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 in an ad-hoc manner 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 being valued 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 expected collection 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

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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 (k) by using

$$E\left(k_i\right) = r_{US}^{f} + CS + 0.6\,\frac{\sigma_i}{\sigma_{US}}\,E\left(r_{US}^{m} - r_{US}^{f}\right) \qquad (1)$$

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

[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.

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]

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, the country risk may be 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

2 The 60% adjustment is due to the finding of Erb, Harvey and Viskanta (1995) that on average, about 40% of the volatilities of emerging equity markets are explained by variations in credit quality. To avoid counting twice the variation in credit spreads, only the fraction of equity variation that is unaccounted for by credit spreads is taken into account --see Godfrey and Espinosa (1996) for details.

valuation and the duration of the most widely used measure 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.

The country risk measures most widely used are J.P. Morgan's Emerging Market Bond Index (EMBI), and its extensions EMBI+ and EMBI-Global (see for instance Pereiro, 2001). 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 it is three years and for Uruguay it is higher than ten years (Figure II). This variability undermines the 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 a 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 expected collection for a given country at one point in time. This model can be used to solve the misvaluation problem.

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

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

II.1. Bond Prices and Expected Collection

Let $r_{0,t}$ be the yield to maturity implicit in prices of a risky sovereign zero-coupon bond denominated in U.S. dollars issued at time 0 and maturing at time t. Similarly, let $f_{0,t}$ be the expected return of holding this bond during the same time interval. We assume that EM sovereign bonds carry no systematic risk and so f is the risk free rate. Let Q_t be the probability of full payment on this bond, and g the recovery rate in the event of default. For a one-period bond issued at time zero, these definitions imply

$$Q_1\left(1+r_{0,1}\right)+\left(1-Q_1\right)g\left(1+r_{0,1}\right)=1+f_{0,1} \quad . \tag{2}$$

Note that as long as there is some probability of default, $r_{0,t} > f_{0,t}$. Rearranging the left-hand side gives the expected collection per dollar due, P_1,

$$P_1 = Q_1 + \left(1-Q_1\right)g = \frac{1+f_{0,1}}{1+r_{0,1}} \quad . \tag{3}$$

Similarly, if there is another bond issued at t=0 and maturing at t=2, we have

$$P_2\left(1+r_{0,2}\right)^2 = \left(1+f_{0,2}\right)^2 \quad . \tag{4}$$

So given a sequence of promised and expected yields for zero-coupon zero-beta bonds of different maturities we can extract the sequence of expected collections for different horizons implicit in bond prices. We call default spread the ratio $(1+r_{0,t})/(1+f_{0,t})$. From (3) and (4) it is easy to see that if the default spread is constant for all t, then

$$P_t = P_1^t \tag{5}$$

The case of constant default spreads corresponds to a risky yield curve whose slope is proportional to that of the risk free yield curve. As we argued in Section I, this case is a rare exception in the data. Most of the times, EM default spreads vary with duration. To account for this, we propose a reduced form model for expected collection over time that seems consistent with the data,[4]

$$P_t = \begin{cases} P_1 & if\ t = 1 \\ m\, P_1^{d\,t} & if\ \ t \geq 2 \end{cases} \quad . \tag{6}$$

Note that this model reduces to (5) in the special case of constant default spreads or proportional yield curves (i.e., $m = d = 1$).

II.2. Implications on Valuation in EM

The volatile environment of EM aggravate the usual difficulties of forecasting dividends many years into the future under different states of nature and their associated probabilities. The standard response from practitioners is to work with the most likely dividends (or the expected dividends under normal circumstances) in the numerator of a present value equation and to add extra factors to the discount rate as in equation (1) to penalize for the uncertainty

[4] See Merrick (2001) and Yawitz (1977) for alternative specifications.

associated with the true expected dividends (see Keck et al., 1998, Pereiro and Galli, 2000, Abuaf and Chu, 1994, Godfrey and Espinosa., 1996).

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.[5] Let $r_{0,t} + b\ MP$ be the constant per-period discount rate stemming from (1), where t stands for the interest rate duration of the bond portfolio used to measure the country risk, and $b\ MP$ is analogous to the last term in (1).[6] In this case, the common practice is to compute the value of the firm as

$$\hat{V} = \sum_{t=1}^{\infty} \frac{d}{(1 + r_{0,t} + b\ MP)^t} = \frac{d}{r_{0,t} + b\ MP} \quad . \tag{7}$$

We call $\hat{V}$ "miscalculated value", for reasons that become apparent below. Note that, from (4),

$$1 + r_{0,t} = \frac{1 + f_{0,t}}{P_t^{1/t}} \quad , \tag{8}$$

so that (7) is equivalent to

$$\hat{V} = \sum_{t=1}^{\infty} \frac{\left(P_t^{1/t}\right)^t d}{\left(1 + f_{0,t} + P_t^{1/t}\ b\ MP\right)^t} = \frac{P_t^{1/t}\ d}{1 + f_{0,t} + P_t^{1/t}\ b\ MP - P_t^{1/t}} \tag{9}$$

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[5] We use "most likely dividends", "central scenario dividends", and "expected dividends under normal circumstances" interchangeably.

[6] Here $r_{0,t}$ is the addition of the risk free rate plus the country spread in (1).

Therefore, the standard approach is tantamount to adjusting central scenario dividends by direct compounding of the t -th root of the expected collection t -periods hence, and using in the denominator an expected return where the market premium is attenuated by $P_t^{1/t}$.

We argue that this is not the best way to convert central scenario dividends into expected dividends, as it does not make an efficient use of the data available from bond markets. Our proposed alternative consists in using the actual sequence of expected collections on government bonds, P_t, as a proxy for the likelihood that central scenario dividends will be realized in each period. The idea is that in the states of nature in which the government breaks its promise to lenders it might also break its promise to foreign direct investors about respecting property rights and it might impose similar losses on both types of investors.[7] This can be interpreted in terms of the typical "downward" risks of EM noted by Estrada (2000).

On the one hand, the government could be more likely to violate the rights of direct investors than those of bondholders. Given that the secondary market for direct investment is much less liquid than that for sovereign bonds, it is relatively more costly for direct investors to get rid of their firms than it is for bondholders and the government may take advantage of this fact.

On the other hand, direct investors are stakeholders in the local economy and have more retaliatory power than bondholders. While both types of investors can threaten to curtail future investment, direct investors can backfire immediately by laying off workers (so raising civilian unrest), postponing the liquidation of foreign exchange earnings (so further reducing the demand for local currency in times of runs on the currency), or delaying investments currently underway, etc. So the government may actually be less hostile towards direct investors.

We use the working assumption of equal expected collection of central scenario cash flows for the bond and equity markets, implicitly assuming that these effects might cancel one another out. Equation (9) shows that the standard practice implicitly makes a similar assumption, though it uses an adjustment factor in the numerator that (under our hypothesis) may be inconsistent with the information provided by bond markets. Our proposal does not

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[7] There are may ways in which the government can violate the property rights of direct investors, for instance changing public utility rate regulations, by shifting tax rates, by inducing inflation when some prices are fixed or by outright confiscation.

provide a solution to the fact that expected collections may vary by sector of industry. Our contribution is to compute the mispricing errors that arise from (9) when the term structure of default risk is non flat and to provide a simple solution to adjust the valuation for any term structure of expected collection.[8] Conditional on this assumption, the "true value", V, of the firm would be

$$V = \sum_{t=1}^{\infty} \frac{P_t\, d}{(1+i_{0,t})^t} \qquad (10)$$

where $i_{0,t}$ is the expected rate of return of investing in this firm, and the numerator gives the expected dividend each period. In equation (10) $i_{0,t}$ does not include the sovereign spread and we can easily assume that it is constant (i.e., $i_{0,t} = i\ \forall t$). In financially integrated markets where the CAPM holds, i would approximately be equal to the risk-free rate plus the beta of the firm with respect to the world portfolio times the world market portfolio premium.[9] In segmented markets, beta and the market premium would be measured locally.[10]

If the default spread is constant, which we stress by using the subscript c, then (10) becomes,

$$V_c = \sum_{t=1}^{\infty} \frac{P_1^t d}{(1+i)^t} = \frac{P_1\ d}{1+i-P_1} \quad . \qquad (11)$$

Note that (11) gives approximately the same solution as (9), the only difference being in the P that multiplies the market premium factor in (9).[11]

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[8] 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.

[9] Plus a term that reflects a premium for real exchange rate risk. See Adler and Dumas (1983).

[10] Note that by explicitly using expected returns grounded on theory in the denominator, sector-specific systematic risks can be accounted for in the discount rate.

[11] Note from (5) that when the default spread is constant, $P_1 = P_t^{1/t}$.

Under the assumption that expected collections from bond markets apply to equities, the practitioner approach would give the right valuation when the default spread is constant. But bond markets seldom display such yield curve structures as shown in Figure I. In the more general case in which m and d are not equal to one, plugging the expected collections from (6) in (10) gives a value of the firm, V_v, as

$$V_v = \frac{d}{1+i}\left\{P_1 + \frac{mP_1^{2d}}{1+i-P_1^d}\right\} \tag{12}$$

where the subscript v indicates that this holds for variable yield curve structures. Note that for any value of m and d there is a value of r that makes $\hat{V} = V_v$, given by

$$r_{0,v} + b\ MP = \frac{1+i}{\left(P_1 + \frac{mP_1^{2d}}{1+i-P_1^d}\right)} \tag{13}$$

We can interpret v as a time subscript referring to the duration of the risky bond (in a non-flat yield curve context) whose yield used in the discount rate as in (7) would give a value of the firm equivalent to that from (12). In Appendix I we show for $t = m = 1$ that if $d > 1\ (d < 1)$, then $r_{0,v} > r_{0,t}\ (r_{0,v} < r_{0,t})$. Naturally, only when $m = d = 1$ will $r_{0,v}$ be equal to $r_{0,t}$.

In general, 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 that we call m,

$$m = \frac{\hat{V} - V_v}{V_v} = \frac{r_{0,v} - r_{0,t}}{r_{0,t} + b\ MP} \tag{14}$$

The mispricing ratio has a straightforward interpretation. If the default spread is upward sloping and t is smaller than the duration of the project, v (so that $r_{0,v} > r_{0,t}$), then the standard practice overestimates the value of the project (*m*>0). This is because such method uses in the numerator of (9) a direct compounding of an expected collection that is very high for the short run , and that when compounded directly over time, gives values of expected collections for long-run dividends that are too high relative to what is implicit in contemporaneous long bond prices. Hence the overestimation.

Below, we use data from U.S. dollar-denominated EM bonds to estimate equation (6) and illustrate the mispricing ratios that are likely to be observed for empirically reasonable values of m and d .

III. 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.[12] For those sample months for which the shortest bond had a duration greater

[12] 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.

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.[13] The horizontal axis shows the duration of the respective bonds measured in years. None of the bonds considered are actually zero coupon. However, we used the fact that for zero coupon bonds, duration and maturity are equal and that the main determinant of yield for a given credit quality is duration. Therefore, we assumed that each country had outstanding, at each month in the sample, a set of zero coupon bonds for maturities at one year intervals into the future. The duration of the longest zero coupon bond so constructed was smaller than that for the bond outstanding of highest duration. We assumed that these bonds had no systematic risk and so set their expected returns equal to the risk free rate for each duration. With this information we used equation (3) to estimate the sequence of expected collections for different horizons that are consistent with EM sovereign bond prices, which are shown in Table II.

It shows that while on some occasions $P_t \approx P_1^{\,t}$, it is often the case that they differ substantially. For example, Figure I.A shows that Argentina had a negatively sloping yield curve in August 2001. This translates in an expected collection for year 10 implicit in bond prices of 0.30 (Table II.A), which is about twice the 0.16 that would result from direct compounding of the first year expected collection. 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 (6),

$$\ln\left(P_t\right) = \ln\left(m\right) + d\ t \ln\left(P_1\right) + e_t \qquad t = 2,\ldots,T \tag{15}$$

[13] Plots of all available yields available are posted at http://www.udesa.edu.ar/cruces/cc/yield_curves.pdf.

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 (15) for all months in the sample and report the key parameters. Figure III reports the estimated m and d from (15) for all months in the sample. It is apparent that most of the action of the expected collection model (6) 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 (15), and shows that the model fits well the sequence of expected collection implicit in bond prices. It seems as though the variation of expected collection for different horizons is well captured by a flexible power function of the first period expected collection. 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 (9) if the t used is one year. Since d is the parameter that affects the expected collection 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 the paper. Table IV shows $r_{0,v}$ from (13), the mispricing ratio m for $t = 1$ as in (14), 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 the risk free rate that are consistent with real returns on long-term U.S. government bonds. The mispricing ratios are computed assuming that b in (14) is zero which is consistent with the evidence in Harvey (1995). [14]

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 estimated value using a constant discount rate of 9 percent (i.e., by assuming a flat term structure of default risk) would be 30 percent higher than the true value.

The top and bottom panels differ only by the value of the risk-free rate (*f*). For a 95 percent expected collection one year hence, the short-term risky rate is 9 percent when *f* is 4 percent and it jumps to 12 when *f* equals 6.

When d is less than one, the short-term sovereign spread is much higher than its long-term counterpart and the estimated value can miss up to 35 percent of the true value. On the contrary, when d is larger than one, the estimated value under the current practice (using $t = 1$) can overestimate the true value of a project by a factor of about three or four.

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 (7) equal to that of (12) is much higher than the short-term rate.

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

Table V uses actual sovereign yields for each duration to show the mispricing error that the current practice may induce when the duration of the project differs from that of the bond

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[14] Note that if dividends grew over time, the durations of the projects would be even larger for a given r.

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 18 percent (Argentina in April 1997), to undervaluations of 6 percent (Mexico and Russia in 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 (12) 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.

We establish that such practice amounts to reducing central scenario dividends by a power of the expected collection for a horizon equal to the duration of the bonds used to measure the country spreads. This would not be subject to additional criticisms to those already raised in the literature if the default spreads were constant but it is problematic when they are not. In normal times, however, default risk is low at the short end of the curve and slopes upward for longer durations. Moreover, often times 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.

We use data from five EM to 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 minus 30 to plus 400 percent can be made for reasonable parameter values. This mispricing can be avoided by using data that are readily available from bond markets.

There are two directions for further research. First, it would be useful to generate expected collections that vary by industrial sector, since the instability of EM has heterogeneous impact across sectors (Eaton and Gersovitz, 1984). Second, by using conditioning information to model the term structure of default risk, we could estimate how its shape responds to fundamentals. If yield spreads are upward sloping in booms and downward sloping in recessions, it would imply that the current valuation practice induces extra pro-cyclicality in private investment in EM. This could be avoided by using our proposed valuation approach.

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

Figure I.A. August 2001

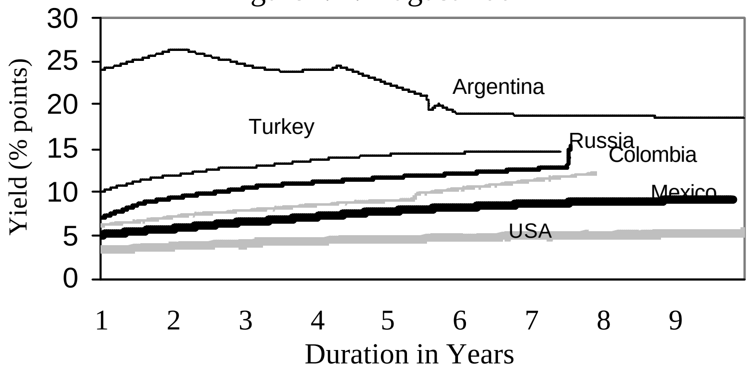


Figure I.B. January 2000

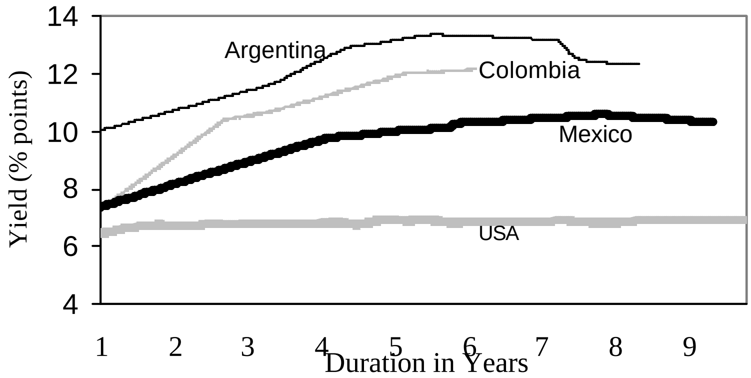


Figure I.C. April 1997

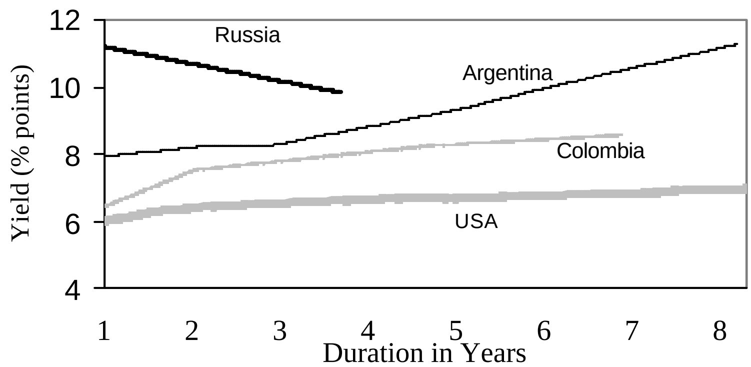


Figure II. Interest Rate Duration of Selected EMBI-Global Country Components, December 1997 - March 2002

Figure II.A.

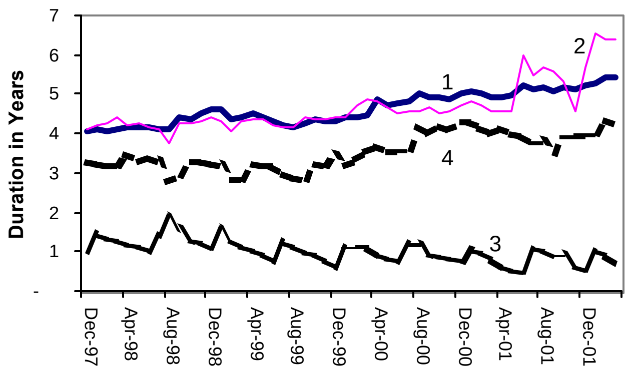


Figure II.B.

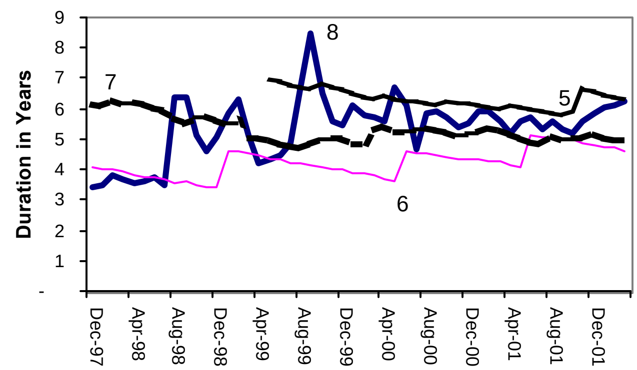


Figure II.C.

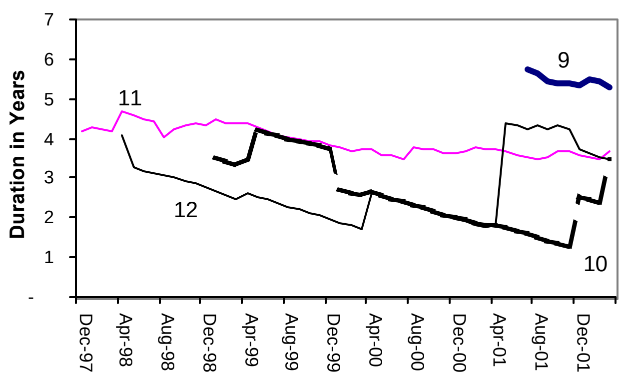


Figure II.D.

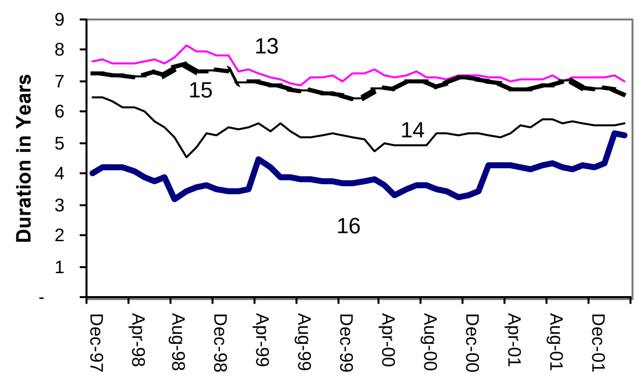


Figure II.E.

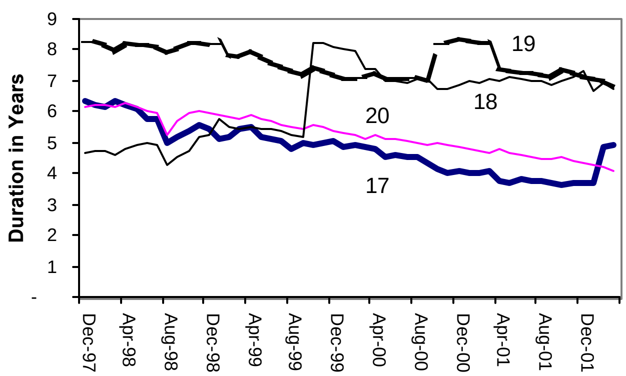
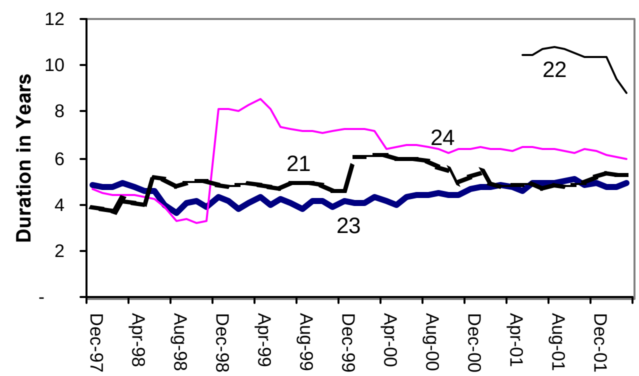


Figure II.F.



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

Source: J.P. Morgan

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

Figure III.A. Argentina

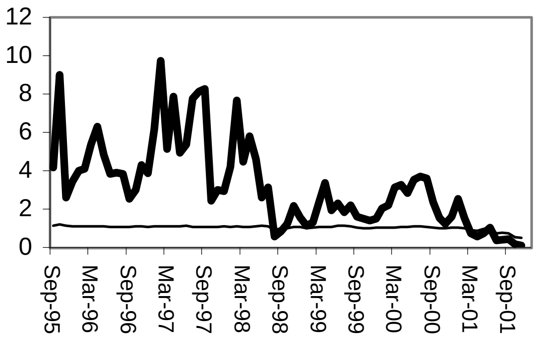


Figure III.B. Colombia

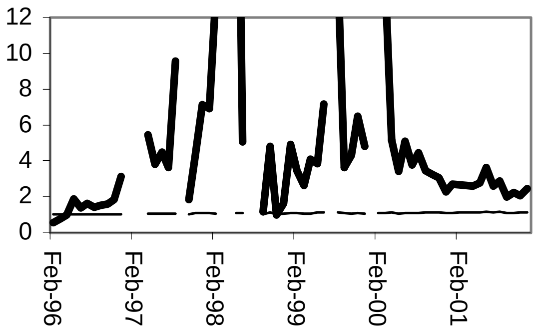


Figure III.C. Mexico

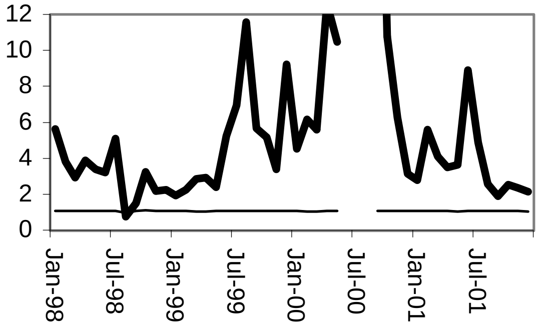


Figure III.D. Russia

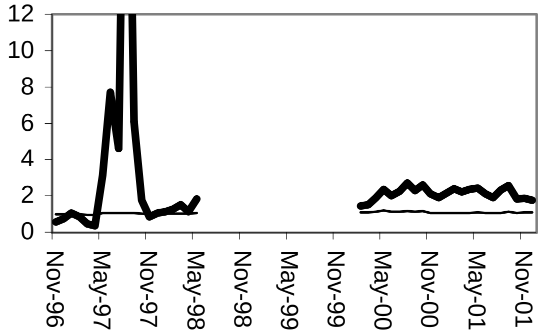
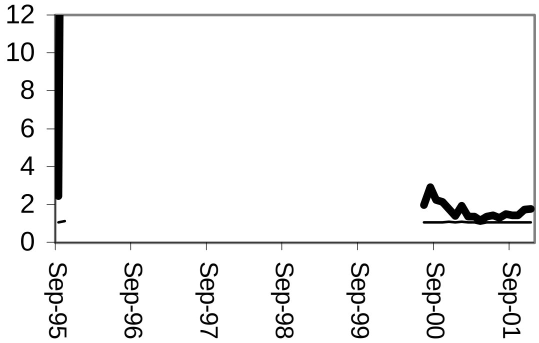


Figure III.E. Turkey



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: Expected Collection on Emerging Sovereign Bonds for Different Horizons

II.A: August 2001

t	Argentina			Colombia			Mexico			Russia			Turkey		
	P_1^t	P_t	Est. P_t	P_1^t	P_t	Est. P_t	P_1^t	P_t	Est. P_t	P_1^t	P_t	Est. P_t	P_1^t	P_t	Est. P_t
1	0.83	0.83	.	0.97	0.97	.	0.98	0.98	.	0.97	0.97	.	0.94	0.94	.
2	0.69	0.67	0.65	0.95	0.94	0.98	0.97	0.96	0.97	0.93	0.90	0.90	0.88	0.86	0.86
3	0.58	0.58	0.60	0.92	0.90	0.91	0.95	0.93	0.93	0.90	0.84	0.83	0.83	0.78	0.78
4	0.48	0.50	0.56	0.90	0.86	0.84	0.94	0.90	0.90	0.87	0.78	0.77	0.78	0.71	0.71
5	0.40	0.45	0.52	0.88	0.81	0.78	0.92	0.86	0.86	0.84	0.72	0.71	0.73	0.64	0.65
6	0.34	0.45	0.48	0.85	0.73	0.72	0.91	0.82	0.82	0.81	0.66	0.66	0.69	0.58	0.59
7	0.28	0.41	0.45	0.83	0.67	0.67	0.89	0.79	0.79	0.78	0.61	0.60	0.64	0.54	0.54
8	0.23	0.37	0.42	0.81	0.59	0.62	0.88	0.74	0.75	.	.	.	.	.	.
9	0.19	0.33	0.39	.	.	.	0.86	0.72	0.72	.	.	.	.	.	.
10	0.16	0.30	0.36	.	.	.	.	.	.	.	.	.	.	.	.

II.B: January 2000

t	Argentina			Colombia			Mexico		
	P_1^t	P_t	Est. P_t	P_1^t	P_t	Est. P_t	P_1^t	P_t	Est. P_t
1	0.97	0.97	.	0.99	0.99	.	0.99	0.99	.
2	0.94	0.93	0.91	0.98	0.96	0.95	0.98	0.97	0.98
3	0.91	0.88	0.85	0.98	0.90	0.90	0.97	0.94	0.94
4	0.88	0.82	0.79	0.97	0.85	0.85	0.97	0.90	0.90
5	0.85	0.75	0.74	0.96	0.80	0.80	0.96	0.87	0.87
6	0.82	0.70	0.69	0.95	0.75	0.75	0.95	0.83	0.84
7	0.79	0.67	0.65	.	.	.	0.94	0.79	0.80
8	0.77	0.67	0.61	.	.	.	0.93	0.76	0.77
9	.	.	.	.	.	.	0.92	0.75	0.74

II.C: April 1997

t	Argentina			Colombia			Russia		
	P_1^t	P_t	Est. P_t	P_1^t	P_t	Est. P_t	P_1^t	P_t	Est. P_t
1	0.98	0.98	.	0.996	0.996	.	0.95	0.95	.
2	0.97	0.97	0.83	0.99	0.98	1.00	0.91	0.92	0.92
3	0.95	0.95	0.72	0.99	0.97	0.97	0.87	0.90	0.90
4	0.93	0.92	0.62	0.98	0.95	0.95	.	.	.
5	0.91	0.89	0.54	0.98	0.93	0.93	.	.	.
6	0.90	0.84	0.47	0.98	0.91	0.91	.	.	.
7	0.88	0.79	0.41	.	.	.	.	.	.
8	0.87	0.74	0.36	.	.	.	.	.	.

Note: Based on closing prices from end of August 2001of dollar-denominated sovereign bonds, taken from Bloomberg assuming that EM bonds carry no systematic risk. For Argentina at t=6 in Aug-2001, the risky yield curve dropped so sharply that the implied risky forward rate was lower than the implied risk free forward risk. We attributed this to measurement error (possibly arising from illiquidity in the EM bonds market) and assumed that for that time interval the risky and risk free forward rates were equal. The last column for each country reports the estimated Pt using the parameter estimates reproted in Table III.

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-1	m	d	R^2
Argentina	10	0.75	0.40	0.98
		(0.022)	(0.019)	
Colombia	7	1.14	2.86	0.96
		(0.04)	(0.249)	
Mexico	8	1.06	2.55	0.99
		(0.007)	(0.07)	
Russia	6	1.06	2.31	0.99
		(0.005)	(0.029)	
Turkey	6	1.04	1.50	0.99
		(0.007)	(0.024)	

January 2000

	T-1	m	d	R^2
Argentina	7	1.04	2.03	0.97
		(0.028)	(0.169)	
Colombia	5	1.07	7.33	0.99
		(0.008)	(0.256)	
Mexico	8	1.06	4.53	0.99
		(0.008)	(0.159)	

April 1997

	T-1	m	d	R^2
Argentina	7	1.10	7.86	0.97
		(0.02)	(0.628)	
Colombia	5	1.04	5.45	0.98
		(0.007)	(0.4)	
Russia	2	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

$$m = \frac{\hat{V} - V_v}{V_v} = \frac{r_{0,v} - r_{0,t}}{r_{0,t}}$$

Assumptions:		f =	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	$r_v \mid V = V$**hat**	8%	10%	12%	15%	22%	31%	50%
	m	-13%	8%	22%	58%	128%	232%	425%
	Dur. Proj.	13.1	10.7	9.6	7.7	5.6	4.2	3.0
1.0	$r_v \mid V = V$**hat**	7%	8%	9%	12%	18%	27%	44%
	m	-29%	-12%	0%	30%	90%	182%	362%
	Dur. Proj.	15.9	13.0	11.6	9.1	6.6	4.7	3.3
1.1	$r_v \mid V = V$**hat**	6%	8%	9%	11%	17%	25%	41%
	m	-35%	-19%	-8%	19%	75%	162%	336%
	Dur. Proj.	17.3	14.1	12.5	9.9	7.0	5.0	3.4

Assumptions:		f =	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	$r_v \mid V = V$**hat**	11%	13%	14%	17%	24%	34%	52%
	m	-7%	10%	22%	51%	109%	194%	351%
	Dur. Proj.	10.3	8.8	8.1	6.7	5.1	3.9	2.9
1.0	$r_v \mid V = V$**hat**	9%	10%	12%	14%	20%	29%	46%
	m	-24%	-10%	0%	25%	75%	151%	298%
	Dur. Proj.	12.4	10.6	9.6	7.9	5.9	4.4	3.2
1.1	$r_v \mid V = V$**hat**	8%	10%	11%	13%	19%	27%	44%
	m	-31%	-17%	-8%	15%	61%	133%	276%
	Dur. Proj.	13.5	11.4	10.4	8.5	6.3	4.7	3.3

Table V. Mispricing Error Using EMBI

Period and Country	EMBI		Duration of the Investment Project in Years								
	Spread over Treasury	Interest Rate Duration	1	2	3	4	5	6	7	8	9
August 2001											
Argentina	14.3	5.7	4.3%	12.7%	15.0%	17.8%	15.4%	-0.2%	-0.8%	-1.7%	-2.7%
Colombia	4.4	5.1	-2.7%	-3.7%	-3.6%	-2.4%	-0.8%	6.8%	14.6%	.	.
Mexico	3.7	7.2	-3.1%	-4.8%	-5.1%	-4.6%	-2.8%	-1.1%	1.2%	4.0%	5.2%
Russia	7.4	5.8	-4.6%	-5.0%	-4.6%	-3.6%	-2.3%	-0.2%	2.9%	.	.
Turkey	9.7	4.8	-3.8%	-4.4%	-4.2%	-2.7%	-0.7%	0.3%	0.8%	.	.
January 2000											
Argentina	5.7	4.4	-2.2%	-3.1%	-2.8%	0.0%	3.1%	4.5%	4.5%	-0.9%	.
Colombia	5.0	4.9	-4.0%	-4.7%	-3.3%	-2.2%	0.5%	1.8%	.	.	.
Mexico	3.6	7.2	-2.7%	-4.0%	-3.9%	-2.5%	-1.7%	-0.5%	0.4%	1.2%	-0.2%
April 1997											
Argentina	2.2	3.9	-0.8%	-1.1%	-1.4%	0.0%	2.3%	6.4%	11.8%	18.5%	.

Appendix I

Let $t = m = 1$ for simplicity and assume that b in (7) and (14). 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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