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The Term Structure of Country Risk and Valuation in Emerging Markets*

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Abstract

Most practitioners add the country risk to the discount rate when valuing projects in Emerging Markets. This practice does not account for the fact that the default risk term structure can be non-flat. The mismatch between the duration of the project under valuation and the duration of the most widely used measure of country risk, J.P. Morgan's EMBI, leads to an overvaluation (undervaluation) of long-term projects when the term structure of default risk is upward (downward) sloping. Using sovereign bond data from five Emerging Markets, we estimate a simple model that captures most of the variation of conditional default probabilities at different horizons for a given country at one point in time. This model can be used to solve the misestimation problem.

JEL classification codes: G15, G31

Keywords: Emerging Economies, Cost of Capital, Default Risk

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I. Introduction

Investment projects in emerging markets are generally perceived as riskier than otherwise similar projects in developed countries. The "additional risks" include currency inconvertibility, civil unrest, institutional instability, expropriation, and widespread corruption. Emerging markets (henceforth EM) are also more volatile than developed economies: their business cycles are more intense, and inflation and currency risks are higher.[1]

Several problems have restricted the use among practitioners of the Capital Asset Pricing Model (CAPM) or its international version, the ICAPM, to calculate the cost of capital of projects in EM. First, there is no complete agreement about the degree of integration of EM capital markets to the world market (see Errunza and Losq, 1985, and Bekaert et al., 2001). Second, local returns are non-normal, show significant first-order autocorrelation (Bekaert et al., 1998), and there are problems of liquidity and infrequent trading (Harvey, 1995). Finally, as correlations between local returns and international returns are so low, the cost of capital that emerges from the use of these models appears as "too low".

These problems have lead practitioners to account for the "additional risks" by making ad-hoc adjustments to the CAPM. Godfrey and Espinosa (1996), for instance, propose to calculate the cost of capital in EM by using

$$E[R_i] = (R_f^{US} + CS) + \frac{s_i}{s_{US}} * 0.60 * (E[R_m^{US}] - R_f^{US}) \qquad (1)$$

where CS is the credit spread between the yield of a U.S. dollar-denominated EM sovereign bond and the yield of a comparable U.S. bond, and the term preceding the last parenthesis is an "adjusted beta", that is equivalent to 60% of the ratio of the volatility of the domestic market to that of the U.S. market.[2]

[1] Neumeyer and Perri (2001) find that output in Argentina, Brazil, Korea, Mexico and Philippines is at least twice as volatile as it is in Canada.

2 The 60% adjustment is due to the finding that 40% of the volatilities of domestic markets are explained by variations in credit quality --see Godfrey and Espinosa (1996) for details.

Although there are different versions of this model (see Pereiro and Galli, 2000, Abuaf and Chu, 1994, and Harvey, 2000), all of them add the country risk to the U.S. risk free rate in order to define the EM´s “analog” of the U.S. risk free rate.

There are few systematic surveys of cost of capital estimation practices in EM, but those available show that variants of this model are the most widely used among practitioners. Keck et al. (1998) find in a survey of Chicago School of Business graduates that in international valuations most respondents adjust discount rates for factors such as political, sovereign, or currency risks. Pereiro and Galli (2000) show that the vast majority of Argentine corporations (including financial firms) add the country risk to the U.S. risk free rate.[3]

Several objections have been raised in the literature to the addition of the country risk to the discount rate. First, the model lacks any sound theoretical foundation (Harvey, 2000). Second, in most versions of this model country risk is double counted, since part of the variability in market returns is correlated with country risk (Estrada, 2000). The 60% adjustment of Godfrey and Espinosa does not solve the problem, as it is completely ad-hoc. Third, for global investors part of the country risk is diversifiable, and hence it should not be included in the discount rate. Fourth, although this model gives a unique discount rate for all projects, the “additional” risks inherent to EM do not have a uniform impact on all firms and projects (Harvey, 2000). For example, sometimes the country risk is high because the market expects a sharp devaluation that would deteriorate the public sector’s financial position. A devaluation, however, would benefit some sectors (e.g., exporters), and damage others (e.g., importers).

In this paper, we discuss another problem that the addition of country risk in the discount rate as in equation (1) has; namely, that the mismatch between the duration of the project under valuation and the duration of the most widely used measures of country risk leads to an overvaluation (undervaluation) of long-term projects when the term structure of default risk is upward (downward) sloping. The reverse is true for short-term projects.

[3] A number of important investment banks also add the country spread to the discount rate (Harvey, 2000).

The country risk measures most widely used are J.P. Morgan's Emerging Market Bond Index (EMBI), and its extensions EMBI+ and EMBI-Global. Using these default risk measures in the discount rate to value long-term projects would bear no additional problem to the ones mentioned above if the default risk term structure were flat. But, in fact, this is not the case. In normal times, default risk spreads are low at the short end of the curve and slope upward for longer durations. Often times, however, the default risk term structure is downward sloping --as when the market expects a default in the short run (see Figure I).

The mismatch between the duration of the project and the duration of the EMBI leads to an overvaluation of long-term projects in the first case and to an undervaluation of them in the second case. Figure I.C. illustrates this point: if, say, the project at hand had a duration of four years and Argentina's and Russia's EMBI spreads had a duration of two years each, valuation according to (1) would have overestimated the value of the Argentinean relative to the Russian project.

In addition, there is a high cross-country variability in the average duration of the EMBI-Global country components (see Table I and Figure II). While the duration for Bulgaria is lower than one year, for Hungary is three years and for Uruguay is higher than ten years (Figure II). This variability reduces the economic significance of net present value comparisons of otherwise similar projects in different countries, discounted in each country with the EMBI Global as the country spread used in equation (1). For example, in June 2001 an investor considering whether to locate an otherwise similar factory in Korea or in the Philippines would have used for Korea a country spread corresponding to a duration of 3.6 years, whereas in the Philippines he would have used a spread associated with a duration of 7.1 years.

Using sovereign bond data from five Emerging Markets, we estimate a simple model that captures most of the variation in the sequence of default probabilities conditional on previous full payment for a given country at one point in time. This model can be used to solve the misestimation problem.

The paper proceeds as follows. Section II explains the model used to estimate the default risk term structure in EM sovereign debt markets and discusses the effects that a non-flat default risk term structure has on the valuation of projects. Section III describes the data and section IV presents the estimation results. Section V concludes.

II. The Model

Consider a perpetuity that promises to pay a coupon of \$ c every period (a period represents one year for simplicity). Let i_t be the expected annual rate of return on this bond from period zero up to period t, g the recovery value conditional on default, p_t the period-t probability of payment conditional on previous full payment, and P_t the probability of payment t-periods from now. Given that each coupon payment has "cross-default" provisions with every successive coupon, P_t measures the cumulative probability of no default from inception up to period t.

Then, we can express the bond's current value, B_0, as

$$B_0 = \sum_{t=1}^{\infty} \frac{P_t c + P_{t-1}(1 - p_t) g}{(1 + i_t)^t} \tag{2}$$

where the numerator gives the expected receipts from the bond in period t.

For simplicity, we assume that the recovery value once there is a default on a sovereign bond is zero (i.e., $g = 0$). This assumption does not change the main results of this paper and avoids unnecessary complications in the estimation. We also postulate that [4]

$$P_t = \begin{cases} p_1 & \text{if } t = 1 \\ m P_1^{d\,t} & \text{if } t \geq 2 \end{cases} \tag{3}$$

so we can express

$$B_0 = \frac{P_1 c}{(1 + i_1)} + \sum_{t=2}^{\infty} \frac{m P_1^{d\,t} c}{(1 + i_t)^t} \tag{4}$$

[4] See Merrick (1999) and Yawitz (1977) for alternative specifications.

Note that this specification implies that p_t may differ from p_s, $s \neq t$.

II.1. Implications on Valuation in EM

Consider the case of a firm located in an EM whose most likely outcome is that it will produce a dividend of \$ d (constant) per period forever. The standard valuation practice is to discount the most likely outcome (central scenario) at a constant discount rate r_t, where t stands for the duration of the bond portfolio used to measure the country risk as in equation (1). In this case, the value of the firm in our example can be calculated as

$$\hat{V} = \sum_{t=1}^{\infty} \frac{d}{(1+r_t)^t} = \frac{d}{r_t} \tag{5}$$

We call $\hat{V}$ "miscalculated value", for reasons that will become apparent below. Traditional finance theory suggests, however, that we should discount the *expected* free cash flows by their respective *expected* returns. The question is how to translate d into expected dividends. This can be done by using information readily available from bond markets on the probability of full payment on sovereign debt.[5] The "true value", V, of the firm in our example would be

$$V = \frac{p_1 d}{(1+f_1)} + \sum_{t=2}^{\infty} \frac{P_t d}{(1+f_t)^t} \tag{6}$$

[5] Note that we are using the information given by country risk in order to assess the probability of receiving the most likely dividend. Given the typical "downward" risks borne by projects in EM (Estrada, 2000) we take d as an approximate upper bound on dividends and use P to estimate their expected value. The usual criticisms to this practice have been outlined in Section 1. Here we only want to point out the problems originated by implicitly assuming a flat default risk term structure. See Robichek and Myers (1966) and Chen (1967) for an old debate about the effects on discount rates of alternative assumptions about the resolution of uncertainty over time.

where f_t is the expected rate of return of investing in this firm, and the numerator gives the expected dividend each period. In equation (6), f_t does not include the country risk and we can easily assume that it is constant, but every term in its numerator is lower than the corresponding one in equation (5). If per-period default probabilities were constant (i.e., $P_t = p_1^t$), which given $f_t = f$, implies a flat yield curve, then we could express V as

$$V_c = \frac{d\, p_1}{1 + f - p_1} \tag{6b}$$

where the subscript c is added to stress that a constant probability of default is assumed. It is easy to show that the r that makes $\hat{V} = V_c$, r_c, is given by

$$r_c = \frac{1 + f - p_1}{p_1} \tag{7}$$

Suppose now that the default risk term structure is as in equation (3). Plugging these probabilities in (6) we can solve for the value of the firm, V_v, as

$$V_v = \frac{d}{1+f}\left\{ p_1 + \frac{m P_1^{2d}}{1 + f - P_1^d} \right\} \tag{6c}$$

where the subscript v indicates that default risk per period varies with duration. Again, for any value of m and d there is a value of r, r_v, that makes $\hat{V} = V_v$. It is given by

$$r_v = \frac{1+f}{\left(p_1 + \dfrac{m P_1^{2d}}{1 + f - P_1^d} \right)} \tag{7b}$$

We can interpret v as a time subscript referring to the duration of the bond (in a non-flat yield curve context) whose yield used in the discount rate as in (5) would give a value of the firm equivalent to that from (6c).

In Appendix I we show for $t = m = 1$ that if $d > 1\,(d < 1)$, then $r_v > r_t$ $(r_v < r_t)$. Only when $m = d = 1$ will r_v be equal to r_t. When the default risk term structure is non-flat, on the other hand, the mismatch between the duration of the project and the duration of the bond portfolio used to measure the discount rate as in equation (1) introduces a mispricing error. Let m be the ratio of the correct to the miscalculated value,

$$m = \frac{\left(V_v - \hat{V}\right)}{\hat{V}} = \frac{r_t}{r_v} - 1 \qquad (8)$$

We use data from U.S. dollar-denominated EM bonds to estimate equation (3) and illustrate how different implied values of m and d change the mispricing ratio.

III. The Data

We collected effective annual ask yields and durations of non-guaranteed U.S. dollar-denominated EM sovereign bonds (typically called "global bonds"). Data are from Bloomberg for the last trading day of each month since September 1995 until December 2001. Also included are comparable U.S. Treasury yields, which are taken as the risk free rate.

The sample was narrowed to those emerging countries which had data for more than one bond at any point throughout the sample: Argentina, Brazil, Colombia, Ecuador, Mexico, Poland, Russia, Thailand, Turkey, and Venezuela. Since we focus on yields spaced one-year apart starting one year from the beginning of each period, we further narrowed the sample to countries whose shorter traded bond had a duration smaller than 365 days for three months that we considered representative of likely yield curve configurations: April 1997, January 2000 and August 2001. This restricted our sample to Argentina, Colombia, Mexico, Russia and Turkey.[6] For those sample months for which the shortest bond had a duration greater than one year, we estimated the one-year yield by linear extrapolation of the two nearest bonds available.

Figure I reports the yield curves for the sample considered, which were constructed by linear interpolation of the available data. Nevertheless, plots of all the yield curves (without extrapolations) available are posted at http://www.udesa.edu.ar/cruces/cc/yield_curves.pdf.

We focused on effective yields at intervals of one year up to where the available data permitted. From the no arbitrage condition between t-year and t+1-year spot yields we computed the forward one-year yield starting at time t for each country (see Table II). For a bond that carries no systematic risk, and assuming that recovery conditional on default is zero [i.e. $g = 0$ in (2)], the probability of full payment for period t results from,

$$p_t \left(1 + r_{t-1,t}\right) = 1 + i_{t-1,t} \tag{9}$$

where $r_{t-1,t}$ is the one-year risky forward rate starting in year t-1 and i is the comparable risk free rate. When t=1 both rates are spot rates and p_1 is the probability of full payment during the first period, while for t>1, both rates are forward rates and p_t is the probability of full payment conditional on full payment up to time t-1.

Table II reports, for each country, p_t, the cumulative probability of full payment that would result from assuming $m = d = 1$, P_1^t, and the probability of full payment from time zero up to and including time t implicit in bond prices, P_t. It shows that while on some occasions $P_t \approx P_1^t$, it is often the case that they differ substantially. As an example of our point, Figure I.A reports that Argentina had a negatively sloping yield curve in August 2001. This translates in a cumulative probability of full payment up to year 11 implicit in bond prices of 0.29 (Table II.A), which is much higher than the 0.09 that would result from

[6] Appendix I lists the characteristics of all the included bonds. The only bond that is partially guaranteed is Russia-99, which had debentures as collateral. If the bond were stripped, the non-guaranteed part of the bond should have a greater duration and a higher yield, so the April 1997 Russian yield curve would have had an even greater downward slope than that reported in Figure I.C.

compounding for ten years the first period probability of full payment. The converse is true for Colombia, which had a steep yield curve at that time.

IV. Estimation Results and their Implications on Valuation in EM

IV.1. Estimation Results

With these data in hand, we estimated the empirical analog of equation (3),

$$\ln(P_t) = \ln(m) + d\, t \ln(P_1) + e_t \qquad t = 2,\ldots,T \tag{10}$$

separately for each country and for each month, by OLS. The rationale behind separate estimation is that the yield curves in Figure I change dramatically across time and countries so that assuming a model with constant parameters would be inadequate. This shortcoming could be avoided by the use of conditioning information so that m and d depend on lagged instruments. While that is an interesting approach that we propose to explore in future research, it would lead us into yield curve modeling, an issue beyond the scope of this paper.

We estimated (10) for all months in the sample and report the key parameters. Figure III reports the estimated m and d from (10) for all months in the sample. It is apparent that most of the action of the default probability model (3) is around the parameter d, while m is rather stable around one over time for all countries. Most of the time d is greater than one, corresponding to an upward sloping default spread term-structure. Nevertheless, d smaller than one are not uncommon, as in Mexico and Argentina in mid-1998, Russia in early 1997, Colombia around February 1996 and finally as Argentina approached the sovereign default of 2001.

Given the possible measurement error implicit in the extrapolation, we focus the subsequent analysis on the results for three representative months at which the shortest traded bond had a duration lower than one year.

Table III reports the results of estimating (10), and shows that the model fits well the sequence of conditional default probabilities implicit in bond prices. All parameter signs agree with the intuition that when sovereign spreads are upward sloping, ds are greater than one, and conversely when they are decreasing. It is noteworthy that all parameter estimates are statistically significantly different from one --the maintained hypothesis in the standard practice reflected in equation (5). Since d is the parameter that affects the cumulative probability of full payment as time passes, it is the one that changes the most as the economic environment changes: from a minimum of about 0.4 as countries approach default (Argentina in August 2001 and Russia in April 1997) to about 8 when the yield curve steeps up.

IV.2. Implications for Valuation in Emerging Markets

This section reports the main findings of this paper. Table IV shows r_v from (7b), the mispricing ratio m for $t = 1$ as in (8), and the duration of a constant free cash flow project, for a range of parameter values that are consistent with the empirical estimates of m, d, P_1, and for values of i that are consistent with real returns on long-term bonds.
For $m = 1$ and $d = 1.5$, for instance (see top panel), the constant discount rate that would correctly value the project is 12 percent, the true value of the project would be 23 percent lower than the one calculated by using a constant discount rate of 9 percent (i.e., by assuming a flat term structure of default risk), and the project would have a duration of 9.1 years.

The top and bottom panels differ only by the value of the risk-free rate (i). For a 95 percent probability of full payment during the first year, the short-term risky rate is 9 percent when i is 4 percent and it jumps to 12 when i equals 6.

When d is less than one, the short-term sovereign spread is much higher than its long-term counterpart and the true value of a long-term project can be up to 54 percent higher than the value estimated using a one-year discount rate and assuming a flat yield curve. On the contrary, when d is larger than one, the real value can be only one third of the "miscalculated" value. For a given d, higher values of m raise the true value relative to its estimated one since a higher m raises expected dividends. Naturally, when the yield curve steeps up, the constant discount rate that would make the value of the project from (5) equal to that of (6) is much higher than the short-term rate.

Instead of calculating the first-year sovereign spread and assuming that its term structure is flat, most practitioners use J.P. Morgan's Emerging Bond Market Indices (EMBI) as the measure of country risk in equation (1).

Table V shows, for three selected dates, the mispricing error that this practice may induce when the term structure of default-risk is non flat and the duration of the project differs from that of the bond portfolio used to calculate the EMBI. In August 2001, for instance, the use of the EMBI Global would have led to a 14 percent overvaluation of a project with a duration of seven years in Colombia, and 3 percent in Russia. Errors range from overvaluations of up to 16 percent (Argentina, April 1997), to undervaluations of 6 percent (Mexico, August 2001).

Note that these misestimation problems could be solved by using public information from bond markets to estimate P_1, m and d and, using equation (6c) to appraise the correct value of the project.

V. Conclusions and Further Research

Several problems have restricted practitioners from using the CAPM in order to estimate discount rates in Emerging Markets, and have led them to account for the "additional" risks of EM by adding the country risk to the discount rate.

In this paper we claim that such practice does not make an efficient use of the information given by sovereign debt markets. In particular, it does not account for the fact that the default risk term structure is non-flat and, hence, the mismatch between the duration of the project under valuation and the duration of the most widely used measures of country risk, J.P. Morgan's EMBI, leads to an overvaluation (undervaluation) of long-term projects when the term structure of default risk is upward (downward) sloping. The reverse is true for short-term projects.

In normal times, default risk spreads are low at the short end of the curve and slope upward for longer durations. Often times, however, the default risk term structure is downward sloping --as when the market expects a default in the short run.

In addition, there is a high cross-country variability in the average duration of the EMBI-Global country components. This variability reduces the economic significance of net present value comparisons of otherwise similar projects in different countries.

In this paper, using data from five EM, we estimate a simple model of the term structure of default risk and derive its implications on valuation. We find that by implicitly assuming that the term structure of default risk is flat, mispricing errors in the range of plus or minus 50 percent can be made for reasonable parameter values. This mispricing can be avoided by using data that are readily available from bond markets.

To enrich the analysis, future research should be directed at the inclusion of recovery values and the use of conditioning information in a model of default risk term structure.

Figure I. Yields on U.S. Dollar-Denominated Sovereign Bonds

Figure I.A. August 2001

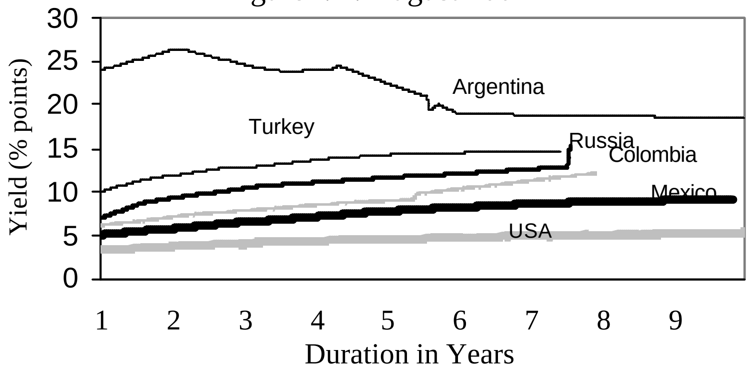


Figure I.B. January 2000

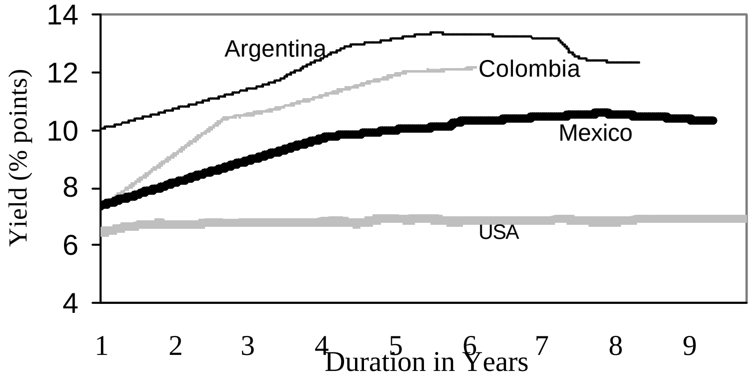


Figure I.C. April 1997

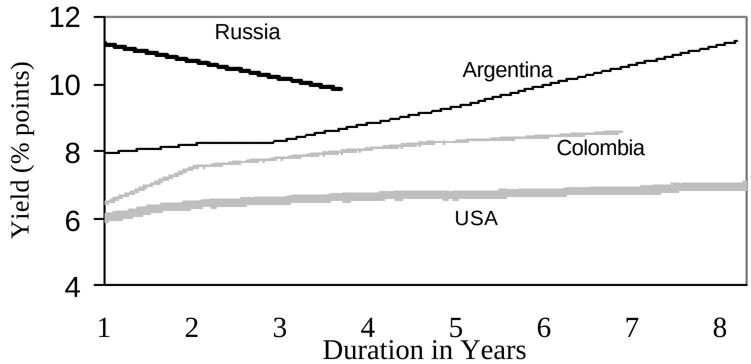


Figure II. Interest Rate Duration of Selected EMBI-Global Country Components, December 1997 - March 2002

Figure II.A.

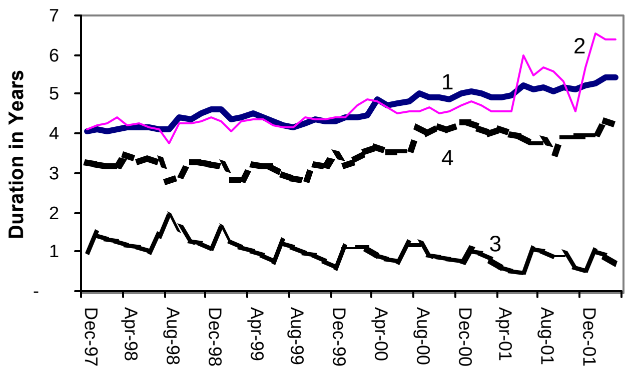


Figure II.B.

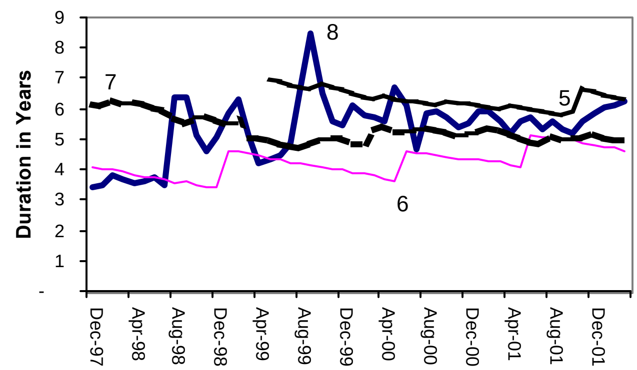


Figure II.C.

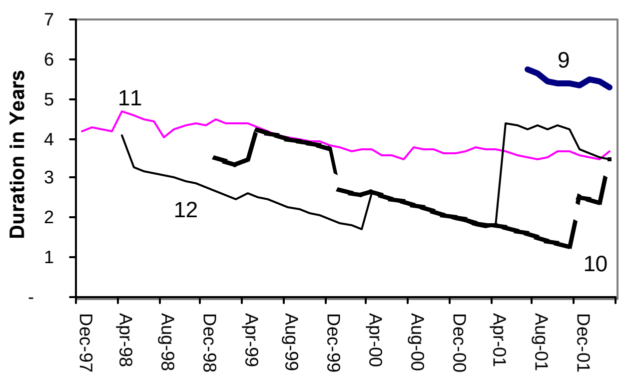


Figure II.D.

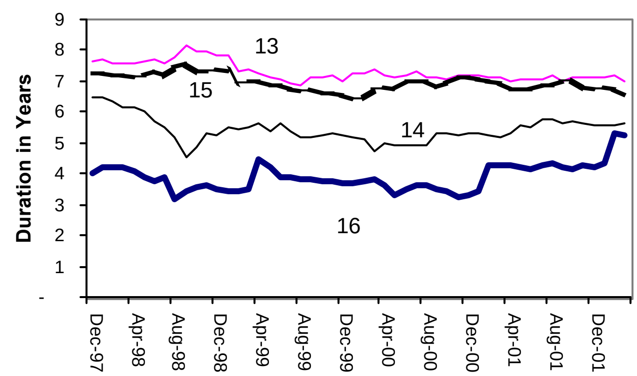


Figure II.E.

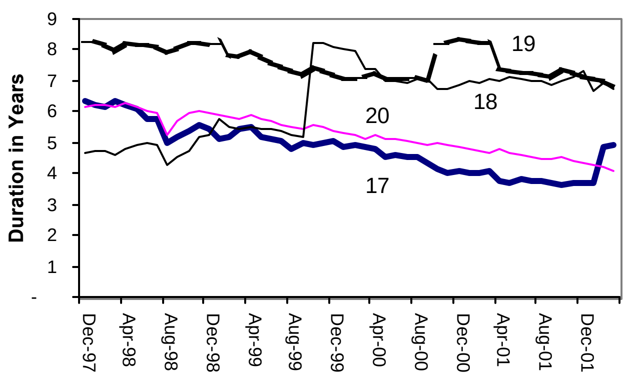
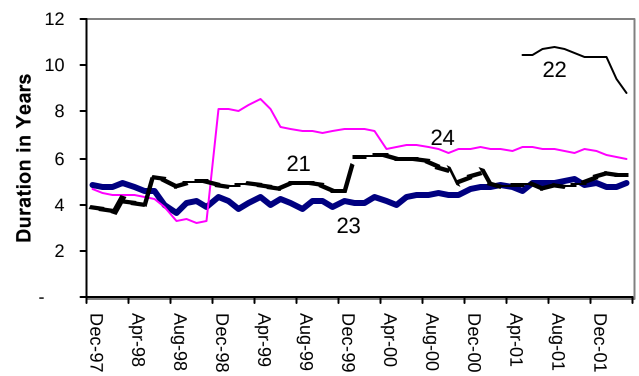


Figure II.F.



1. EMBI Global	5. Chile	9. Egypt	13. Mexico	17. Peru	21. Turkey
2. Argentina	6. China	10. Hungary	14. Malaysia	18. Philippines	22. Uruguay
3. Bulgaria	7. Colombia	11. Korea	15. Nigeria	19. Poland	23. Venezuela
4. Brazil	8. Ecuador	12. Lebanon	16. Panama	20. Thailand	24. South Africa

Source: J.P. Morgan

Figure III. Estimates of Mu and Delta for each Month in the Sample

Figure III.A. Argentina

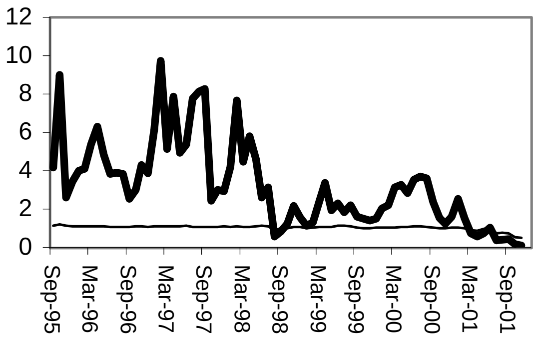


Figure III.B. Colombia

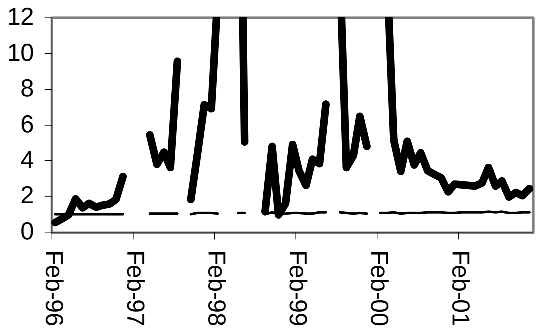


Figure III.C. Mexico

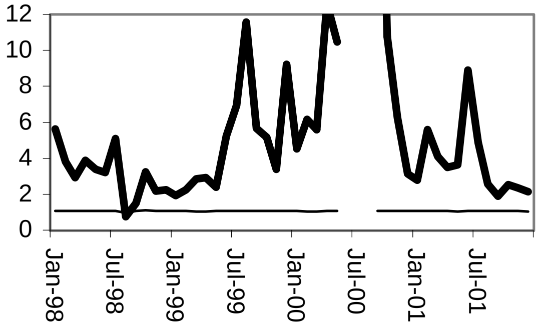


Figure III.D. Russia

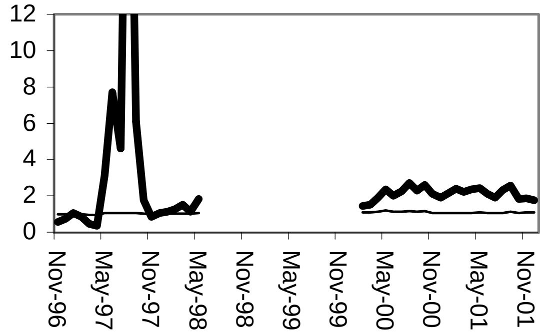
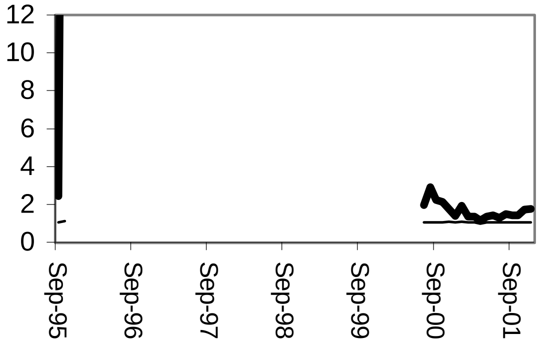


Figure III.E. Turkey



Dark line = Delta
Light line = Mu

Table I: Interest Rate Duration of EMBI Global Country Components

	Dec-97	Jun-98	Dic 98	Jun-99	Dec-99	Jun-00	Dec-00	Jun-01	Dec-01
EMBI Global	4.1	4.2	4.6	4.3	4.3	4.8	5.0	5.2	5.2
Argentina	4.1	4.1	4.4	4.2	4.4	4.5	4.7	6.0	5.7
Bulgaria	1.0	1.0	1.1	0.8	0.6	0.7	0.8	0.4	0.5
Brazil	3.3	3.4	3.3	3.2	3.4	3.6	4.3	3.9	4.0
Cote d"Ivoire		8.4	7.7	7.5	6.3	5.6	4.5	4.9	4.5
Chile				6.9	6.6	6.3	6.1	6.0	6.5
China	4.1	3.7	3.4	4.4	4.0	4.6	4.3	5.1	4.8
Colombia	6.2	6.0	5.6	4.9	5.0	5.3	5.2	4.9	5.2
Ecuador	3.4	3.8	5.0	4.5	5.4	6.1	5.5	5.7	5.9
Greece	1.7	5.6	6.7	6.3	6.0				
Korea	4.2	4.5	4.3	4.2	3.8	3.6	3.6	3.6	3.6
Lebanon		3.2	2.8	2.4	2.0	2.5	2.0	4.3	3.7
Mexico	7.7	7.7	7.8	7.0	7.0	7.2	7.2	7.0	7.1
Malaysia	6.5	5.7	5.2	5.6	5.3	4.9	5.3	5.5	5.6
Nigeria	7.3	7.3	7.4	6.9	6.6	7.0	7.1	6.7	6.7
Panama	4.0	3.8	3.5	3.9	3.7	3.5	3.3	4.1	4.2
Peru	6.3	5.8	5.5	5.1	5.0	4.6	4.1	3.8	3.7
Philippines	4.7	5.0	5.2	5.5	8.1	7.0	6.8	7.1	7.3
Pakistan								2.2	2.0
Poland	8.2	8.1	8.1	7.6	7.2	7.1	8.3	7.3	7.1
Russia						5.3	5.4	5.8	6.2
Thailand	6.2	6.0	5.9	5.7	5.4	5.1	4.9	4.6	4.3
Turkey	3.9	5.2	4.8	4.6	4.6	6.0	5.2	4.9	5.2
Ukraine						2.6	2.3	2.3	2.2
Uruguay								10.5	10.4
Venezuela	4.9	4.6	4.3	4.3	4.2	4.3	4.7	4.9	5.0
South Africa	4.7	4.2	8.1	7.3	7.3	6.5	6.4	6.5	6.3

Source: J.P. Morgan

Table II.A: Sovereign Rates and Implied Default Probabilities - August 2001

t	USA	Argentina				Colombia				Mexico			
	Forward	Forward	p_t	P_1^t	P_t	Forward	p_t	P_1^t	P_t	Forward	p_t	P_1^t	P_t
1	3.33	24.00	0.83	0.83	0.83	6.13	0.97	0.97	0.97	5.06	0.98	0.98	0.98
2	4.01	28.56	0.81	0.69	0.67	8.03	0.96	0.95	0.94	6.51	0.98	0.97	0.96
3	4.52	21.65	0.86	0.58	0.58	9.25	0.96	0.92	0.90	7.96	0.97	0.95	0.93
4	5.40	21.64	0.87	0.48	0.50	10.34	0.96	0.90	0.86	9.00	0.97	0.94	0.90
5	5.52	17.51	0.90	0.40	0.45	11.01	0.95	0.88	0.81	10.36	0.96	0.92	0.86
6	5.29	3.45	1.00	0.34	0.45	17.08	0.90	0.85	0.73	10.37	0.95	0.91	0.82
7	6.22	16.68	0.91	0.28	0.41	16.97	0.91	0.83	0.67	10.86	0.96	0.89	0.79
8	5.64	17.97	0.90	0.23	0.37	18.90	0.89	0.81	0.59	11.59	0.95	0.88	0.74
9	6.34	17.76	0.90	0.19	0.33	.	.	.	.	9.64	0.97	0.86	0.72
10	6.65	17.54	0.91	0.16	0.30	.	.	.	.	.	.	.	.

t	Russia				Turkey			
	Forward	p_t	P_1^t	P_t	Forward	p_t	P_1^t	P_t
1	6.99	0.97	0.97	0.97	10.04	0.94	0.94	0.94
2	11.57	0.93	0.93	0.90	13.71	0.92	0.88	0.86
3	12.59	0.93	0.90	0.84	14.68	0.91	0.83	0.78
4	13.31	0.93	0.87	0.78	16.11	0.91	0.78	0.71
5	13.59	0.93	0.84	0.72	16.81	0.90	0.73	0.64
6	14.58	0.92	0.81	0.66	15.74	0.91	0.69	0.58
7	15.46	0.92	0.78	0.61	15.01	0.92	0.64	0.54
8	.	.	.	.	.	.	.	.
9	.	.	.	.	.	.	.	.
10	.	.	.	.	.	.	.	.

Note: Based on closing prices from end of August 2001of dollar-denominated sovereign bonds, taken from Bloomberg. The rates for the first year are spot rates while for subsequent years they are forward one year rates implied by the linearly interpolated yield curves of each country assuming that recovery value conditional on default is zero and that EM bonds carry no systematic risk. Given cross-default provisions, the cummulative probability that payments in year t will be honored in full and on time is the product of the probability that all payments be made in like manner up to and including year t. For Argentina in t=6 in Table II.A its forward rate was lower than the risk free rate --we assumed that this was due to measurement error and declared p6=1.

Table II.B: Sovereign Rates and Implied Default Probabilities - January 2000

t	USA	Argentina				Colombia				Mexico			
	Forward	Forward	p_t	P_1^t	P_t	Forward	p_t	P_1^t	P_t	Forward	p_t	P_1^t	P_t
1	6.44	10.04	0.97	0.97	0.97	7.30	0.99	0.99	0.99	7.38	0.99	0.99	0.99
2	7.02	11.40	0.96	0.94	0.93	10.97	0.96	0.98	0.96	8.95	0.98	0.98	0.97
3	6.86	12.75	0.95	0.91	0.88	13.41	0.94	0.98	0.90	10.46	0.97	0.97	0.94
4	6.93	15.56	0.93	0.88	0.82	13.01	0.95	0.97	0.85	11.95	0.96	0.97	0.90
5	7.40	16.07	0.93	0.85	0.75	14.75	0.94	0.96	0.80	11.30	0.97	0.96	0.87
6	6.40	14.29	0.93	0.82	0.70	13.33	0.94	0.95	0.75	11.87	0.95	0.95	0.83
7	7.01	12.48	0.95	0.79	0.67	.	.	.	.	11.27	0.96	0.94	0.79
8	6.58	6.70	0.999	0.77	0.67	.	.	.	.	11.59	0.96	0.93	0.76
9	7.48	.	.	.	.	.	.	.	.	8.91	0.99	0.92	0.75

Table II.C: Sovereign Rates and Implied Default Probabilities - April 1997

t	USA	Argentina				Colombia				Russia			
	Forward	Forward	p_t	P_1^t	P_t	Forward	p_t	P_1^t	P_t	Forward	p_t	P_1^t	P_t
1	5.99	7.92	0.98	0.98	0.98	6.43	0.996	0.996	0.996	11.19	0.95	0.95	0.95
2	6.81	8.46	0.99	0.97	0.97	8.52	0.98	0.99	0.98	10.20	0.97	0.91	0.92
3	6.76	8.48	0.98	0.95	0.95	8.39	0.99	0.99	0.97	9.21	0.98	0.87	0.90
4	7.01	10.28	0.97	0.93	0.92	8.84	0.98	0.98	0.95	.	.	.	.
5	6.84	11.28	0.96	0.91	0.89	9.24	0.98	0.98	0.93	.	.	.	.
6	7.10	13.05	0.95	0.90	0.84	9.11	0.98	0.98	0.91	.	.	.	.
7	7.15	14.17	0.94	0.88	0.79	.	.	.	.	.	.	.	.
8	7.78	15.28	0.94	0.87	0.74	.	.	.	.	.	.	.	.

Table III: Estimates of Mu and Delta for Different Samples

$$\ln(P_t) = \ln(m) + d\, t \ln(P_1) + e_t \qquad t = 2,\ldots,T$$

August 2001

	T	m	d	R^2
Argentina	11	0.75	0.40	0.98
		(0.022)	(0.019)	
Colombia	8	1.14	2.86	0.96
		(0.04)	(0.249)	
Mexico	9	1.06	2.55	0.99
		(0.007)	(0.07)	
Russia	7	1.06	2.31	0.99
		(0.005)	(0.029)	
Turkey	7	1.04	1.50	0.99
		(0.007)	(0.024)	

January 2000

	T	m	d	R^2
Argentina	7	1.04	2.03	0.97
		(0.028)	(0.169)	
Mexico	8	1.06	4.53	0.99
		(0.008)	(0.159)	

April 1997

	T	m	d	R^2
Argentina	8	1.10	7.86	0.97
		(0.02)	(0.628)	
Colombia	6	1.04	5.45	0.98
		(0.007)	(0.4)	
Russia	3	0.95	0.37	.
		.	.	

Minimum		0.75	0.37	
Maximum		1.14	7.86	

Estimated by OLS. Std. Errors in parentheses. For mu, standard errors are estimated using the delta method and so are approximate. Since only two observations (T-1=2) of P_t are available for Russia in April 1997, we solved analytically for the two unknowns. No statistics are involved in that particular case.

Table IV: Percentage Misestimation for Different Parameter Specifications

Assumptions:		i =	4%	P_1 =	0.95	r_1 =	9%	
m	**Row Content**	d						
		0.5	**0.8**	**1.0**	**1.5**	**2.5**	**4.0**	**7.0**
0.8	r_v|V=V**hat**	8%	10%	12%	15%	22%	31%	50%
	m	15%	-8%	-18%	-37%	-56%	-70%	-81%
	Dur. Proj.	13.1	10.7	9.6	7.7	5.6	4.2	3.0
1.0	r_v|V=V**hat**	7%	8%	9%	12%	18%	27%	44%
	m	41%	13%	0%	-23%	-47%	-65%	-78%
	Dur. Proj.	15.9	13.0	11.6	9.1	6.6	4.7	3.3
1.1	r_v|V=V**hat**	6%	8%	9%	11%	17%	25%	41%
	m	54%	24%	9%	-16%	-43%	-62%	-77%
	Dur. Proj.	17.3	14.1	12.5	9.9	7.0	5.0	3.4

Assumptions:		i =	6%	P_1 =	0.95	r_1 =	12%	
m	**Row Content**	d						
		0.5	**0.8**	**1.0**	**1.5**	**2.5**	**4.0**	**7.0**
0.8	r_v|V=V**hat**	11%	13%	14%	17%	24%	34%	52%
	m	8%	-9%	-18%	-34%	-52%	-66%	-78%
	Dur. Proj.	10.3	8.8	8.1	6.7	5.1	3.9	2.9
1.0	r_v|V=V**hat**	9%	10%	12%	14%	20%	29%	46%
	m	32%	11%	0%	-20%	-43%	-60%	-75%
	Dur. Proj.	12.4	10.6	9.6	7.9	5.9	4.4	3.2
1.1	r_v|V=V**hat**	8%	10%	11%	13%	19%	27%	44%
	m	44%	21%	9%	-13%	-38%	-57%	-73%
	Dur. Proj.	13.5	11.4	10.4	8.5	6.3	4.7	3.3

Table V. Mispricing Error Using EMBI

	EMBI		Duration of the Investment Project in Years								
Period & Country	Spread over Treasury	Interest Rate Duration	1	2	3	4	5	6	7	8	9
August 2001											
Argentina	14.3	5.7	-4%	-11%	-13%	-15%	-13%	0%	1%	2%	3%
Colombia	4.4	5.1	3%	3%	3%	2%	0%	-7%	-14%		
Mexico	3.7	7.2	3%	5%	6%	6%	4%	2%	0%	-2%	-3%
Russia	7.4	5.8	5%	5%	5%	4%	2%	0%	-3%		
Turkey	9.7	4.8	4%	4%	4%	2%	0%	-1%	-2%		
January 2000											
Argentina	5.7	4.4	2%	3%	3%	0%	-3%	-4%	-4%	1%	
Colombia	5.0	4.9	4%	5%	4%	3%	0%	-1%			
Mexico	3.6	7.2	3%	4%	4%	3%	2%	1%	0%	-1%	1%
April 1997											
Argentina	2.2	3.9	1%	1%	1%	0%	-2%	-6%	-11%	-16%	

Appendix I

Let $t = m = 1$ for simplicity. We want to show that if $d > 1\,(d < 1)$, then $r_v > r_t$ $(r_v < r_t)$. Assume that $d > 1$ but $r_v \leq r_t$. This would imply that

$$\frac{1}{r_v} \geq \frac{1}{r_t}$$

$$\Leftrightarrow \frac{p_1}{1+f} + \sum_{t=2}^{\infty}\left(\frac{P_1^{d}}{1+f}\right)^{t} \geq \frac{p_1}{1+f} + \sum_{t=2}^{\infty}\left(\frac{P_1}{1+f}\right)^{t}$$

For every *t*, the term between parenthesis on the left hand side is bigger than the corresponding term on the right hand side if and only if $P_1^d \geq P_1$, which is a contradiction.

Appendix II: Characteristics of the Bonds Used

Argentina			
Coupon	**Maturity**	**Code**	**ISIN**
8.25%	15-Oct-97	(Arg-97)	XS0040079641
10.95%	1-Nov-99	(Arg-99)	US040114AJ99
9.25%	23-Feb-01	(Arg-01)	US040114AK62
8.375%	20-Dec-03	(Arg-03)	US040114AH34
11%	4-Dec-05	(Arg-05)	US040114BA71
11%	9-Oct-06	(Arg-06)	US040114AN02
11.75%	7-Apr-09	(Arg-09)	US040114BE93
11.375%	15-Mar-10	(Arg-10)	US040114FC91
11.75%	15-Jun-15	(Arg-15)	US040114GA27
11.375%	30-Jan-17	(Arg-17)	US040114AR16
12.125%	25-Feb-19	(Arg-19)	US040114BC38
12%	1-Feb-20	(Arg-20)	US040114FB19
9.75%	19-Sep-27	(Arg-27)	US040114AV28
10.25%	21-Jul-30	(Arg-30)	US040114GB00
12.25%	19-Jun-18	(Arg-18)	US040114GG96
12%	19-Jun-31	(Arg-31)	US040114GH79
0%	15-Mar-02	(LETE 90)	ARARGE033134

Turkey			
Coupon	**Maturity**	**Code**	**ISIN**
8.75%	5-Oct-98	(Tur-98)	XS0060514642
9.00%	15-Jun-99	(Tur-99)	US900123AC41
10%	23-May-02	(Tur-02)	XS0076567774
8.875%	12-May-03	(Tur-03)	XS0086996310
11.875%	5-Nov-04	(Tur-04)	US900123AK66
9.875%	23-Feb-05	(Tur-05)	XS0084714954
10%	19-Sep-07	(Tur-07)	XS0080403891
12.375%	15-Jun-09	(Tur-09)	US900123AJ93
11.75%	15-Jun-10	(Tur-10)	US900147AB51
11.875%	15-Jan-30	(Tur-30)	US900123AL40

Colombia			
Coupon	**Maturity**	**Code**	**ISIN**
7.125%	11-May-98	(Col-98)	USP28714AE62
8%	14-Jun-01	(Col-01)	US19532NAA46
7.5%	1-Mar-02	(Col-02)	US19532NAE67
7.25%	15-Feb-03	(Col-03)	US195325AH80
10.875%	9-Mar-04	(Col-04)	US195325AP07
7.625%	15-Feb-07	(Col-07)	US195325AK10
8.625%	1-Apr-08	(Col-08)	US195325AM75
9.75%	23-Apr-09	(Col-09)	US195325AR62
11.75%	25-Feb-20	(Col-20)	US195325AU91

Mexico			
Coupon	**Maturity**	**Code**	**ISIN**
9.75%	6-Feb-01	(Mex-01)	US593048AV35
8.5%	15-Sep-02	(Mex-02)	US593048AQ40
9.75%	6-Apr-05	(Mex-05)	US91086QAB41
9.875%	15-Jan-07	(Mex-07)	US593048BB61
8.625%	12-Mar-08	(Mex-08)	US593048BF75
10.375%	17-Feb-09	(Mex-09)	US593048BG58
9.875%	1-Feb-10	(Mex-10)	US91086QAD07
11.375%	15-Sep-16	(Mex-16)	US593048BA88
11.5%	15-May-26	(Mex-26)	US593048AX90

Russia			
Coupon	**Maturity**	**Code**	**ISIN**
3%	14-May-99	(Rus-99)	RU0004146067
9.25%	27-Nov-01	(Rus-01)	XS0071496623
11.75%	10-Jun-03	(Rus-03)	USX74344CZ79
8.75%	24-Jul-05	(Rus-05)	XS0089372063
8.25%	31-Mar-10	(Rus-10)	XS0114295560
11%	24-Jul-18	(Rus-18)	XS0089375249
5%	31-Mar-30	(Rus-30)	XS0114288789

* ISIN is the International Securities Identification Number.

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