# Country Risk Premium: Theoretical Determinants and Empirical Evidence for Latin American Countries*

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Summary: 1. Introduction; 2. The country risk concept; 3. Features of the international bond market; 4. Determinants of the term interest rate; 5. Empirical evidence; 6. Conclusions.

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JEL codes: C20, D81, E43, and G15.

This paper investigates the behavior of the country risk premium for Argentina, Brazil and Mexico, from June 1997 to September 1998. It shows that the level of country risk premium is determined by different factors: the US dollar bond market structure; restrictions on the acquisition of emerging market bonds imposed by developed nations regulators; the credit risk measured by the notion of *implied risk-neutral probability default*; the different ways agents react to country risk due to asymmetric and imperfect information. The empirical investigation shows: the worse the country credit rating, the greater is the impact on international borrowing cost, which implies that negative expectations have greater impact on lower rated Latin American nations' bonds; country risk yield spreads overreacted to changes in the US dollar interest rates in the sample period.

Este artigo investiga o comportamento do conceito de prêmio de risco-país para Argentina, Brasil e México, de junho de 1997 até setembro de 1998. Mostra-se que tal prêmio é determinado pelos seguintes fatores: a estrutura do mercado de títulos de dívida em dólares norte-americanos; as restrições à aquisição de títulos de dívida impostas por agentes reguladores de países desenvolvidos; o risco de crédito mensurado pelo conceito de probabilidade de inadimplência risco-nêutra implícita; o modo como os agentes reagem à informação assimétrica ou imperfeita. A evidência empírica revela que: quanto pior a classificação de risco de crédito, maior é o impacto esperado sobre as condições de captação externa, implicando que expectativas desfavoráveis afetam de forma mais acentuada países com baixa classificação de crédito; o valor do *spread* representativo do risco-país mostrou-se superelástico à variação da taxa de juros de longo prazo do Tesouro norte-americano no período da amostra.

# 1. Introduction

The market for bonds issued by emerging countries has grown at a fantastic pace over the 90s. According to Capital Data Bond Corporation, Latin American and Eastern European governments, who had accounted for just US$2.3 billion of international bond issuance in 1991, issued US$34 billion in international bonds in 1997.[1] This figure at least doubles if the respective private sectors are taken into account. The reasons for such capital movement should be sought inside and outside of the emerging markets. After the 80's debt crises, several countries implemented economic reforms that received support and public recognition from multilateral institutions and developed nations. With these reforms and the greater political commitment to gradualist and market-oriented economic policies – such as deregulation, trade liberalization and privatization programs –, international investors became attracted to the new and supposedly safe profit opportunities.

However, the *external* reasons were far more important. First, following the 80's debt crises, banks adopted a more parsimonious credit policy towards developing countries, especially with respect to countries which had defaulted over the preceding decade. Instead of assuming the credit risk,[2] banks have operated as placement agents in securities deals principally, searching for potential non-bank investors who could be interested in assuming the credit risk. Second, the low level of nominal interest rates in developed countries made investors less averse to assume higher risks to obtain greater nominal rewards. Third, investors' belief that the low inflation rate of the 90's is permanent – mainly in the USA and Western European countries – has encouraged them to shift part of their wealth from low-liquid assets (such as real estate) to more liquid bonds and shares. Fourth, the international private financial savings have augmented due to world population aging, which has been increasingly managed by professional and institutional investors such as pension funds, insurance companies and mutual funds. Fifth, the decrease in the developed nations' fiscal deficits, in an environment of increasing financial savings, led investors to expand the amount invested in risky bonds. Calvo, Leiderman and Reinhart (1996) present a further discussion on the causes of capital inflows to developing countries in the 90's.

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[1] *See* Euromoney Magazine, *Nov. 1998.*

[2] *Except for credit lines linked to international trade in which the credit risk can be mitigated by: the traded product/commodity given as guarantee, guarantees from governmental agencies, and financial structures that decrease the credit risk.*

As a result of larger volumes of resources that have been invested overseas, more analyses have been conducted into emerging markets, and more institutions and publications are now dedicated to following and evaluating these markets. Notwithstanding, relatively recent events like the 1994/95 Mexican crisis and the 1997 Asian crisis were not anticipated in their magnitude and extension by international investors and professional analysts. Under these circumstances, it becomes increasingly important to understand the nature of the risk of investing in emerging markets' external debt assets, which can be synthesized by the measure provided by the country risk concept.

This paper investigates why the financial measure of country risk has been so volatile for the most important Latin American countries from June 1997 to September 1998, and what factors can explain the current pattern. In spite of the prevailing perception, country risk is not only an absolute measure of a country's chance of default. It is the risk of investing in one developing country's debt securities against the risk of investing in a developed nation's financial assets.

It will be shown that country risk premium can be affected by the US dollar bond market structure, which represents common factor to any other debt security issued in this currency, as well as by the credit risk and the different ways agents react to country risk due to asymmetric and imperfect information. The concept of risk-neutral implied probability of default will be employed as a measure of credit risk for econometric purposes. In fact, the results of the empirical analysis confirm that default risk is the most important component of the country yield-to-maturity. Nevertheless, US Treasury interest rates have an important effect on the long-term bonds of Argentina, Brazil, and Mexico too. Moreover, the combination of imperfect information and the positive performance of the US economy resulted in the over-reaction of secondary market international yields-to-maturity to changes in US dollar interest rates.

This paper is organized as follows. Section 2 describes the concept of country risk, highlighting the nature of the information this concept can provide. Section 3 discusses the features of the international bond market. Section 4 provides the theoretical framework to analyze the internal borrowing cost and the country risk premium. Section 5 contains the estimates of the factors that determine one country's international borrowing costs. Section 6 presents the conclusions.

## 2. The Country Risk Concept[3]

When a financial analyst or a researcher has to evaluate the risks of foreign government bonds or the information derived from international market prices, a broad concept is immediately evoked: country risk. This concept *mainly* (but not only) refers to the credit risk itself, i.e., the risk that a government might default on its obligations by delaying or restricting the movement of capital outside the country.

The *country risk spread* $(S_{in})$ is defined as the compensation required by a foreign investor for assuming the risk of default implicit in a bond issued by a government $i$, which matures in $n$ years and yields $R_{in}$, when compared to the alternative return of purchasing a default risk-free bond of the same maturity $(R_{fn})$. Default risk-free bonds denote domestic debt bills and notes issued by developed countries' governments. Thus,

$$S_{in} = R_{in} - R_{fn} \qquad (1)$$

With limited supply of domestic savings directed to mid and long-term marketable debt instruments, the most important reference for the opportunity cost of domestic fixed capital investments continues to be interest rates in US dollars. In fact, external sovereign borrowing is a significant source of capital for emerging markets and for this reason the government borrowing cost in US dollars is a useful reference for long-term projects, as well as an important indicator of a country's credit risk and credibility.

The risk concept introduced here is particularly useful due to its ability to describe financial market agents' perceptions about an economy's long-term fundamentals expressed by secondary market quotations of highly traded government bonds. As secondary market liquidity is closely linked to the size of outstanding balances of specific bonds, only bonds with outstanding values over US$1.5 billion will be taken into consideration.

## 3. Features of the International Bond Market

As a natural consequence of the market's deepening, investors and issuers have been offered an increasingly wide variety of financial instruments, ranging

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[3] *See Domowitz, Glen & Madhavan (1998) for a further discussion of this concept and an empirical experiment on the interrelationship between country risk premia and currency risk premia for the 1994/95 Mexican exchange crisis.*

from the more traditional (fixed-rate notes, floating-rate notes, zero-coupon bonds, etc.) to the more sophisticated products which combine debt security characteristics with all kind of shares and derivatives.

In spite of the great variety of alternatives that are available – to which more and more products, derived from existing ones, are added every year –, the most popular instrument is the fixed-interest rate note. According to BIS (1998), straight fixed-rate issues have consistently composed over two thirds of the total international debt issues in the 90's. This pattern is driven by relatively low national inflation rates in the group of industrialized countries. In the debt securities market the concentration in fixed-interest rate notes also reflects the differentiation between the products of the *securities* and the bank loan markets. In the latter, *libor* is used as the industry-wide basic financing rate. It should be noted that the broadening and deepening of the derivatives market enable investors and/or borrowers to change the type of interest rate and unit of currency to those which best suit their investment or treasury management policies.

In order to focus attention on the most widely used instrument – fixed-interest debt – the next section presents the factors which financial theory usually holds as determinants of international borrowing costs of emerging countries. As well as ignoring other financial instruments, certain simplifications will be made: specific financial clauses and covenants will not be considered, such as call and put options and the granting of special guarantees which affect the perception of risk incurred and, thus, influence the cost of a given financial instrument. These are the standard assumptions adopted in order not to unnecessarily complicate the pricing model (see Cuthbertson, 1996, for a discussion of different interest rate models).

In contrast to the stock market, the bond market is essentially one for new issues. This is because the secondary market for risky debt securities is not well developed and its liquidity is low compared to that of the stock market. While shares are predominantly traded through institutions such as stock exchanges, which organize and standardize the deals, and compile and make public a wide range of information, such as volume traded and the prices quoted during the session, the same is not true of debt securities. Bond deals are highly decentralized and the secondary market is made through over-the-

counter deals,[4] even though most of international bonds are listed on at least one stock exchange.[5] As a result of disperse and private trading systems, the actual terms of deals are not made known to the rest of the market's agents. Therefore, the available information may not be the ideal required by perfect-foresight models and often – when the bond has not actually been traded – what becomes public are opinions of certain financial agents of how a given bond should be or should have been priced on a given date. In contrast to the stock market, bond prices vary significantly among institutions according to the level of interest a given financial agent has in trading a given debt security.

## 4. Determinants of the Term Interest Rate

In order to understand the concept of country risk yield spread it is important to analyze the main determinants of the risky bond interest rate. This section provides an overview of the best known explanatory factors:

a) expectation hypothesis (interest rate term structure);

b) the liquidity preference theory;

c) marketability risk;

d) the theory of segmented markets;

e) the imperfect and asymmetric information;

f) the credit risk.

Item (e) is not regularly mentioned in corporate finance handbooks, but it can provide interesting insights why sometimes a certain credit risk rating country (for instance, BBB or B+) bears a greater yield spread than a company with the same credit risk classification.

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[4] *The features of international bond markets are quite similar to those presented to Frankel (1996) with respect to the nature of foreign exchange trading and the potential room for noise traders due to the non-ideal quality of information. Nevertheless, a relevant distinction should be made: while the number of traded currencies does not vary over time, practically everyday new bonds (and even new issuers) come to the market, which increase the cost of following the market.*

[5] *Benzie (1992:40) argues that "the listing is a cosmetic exercise designed to get around the restriction imposed on many institutional investors who are not permitted to purchase unlisted securities".*

## 4.1 The expectations hypothesis[6]

The expectation hypothesis assumes that coupon-bearing bonds can be thought of as packages of zero-coupon securities, transforming the prevailing market instrument into hypothetical zero-coupon bonds that pay only face values at the end of each coupon or principal period. This kind of exercise is done for three reasons. First, the available information, yields-to-maturity of coupon-bearing bonds, represent the average interest rate over a certain period, implying that investors are able to reinvest the coupon payments at a constant interest rate. The stripping process restores the notion of having different pieces of an investment (coupons and principal) valued according to the spot interest rate to each payment day or "maturity". Thus, the term structure of interest rates can be analyzed. Second, the efficient market assumption implies that the stripping process is a mechanism to prevent risk-free arbitrage gains from continuing. Third, the mathematical expressions are a lot simpler if one assumes the existence of zero-coupon bonds only. In fact, a zero-coupon is sold at a discount price, the issuer not having to pay any coupon, only the principal on the maturity date.

Given the conventional concept of yield-to-maturity of a risk-free bond $(R_{ft})$, the price of a zero-coupon bond of a default risk-free note $(P)$ that matures in $n$ years can be written as:[7]

$$P_{nt} = \frac{1}{(1 + R_{ft})^n} \tag{2}$$

By taking the *logs* of equation (2),

$$p_{nt} = -n \, r_{f,t} \tag{3}$$

where $p_{nt} = \ln P_{nt}$ is the natural logarithm of the sovereign risk bond, and $r_{f,t} = \ln(1 + R_{f,t})$ is the continuously compounded yield for $n$ years to maturity. Note that the price of discount-bond changes by $n$ (the duration) when $r_{f,t}$ changes by 1%.

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[6] *See Campbell (1995) and Brealey & Myers (1988) for detailed description of this theory. Econometric investigation for the USA is presented in Campbell & Schiller (1989), while Sutton (1998) tests the hypothesis of spread overreaction (i.e., failure of expectation hypothesis) for the USA, Canada, the United Kingdom, Germany and Japan. Cuthbertson (1996) presents alternative methods to empirical investigation and briefly discusses the reasons why different statistical methods have produced distinct results.*

[7] *Litterman and Iben (1991) develop a theoretical approach for valuing bonds from credit risk interest rate yield curves, but in this section I work with sovereign risk-free bonds only.*

When an investor sells the government bond before its maturity, he or she receives a holding-period return. While the investor knows how much he would receive if the USA Treasury note were held up to maturity, the holding-period return depends on the uncertain price at which the security can be sold. If the bond yield rises (falls) over the holding period, the resulting return is lower (greater) than the initial yield. Assuming the bond is held for one year, the holding-period return ($h$) is equivalent to the difference between the prices on $t + 1$ and on $t$ – from equation (3) – subtracting from both sides $rf_{nt}$.

$$h_{n,t+1} = p_{n-1,t+1} - p_{n,t} = rf_{nt} - (n - 1)(rf_{n-1,t+1} - rf_{nt}) \qquad (4)$$

Equation (4) shows the return on $t + 1$ when an investor sells a bond at the price $p_{n-1,t+1}$. Note that on $t + 1$, the bond has $n - 1$ years to maturity. Thus, the holding-period return, also called the excess return, is the yield on time $t$ less $(n - 1)$ times the difference between the (expected) government bond's yield-to-maturity on $t + 1$ less the current return (or alternatively, the term yield spread).

One basic assumption of the expectations based approach is the risk neutrality of all agents who are only concerned with the expected one-period return ($h_{n,t+1}$) on all bonds. The pure expectations hypothesis states, no matter how long the bond maturity, that the one-period return would be equalized and equal to the known return on a one-period asset, i.e., under the pure expectations hypothesis the second-term on the right-hand side of (4) vanishes. The conventional expectations theory approach says that $h_{n,t+1}$ should depend on some form of reward for risk on the term-premium ($rf_{n-1,t+1} - rf_{n,t}$), which is assumed to be constant over time and independent of bond maturity.[8]

By definition, US Treasury interest rates can be broken down into inflation rate plus real interest rates. Thus, the term structure should provide information about two distinct variables and not only one. Mishkin (1989) studies to what extent the term structure, for maturities less than or equal to 12 months, can explain future inflation in 10 OECD countries. His findings contrast with those that claim term structure helps forecast the future level of inflation.[9] The term structure seems to be a more efficient predictor of real

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[8] *Campbell and Shiller (1989) test for the USA a time-varying risk premia model. They show that: rational or pure expectations theories fail in their sample period; when the yield spread is high the yield on the long-term bond tends to rise, contrary to the expectations theory; and the short-term interest rate tends to rise, just as the expectations hypothesis requires.*

[9] *In fact, for three countries – France, the United Kingdom and Germany – he identifies that term structure contains a greater amount of information about future changes in inflation.*

interest rates structure and, so, a leading indicator of future levels of economic activity.

## 4.2 The liquidity preference theory

According to this theory, the longer the term to maturity of a given security, the greater the investor's return should be. This is in order to compensate the rational individual for abstaining from consuming during the bond's life time. The introduction of a reward proportional to the security's maturity term implies that the investment yield curve will be positive even under the hypothesis of future inflationary stability. On the other hand, if the prevailing expectation is that interest rates will fall, then incorporating the liquidity premium should make the expected negative slope in the investment yield curve less accentuated than that suggested by the expectation hypothesis. The intuition behind this hypothesis is clearly expressed in equation (3), which shows that the higher $n$ is, the greater the impact of an interest rate change on the bond price.

The liquidity preference theory asserts that the excess yield is constant for any given maturity, but for those bonds which have a longer period to maturity, the term premium will increase. This can be formalized as follows:

$$h_{n,\,t+1}^{e} - rf_{nt} = T(n) \qquad T(n) > T(n-1) > T(n-2) > \cdots \qquad (5)$$

The script $e$ denotes expected values, while $T$ is the premium for holding a long-term bond. While the liquidity preference hypothesis assumes a different constant premium for each bond of maturity $n$, recall that expectations hypothesis assumes that $T$ is constant or zero (pure expectations hypothesis).

## 4.3 Marketability or liquidity risk

For non-default-free bonds, the marketability or liquidity risk results from the price volatility risk an investor has to bear if he or she might decide to sell the debt security before its maturity. The less traded a given financial security, the greater is the risk that its price should suffer from large fluctuations in the secondary, over-the-counter market. This is due to the limited number of agents who are interested in buying and/or selling a given debt security. Consequently, the process of trading which seeks to establish the market price

becomes more uncertain as there are fewer market parameters which can be used for comparison's sake.

As mentioned in section 3, the negotiating structure in the over-the-counter market is such that only a very limited body of information becomes available to the market. In the absence of information regarding volume traded, approximate indicators of liquidity levels are:

a) the size of the spread between bid and ask prices quoted by dealers;

b) the volume originally issued;

c) the total amount of bonds that a single issuer has issued in a given market.

Factors (b) and (c) work on the assumption that the bigger the primary issue (or the set of bond issues), the greater the number of buyers at the issue. Such a situation, where there have been a large number of buyers at the outset of a security's life, serves as an indicator of the size of the potential universe of agents who might be interested in trading a given debt security in the future. These, in turn, should attract other investors, who are drawn by the increased liquidity, to operate in the secondary market.[10]

Some qualification is required. Sometimes one borrower pushes the market in the sense that this agent demands more cash than potential lenders are willing to grant. In this case, size affects the liquidity premium in an adverse way.

In some markets, the low liquidity level of the secondary market is due to the high transaction costs that investors are subject to. The higher transaction costs take the form of high brokerage/service charges and large differences between the buy and sell prices that a financial agent establishes because of lack of competition in the brokerage and security trading areas. These are common explanations of a phenomenon which is often called exclusively cultural: the holding of securities until their settlement dates.

## 4.4 The theory of segmented markets

This theory sets out that some agents have preferences or guidelines dictated by natural (or structural) and regulatory factors. By natural factors, I

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[10] *For the US high-yield bond market, the evidence is controversial. Ma, Rao and Peterson (1990) do not identify statistical relevance in the size of the original bond to explain the yield spread. However, Crabbe and Turner (1995) present some evidence for this hypothesis.*

mean that there are certain groups of investors or borrowers that concentrate their transactions in certain market segments, such as short-term or long-term investments, for instance. They act so in order to match their financial assets or liabilities with their respective future cash flow needs or business profiles. This is the case of institutional investors – pension funds and insurance companies – who focus their investments on longer term securities, while other asset managers (such as commercial banks and call-money funds) may prefer securities with shorter terms-to-maturity.

The segmentation hypothesis gives rise also to regulatory restrictions which are designed to prevent certain investors from assuming particular types of risk. Various countries impose restrictions on their insurance companies and pension funds with regard to buying high credit-risk securities, in an attempt to minimize their exposure to risks that might not be compatible with the nature of their obligations to beneficiaries and pensioners.

With regard to securities issued by foreign non-investment grade issuers, natural and regulatory restrictions limit the acquisition and potential trading level of the region's assets. While natural restrictions push liquidity risk premium upward, regulatory restrictions create barriers to supply-demand equilibrium, implying that the interest rates and respective country risk spreads might be somehow inflated.

## 4.5 Imperfect and asymmetric information

The notion of imperfect and asymmetric information is related to a complex set of factors:

a) the quality of secondary market information (as discussed in section 3);

b) any other sort of information about market participants (creditors and debtors) that may be important to risk assessment;

c) the different individual reaction-functions in an uncertain economic environment;

d) the premium one group of creditors might demand to take part in a specific game if it believes it is to be at disadvantage in relation to any other group of creditors.

In the recent past, Argentina, Brazil and Mexico secondary market spreads have been higher than the equivalent average premia for US corporations with

equivalent ratings as shown in figure 1, appendix A. At least in theory, it seems unexpected because sovereign risk agents, unlike corporations, do not go bankrupt. The immediate economic explanation for this phenomenon is the difference between domestic and foreign business cycles. The short period of time plotted in figure 1 coincides with a period of robust US economy growth and the effects of the Asian currency crises on Latin American nations. However, some studies have shown that imperfect and asymmetric information play an important role too (Ganapolsky & Schmukler, 1997, and Frankel & Schmukler, 1997).

Assume that the buyers of long-term bonds are institutional investors only. First, even very well informed foreign investors do not have access to an emerging market's information as immediately as domestic investors do. Foreign investors can obtain the same level of information, but bear extra costs and extra risks due to time differences and occasional differences in the business calendar. Second, even if both foreign and domestic investors have the same information, domestic investors' ability to interpret them tend to be higher. Third, there might be information leaks, and domestic investors are able to obtain them first. Fourth, the United States Securities and Exchange Commission disclosure requirements for local corporations are higher than for foreign governments. Fifth, the costs of occasional bankruptcy procedures differ in an international context. The costs of not taking legal actions against central governments are not negligible. Despite the availability of legal clauses to defend creditors in case of default, there are more than economic and financial implications to be considered when the debtor is a government (see "Recent developments on credit risk", ahead).

Ganapolsky and Schmukler (1997) highlight that, as a consequence of increasing integration of Latin American capital markets, asset prices tend to co-move, which implies that external shocks are more prone to have similar effects on different Latin American countries today than in the past. Figure 2 and table in appendix A, based on daily data from June 1997 to September 1998, confirm the high co-movement levels between Latin American fixed income assets, even though Brazil had de-coupled from its relatively stable premium difference to Mexico and Argentina in mid-August of 1998. International investor suspicion that Brazil would be the next, after Russia, in not to being able to guarantee its fixed exchange rate regime triggered a massive sell off of Brazilian assets, which affected Argentina and Mexico as well.

According to Ganapolski and Schmukler (1997:7), the co-movement might be explained by two factors. "First, if mutual funds managers need to keep a balanced portfolio across emerging markets, they might be induced to buy and sell assets of different countries simultaneously. Second, if small international investors – who buy the new financial instruments – face a cost to acquire information about each particular country, they would be less likely to distinguish across emerging markets."

The correlation coefficients shown in appendix A for the recent period are still higher than in the Mexican crisis period as calculated by Ganapolski and Schmukler. While table shows correlation coefficients higher than 95% for bonds with almost 30 years to maturity, those authors find coefficients of 80% for the prices of Brady bonds during the Mexican crisis. "Latin American markets tend to move together and are influenced by a different factor than the US market, particularly during a crisis period. This might be a combination of different circumstances. Latin American countries might share some common fundaments, so their capital markets move together. Investors might perceive these countries as being similar (even though they are not). (...) Similar fundaments or contagion might be explaining the co-movement" (Ganapolski & Schmukler, 1997:10 and 12).

Another important contribution to the comprehension of how agents react under uncertainty is the model developed by Stiglitz and Weiss (1981). They show that rational bankers should prefer to ration credit to risky borrowers instead of supplying them with more funds at higher interest rates when bankers have doubts about clients' solvency. Thus, bankers face an "adverse selection" problem. That is because the increase in the interest rates (prime rate) would chase away good clients and worsen the quality of banks' asset portfolios. Unlike bankers, bondholders can walk away from credit risk by selling their assets when there are suspicions of increasing chance of default, even having to assume meaningful capital losses. The strategy of selling risky assets and investing the obtained revenues in developed nation's government bonds, known as "flight-to-quality", is recurrently observed in periods of exchange crises and is one the most common symptoms of contagion.

Consider a representative investor whose portfolio is composed of two types of fixed-income securities of same maturity (one year), risk-free bonds and risky bonds whose respective weights in the total portfolio ($x_f$ and $x_i$) are functions of the probability of default ($\Pi$). The representative investor's

net wealth is assumed constant and bonds are the only source of funds for borrowers. Also, probability of default affects the risky interest rate ($R_i$), but the interest rate does not affect the expected default rate. When default likelihood is greater than zero, the investor cannot anticipate with 100% of accuracy what the net income will be from holding the risky bond over its life. Given these economic characteristics, the representative investor's utility function is shown below.

$$U = x_f Rf + (1 - \Pi)x_i R_i \quad x_f + x_i = 1; \quad \delta x_f / \delta(\Pi) > 0; \tag{6}$$
$$x_f, x_i \geq 0; \quad \delta x_i / \delta(\Pi) < 0$$

The optimum portfolio is obtained when the investor maximizes its utility function in relation to the exogenous expectation of default.

$$\frac{\delta U}{\delta \Pi} = \frac{-\delta x_i R_f}{\delta \Pi} - x_i R_i + \frac{\delta x_i}{\delta \Pi}(1 - \Pi)R_i + \frac{\delta R_i}{\delta \Pi}(1 - \Pi)x_i$$
$$\delta x_i / \delta \Pi < 0 \quad \text{and} \quad \delta R_i / \delta \Pi > 0$$

Given the optimum condition $\delta U / \delta \Pi = 0$, rearranging the terms for $x_i$ the expression for the optimum composition is as follows:

$$x_i = \max\left\{0, \ \frac{(\delta x_i / \delta \Pi)[Rf - (1 - \Pi)R_i]}{(\delta R_i / \delta \Pi)(1 - \Pi) - R_i}\right\} \tag{7}$$

Risky assets will form part of an investor's portfolio only if their expected return is greater than the return of the default risk-free asset in this very simplistic framework.[11] Assuming that the ($\delta x_i / \delta \Pi$), ($\delta R_i / \delta \Pi$) and $\Pi$ are given, it is possible to see that in order to keep $x_i$ constant, an exogenous increase in the US government bond interest rate should be followed by an increase in the risky bond interest. Also, the denominator of (7) should be positive, which implies that the probability of default has to be $\Pi < 1 - R_i(\delta R_i / \delta \Pi)$ when investors are risk-averse.

This simple imperfect information model linked to risk aversion behavior predicts that investors will shift from high-yield investments to default risk-free investments when the expected return on risky assets does not overcome the return on government bonds due to increasing default risk. This movement (flight-to-quality) is associated not only with credit rationing to risky

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[11] *Note that the risk propensity behavior is dismissed.*

borrowers, as they do not have further access to representative investor's funds since the investor's net worth is supposed constant over time, but also with a sudden deterioration of secondary market prices as there will only be investors interested in selling assets in the above stylized theoretical framework.

## 4.6 Credit risk

Frequently, the credit risk premium is taken as a simple synonym for country risk. It is certainly the most important component of the total risk factor. However, the above-discussed factors should not be dismissed as explanatory factors as long as country risk is correctly defined in equation (1). This section, divided into three subsections, discusses credit risk. The first subsection presents a brief description of credit risk concepts, mostly those provided by the leading credit rating institutions – Standard & Poor's and Moody's – and assesses empirical evidence of the relationship between ratings and sovereign risk spreads. The following subsection looks at the most common ways of evaluating credit risk. While there is a vast and rich body of literature on this subject, the task at hand requires a straightforward approach. My aim is to provide a general overview of what I believe are the most promising credit risk models in terms of potential application in economic research. The last subsection formalizes the concept of *implied risk-neutral probability of default*, extracted from market quotations.

## Credit risk and rating agencies

The most popular credit risk method is the rating system, which is designed to identify the probability of a specific agent not being able to honor the assumed financial obligations timely. The two leading companies, Moody's and Standard & Poor's, use different credit risk symbols. However, they are easily cross referenced as table in appendix B shows.[12]

Despite following similar criteria, specific credit risk classifications granted by Moody's may diverge from Standard and Poor's. Some of the variables are of a qualitative nature and the relative weight they assign each factor, besides not being disclosed, might be different. In fact, table 1 shows that their

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[12] *See Erb, Campbell & Viskanta (1996) for an introduction to other available indices of country risk.*

equivalent ratings for Argentina and Brazil have hardly ever coincided since 1992.

Table 1
Argentina, Brazil and Mexico: long-term foreign currency credit risk ratings
(1992/4Q - 1998/3Q)*

| Period | Argentina | | Brazil | | Mexico | |
|---|---|---|---|---|---|---|
| | Moody's | S&P | Moody's | S&P | Moody's | S&P |
| 1992/4Q-1994/3Q | B1 | Not rated | B2 | Not rated | Ba2 | BB+ |
| 1994/4Q | B1 | BB- | B2 | Not rated | Ba2 | BB+ |
| 1995/1Q-1995/2Q | B1 | BB- | B1 | B | Ba2 | BB |
| 1995/3Q-1997/1Q | B1 | BB- | B1 | B+ | Ba2 | BB |
| 1997/2Q | B1 | BB | B1 | BB- | Ba2 | BB |
| 1997/3Q-1998/2Q | Ba3 | BB | B1 | BB- | Ba2 | BB |
| 1998/3Q | Ba3 | BB | B2 | BB- | Ba2 | BB |

Note: Author's own calculations.

*Refers to the prevailing rating in the quarter-end.

Credit rating agencies did not succeed in predicting Mexico's 1994/95 economic crisis, nor the extent and impact of the 1997 East Asian crisis. As the ratings were downgraded only *after* the market had substantially adjusted the country risk spread, the impression that rating agencies react to events rather than anticipate them was given force.[13] Cantor and Packer (1996), and Larrain, Reisen and von Maltzan (1997) studied this subject.

Cantor and Packer's (1996) research focuses on two subjects:

a) finding out if rating companies follow some pattern when granting sovereign ratings;

b) checking if sovereign credit rating changes affected market prices in their data sample from 1984 to 1994.

With regard to the first item, they found that six factors were important in determining a country's rating: *per capita* income, GDP growth, inflation, external debt, level of economic development and default history. Surprisingly, they do not find any relationship between ratings and either fiscal or

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[13] *Both agencies anticipated the Russian economic crisis by downgrading the sovereign credit risk and issuing warnings on the risk of investing in Russia through the international financial press. In the case of Brazil, Moody's downgraded its rating in the third quarter of 1998, while S&P downgraded the sovereign classification in the same day Central Bank announced changes in the R$/US$ band zone (Jan. 13, 1999). Thus, one day earlier than the change in the domestic exchange regime.*

current account deficits, which might be explained by the endogeneity of fiscal policies and international capital flows. This puzzling evidence appears to be consistent with the findings of Frankel and Rose (1996) in their study of empirical indicators of currency crashes in emerging markets. Razin (1998) confirms that government budget deficit seems not to predict reversals in current account (currency crisis), but he argues for the empirical importance of the current account deficit level.

Having confirmed the structural relationship between macroeconomics fundamentals and ratings, Cantor and Packer evaluated the cross-sectional relationship between ratings and sovereign risk yield spreads. They use multiple regression technique and an event study of what happened to the mean of relative spreads (country risk spread divided by US Treasury yield) for 79 rating announcements for 18 countries between 1987 and 1994. They conclude that rating agencies's opinions[14] affect market spreads and that speculative-grade countries suffered higher impact than investment-grade countries.

On the other hand, Larrain, Reisen and von Maltzan's (1997) findings are quite different from the preceding ones as regards the impact of ratings announcements on prices. They employ Granger causality tests to study the causal relationship between credit ratings and country risk spreads on 26 sovereign ratings from 1988 to 1995. They find a two-way causality between ratings and risk premia that weakens the importance of rating agency information. In addition, they carry out an event study on 78 rating announcements of 26 sovereign ratings from 1987 to 1996. In contrast to Cantor and Packer's results, the impact of rating announcements on dollar bond spreads is found not to be significant. However, they find that the impact of announcements on emerging markets sovereign bond are statistically significant when they are put on review with negative outlook, despite the strong market anticipation. Dividing the emerging markets group into below and above investment-grade, a higher impact is found in the group of countries with investment-grade level. Larrain, Reisen and von Maltzan also find that the yield spread is partly reversed one month after the announcement of negative outlook, which can either be identified with economic policy reactions or market adjustments after an overshooting caused by rating statements.

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[14] *Opinions are not only rating changes, but also public announcements made by Standard & Poor's ("outlook") and Moody's ("watchlist") that they might consider upgrading or downgrading a specific sovereign issuer in the future.*

The controversy suggests that additional research in this field is necessary and desirable in order to deepen the current discussion on causality and effective impacts of rating announcements on market prices. Nevertheless, Larrain, Reisen, and von Maltzan results are more robust and convincing as their findings are based on the application of a more sophisticated econometric approach.

## Recent developments on credit risk

Credit risk modeling has stimulated a remarkable academic and professional production for a simple reason: the interest and investments of financial institutions in risk management. The 80's debt crises, the credit risk capital ratios imposed by the 1988 Basle Accord on capital adequacy, and the increasing complexity of the banking business, as well as its degree of interrelationship, all played an important role in convincing banks to be more active in this area.[15] Because of the evident complexity of this subject, I intend to provide only an overview of the instruments and respective literature in this area. A survey of the technical literature is found in Altman and Saunders (1998), who provide a detailed and clarifying discussion of credit risk measurement over the last two decades. Most of the available techniques were constructed to evaluate corporate risks. However, it is not difficult to extrapolate them to sovereign risk analysis.

Credit measurement techniques can be classified as follows:

a) historical information credit-scoring systems;

b) contingent claims (option price-like) models;

c) mortality-default rate models;

d) term credit risk.

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[15] *Euromoney of October 1998 depicts the results of a two-day meeting between leading banks, academics and regulators to discuss bankers' proposal to calculate bank capital requirement needs using their own internal risk models instead of the current regulatory framework, i.e., to extend to credit risk what regulators conceded to market risk in 1997. According to Euromoney, regulators are still not convinced about the superiority of banks' internal rules to capital adequacy ratios, but their participation in that event shows that they are taking bank proposals seriously. At least because of apparent flaws with Basle rules: "(...) the risk weights are five times more favorable to an OECD bank, however poorly rated, than to a non-bank company, even if it is triple-A-rated".*

The *historical information credit-scoring systems* are multivariate models in which the key variables are combined to produce either a credit risk score or a probability of default measure. This is the exact description of Moody's and Standard & Poor's rating systems analyzed in the previous subsection.

The *contingent claims models* are based on option price models in the sense that corporate liabilities are viewed as combinations of options contracts defined by their cash-flow and boundary conditions. In the case of a company which has only one outstanding bond, it is assumed that a call option is attached to that bond which gives the stockholders the right to walk away from the assumed obligation if the firm's value falls below the promised payments to the debtholders on the bond maturity date – limited liability option. The conclusion is that the stockholders let the company default when the company's value is not enough to cover the assumed financial obligations.[16] This result can be extrapolated to sovereign risk agents: a government defaults if the present value of its net revenues – expressed either by net present value of future current account surpluses or future fiscal budget surpluses – are not sufficient to cover the short-term liabilities (external and domestic debts). It is implicit that bankers and investors stop supplying funds to agents under suspicion of future financial problems.

Some models assume that the value of an asset in default should take into consideration the costs with bankruptcy procedures. In a bankruptcy situation, creditors will receive less than the companies' value in order to cover their not honored rights. As bankruptcy is costly, borrowers may find a surplus to be re-negotiated prior to triggering the bankruptcy procedure. Of course, the cost of a bankruptcy is higher to those investors who have amounts to receive in the short term than to those whose assets only mature in the long term because the default puts all creditors in the same situation.[17] In such case, there is a larger scope for negotiation because short-term creditors are more willing to make self-interested concessions to the debtors, and debtors can

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[16] *Ambarish and Subrahmanyam (1990), and Trussel (1997) present alternative models using option price models. Still, Trussel tests the statistical plausibility of a contingent claims model for US corporate bonds.*

[17] *The cross-default, which is a standard covenant in bond or loan agreements, states that in the event of default every creditor favored by that clause will have equal right to receive for their rights even if one specific right refers to a debt that would be due (mature) in the long term only. A short-term creditor, under these circumstances, would be willing to make self-interested concessions as long as its potential return is higher than in the default case. See Mella-Barral & Tychon (1996) for a formal presentation of a model that consider this kind of creditor behavior.*

expect to strategically extract more concessions from creditors. As suggested by Franks and Touros (1989), the higher the bargaining power of a specific debtor, the higher the possibility of debtor's opportunistic behavior.

Again, the above conclusion can be immediately transposed to the sovereign risk case. On the one hand, in the latest currency market crises a common element was the prompt reaction of commercial banks, whose risk exposure is mostly concentrated in short-term debt, either in committing emergency credit lines or pushing developed nation governments and multilateral institutions to support distressed countries and, thus, minimize the financial sector potential loss. On the other hand, the examples of debt restructuring in the 80's and in the 90's show that countries were able to use their bargaining power.

The third credit risk measurement technique is the *mortality-default rate models*. Altman (1989 and 1990) measures the expected mortality of bonds in a manner similar to those used by actuaries in assessing human mortality and life expectancy. He calculates survival rates (or conditional life expectancy) for various periods of time after issuance. Currently, this method is employed by rating agencies that routinely use it in their analyses (Altman & Saunders, 1998:1.726).

In his very influential work, Altman demonstrates that, given the rating, the cumulative probability of default increases over time. In addition, for some rating levels, mainly those classified as speculative grade, yearly expected loss increases dramatically after the first year of life. After reaching the maximum yearly number, somewhere between the second and the fifth year, the mortality rate decreases but does not present a clear trend from this point on.

The *term credit risk approach* seeks the implied probability of default from the term structure of risky bond yield spreads. The model presented by Litterman and Iben (1991) extracts from the forward default free and risky bonds the implied market expectation of default for different times in the future. The assumptions underlying Iben and Litterman's approach are:

a) there is risk neutrality;

b) expectations theory of interest rate holds;

c) transactions costs are small;

d) calls, sinking fund and other option features are absent;

e) discount bond yield curves exist or can be extracted from coupon bearing yield curves.

## The implied probability of default

Most studies of determinants of country solvency or currency crashes aim at figuring out which variables are useful to predict economic problems (Frankel & Rose, 1996; Razin, 1998). These studies are interested in identifying the fundamentals that affected agents' expectations and triggered either capital outflows or speculative attacks. Likewise, the rating agencies and most of the mentioned credit risk techniques are driven by long-term fundamentals. This is why rating companies do not change their country risk assessments as fast as market agents do.

Two methods have been often employed to capture changes in the credit risk for econometric purposes. First, numerical transformations of credit ratings. Cantor and Packer (1996), and Larrain, Reisen, and von Maltzan (1997) show alternative numerical transformation methods for Moody's and Standard and Poor's classifications and both briefly discuss the findings in the US high-yield bond literature. Another group of studies seeks to explain the corporate risk spread within credit rating categories, such as Duffee (1996), who also provides a survey of the related literature. As table 1 shows, the Latin American sovereign ratings have been relatively stable, while the market quotations (see appendix A) have been very volatile. This study follows an alternative approach to evaluate country risk, deriving credit risk expectations from secondary market quotations. I believe that this approach has some advantages:

a) it is useful to differentiate from country risk what is credit risk and what is not;

b) country risk spread can be expressed in terms of changes in the expected probability of default;

c) any market variable (such as interest rate) depends on expectations.

The greatest drawback to this approach might be in the quality of available secondary market quotations during periods of high volatility and low liquidity, as argued in section 3. This problem can be circumvented by using highly

traded securities, such as the cases of Argentina, Brazil and Mexico's long-term US dollar bonds. Another criticism might be the excessive importance given to market judgements when they could be highly influenced by noise traders. Furthermore, when sometimes positive or negative expectations are reversed rapidly that gives rise to the sentiment that market expectations are not always precise. High volatility might reduce the accuracy of estimates, but there is some information to be extracted from highly volatile environments, such as investors' behavior at times of greater uncertainty.

The following standard assumptions are employed:

a) expected return is measured on credit risk changes and not on credit risk term structure;

b) risk-neutral investment strategy – that is, the only factor that matters is the return distribution of a debt with no relevance for volatility and liquidity factors;

c) in the event of default and for all debtors, investors only recover the nominal amount invested;

d) probabilities of default are uncorrelated with changes in the level of interest rates.

Given an assumed exogenous cumulative probability of default $(\Pi_n)$ for a security that matures in $n$ years, the expected rate of return $E(Ri_{n,t})$ of a risky bond is given as follows:

$$E(Ri_{n,t}) = (1 - \Pi_n)(Ri_{n,t}) + (\Pi_n)(Rd) \qquad 0 < \Pi < 1 \qquad (8)$$

where $Ri_{n,t}$ is the promised yield-to-maturity, i.e., the return when the issuer does not default, while $Rd$ is assumed equal to zero (the above mentioned assumption (c)). Define $E(Ri_{n,t})$ as

$$E(Ri_{n,t}) = Rf_{nt} + K_n \qquad K_n \geq 0 \qquad (9)$$

The expected return equals the return with the risk-free bond plus a constant value $K$. As the variable $K$ is unobservable and one of the described assumptions is risk neutrality, which is widely employed in financial risk models, the value of $K$ is assumed to be zero. Thus, equation (9) is re-written as follows:

$$E(Ri_{n,t}) = Rf_{nt} \qquad (10)$$

Note that $\Pi_n$ is an exogenous variable whose fundamental function is to determine the expected return. Investors will buy a bond only if the premium offered by a certain debt security is compatible with the risk they believe they would run in purchasing this specific asset.

$\Pi_n$ is an unobservable variable in the real world. Even though unknown, it seems reasonable to state that it depends on how risk averse investors are and what is the actual expected return in case of default ($Rd$). However, it is possible to estimate the *implied risk-neutral probability of default* ($\Pi^i$), a theoretical concept based on the assumption that investors do not consider the volatility of expected gains, but only the expected value.[18] For that concept, $Rd$ equals to zero is not an absolute requirement, but it is used here to provide a simpler expression. So, $\Pi_n^i$ can be taken as a proxy for $\Pi_n$ under the aforementioned assumptions.

In order to extract the *implied risk-neutral probability* of default from market quotations ($\Pi_n^i$), the following step is required. Substitute (10) into (8), and rearrange for $\Pi_n^i$:

$$\Pi_n^i = \frac{Ri_{n,t} - Rf_{nt}}{Ri_{nt}} \qquad (11)$$

Note that $S_{int}$ (equation 1) and $\Pi_n^i$ (equation 11) are different rearrangements of the same variables, risky yield-to-maturity and risk-free interest rate. But each variable describes a different aspect. While equation (1) reflects the absolute difference between them, $\Pi_n^i$ shows the relative difference between the risky and risk-free interest rates. It can be seen that proportional changes of $Rf_{nt}$ and $Ri_n$ increase the risk spread, but do not imply any change in the *implied risk-neutral probability of default*. Thus, $\Pi_n^i$ can be used to filter from the absolute difference the part that explains relative changes between risky and risk-free interest rates.

Fons (1987) shows that for the US corporate bond market the expected risk-neutral default likelihood exceeded the actual default experience of low-rated debt during the first half of the 80's. In addition, bondholders were rewarded for bearing default risk. His conclusions have two important implications. First, they stress the significance of investors' expectations in debt securities pricing, thus reinforcing the importance of this variable in explaining country risk premia. Second, his findings suggest that risk neutrality may

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[18] *It does not mean that investors who employ this concept as an analytical tool disregard volatility as an important factor.*

not explain investors behavior. However, as a first approach to the country risk premia problem, the *implied risk-neutral default probability* will be used to express investors' expectations in the econometric experiment.

## 5. Empirical Evidence[19]

I have reviewed six different explanatory theories for the country interest rate level and respective country risk premium level, although for empirical investigation the equation specification could be simpler if the empirical test seeks to explain the first-time difference of Argentina, Brazil and Mexico's yield spreads. Few elements that are relatively constant over time can be disregarded, such as the liquidity risk (as the selected bonds are often traded) and the premium due to structural access restrictions to speculative grade emerging markets' bonds.

There is a clear problem of simultaneous determination of $S_{int}$ and $\Pi_n^i$, as both are constructed with the same variables. However, this problem can be circumvented if the current risk-neutral probability of default (as an equation regressor) is substituted with an auto-regressive specification of $\Pi_n^i$. This implies that investors take decisions based upon the observed default likelihood in the days prior to date $t$. Also, the value of $\Pi^i$ will be annualized in order to avoid the comparison of values that do not reflect the same time range. Thus, let $\pi = \Pi_n^i / N_t$; where $N_t$ is the time to maturity in years.

Table 2 presents the results of the auto-regressive specification for the default likelihood of Argentinean, Brazilian and Mexican bonds for five days lag. Estimations with larger lags, not presented here (for instance, 10 to 20 days), demonstrated the same features described in table 2: the first two prior days are statistically significant (10% level) with further lags showing lower statistical significance with preponderance of sign inversion.

Having defined the default likelihood indicator, the following specification was estimated for each country:

$$\Delta S_{it} = \alpha_0 + \sum_0^j \beta_j \Delta \pi_{i,\,t-j}^e + \sum_0^j \gamma_j \Delta Rf_{,\,t-j} + \sum_0^j \lambda_j \Delta S_{\text{US},\,t-j} + e_{it} \quad (12)$$

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[19] *Appendix C describes the data and respective sources of information.*

where:

$$\Delta S_{it} \equiv S_{it} - S_{i,t-1};$$

$\Delta \pi_{it}^e \equiv \pi_{it}^e - \pi_{i,t-1}^e$. $\pi^e$ is the forecasted risk-neutral probability of default derived from the coefficients shown in table 2;

$\Delta Rf_t \equiv Rf_t - Rf_{t-1}$. $Rf_t$ is the 30-year US Treasury note interest rate;

$\Delta S_{\text{US}t} \equiv S_{\text{US}t} - S_{\text{US}t-1}$. $S_{\text{US}}$ is the spread between the 30-year US government bond interest rate and the six-month US government bill interest rate;

$e_i$ = random error;

$j$ = zero, two and four days.

Equation (12) breaks down the first difference of the yield-to-maturity premium into four components: the constant term, expected credit risk changes, the changes in the 30-year US government interest rate, and the change in the slope of the US government term structure.

Table 2
Estimation of autoregressive specification of $\pi^e$:
ordinary least squares – Newey-West heteroskedasticity and autocorrelation
consistent standard errors & covariance (daily data)

| Country | Constant | $\pi_{-1}$ | $\pi_{-2}$ | $\pi_{-3}$ | $\pi_{-4}$ | $\pi_{-5}$ | Adj $R^2$ | DW | LM(1)* | LM(4)* | F |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Brazil | 8.9E-05 | 0.775 | 0.226 | 0.058 | -0.052 | -0.009 | 0.976 | 2.000 | 0.180 | 4.360 | 2534.3 |
| | (0.614) | (13.423) | (3.091) | (0.780) | (-0.714) | (-0.154) | | | (0.671) | (0.359) | |
| Mexico | 7.7E-05 | 0.747 | 0.204 | 0.022 | 0.053 | -0.029 | 0.970 | 2.001 | 0.129 | 1.400 | 1967.1 |
| | (0.480) | (5.429) | (1.642) | (0.276) | (0.518) | (-0.350) | | | (0.719) | (0.844) | |
| Argentina | 3.4E-04 | 0.785 | 0.198 | 0.037 | -0.032 | -0.009 | 0.950 | 2.001 | 0.709 | 3.353 | 934.9 |
| | (1.286) | (6.718) | (1.605) | (0.500) | (-0.367) | (-0.095) | | | (0.400) | (0.501) | |

Note: $t$-statistics are in parenthesis.
*Breusche-Godfrey serial correlation LM test for one and four lags. The probability of no serial correlation in the residuals is shown in parenthesis.

Table 3 reports OLS estimates of equation (12) for Brazil, Argentina and Mexico using daily information, and lags of zero, two and four days. The variance-covariance matrix of the estimated coefficients was adjusted by the Newey-West heteroskedasticity and autocorrelation standard errors and covariances method. The non-lagged specification of Argentina and Mexico's estimation was corrected by Cochrane-Orcutt 1 (CO-1) when the original DW statistic was inside the inconclusive region for autocorrelation diagnosis.

The results indicate that the current and lagged expected changes in the probability of default have a remarkable impact on the Latin American external borrowing cost. For instance, an increase in the annual implied default probability of Brazil by 0.10% in $t$ impacts its current borrowing cost by 0.42%, while lagged expectations also present significant effects: 0.13% $(t-1)$ and 0.05% $(t-2)$. Note that the non-lagged equations displayed serial autocorrelation problems, which were not identified for Brazil with two lags, and Mexico and Argentina (two and four lags). The finding that changes in the risk spread are highly dependent on current and lagged changes in default expectations suggests that Latin American assets are subject to a certain level of persistence in country premia after the initial shift.

In addition, the coefficient values for the three countries are consistent with their respective ratings. Mexico, which is the country with the best rating in the group, has the lowest coefficients – all of them being statistically significant from $t$ to $t-4$. Argentina, which is higher rated than Brazil but lower than Mexico according to Moody's, suffers an intermediate impact. Thus, market quotations and, therefore, investors react more intensively to an increasing risk from lower rated countries. This finding is coherent with Altman's bond mortality ratio discussed earlier (Altman, 1989, and Altman & Saunders, 1998).

For both countries, credit spreads are highly sensitive to long-term US Treasury interest rate movements. In fact, risk premia overreact to current changes in the US interest rate. Note that the remaining coefficients are statistically non-significant except to the third lag for Brazil and Argentina. This result is consistent with some studies that claim increases in the North American interest rates push foreign capital out of Latin American countries, thus pressing the country risk upwards.[20] Still, the lower the country rating, the higher is the impact of US Treasury interest rate changes. The US Treasury rate might affect investor's expectations of emerging market solvency. However, the high statistical significance of $\Delta\pi_{i,t}$ and $\Delta Rf_{,t}$ does not suggest the observance of multicollinearity problems.

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[20] *See Cardoso & Goldfajn (1998) for a review of the empirical evidence for Latin America and an econometric investigation of the determinants of capital flows movements into and out of Brazil.*

Table 3

Estimation of $\Delta S_{it}$: ordinary least squares – Newey-West heteroskedasticity and autocorrelation consistent standard errors & covariance (daily data)

| Equation | Dependent variable | Constant | $\Delta\pi^e$ | $\Delta\pi^e_{-1}$ | $\Delta\pi^e_{-2}$ | $\Delta\pi^e_{-3}$ | $\Delta\pi^e_{-4}$ | $\Delta Rf$ | $\Delta Rf_{-1}$ | $\Delta Rf_{-2}$ | $\Delta Rf_{-3}$ | $\Delta Rf_{-4}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $\Delta S_{\mathrm{BR27}}$ | 1.7E-04 (1.344) | 3.477 (7.748) | | | | | 1.412 (4.187) | | | | |
| 2 | $\Delta S_{\mathrm{BR27}}$ | 5.42E-05 (0.651) | 4.173 (8.486) | 1.312 (7.583) | 0.531 (4.131) | | | 1.441 (4.992) | -0.200 (-1.558) | -0.148 (-1.500) | | |
| 3 | $\Delta S_{\mathrm{BR27}}$ | 3.28E-05 (0.469) | 4.267 (8.137) | 1.490 (8.660) | 0.841 (6.409) | 0.636 (6.429) | 0.166 (0.892) | 1.505 (4.927) | -0.115 (-1.074) | -0.039 (-0.425) | 0.268 (2.150) | 0.072 (0.552) |
| 1 | $\Delta S_{\mathrm{MEX26}}$ | 9.46E-05 (1.188) | 2.718 (8.102) | | | | | 1.326 (5.041) | | | | |
| 2 | $\Delta S_{\mathrm{MEX26}}$ | 2.01E-05 (0.530) | 3.261 (12.085) | 0.901 (9.071) | 0.384 (4.582) | | | 1.296 (7.499) | -0.205 (-2.366) | -0.155 (-1.776) | | |
| 3 | $\Delta S_{\mathrm{MEX26}}$ | 7.70E-08 (0.003) | 3.328 (12.181) | 1.007 (9.813) | 0.542 (6.006) | 0.306 (6.201) | 0.254 (2.167) | 1.345 (7.488) | -0.147 (-2.282) | -0.094 (-1.359) | 0.119 (1.630) | 0.079 (0.786) |
| 1 | $\Delta S_{\mathrm{ARG27}}$ | 1.00E-04 (0.764) | 3.092 (8.933) | | | | | 1.430 (5.255) | | | | |
| 2 | $\Delta S_{\mathrm{ARG27}}$ | 1.32E-05 (0.198) | 3.749 (11.443) | 1.170 (9.483) | 0.499 (5.873) | | | 1.397 (6.812) | -0.133 (-1.211) | -0.100 (-1.137) | | |
| 3 | $\Delta S_{\mathrm{ARG27}}$ | -1.9E-06 (-0.037) | 3.841 (10.806) | 1.313 (10.541) | 0.732 (8.187) | 0.520 (7.459) | 0.237 (1.776) | 1.466 (6.744) | -0.075 (-0.947) | -0.041 (-0.577) | 0.196 (1.989) | 0.109 (0.968) |

(continuation)

| Equation | $\Delta sus$ | $\Delta sus_{-1}$ | $\Delta sus_{-2}$ | $\Delta sus_{-3}$ | $\Delta sus_{-4}$ | Adj $R^2$ | DW | LM(1)* | RHO** | F | Nº obs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.013 (-2.305) | | | | | 0.717 | 1.75 | 4.891 (0.027) | | 258.2 | 305 |
| 2 | 0.014 (1.950) | 0.030 (2.859) | 0.030 (2.654) | | | 0.824 | 2.145 | 1.629 (0.201) | | 158.9 | 303 |
| 3 | 0.010 (1.543) | 0.013 (1.316) | 0.017 (1.467) | -0.018 (-1.622) | -0.014 (-1.904) | 0.837 | 2.241 | 4.454 (0.0348) | | 92.3 | 301 |
| 1 | -0.012 (-3.028) | | | | | 0.804 | 1.902 | 10.413 (0.0012) | 0.260 | 312.4 | 305 |
| 2 | 0.003 (0.549) | 0.009 (1.742) | 0.015 (2.796) | | | 0.924 | 1.868 | 1.372 (0.241) | | 413.7 | 303 |
| 3 | 0.001 (0.260) | 0.002 (0.591) | 0.003 (0.736) | -0.015 (-3.213) | -0.009 (-2.910) | 0.932 | 2.069 | 0.404 (0.525) | | 280.7 | 301 |
| 1 | -0.013 (-4.688) | | | | | 0.798 | 1.917 | 4.354 (0.0369) | 0.304 | 241.1 | 244 |
| 2 | 0.008 (1.600) | 0.021 (3.329) | 0.019 (2.808) | | | 0.910 | 1.837 | 1.602 (0.2056) | | 271.6 | 243 |
| 3 | 0.007 (1.775) | 0.011 (1.774) | 0.008 (1.366) | -0.013 (-2.741) | -0.010 (-2.217) | 0.923 | 2.06 | 0.225 (0.6352) | | 193 | 241 |

Note: $t$-statistics are in parenthesis.

*Breusche-Godfrey serial correlation LM test for one lag. The probability of no serial correlation in the residuals is shown in parenthesis.

**Value of the inverted AR roots − Cochrane-Orcutt 1 correction for serial correlation.

These coefficients differ from the expected results for US corporate risk and risk-free interest rate. According to Duffee (1996), the increase in the three-month US interest rate tends to reduce corporate yield spreads because the higher US government rate is an indicator of favorable business cycles, thus on average lowering corporate probability of default. In a broad international bond portfolio, Latin American bonds seem to substitute US High Yield bonds and not to complement them.

Furthermore, with respect to the US market structure, no inference can be drawn on the effect of changes in the US term structure. With no lagged regressors, the coefficients are negative and statistically significant. As lags are introduced, the values of current and lagged coefficients either change sign or become non-significant. As reported by Duffee (1996), most research on US corporate risk argues for that the relation between the Treasury slopes and risky bond yield-to-maturities and corporate spreads are not significant. However, Duffee's results demonstrate that some classes of rating have negative and statistically significant coefficients.

## 6. Conclusions

There are different methods for measuring credit risk of sovereign agents. The most well known, ratings issued by leading credit agencies, have been under scrutiny because rating agencies did not anticipate the Mexican crisis or the magnitude and extension of the Asian crises that started in July 1997. Great investments in applied research to improve credit risk measurement have been made. These have produced new and interesting techniques and powerful and complex models. From the methodologies I have briefly decribed, the concept of *implied risk-neutral probability of default* is particularly useful, for its ability to capture investors sentiments and for being an alternative measure of default risk to the numerical transformation of credit risk ratings. This variable does not only reflect the strength of an economy's fundamentals, but also indicates how investors perceive these fundamentals in different contexts, such as contagion due to currency crisis or suspicion that a country may be at risk of suffering a currency crisis, as well as the efforts taken by the national economic authorities to ensure a country's solvency.

Having assumed that some risk components do not vary over time, I proposed an equation specification that decomposes the first difference in country yield-to-maturity into the following components: the credit risk changes, the

changes in the 30-year US government interest rate, and the change in the slope of the US government term structure. The estimation results clearly show the importance of the probability of default and the level of the 30-year US Treasury interest rate in explaining the country's financial cost expressed by the long-term US dollar bonds of Argentina, Brazil and Mexico. The worse the rating level, the higher the market reaction is to the perception of credit worsening. The estimated coefficients are the first quantitative evidence for Argentina, Brazil and Mexico of how much one of these countries can have its external borrowing cost affected by changes in investor's perceptions. Moreover, it provides an estimate of how much a country could save if it were able to convince international investors of the strength of its fundamentals.

I found evidence that the Argentinean, Brazilian and Mexican long-term bonds overreact to US Treasury interest rate changes. And the worse the credit rating, the higher the expected overreaction. These results corroborate the findings of other studies, which show that the level of capital flows to emerging markets is highly sensitive to developed nations' business cycles. As reductions in US interest rates affect Latin American risk premia more than proportionally, this finding reinforces the interpretation that the Fall 1998 US Federal Reserve interest rate reductions were targeted to support certain emerging countries.

Finally, the usage of *implied risk-neutral probability of default* as an explainatory factor of risk premia shed light on the process by which investor's expectations of credit risk affects a country's long-term funding cost. A government interested in reducing its external borrowing cost has to be aware of the importance of information disclosure in order to keep the market up-to-date with its economic indicators and prospects. In addition, governments must be aware of the effects of misleading economic policies on country credibility and, consequently, on the access to international savings. Nations that need private foreign savings to finance their social projects or even budget deficits should keep in mind that bankers and investors evaluate their credit quality in a similar way to corporate risk, based on their ability to meet their outstanding liabilities.

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# Appendix A

## Figures of Yields to Maturity and Correlation Matrix

### Figure 1
### Risk spread of Argentina, Brazil, Mexico and US high yield bonds
### June 1997-Sept. 1998 (month-end)
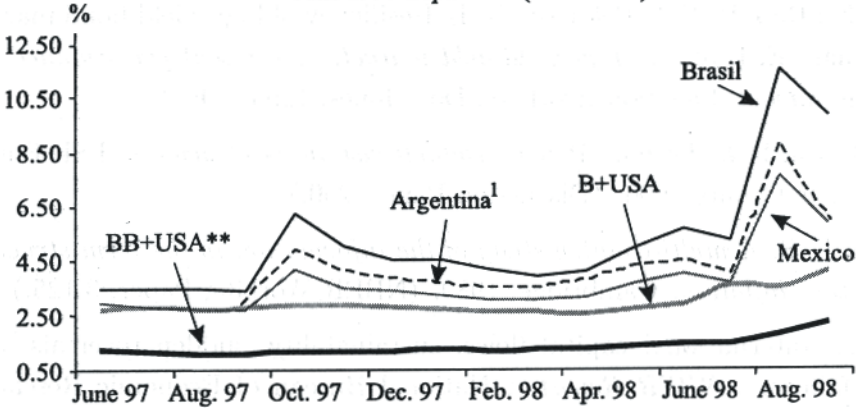


Source: Bloomberg Financial Services.
[1] While Brazil, Argentina and Mexico refer to their bonds that mature, in 2027 (Brazil and Argentina) and 2026 (Mexico), BB+ and B+ represent average interest rates for 30-year bonds issued by these categories of credit risk, less the equivalent 30-year US Treasury bond.

### Figure 2
### Argentina, Brazil and Mexico: bid yield spreads on long term bonds
### 4-6-1998 — 9-30-1998
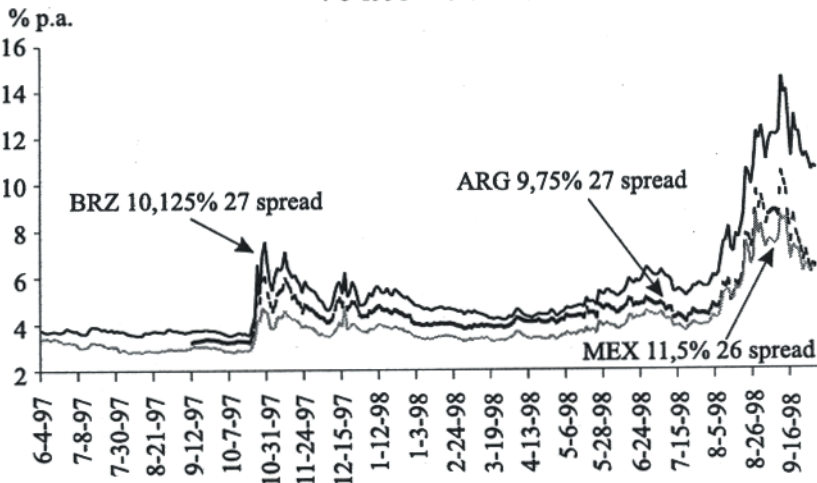


Source: Bloomberg and ING Barings Bank.

<div align="center">

Correlation matrix of yield to maturities
June 1997 - Sept. 1998*

</div>

|            | UST 30 years | YTM BR27 | YTM ARG27 | YTM MEX 26 |
|------------|:------------:|:--------:|:---------:|:----------:|
| UST 30 years | 1.0000     | ....     | ....      | ....       |
| YTM BR27   | -0.6843      | 1.0000   | ....      | ....       |
| YTM ARG27  | -0.6165      | 0.9587   | 1.0000    | ....       |
| YTM MEX 26 | -0.5383      | 0.9666   | 0.9771    | 1.0000     |

*Except correlation with the Argentinean bond, the sample for which goes from Sept. 1997 to Sept. 1998.

## Appendix B

<div align="center">

Long-term debt rating symbols

</div>

| Interpretation | Moody's | Standard & Poor's |
|----------------|:-------:|:-----------------:|
| Investment grade ratings | | |
|     Highest quality | Aaa | AAA |
|     High quality | Aa1 | AA+ |
| | Aa2 | AA |
| | Aa3 | AA- |
| Strong payment capacity | A1 | A+ |
| | A2 | A |
| | A3 | A- |
| Adequate payment capacity | Baa1 | BBB+ |
| | Baa2 | BBB |
| | Baa3 | BBB- |
| Speculative-grade ratings | Ba1 | BB+ |
|     Likely to fulfill obligations, | Ba2 | BB |
|     but under ongoing uncertainty | Ba3 | BB- |
| High-risk obligations | B1 | B+ |
| | B2 | B |
| | B3 | B- |
| Extremely poor prospects | C | CCC or worse |

Note: adapted from Cantor & Packer (1996).

## Appendix C

## Data Description

The data used for the empirical experiments are yields-to-maturity and respective spreads on bonds of Brazil, Argentina and Mexico that mature, respectively, in May 2027, September 2027 and May 2026. On September 30, 1998, the outstanding balances of these bonds were: US$3.5 billion for Brazil; US$2.75 billion for Argentina; and US$1.75 billion for Mexico.

The sources for Latin American time series are Bloomberg Financial Services for Mexico and Argentina, and ING Barings Bank for the Brazilian bond. The sample ranges from June 4, 1997 to September 30, 1998. While the time series obtained from Bloomberg presents some discontinuities due to lack of trading of either Mexican or Argentinean bonds on some dates, the time series from ING Barings Bank is more continuous with few breaks due to business holidays in the Brazilian financial market and in New York. In order to have a set of data as compatible as possible, dates on which quotations for the whole set of outstanding bonds were not available were disregarded. As a consequence, the time series on bid yields-to-maturity and bid spreads are composed of 310 daily observations for Brazil and Mexico, and 250 daily observations for Argentina, whose bond was launched in September 1997.