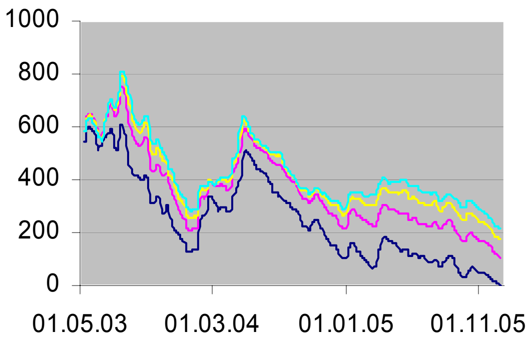


Table 3.1
Median values of the zero-coupon yield spreads and default premia in sub-period I (1 May 2003 – 30 July 2004) and sub-period II (20 September 2004 - 30 December 2005). Yield spreads are in basis points. Default premia are expressed in basis points as well as a fraction of the yield spread

Maturity	**Mexico**			**Colombia**			**Brazil**		
	Yield spread	Default premium	Fraction	Yield spread	Default premium	Fraction	Yield spread	Default premium	Fraction
				Sub-period I					
		BBB-			**BB**			**B+**	
3	93	54	**58%**	274	109	**40%**	513	233	**45%**
4	116	66	**57%**	370	120	**32%**	583	242	**42%**
5	135	76	**56%**	422	121	**29%**	615	237	**38%**
6	151	84	**56%**	453	119	**26%**	636	222	**35%**
7	166	91	**55%**	469	117	**25%**	648	206	**32%**
8	179	96	**54%**	479	114	**24%**	652	192	**30%**
9	191	101	**53%**	486	112	**23%**	655	181	**28%**
10	202	104	**51%**	489	110	**22%**	656	171	**26%**
11	211	106	**50%**	492	108	**22%**	657	162	**25%**
12	220	107	**49%**	493	107	**22%**	654	154	**24%**
13	228	109	**48%**	493	106	**22%**	650	145	**22%**
14	236	110	**47%**	492	105	**21%**	647	138	**21%**
15	242	111	**46%**	494	104	**21%**	645	132	**21%**
16	247	111	**45%**	495	103	**21%**	641	128	**20%**
17	252	112	**44%**	495	102	**21%**	639	124	**19%**
18	256	112	**44%**	496	102	**20%**	638	121	**19%**
19	259	112	**43%**	497	101	**20%**	636	118	**19%**
20	263	112	**43%**	496	101	**20%**	635	115	**18%**
				Sub-period II					
		BBB-/BBB			**BB**			**BB-**	
3	71	36	**50%**	170	103	**61%**	214	185	**87%**
4	82	44	**54%**	234	116	**50%**	261	190	**73%**
5	92	51	**56%**	279	124	**44%**	301	192	**64%**
6	102	58	**57%**	311	128	**41%**	333	190	**57%**
7	114	64	**57%**	336	130	**39%**	359	186	**52%**
8	126	69	**55%**	357	130	**36%**	382	181	**47%**
9	138	74	**54%**	374	128	**34%**	400	175	**44%**
10	149	77	**52%**	391	126	**32%**	415	170	**41%**
11	160	80	**50%**	402	123	**31%**	427	164	**39%**
12	169	82	**49%**	412	121	**29%**	437	159	**36%**
13	176	83	**47%**	419	119	**28%**	445	155	**35%**
14	184	84	**45%**	424	117	**28%**	451	150	**33%**
15	192	84	**44%**	429	115	**27%**	457	146	**32%**
16	199	84	**42%**	434	113	**26%**	461	143	**31%**
17	204	83	**41%**	438	111	**25%**	465	139	**30%**
18	210	82	**39%**	442	110	**25%**	469	136	**29%**
19	215	82	**38%**	444	108	**24%**	473	134	**28%**
20	218	81	**37%**	445	107	**24%**	475	132	**28%**

2005 also appear to differ for investment- and non- investment grade assets. The improvement in the credit quality of Mexican bonds translated into a significant reduction (about 30%) in the default premium along the yield curve. The default risk and global liquidity factors have played roughly identically important roles in the decline of the Mexican yield spread at medium maturities (5-16 years). The default risk factors had a greater contribution at maturities of less than 5 and greater than 16 years.

The Brazilian default premium declined significantly (by around 20%) only at the short-to-medium maturity horizons. There is no indication of an improvement in the default premium of Brazilian bonds at maturities longer than 10 years even though Brazil was upgraded to a next coarse-letter rating category just prior to sub-period II. On the contrary, the Brazilian default premium went up at long maturities in sub-period II (Table 3.2). The Colombian default premium also increased at medium-to-long maturities. An explanation for such increase in the default premia of non-investment quality bonds could be the expectation of a turning of the global credit cycle that entails deterioration in the creditworthiness of non-investment-grade issuers. This is in line with related findings by Arellano (2006) and Kamin and von Kleist (1999).

Risk premium

The risk premia of the non-investment grade Colombian and Brazilian Eurobonds declined dramatically at all maturities both in absolute and relative terms: by 268 basis points (79%) at 4-year maturity gradually reducing to 189 basis points (36%) at 20-year maturity for Brazil and by 131 basis points (53%) and 58 basis points (15%) correspondingly for Colombia. Therefore, the fall in these countries' yield spreads between sub-period I and sub-period II appears to be mainly driven by the decline in the risk premium with its greater relative contribution against the default-risk factors at longer maturities. In the Brazilian case, only about one sixth of the reduction in the yield spread at maturities of 3-5 years is due to the decrease in the risk of default. This fraction declines at longer maturities, and the global liquidity factors determining

Table 3.2
The change in the zero-coupon yield spreads and default premia from sub-period I to sub-period II. Changes are indicated in absolute terms (in basis points) and relative terms (in percentages)

Matu-rity	**Mexico**				**Colombia**				**Brazil**			
	Yield spread		Default premium		Yield spread		Default premium		Yield spread		Default premium	
3	22	**23%**	18	**33%**	104	**38%**	5	**5%**	300	**58%**	48	**20%**
4	34	**30%**	22	**33%**	136	**37%**	4	**3%**	322	**55%**	52	**21%**
5	43	**32%**	25	**32%**	143	**34%**	-3	**-3%**	315	**51%**	45	**19%**
6	49	**32%**	26	**31%**	142	**31%**	-9	**-8%**	304	**48%**	32	**14%**
7	52	**32%**	27	**29%**	133	**28%**	-13	**-11%**	289	**45%**	20	**10%**
8	54	**30%**	27	**28%**	122	**25%**	-16	**-14%**	270	**41%**	11	**6%**
9	54	**28%**	27	**27%**	112	**23%**	-17	**-15%**	255	**39%**	6	**3%**
10	53	**26%**	26	**25%**	97	**20%**	-16	**-15%**	241	**37%**	1	**1%**
11	51	**24%**	26	**25%**	89	**18%**	-15	**-14%**	230	**35%**	-3	**-2%**
12	51	**23%**	26	**24%**	81	**16%**	-14	**-13%**	218	**33%**	-5	**-4%**
13	52	**23%**	26	**24%**	74	**15%**	-13	**-12%**	205	**32%**	-9	**-6%**
14	51	**22%**	26	**24%**	68	**14%**	-12	**-11%**	196	**30%**	-12	**-9%**
15	50	**21%**	27	**24%**	65	**13%**	-11	**-11%**	188	**29%**	-14	**-10%**
16	48	**19%**	28	**25%**	61	**12%**	-10	**-10%**	180	**28%**	-14	**-11%**
17	47	**19%**	28	**26%**	58	**12%**	-9	**-9%**	174	**27%**	-15	**-12%**
18	46	**18%**	29	**26%**	54	**11%**	-8	**-8%**	168	**26%**	-15	**-13%**
19	45	**17%**	30	**27%**	52	**11%**	-7	**-7%**	163	**26%**	-16	**-14%**
20	45	**17%**	32	**28%**	52	**10%**	-6	**-6%**	161	**25%**	-17	**-15%**

the risk premium seem to be the only contributors to the fall in the yield spread at maturities longer than 10 years. For Colombian Eurobonds, the non-default risk factors are responsible for the decline in the yield spreads at all maturity horizons even though there are signs of a small improvement in the borrower's creditworthiness translating into a smaller default premium at short maturities.

Interpretation of the results

Our findings have interesting implications. The lesser importance of the global liquidity factors versus economic fundamentals in the fall of Mexican yield spreads – as opposed to those of Colombia and Brazil – indirectly supports the hypothesis that the 2003-2005 fall in the emerging market yield spreads was, to a large degree, caused by a significant shift in the investor base of this class of assets. The traditional investors in emerging market Eurobonds were hedge funds, banks and other specialist investors. The portfolios of the mature-markets-based institutional investors, including large pension funds and insurance companies, largely consisted of the Treasury securities and other investment-quality assets. The IMF (2003a) points out that at the end of 2002 “retail investors … have been pushed by low yields on U.S. treasuries and disillusionment with equities to increase their exposure to … emerging bond market mutual funds”. Pension funds and life insurance companies also made strategic allocations to the emerging markets sovereign bonds in 2003 persuaded by strong risk-adjusted performance of this class of assets (IMF, 2003b). However, it is noted that the total allocations of the institutional investors to emerging markets remained rather small during 2003 and the first half of 2004 and mainly focused on high-grade debt. As a result, it appears that only Mexican Eurobonds open to investments from the mature markets-based institutional investors already enjoyed an improved liquidity and, hence, exhibited relatively low risk premia during 2003 and the first half of 2004.

Our findings are consistent with the IMF (2003a,b and 2006)’s comment that as a result of a prolong period of low interest rates in the U.S. and thin returns in the investment-grade sector, institutional investors increased their exposure to emerging markets and, in particular, the non-investment grade bonds towards the end of 2004 and in 2005. In the first half of 2005, U.S. based pension funds increased their strategic allocations to emerging market bonds by 73% over a similar period a year earlier to $7.3 billion according to the IMF (2006). This implied a significant improvement in the liquidity of Colombian and Brazilian bonds in 2005, which resulted in a lower risk premium and a reduction in the overall yield spread – the presence of this effect is supported by our results. The biggest fall among the three countries in the Brazilian risk premium could be related to the heavy weighting of Brazil’s international debt in global emerging market indices. Pension funds and insurance companies usually outsource their funds to specialist investors and mutual funds, who invest on their behalf. At the same time, mutual fund managers, subject to quarterly performance reviews, tend to avoid too risky investments, which could lead to large deviations of the short-term returns from the market benchmark. Fund managers, therefore, often prefer to imitate the composition of global emerging market bond indices such as JP Morgan’s EMBI Global index, where Brazilian Eurobonds are heavily weighted (IMF, 2003b). Moreover, a significant liquidity-driven fall in the Colombian and

Brazilian yield spreads of medium-to-long maturities corresponds to the long-term investment profile of life-insurance companies and pension funds.

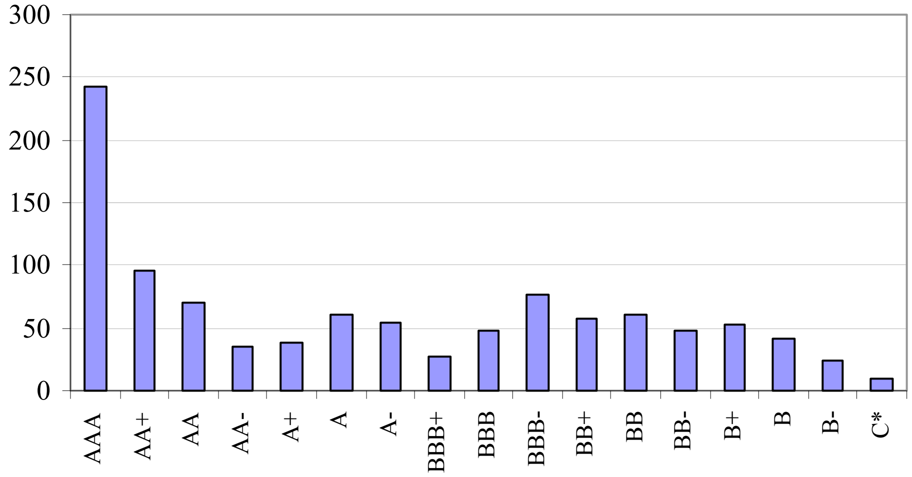
7. Conclusion

This paper contributes to the estimation of the sovereign rating transitions based on a small data sample. A Bayesian approach is employed to introduce "expert knowledge" into the model of rating transitions. In addition, an expected value estimator of rating transitions is used that takes into account the probability mass distribution. Employing the expected value estimate as a measure of default risk in the pricing of emerging market Eurobonds gives a better fit than the conventional 'cohort' methodology, Hu, Kiesel and Perraudin (2002)'s method and the continuous-time observation approach by Lando and Skødeberg (2002). Our approach also yields a realistic measure of the default premium for all countries and time periods tested.

The empirical analysis shows that default risk accounted for a rather small share of the yield spread of non-investment grade Colombian and Brazilian Eurobonds in 2003. The share of the default premium within the yield spread increased significantly for these countries' Eurobonds over the period 2003-2005. The risk premium driven by the global liquidity factors appears to be the main contributor to the recent unprecedented fall in the emerging market yield spreads of non-investment quality Eurobonds. Global liquidity factors as well as improvements in economic fundamentals both played a significant role in the fall of the investment-grade Mexican spreads. Our findings support the hypothesis that the 2003-2005 fall in the emerging market yield spreads was, to a large degree, caused by a significant shift in the investor base of this class of assets. This shift was highlighted by the IMF, who argued that large institutional investors increased considerably their allocations to the non-investment grade emerging market bonds. This in turn led to a significant fall in the non-default risk premia and the overall yield spread.

Appendix A. Annual observations of rating transitions

Figure A.1. Number of annual observations of rating transitions from a given initial state, 1985-2005. Source: Standard and Poor's (2006a) and authors' calculations



Appendix B. Sovereign one-year rating transition matrices

Table B.1
The expected value estimates of the one-year rating transitions between 8 coarse-letter rating categories, 1985-2005

Initial rating	Rating at the year end							
	AAA	AA	A	BBB	BB	B	C*	SD
Based on the informative prior								
AAA	97.1	2.4	0.4	0.0	0.0	0.0	0.0	0.0
AA	4.4	93.2	1.0	0.5	1.0	0.0	0.0	0.0
A	0.6	3.8	91.8	2.5	0.6	0.6	0.0	0.0
BBB	0.0	0.6	8.2	84.9	3.1	1.3	1.3	0.6
BB	0.0	0.0	0.6	7.6	81.3	8.8	0.6	1.2
B	0.0	0.0	0.0	0.8	11.4	78.0	4.1	5.7
C*	0.0	0.0	0.0	0.0	7.7	15.4	38.5	38.5
SD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Based on the noninformative prior								
AAA	95.2	2.4	0.4	0.4	0.4	0.4	0.4	0.4
AA	4.3	91.9	1.0	0.5	1.0	0.5	0.5	0.5
A	0.6	3.8	90.6	2.5	0.6	0.6	0.6	0.6
BBB	0.6	0.6	8.1	84.4	3.1	1.3	1.3	0.6
BB	0.6	0.6	0.6	7.5	80.3	8.7	0.6	1.2
B	0.8	0.8	0.8	0.8	11.1	76.2	4.0	5.6
C*	5.9	5.9	5.9	5.9	5.9	11.8	29.4	29.4
SD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

C* incorporates ratings CCC and CC

Table B.2
The expected value estimates of the one-year rating transitions between 18 fine-letter rating categories, 1985-2005

Initial rating	Rating at the year end																	
	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	C*	SD
Based on the informative prior																		
AAA	95.6	2.4	0.4	0.4	0.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AA+	8.5	77.4	5.7	2.8	0.9	0.9	0.9	0.9	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AA	1.2	11.0	73.2	6.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AA-	2.1	2.1	12.8	61.7	4.3	2.1	2.1	2.1	2.1	2.1	4.3	2.1	0.0	0.0	0.0	0.0	0.0	0.0
A+	2.0	2.0	2.0	11.8	54.9	11.8	3.9	2.0	2.0	2.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0
A	1.4	1.4	1.4	1.4	13.5	67.6	2.7	1.4	1.4	2.7	1.4	1.4	1.4	1.4	0.0	0.0	0.0	0.0
A-	0.0	1.5	1.5	1.5	2.9	8.8	69.1	2.9	1.5	2.9	1.5	1.5	1.5	1.5	1.5	0.0	0.0	0.0
BBB+	0.0	2.4	2.4	2.4	2.4	4.8	26.2	38.1	4.8	2.4	2.4	2.4	2.4	2.4	2.4	2.4	0.0	0.0
BBB	0.0	1.6	1.6	1.6	1.6	1.6	3.2	26.6	45.3	3.2	1.6	1.6	1.6	3.2	1.6	1.6	3.2	0.0
BBB-	0.0	0.0	0.0	1.1	1.1	1.1	1.1	1.1	17.4	64.1	4.3	2.2	1.1	1.1	1.1	1.1	1.1	1.1
BB+	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	1.4	16.9	59.2	7.0	1.4	1.4	1.4	2.8	1.4	1.4
BB	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	2.7	11.0	63.0	8.2	2.7	2.7	1.4	1.4	1.4
BB-	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7	1.7	1.7	6.7	8.3	50.0	18.3	3.3	1.7	1.7	3.3
B+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	1.6	1.6	6.3	15.6	45.3	10.9	7.8	4.7	3.1
B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	3.9	21.6	51.0	3.9	5.9	5.9
B-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	3.0	6.1	18.2	48.5	3.0	12.1
C*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	5.9	5.9	5.9	5.9	11.8	29.4	29.4
SD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Based on the noninformative prior																		
AAA	91.5	2.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
AA+	7.9	71.9	5.3	2.6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
AA	1.1	10.1	67.4	5.6	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
AA-	1.9	1.9	11.3	54.7	3.8	1.9	1.9	1.9	1.9	1.9	3.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9
A+	1.8	1.8	1.8	10.7	50.0	10.7	3.6	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
A	1.3	1.3	1.3	1.3	12.8	64.1	2.6	1.3	1.3	2.6	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
A-	1.4	1.4	1.4	1.4	2.8	8.3	65.3	2.8	1.4	2.8	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
BBB+	2.2	2.2	2.2	2.2	2.2	4.4	24.4	35.6	4.4	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
BBB	1.5	1.5	1.5	1.5	1.5	1.5	3.0	25.8	43.9	3.0	1.5	1.5	1.5	3.0	1.5	1.5	3.0	1.5
BBB-	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	16.8	62.1	4.2	2.1	1.1	1.1	1.1	1.1	1.1	1.1
BB+	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	16.0	56.0	6.7	1.3	1.3	1.3	2.7	1.3	1.3
BB	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	2.6	10.3	59.0	7.7	2.6	2.6	1.3	1.3	1.3
BB-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	6.1	7.6	45.5	16.7	3.0	1.5	1.5	3.0
B+	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	5.6	14.1	40.8	9.9	7.0	4.2	2.8
B	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	3.4	18.6	44.1	3.4	5.1	5.1
B-	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	4.8	14.3	38.1	2.4	9.5
C*	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	7.4	18.6	18.5
SD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

C* incorporates all CCC to CC rating categories

Appendix C. Term-structure of the default premium within zero-coupon yield spreads on Mexican, Colombian and Brazilian bonds

Figure C.1 Term-structure of the Mexican default premium as at 9.03.04 (Rating BBB-)

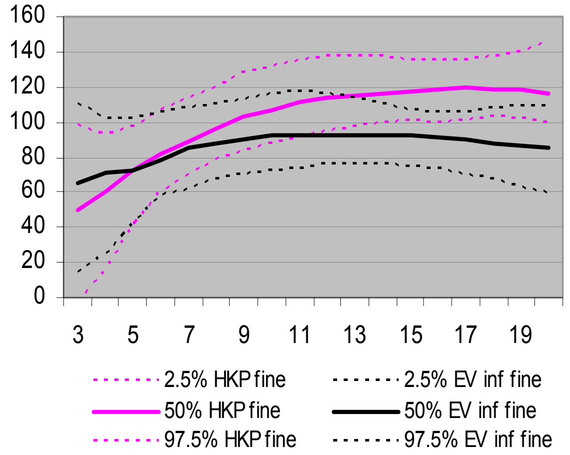


Figure C.2 Term-structure of the Mexican default premium as at 13.12.05 (Rating BBB)

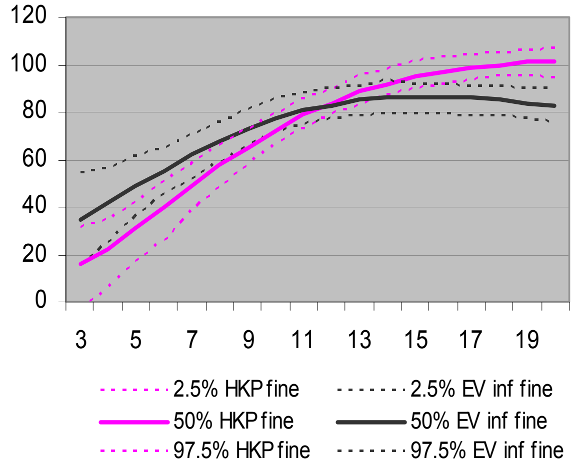


Figure C.3 Term-structure of the Colombian default premium as at 9.03.04 (Rating BB)

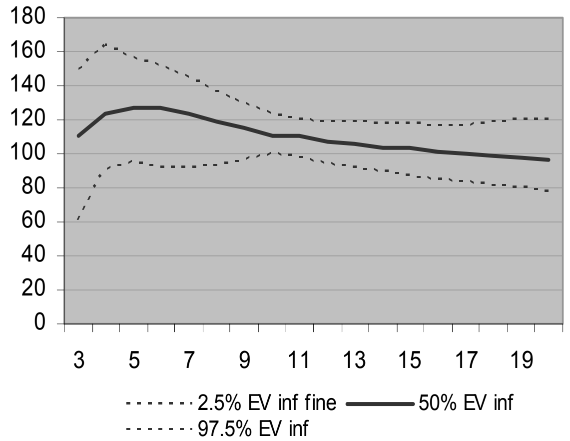


Figure C.4 Term-structure of the Colombian default premium as at 13.12.05 (Rating BB)

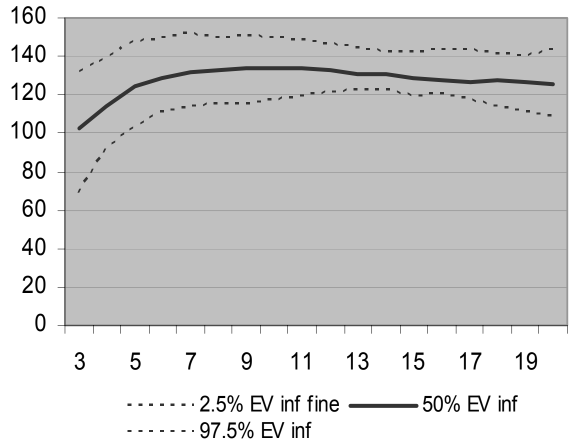


Figure C.5 Term-structure of the Brazilian default premium as at 9.03.04 (Rating B+)

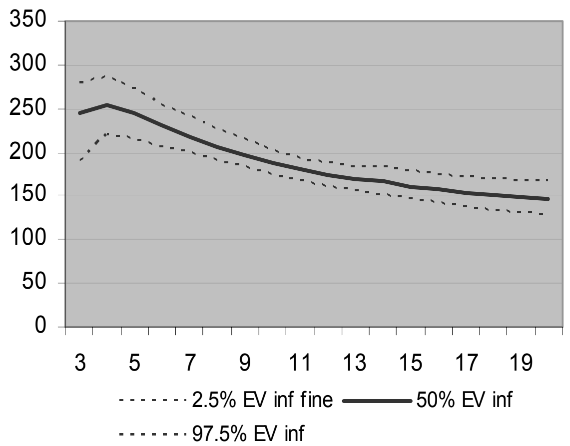
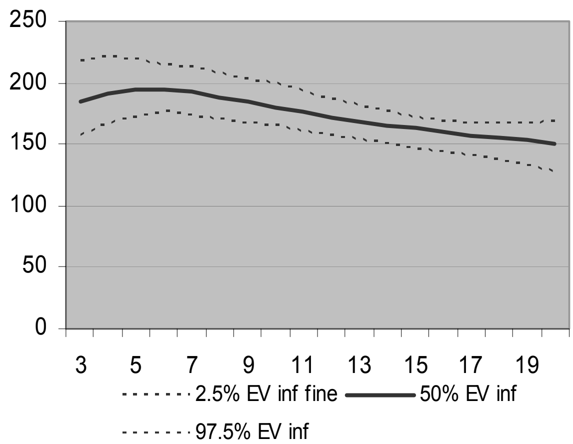


Figure C.6 Term-structure of the Brazilian default premium as at 13.12.05 (Rating BB-)



References

Arellano, C., 2006. Default risk and income fluctuations in emerging economies. Working Paper, University of Minnesota, Federal Reserve Bank of Minneapolis.

Cantor, R., Parker, F., 1996. Determinants and impact of sovereign credit ratings. Federal Reserve Bank of New York Economic Policy Review (October), 1-15.

Eichengreen, B., Mody, A., 1998. What explains changing spreads on emerging-market debt: fundamentals or market sentiment? NBER Working Paper 6408 (Cambridge, Massachusetts: National Bureau of Economic Research), February.

Elton, E.J., Gruber, M.J., Agrawal, D., Mann, C., 2001. Explaining the rate spread on corporate bonds. Journal of Finance 56, 247-277.

Ferrucci, G., 2003. Empirical determinants of emerging market economies' sovereign bond spreads. Bank of England Working Paper No. 205.

Gelman, A., Carlin, J.B., Stern, H.S., Rubin, D.B., 1995. Bayesian Data Analysis. Chapman & Hall / CRC.

Hu, Y.T., Kiesel, R., Perraudin, W., 2002. The estimation of transition matrices for sovereign credit ratings. Journal of Banking and Finance 26, 1383-1406.

Huang, J.Z., Huang, M., 2003. How much of corporate-treasury yield spread is due to credit risk?: a new calibration approach. Working Paper, Penn State University.

IMF, 2003a. Global Financial Stability Report. Market Developments and Issues, March (Washington D.C: International Monetary Fund).

IMF, 2003b. Global Financial Stability Report. Market Developments and Issues, September (Washington D.C: International Monetary Fund).

IMF, 2006. Global Financial Stability Report. Market Developments and Issues, April (Washington D.C: International Monetary Fund).

Jarrow, R.A., Lando, D., Turnbull, S., 1997, A Markov model for the term structure of credit spreads. Review of Financial Studies 10, 481-523.

Kamin, S., von Kleist, K., 1999. The evolution and determinants of emerging market credit spreads in the 1990s. BIS Working Paper No. 68 (Basel: Bank for International Settlements).

Kashiwase, K., Kodres, L.E., 2005. Emerging market spread compression: is it real or is it liquidity? IMF Working Paper. (Washington D.C.: International Monetary Fund, October).

Lando, D., Skødeberg, T., 2002. Analyzing ratings transitions and rating drift with continuous observations. Journal of Banking and Finance 26, 423–444.

Longstaff, F.A., Mithal, S., Neis, E., 2005. Corporate yield spreads: default risk or liquidity? New evidence from the credit default swap market. Journal of Finance 60, 2213-2253.

MacKay, D.J.C., 2003. Information Theory, Inference, and Learning Algorithms. Cambridge University Press.

McGuire, P., Schrijvers, M., 2003. Common factors in emerging market spreads. BIS Quarterly Review, (Basel: Bank for International Settlements).

Moody's Investors Service, Global Credit Research, 2006. Default and recovery rates of sovereign bond issuers, 1983 – 2005. Special Comment (April).

Nelson, C.R., Siegel, A.F., 1987. Parsimonious modeling of yield curves. Journal of Business 60, 473-489.

Nickell, P., Perraudin, W., Varotto, S., 2000. Stability of rating transitions. Journal of Banking and Finance 24, 203-227.

Perraudin, W., Taylor, A.P., 2003. Liquidity and bond market spreads. European Finance Association 2003 Annual Conference. Paper No. 879.

Reisen, H., von Maltzan, J., 1999. Boom and boost and sovereign ratings. International Finance 2, 273-293.

Standard and Poor's, 2006a. 2005 Transition Data For Rated Sovereigns.

Standard and Poor's, 2006b. Sovereign Ratings History Since 1975.

SUPPLEMENTARY MATERIAL

for the paper

Sovereign rating transitions and the price of default risk in emerging markets

Alena Audzeyeva[a] and Klaus Reiner Schenk-Hoppé[b]

25 May 2007

[a] Leeds University Business School, University of Leeds, Leeds, LS2 9JT, UK.

E-mail: A.L.Audzeyeva@leeds.ac.uk (corresponding author)

[b] Leeds University Business School and School of Mathematics, University of Leeds, Leeds, LS2 9JT, UK. Email: K.R.Schenk-Hoppe@leeds.ac.uk

This file is available at *www.schenk-hoppe.net/sovereign/.*

Supplement A: Estimates of the sovereign one-year rating transition matrices

The source is *Sovereign Ratings History Since 1975 (2006)* of Standard and Poor's and the authors' calculations. Rating category *C** includes CCC-CC ratings.

Table 1
The maximum likelihood estimate of the one-year rating transitions between 8 coarse-letter rating categories, 1985-2005

		Rating at the year end							
Initial rating	No of counts	AAA	AA	A	BBB	BB	B	C*	SD
AAA	256	97.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0
AA	205	4.0	95.0	0.5	0.0	0.5	0.0	0.0	0.0
A	169	0.0	3.3	94.7	2.0	0.0	0.0	0.0	0.0
BBB	153	0.0	0.0	7.9	88.2	2.6	0.7	0.7	0.0
BB	183	0.0	0.0	0.0	7.3	83.6	8.5	0.0	0.6
B	130	0.0	0.0	0.0	0.0	11.0	80.5	3.4	5.1
C*	14	0.0	0.0	0.0	0.0	0.0	11.1	44.4	44.4
SD		0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Table 2
Average one-year transition rates between 8 coarse-letter rating categories estimated using the Lando and Skødeberg (2002) method based on continuous observations, 1985-2005

	Rating at the year end							
Initial rating	AAA	AA	A	BBB	BB	B	C*	SD
AAA	98.1	1.9	9E-04	7E-05	7E-07	1E-07	2E-09	6E-10
AA	3.7	95.4	0.9	0.0	1E-04	2E-05	4E-07	2E-07
A	0.1	3.2	94.6	2.1	4E-02	7E-03	2E-04	8E-05
BBB	2E-03	0.1	7.4	88.2	3.6	0.6	2E-02	1E-02
BB	3E-05	3E-03	0.2	6.0	85.9	7.5	0.3	0.1
B	6E-07	8E-05	9E-03	0.3	9.1	81.5	5.2	3.9
C*	2E-08	3E-06	5E-04	2E-02	0.9	14.0	42.7	42.4
SD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Table 3
The maximum likelihood estimate of the one-year rating transitions between 18 fine-letter rating categories, 1985-2005

Initial rating	Rating at the year end																	
	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	C*	SD
AAA	97.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AA+	8.3	84.4	5.2	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AA	0.0	11.3	83.1	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AA-	0.0	0.0	14.3	80.0	2.9	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A+	0.0	0.0	0.0	13.2	71.1	13.2	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A	0.0	0.0	0.0	0.0	15.0	81.7	1.7	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A-	0.0	0.0	0.0	0.0	1.9	9.3	85.2	1.9	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BBB+	0.0	0.0	0.0	0.0	0.0	3.7	37.0	55.6	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BBB	0.0	0.0	0.0	0.0	0.0	0.0	2.1	33.3	58.3	2.1	0.0	0.0	0.0	2.1	0.0	0.0	2.1	0.0
BBB-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.5	75.3	3.9	1.3	0.0	0.0	0.0	0.0	0.0	0.0
BB+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.3	71.9	7.0	0.0	0.0	0.0	1.8	0.0	0.0
BB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	11.7	75.0	8.3	1.7	1.7	0.0	0.0	0.0
BB-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	8.3	60.4	20.8	2.1	0.0	0.0	2.1
B+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	17.0	52.8	11.3	7.5	3.8	1.9
B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	24.4	61.0	2.4	4.9	4.9
B-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	20.8	62.5	0.0	12.5
C*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	44.4	44.4
SD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Table 4
Average one-year transition rates between 18 fine-letter rating categories estimated using the Lando and Skødeberg (2002) method based on continuous observations

Initial rating	Rating at the year end																	
	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	C*	SD
AAA	98.2	1.8	0.1	1E-02	2E-04	6E-06	1E-06	6E-09	3E-09	3E-09	3E-11	6E-12	3E-13	5E-12	2E-13	7E-14	3E-15	1E-15
AA+	7.5	86.3	5.2	1.0	2E-02	1E-03	2E-04	1E-06	8E-07	8E-07	1E-08	2E-09	1E-10	2E-09	6E-11	2E-11	1E-12	5E-13
AA	0.4	9.4	84.2	5.9	0.1	7E-03	1E-03	9E-06	5E-06	5E-06	7E-08	1E-08	7E-10	1E-08	4E-10	2E-10	8E-12	3E-12
AA-	2E-02	0.6	10.8	84.2	4.0	0.3	0.1	5E-04	3E-04	3E-04	5E-06	9E-07	6E-08	8E-07	3E-08	1E-08	8E-10	3E-10
A+	6E-04	3E-02	0.8	11.5	73.8	11.7	2.2	3E-02	2E-02	2E-02	4E-04	7E-05	6E-06	6E-05	3E-06	1E-06	9E-08	4E-08
A	2E-05	9E-04	3E-02	0.8	10.2	85.2	3.7	0.1	3E-02	3E-02	7E-04	1E-04	1E-05	1E-04	5E-06	2E-06	2E-07	7E-08
A-	2E-06	1E-04	5E-03	0.1	1.8	10.4	82.6	2.4	1.3	1.3	4E-02	9E-03	1E-03	7E-03	5E-04	2E-04	2E-05	8E-06
BBB+	2E-07	2E-05	7E-04	2E-02	0.4	4.1	27.6	62.7	2.5	2.5	0.1	2E-02	2E-03	1E-02	1E-03	4E-04	4E-05	2E-05
BBB	1E-08	1E-06	6E-05	2E-03	0.1	0.6	5.4	19.6	67.4	6.6	0.2	5E-02	5E-03	4E-02	3E-03	1E-03	1E-04	5E-05
BBB-	4E-10	4E-08	2E-06	1E-04	3E-03	0.0	0.4	2.2	15.0	74.8	5.3	1.2	0.2	0.8	0.1	4E-02	4E-03	2E-03
BB+	9E-12	1E-09	7E-08	3E-06	1E-04	0.0	2E-02	0.1	1.5	14.7	74.1	7.6	1.5	0.3	0.1	1E-02	1E-03	1E-03
BB	8E-13	8E-11	6E-09	3E-07	1E-05	0.0	2E-03	2E-02	0.2	2.1	10.8	76.2	6.5	2.7	1.3	0.2	3E-02	2E-02
BB-	4E-14	5E-12	4E-10	2E-08	1E-06	2E-05	2E-04	2E-03	2E-02	0.4	3.2	8.9	69.7	14.4	2.6	0.8	0.1	0.1
B+	2E-14	2E-12	2E-10	1E-08	5E-07	7E-06	1E-04	7E-04	1E-02	0.2	1.6	2.2	14.8	60.9	12.7	6.0	1.0	0.6
B	0.0	6E-14	5E-12	3E-10	2E-08	3E-07	5E-06	4E-05	7E-04	1E-02	0.2	0.2	1.9	15.9	64.9	11.2	2.8	2.9
B-	0.0	1E-15	1E-13	9E-12	5E-10	1E-08	2E-07	2E-06	3E-05	8E-04	1E-02	2E-02	0.2	1.9	14.8	54.6	16.8	11.7
C*	0.0	0.0	3E-15	2E-13	1E-11	3E-10	5E-09	5E-08	1E-06	3E-05	7E-04	9E-04	1E-02	0.1	1.6	11.2	44.0	43.0
SD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Supplement B: Plots of the time-series of zero-coupon yield spreads of Mexican, Colombian and Brazilian Eurobonds at 5, 10, 15, and 20-year maturity horizons

Figure 1
Mexican zero-coupon yield spreads

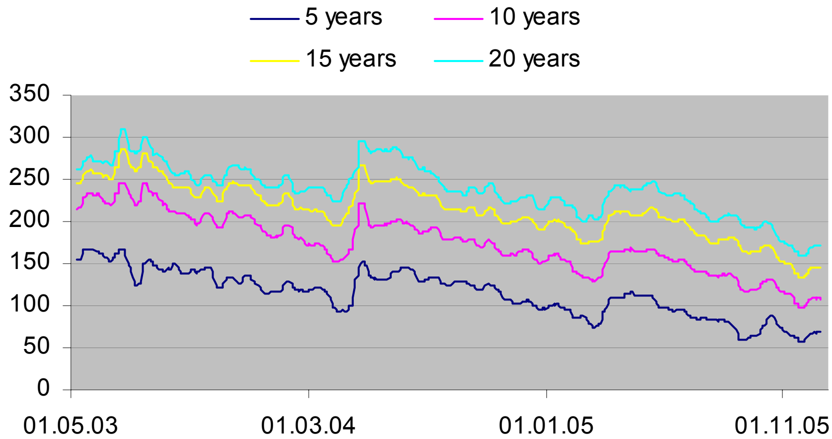


Figure 2
Colombian zero-coupon yield spreads

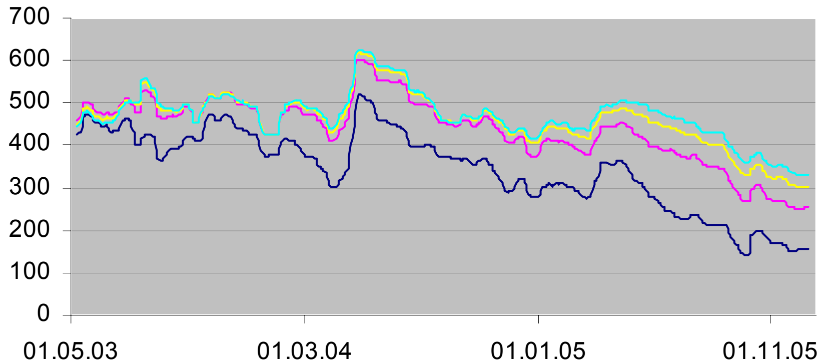
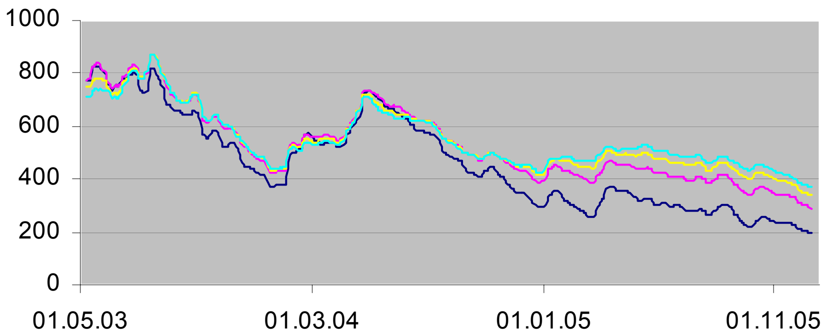


Figure 3
Brazilian zero-coupon yield spreads



Supplement C: Estimates of the Default Premium within Zero-Coupon Yield Spread on Mexican, Colombian and Brazilian Bonds

Table 5
Percentiles of the simulated default premium sample for Mexican, Colombian and Brazilian zero-coupon yield spreads at 10-year maturity; the confidence intervals are estimated as 2.5% and 97.5% percentiles of the simulated sample

Date	13-May-03			9-Mar-04			25-Jan-05			13-Dec-05		
Rating transitions estimate	2.5%	**50%**	97.5%	2.5%	**50%**	97.5%	2.5%	**50%**	97.5%	2.5%	**50%**	97.5%
Mexican Eurobonds												
HKP fine	79	**101**	123	88	**107**	132	59	**72**	85	67	**72**	79
Fine EV inf	76	**95**	115	75	**99**	118	76	**89**	99	84	**91**	98
Fine EV noninf	78	**100**	119	55	**78**	123	109	**123**	137	118	**126**	134
Coar ML	-4	**26**	46	4	**28**		10	**28**	45	23	**30**	39
S&P coar orig	-11	**18**	38	19	**23**	28	2	**20**	37	11	**19**	25
Coar cont	-12	**12**	34	14	**18**	23	0	**13**	28	4	**13**	19
NA Spread	193	**209**	224	157	**175**	195	139	**150**	161	102	**109**	114
Colombian Eurobonds												
Fine EV inf	100	**121**	151	103	**114**	127	93	**127**	174	118	**137**	154
Fine EV noninf	76	**103**	125	81	**94**	107	54	**111**	146	96	**112**	127
S&P coar orig	76	**100**	129	77	**91**	102	51	**101**	162	82	**104**	122
HKP coar	186	**215**	254	188	**213**	241	200	**247**	296	231	**255**	285
Coar ML	50	**76**	108	62	**73**	82	40	**81**	125	70	**86**	100
Coar cont	39	**59**	90	50	**58**	70	21	**58**	114	55	**68**	86
NA	410	**432**	456	466	**476**	486	369	**401**	444	233	**251**	265
Brazilian Eurobonds												
Fine EV inf	1.46	**1.99**	255	179	**191**	203	150	**1.68**	187	162	**182**	200
Fine EV noninf	97	**142**	208	119	**131**	141	111	**127**	145	117	**136**	152
S&P coar orig	153	**203**	278	180	**192**	209	76	**100**	117	89	**108**	124
Coar ML	177	**235**	307	203	**221**	245	57	**79**	100	67	**85**	102
Coar cont	169	**221**	306	202	**218**	238	39	**62**	81	50	**67**	89
HKP coar	377	**485**	572	413	**481**	554	215	**232**	251	230	**253**	271
NA	686	**732**	808	526	**536**	547	417	**433**	448	286	**301**	314