Credit Spread Dynamics: Evidence from Latin America

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Abstract

This paper examines the behaviour of credit spreads on key sovereign issuers from the Latin American region, which accounts for more than one third of international bond issues by developing, or emerging, markets. Since the late 1990s, credit spreads on Latin American issues have declined broadly inline with those in other emerging markets. Recent empirical analysis has explained this phenomenon by identifying critical macroeconomic factors, including the reduction in systematic risk in individual markets, although the structural models from the theoretical finance literature also predict the importance of key default and interest rate variables. This contribution adds to the understanding of these issues by investigating the application of structural models to the Latin American setting, one historically characterized by excessive volatility and susceptibility to episodes of default.

Keywords: credit spreads, long-run dynamics, Latin America, sovereign bonds, cointegration

JEL classification code: G15

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1. Introduction

Fixed income instruments as an asset class play an integral role in portfolios where they substitute, or are held alongside, cash, stocks and occasionally commodities. However, one key segment of this market - the market for risky and in particular non-investment grade bonds - is characterized in secondary market trading by a relative lack of liquidity. Consequently, in order to make effective investment decisions, it is necessary for any analyst, or investor, to determine the fair price of these instruments. This requires an understanding of the complex dynamic relationships that exist between markets more generally and those factors that determine the pricing of bonds more specifically. In comparison with stocks, bonds have a well-defined set of cash flows over their term to maturity. However, these cash flows are subject to default, liquidity and interest rate risks, which need to be considered when pricing the individual security.

The addition of a yield spread (or credit spread) over the equivalent near-maturity, risk-free benchmark, such as the on-the-run US Treasury bond, or note, for US dollar issues, is the industry approach to reflect the issuer's credit worthiness and the associated default and liquidity risks pertinent to the risky instrument being priced (De Almeid et.al., 1998). Structural models of default, such as the model proposed by Longstaff and Schwartz (1995), provide a simple and intuitive framework to capture the factors that drive yield spreads. Empirical evidence from the mature markets of the US and Japan amongst others (see Collin-Dufresne et al. 2001) point to two main factors – the *asset factor* and the *interest rate factor* - as the key drivers of changes in credit spreads. However, the generality of the developed market evidence to emerging markets and the understanding of the factors that drive these credit spreads, which are structurally and otherwise different from those in mature markets, is limited.

Emerging markets in general and Latin American markets in particular have witnessed a persistent decline in credit spreads over the last several years, yet the economic justification for this behaviour remains largely unanswered. The objective of this paper is to critically examine the economic reasons for the behaviour of credit spreads in a key segment of the emerging bond market –the sovereign issues by Latin American issuers in the international bond market. The BIS (2007) reports that Latin American issuers comprise the largest single region (35% in 2006) of developing countries in these markets which comprised a total of US$ 994 billion in outstandings in 2006, followed by the Asia-Pacific (29%), European (26%) and Africa and the Middle East (10%) regions. Emerging market credit spreads also continued to decline prior to and after the near collapse of Long-Term Capital Management (LTCM) and the Asian financial crisis in 1997. The post LTCM crisis also witnessed a declining trend on the credit spreads of other emerging market issuers.

In order to understand the behaviour of emerging market credit spreads and to empirically establish the economic reasons for the persistent decline in credit spreads, we investigate the following important questions in this paper predicted by the structural models of Longstaff and Schwartz (1995):

- *Are the changes in credit spreads of US dollar denominated Eurobonds of Latin America sovereigns driven by key asset and interest rate factors?*

- *Are the changes in credit spreads of US dollar denominated sovereign Eurobonds of Latin America negatively related to changes in asset, and interest rate factors?*

This study seeks to answer these empirical questions in a regional setting using the yield spreads between US dollar sovereign Eurobonds by major Latin American issuers (Brazil, Chile, Colombia, Mexico and Venezuela). The economic reasons underpinning the behaviour of emerging market credit spreads is best understood by only investigating sovereign bonds, which have the benefit of being the most liquid and actively traded. Therefore, this study is limited to sovereign spreads and to a region that is likely representative of the behaviour of credit spreads by other emerging market issuers. The sample period covers the daily yields from 25 February 2000 to 13 January 2006 of the Eurobonds issued by the governments of the above mentioned five countries, consisting of 1483 observation for each of the 18 bonds. Consequently, in addition to investigating the credit spread drivers in Latin American markets, we also investigate the change in behaviour of these factors around the Argentine default which occurred in December 2001.

The paper is organized as follows. In section 2 we present some of the key issues surrounding the Latin American fixed income market. Section 3 presents the pricing issues related to credit spread and then Section 4 outlines data and methods. Empirical results are presented in Section 5, while Section 6 concludes the paper.

2. A Perspective on Latin American Bond Market

2.1 Introduction

Following the Asian financial crisis that began in 1997 emerging market spreads experienced a sharp increase, which continued up to the Russian financial crisis of July 1998. This is clearly evident from the JP Morgan Emerging Market Bond Index (EMBI) which rose to nearly 1600 basis points. After this sharp increase spreads stabilized and from the end of 1998 there was a systematic decline until 2007, where the EMBI is now around 200 basis points. Data provided by the BIS (2006), highlights the persistent reduction in emerging market credit spreads and comments that in first two months of 2006 there was a 70 basis point reduction in credit spreads of dollar denominated Latin American high yield bonds, whilst the European and Asian spreads declined by 20 basis points for the same period.

2.2 Financing Trends in the Latin American Region

The history of economic activities and the political leadership of the countries in the Latin American region are replete with economic mismanagement, inappropriate policy adoptions and inappropriate allocation of funds. Bank intermediated financing and direct financing through the issuance of debt securities in the domestic and international markets are the two major sources that finance the activities of many emerging market governments and corporations.

Traditionally, Latin American governments rely more on the direct issuance of international bonds than their Asian or European counterparts. In fact excessive short term financing from the international bank community was one of key contributing reasons behind the 1997 Asian financial crisis, where nearly 60% of financing had a maturity of less than one year in 1997 (BIS, 1999). Latin America, however, remains the major emerging market issuer in the international bond markets, which Jeanne and Guscina (2006) attribute to the absence of domestic savings. The structure of the fixed income markets in the region also favour US dollar denominated floating rate (short term) instruments and consequently makes these economies more vulnerable to changes both in the financial conditions in the US and contagion from US dollar issuers in other markets. These features have contributed to the exacerbation of several crises in these economies (Turner, 2002 and Mihaljek, Scatigna and Villar, 2002).

Excess volatility in the financial markets is an inherent feature of the countries in the region. Weak international financial links and underdeveloped domestic financial markets are the prime candidates behind such excess volatility (Caballero, 2000). Turner (2002) attributes the switching from international debt securities to domestic securities by emerging market issuers (especially in the Asia Pacific region) to two main reasons: First, conscious efforts to improve the market infrastructure for bond trading by way of enhancing secondary market activities, taxation reform and tailoring insurance policies have been undertaken. Second, the attractiveness of the domestic currency has been enhanced due to lower domestic inflation and declining domestic interest rates.

Classens, Klingebiel and Schmukler (2003) survey of the government bond markets of 24 developed markets and 12 emerging markets found that the total size of the government sector amounted to US$19.1 trillion, with 95% of this total comprising issues by governments in developed markets and only 5% is attributable to governments in emerging markets. Their analysis shows that greater importance is placed on foreign currency denominated bonds by emerging economies compared with those developed economies investigated. This finding is consistent with countries with larger economies, a larger domestic investor base and more flexible exchange rate regimes having a larger domestic currency bond market. In contrast, smaller economies with less flexible exchange rate regimes, weak economic fundamentals and inadequate institutional frameworks rely more on foreign currency denominated bonds. The authors also show that countries that improve their institutional framework and economic fundamentals, can enhance their domestic currency bond market.

***Domestic Bond Market in Latin America*:** Economies in Latin America until recently have relied heavily on the foreign currency denominated international bonds as the main vehicle to finance their economic activities, with less reliance placed sourcing funds in domestic bond markets. On the other hand, lessons from other developed markets point to the importance of having an active and vibrant a domestic bond market for the maintenance of a stable and healthy capital market. Progress has been made most by Mexico and Brazil where domestic bond markets have increased from US$40.4 and US$390.8 billion in 1998 to US$ 251.5 and US$623.5 billion respectively. This increase- in excess of 100%- has resulted from key improvements in bond trading and clearing infrastructure as well as institutional changes, including a greater role for institutional investors.

It is notable that the significant portion of this growth in the domestic bond market is due to issues by the government sector. Jeanne and Guscina (2006) studied the government debt of 19 emerging markets including Latin American countries between 1980 to 2002 and find striking facts about Latin American domestic bond market. Their analysis reveals that domestic bond markets in Asia have a similar structure to that of more advanced countries, where an overwhelming share is concentrated in local currency bonds with a fixed interest rate and a medium to long term maturity.

This, however, is strikingly different to the Latin America markets where the structure of the domestic debt is more concentrated in variable interest rate instruments. Fixed and variable interest rate long term domestic currency denominated bonds are around 10% and 5% of the total domestic debt respectively. Similarly, long term foreign currency denominated variable interest rate debt is around 10% of the total domestic market whilst the fixed rate foreign currency denominated bonds account for only around 2.5%. In addition, they also find that there has been a decline in the number of issues with a medium to long term maturity. This is attributed to weak economic fundamentals and monetary instability in Latin America.

The domestic debt structure between individual countries also reveals a diverse pattern. For example, the majority of Argentine domestic debt is denominated in foreign currency due to its economic and financial circumstances and stands out as country that relies heavily on foreign currency denominated bonds among the emerging market economies. Brazil, on the other hand, stands out as nation with the largest domestic currency bond market in the region with 35% of its domestic debt denominated in local currency (variable interest). A substantial portion of domestic debt in Venezuela is denominated in local currency with a variable interest rate. Mexico on the other hand has a minor proportion of foreign currency denominated debt whilst spreading equal proportion across medium to long term fixed interest rate debt denominated in local currency.

International Bank financing: Rapid structural reforms have been undertaken in the banking sector in Latin America in the recent past to overcome the shortcoming in the sector and to bring about a banking and financial system that is efficient and resilient. Compared to other emerging market regions, Latin America accounts for only 15% of the total international bank lending to emerging markets with between 40% to 50% of this lending attributed to short term financing (BIS, 2006). The Asia Pacific region historically has been the major focus of international bank financing up until 2004, when Eastern Europe became the major beneficiary.

(Insert Table 1)

International Bond Issues: Table 1 provides information on the scale of international bonds issued by emerging market regions. Attention is drawn to the Latin American countries. The Latin American region was the single major issuer in the international bond market, occupying nearly 54% of the total size. However, this position of dominance is maintained by Latin American countries in 2006 but with the relative position of only 35% of the total outstanding of international bonds belonging to emerging markets for the last quarter of 2006. Data provided by the BIS (2007) shows that the overall issues by Latin America in the international bond market has remained stable over the last eight years. Emerging markets in the European region have increased its issues in the international bond market catching up with the Asian region. Brazil, Mexico and Argentina are the sizable issuers that stand out in the Latin American region in terms of size.

3. Pricing Issues

The building block of risky debt valuation consists of the interest rate and default cum asset recovery process. The term structure of interest rates defines the future evolution of interest rates through a probabilistic description. It essentially measures the relationship among the yields on default-free interest instruments that differ only in their terms to maturity. Vasicek (1977), Cox, Ingersoll, and Ross (1985), Ho and Lee (1986), Hull and White (1990), Heath, Jarrow and Morton (1992) are some of the popular studies that attempt to model interest rate process. The model by Vasicek[2] (1977) proposes that the interest rate follows a mean reverting Ornstein Uhlenbeck process. Adopting the property of mean reversion, the short rate *r* rises when it is below the long-term mean, and falls when it is above the long-term mean. As far as the rate dependence on volatility is concerned, Vasick (1977) assumes it to be constant, while Cox, Ingersoll, and Ross (1985) treat rate dependent volatility as proportional to the square root of the short rate. One of the theoretical problems associated with Vasicek's model is that it can generate negative interest rates. The key advantage is that it can be employed in a systematic manner to price interest rate sensitive interments.

The second building block of credit risk pricing is the default process, which attempts to capture the possible implications of a credit-risk event. Sundaresan (2000) categorises the literature on credit-risk pricing into three areas – structural models or firm value approach, reduced form models, and structural models with strategic behaviour. The first category of structural models of default, or firm value approach, to credit risk pricing assumes that default takes place as the forcing process reaches a

[2] $dr(t) = (a + br(t))dt + \sigma dW(t)$ where the interest rate follows an Ornstein Uhlenbeck process and *a, b* and σ are parameters of the process and W(t) is the standard Brownian motion.

reorganisation boundary where the allocation of residual values take place exogenously. Black and Sholes (1973), Merton (1974), Black and Cox (1976), Ingersoll (1977), Brennan and Schwartz (1980), John (1993), Kim, Ramaswamy and Sundaresan (1993), Longstaff and Schwartz (1995) are key authors that adopt this approach.

The second category of models examine the exogenous specification of default outcomes and recovery rates based on an arbitrage-free valuation by assigning probability of default and recovery rates exogenously while deriving pricing formula, which can be calibrated to data. Key examples include, Jarrow and Turnbull (1995), Jarrow Lando and Turnbull (1997) and Duffie and Singlton (1999). The third category of models utilise structural models together with game theory to study the strategic behaviour. Leland (1994), Leland and Toft (1996), Anderson and Sunderasan (1996) and Mella-Barral and Perraudin (1997) are some the studies that endogenise the lower reorganisation boundary whilst accommodating the behaviour of firms in distress situations.

Structural Models: The structural framework captures credit risk based on the economic and financial fundamentals of the risky bond issuers by treating the equity of the firm as a call option on the assets of the issuers. These models exogenously specify a particular firm value process and assume that default is triggered when the firm value falls to some explicit threshold. The structural approach views risky debt as a contingent claim on the value of the issuer. Interest rates are assumed to be constant and an option-pricing framework was used to model default risk for bonds. Merton (1974) formalised this theoretical base and developed a model for pricing risky debt by introducing the theory of a risk structure of interest rates. This perspective views the value of a risky debt as dependant upon a) the required rate of return on the risk free debt; b) provisions on the debt and restrictions contained in the indenture and c) the probability of default.

Although the structural framework was widely used by subsequent researchers (e.g. Geske, 1977 and Ingersoll, 1977) the major problem was the assumption concerning the occurrence of the default event. A default event is conditioned to take place only when the firm exhausts all its asset whilst in practice firms usually default long before assets are exhausted. Black and Cox (1976) significantly extended the previous work of Merton (1974) by explicitly modeling the effects of safety covenants, subordination arrangements, and restrictions on financing of interest and dividend payments. One of the important aspects of the Black and Cox (1976) study is that it conditions the default event to occur before the firm exhausts its assets. Longstaff and Schwartz (1995) incorporate many distinguishing features of the structural framework and formulate a dynamic continuous-time valuation framework which provides a simple closed form model. They relax the restrictive assumptions relating to the interest rate process and the default threshold through a dynamic interest rate process and by allowing an early default.

They make six important assumptions relating to the firm value process, the interest rate process, the capital structure of the issuer, the default process, the payoff in the event of default and the market settings. The dynamic of the total value of the assets of the issuer (dV) is captured through a standard Weiner process: $dV = \mu V dt + \sigma V dZ_1$, where σ is a constant and Z_1 is a standard Weiner process.

The dynamics of the short term interest rate (r) is accommodated through a Vasicek type of interest rate process and is given by $dr = (\zeta - \beta r)dt + \eta dZ_2$, where ζ , β and η are constants and is a standard Weiner process. They assume that the firm value V is independent of the capital structure of the firm and is in line with the Modigiliani-Miller proposition (1958). This assumption implies that any cash outflows arising from existing debts are financed by issuing new debt and therefore the firm value is independent of the capital structure.

Solvency ratio X which is the ratio of threshold value K to firm value V takes care of the default process. The issuing firm is solvent when the firm value is above the threshold point and the firm enters bankruptcy if the ratio reaches 1 where $K=V$. Once the firm reaches insolvency position all debt contracts concurrently enter the default status. The Longstaff and Schwartz (1995) assumes that debt holders receive $1 - w$ times the face value of the debt at maturity where w represent the written down value of the bond.

Longstaff and Schwartz (1995) specifies the price of a risky bond with maturity T as an explicit function of solvency ratio X, interest rate r and maturity T where the price of the risky bond is an increasing function of the solvency ratio X and a decreasing function of r and T .

$$P(X,r,T) = D(r, T) - wD(r,T)Q(X,r,T) \quad (1)$$

The first term $D(r,T)$ in the above equation represents the value of a benchmark risk-free bond and $wD(r,T)$ represents the present value of the loss to the risky bond holder in the event of distress. $Q(X,r,T)$ represents the risk-neutral probability of default. The above equation can be rearranged to represent the credit spread as the yield difference between a risky bond *P(X,r,T)* and a risk-free bond *D(r, T)* .

Using the simple closed form model of Longstaff and Schwartz (1995) provide the following platform to test yield spread empirically. They differentiate equation (1), and substitute the yield on a risk-free bond of -ln*(D(r, T))/T* to obtain the yield of a risky bond. The yield difference between the risky bond and the risk-free bond is the credit spread and is given by equation (2),

$$S = -\frac{\ln(1 - wQ(X,r,T))}{T} \quad . \qquad (2)$$

with the first difference of *S*, ΔS

$$= \frac{wQ_X X}{T(1 - wQ(X,r,T))}\frac{\Delta X}{X} + \frac{wQ_r}{T(1 - wQ(X,r,T))}\Delta r + \left(\frac{wQr}{T(1 - wQ(X,r,T))} - \frac{\ln(1 - wQ(X,r,T))}{T^2}\right)\Delta T \qquad (3)$$

Having obtained the first difference of the credit spread *(S)* the regression form of Longstaff and Schwartz (1995) is given by simple equation (4),

$$\Delta S_t = a + b\Delta Y_t + c\Delta I_t + \varepsilon_t \qquad (4)$$

where $\Delta St = S_t - S_{t-1}$ is the change in credit spread between a risky bond and the risk-free US T-bond with the same maturity. $\Delta Yt = Yt - Yt\text{-}1$ is defined as the change in interest rate factor. $\Delta I_t = I_t - I_{t-1}$ is the change in the asset factor which is proxied by the return on the broader stock market index. Regression coefficients are represented by *a, b* and c.

4. Data and Method

We use daily yield series belonging to five sovereign issuers in Latin America. For the purpose of this study only US dollar denominated sovereign issues without a call provision are used. Latin American sovereign issues were searched in the Reuters Fixed Income Database, with 18 bonds identified that fit this criteria. The sample period covers February 2000 to January 2006 (1483 observations). US benchmark bonds with a similar maturity were used as the risk-free bonds to generate the spreads.

Following Longstaff and Schwartz (1995) and Batten, Fetherston and Hoontrakul (2006) we proxy the change in the asset factor ΔI_t by the return on the stock market indices of Brazil, Chile, Colombia, Mexico and Venezuela. Specifically, the Bovespa index for Brazil, the IPSA index for Chile, HSBC JCLACOL for Colombia, the Mexican Bolsa Index for Mexico and the IBC index for Venezuela were used in this study. The Bovaspa index was chosen since it is a total return index and comprises the most liquid stocks from the Sao Paulo Stock Exchange. The Chilean IPSA index incorporates 40 actively traded stocks from the Santiago Stock Exchange and is regarded as the most popular market index. The IGBC index, from the Colombia Stock Exchange, commences in July 2001 and so could not be used given the February 2000 start date of our sample period. Instead, we utilize the HSBC JCLACOL index as the proxy for the Colombian asset factor. The Mexican Bolsa index from the Mexican stock exchange is the capitalisation weighted index comprising of leading stocks, while the IBC index from the Caracas Stock Exchange of Venezuela comprises the most liquid and capitalized stocks.

The credit spread *ΔSt* and interest rate variable *ΔYt* was determined by first matching each of the sovereign bonds with a near maturity US Treasury bonds, with the following bonds selected:

(i) 6.25% coupon maturing on February 15, 2007

(ii) 6.625% coupon maturing on May 15, 2007

(iii) 5.625% coupon maturing on May 15, 2008

(iv) 9.125% coupon maturing on May 15, 2009

(v) 6.0% coupon maturing on August 15, 2009

(vi) 7.5% coupon maturing on November 15, 2016

(vii) 8.5% coupon maturing on February 15, 2020

(viii) 6.75% coupon maturing on August 15, 2026

(ix) 6.625% coupon maturing on February 15, 2027

(x) 6.375% coupon maturing on August 15, 2027

(xi) 6.25% coupon maturing on May 15, 2030

(Insert Table 2 about here)

Table 2 reports the summary statistics for the spreads between the respective Latin American sovereign Eurobonds and the benchmark US treasury bonds. The mean spread for Brazil and Venezuela is higher than the Chilean and the Mexican spreads. Colombian spreads fall in between these two groups. The standard deviation of the spreads also reveal a similar pattern with higher volatility being associated with Brazilian and Venezuelan series. Higher spreads and higher volatility reflect the economic conditions that prevailed in Brazil and Venezuela during the sample period. The mean spread for Brazil ranges from 6.91% to 7.81% on the other hand the mean spread for Mexican issues are in range of 1.69% to 2.68%. Similar to Brazilian spreads, the mean spreads for Venezuelan issues are in the range of 6.91% to 7.9%. Colombian spreads are in the range of 4.27% to 5.74%, which lies between the Brazilian range and Venezuelan range. It should be noted that all of the mean spreads increase with maturity –that is the longer the maturity of the bond, the higher the mean credit spread for each country. There is also excess kurtosis on Brazilian spreads compared to other spread series in this study. A common feature that we observe in the descriptive statistics is that the standard deviations within each market consistently tends to decrease with increasing maturity.

During our sample period the capital reserves of Argentina were depleted (23rd of December 2001) and the country declared a moratorium on international debt repayments. Therefore, for the purposes of this study we choose the official default date as the 23rd of December 2001. We then divide the sample into two sub-periods -pre-Argentine default period and post-Argentine default period - in addition to the analysis comprising all observations for the full sample period. Accordingly our sample is subdivided as pre-crisis period (25 February 2000 to 23 December 2001) and post-crisis period (24 December 2001 to 13 January 2006) consisting of 457 and 1027 observations respectively.

(i) Changes in Credit Spreads

An important implication of Longstaff and Schwartz (1995) model is that credit spread, the yield difference between a risky bond and a risk free benchmark bond, is driven by two major factors – an asset factor and interest rate factor. Given the problems of heteroscedasticity and autocorrelation associated with the data in our sample we employ the Bollerslev (1986) GARCH(1,1) specification within an Autoregressive (AR) Moving Average (MA) framework, with Equation 4 now specified as:

$$\Delta S_t = a + b\Delta Y_t + c\Delta I_t + AR(1) + MA(1) + \varepsilon$$
$$\sigma^2 = \alpha + \beta\varepsilon^2_{t\ 1} + \gamma\sigma^2_{t\ 1} \tag{5}$$

where $\Delta S_t = S_t - S_{t-1}$ is the change in credit spread between the risky Latin American bond the risk-free US T-bond with the same maturity. $\Delta Y_t = Y_t - Y_{t\ 1}$ is defined as the change in interest rate factor. $\Delta I_t = I_t - I_{t-1}$ is the change in the asset factor which is proxied by the return on the broader stock market index of individual countries in our sample. *a, b* and *c* are the regression coefficients of the mean equation. In line with the theory, we expect the regression coefficients *b* and *c* representing interest rate factor and asset factor to be inversely related to the dependent variable, ΔS_t. The conditional variance term (σ^2) in the variance equation is a function of mean α; the ARCH term $\beta\varepsilon^2_{t-1}$ which is measured as the lag of the squared residuals from the mean equation effectively represents the information about the volatility from the previous period; and the GARCH term $\gamma\sigma^2_{t-1}$ representing the last period's forecast variance. The Bollerslev and Wooldridge (1992) procedure was also applied to ensure that the statistical significance of the results was not affected by conditionally non-normally distributed residuals.

5. Empirical Results

To provide an insight into the applicability of structural models in market settings that are often described as immature, highly volatile and a region replete with default events, we investigate five important bond markets in Latin America in this study. We examine the spreads between 18 sovereign issues matched with their US benchmark bonds of the same maturity structure. For simplicity this study focuses only on sovereign Eurobond issues with no embedded options such as callable, puttable and convertible bonds. Given the problems of hetroskedasticity and autocorrelation we employ a GARCH(1,1) specification within an Autoregressive Moving Average framework – ARMA (1,1) - to accommodate the time varying volatility structure of the return series and autocorrelation in the regression residuals at lag one. The regression tested the change in credit spread as a function of well established asset factor and interest rate factor with AR(1) and MA(1) terms.

(Insert Table 3 about here)

The theory on credit risk suggests that credit spreads are inversely related to interest rate factor and asset factor. Our regression of changes in credit spreads on changes in asset and interest rate factor confirms this theoretical proposition and the coefficients are highly significant (Beyond 99.9%). Table 3 outlines the results for the whole sample (1483 observations), with the inverse relationship between the changes in credit spread and the interest rate factor clearly evident for all of the 18 bonds in our sample.

Argentina officially defaulted on the 23rd of December 2001 and to account for this credit event we divide the data into two sub-periods with the analysis conducted for the whole period as well as sub-periods. For the sake of brevity the results from this additional analysis are not reported. With the exception of two cases, the coefficient for the asset factor for the whole sample as well as the pre and post Argentine default period were negative as predicted by the model. This is consistent with the existing evidence both in emerging and developed markets. The ARMA terms were also found to significant in most cases suggesting that there was pricing inefficiency in the market. The coefficients on the lagged squared error and lagged conditional variance in the conditional variance equation are also highly statistically significant (beyond 99.9%). In addition, the sum of the coefficients of the lagged squared error and lagged conditional variance is very close to unity which implies that the shock to the conditional variance will be highly persistent.

6. Conclusion

We test the Longstaff and Schwartz (1995) model in an emerging market setting using the spread between 18 sovereign issues matched with a US benchmark bond of equivalent maturity. Brazil, Chile, Colombia, Mexico and Venezuela were the specific markets in the emerging Latin American region that were included in this study. The purpose of this investigation was to provide an insight into the valuation issues surrounding emerging Latin American fixed income markets and the efficacy of Longstaff and Schwartz (1995) type structural model in market settings that are often described as immature and excessively volatile. Given the problems of hetroskedasticity and autocorrelation associated with the data we employ a GARCH(1,1) specification within an ARMA (1,1) framework. Tests were conducted for the whole sample as well as the sub sample for the 2001 pre-Argentine and post-Argentine crisis periods. As predicted by structural models, changes in credit spreads of emerging Latin American markets were driven by interest rate and asset factors with both these two factors negatively related to changes in yield spreads.

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Table 1: International Bonds and Notes issued by selected Latin American Countries

Amounts Outstanding (US $ billions)

	1998 Dec	1999 Dec	2000 Dec	2001 Dec	2002 Dec	2003 Dec	2004 Dec	2005 Dec	2006 Dec
All Countries	**4,181.1**	**5,116.8**	**6,004.4**	**7,204.7**	**8,841.4**	**11,156.9**	**13,311.2**	**13,964.0**	**17,561.6**
Developed countries	**3,263.3**	**4,146.6**	**4,974.2**	**6,140.7**	**7,665.8**	**9,820.5**	**11,811.8**	**12,415.8**	**15,791.2**
Developing countries	**508**	**542.5**	**584.9**	**588.1**	**634.3**	**705**	**795.8**	**841.2**	**993.9**
Africa & Middle East	**17.7**	**22**	**26.4**	**31.1**	**36.5**	**44.6**	**55.4**	**66.5**	**104.6**
Asia & Pacific	**142.6**	**142**	**137.9**	**135.6**	**153.8**	**176.3**	**211.4**	**240.4**	**285.3**
Europe	**74.2**	**79.6**	**104**	**105.5**	**117.1**	**140.8**	**172.1**	**198.8**	**255.3**
Latin America & Caribbean	**273.5**	**299**	**316.5**	**315.9**	**326.9**	**343.3**	**356.9**	**335.5**	**348.8**
Argentina	72..2	79.6	86.7	89.8	90.9	94.1	92.7	58.0	60.8
Brazil	71.1	76.7	83.8	80.9	87.4	102.2	104.9	107.5	109.9
Chile	3.4	4.8	5	6.6	8.8	10.3	11	11.1	10.9
Colombia	6.2	7.7	8.9	12.1	12.5	13.6	14.4	14.7	16.2
Mexico	84.3	92.7	93.6	87.8	87	80.1	86.5	88.8	92.7
Peru	4.3	4.3	4.3	4.3	4.6	4.9	6.3	8	9.4
Uruguay	2.3	2.7	3.1	3.9	4.2	4.4	4.8	5.6	8.3
Venezuela	20.8	21.1	19.4	20.2	19.4	20.1	21.1	25.7	22.6
United States	796.4	1229.2	16.53.5	2259.9	2656.5	2997.5	3269.9	3,449.8	3,972.1

Source: *BIS International Financial Statistics – Securities (Table 25 B)*

Table 2: Descriptive Statistics for Spreads on Latin American Sovereign Issues and US Benchmark Issues

The credit spreads are calculated as the arithmetic difference in the yields of the respective sovereign bond and the equivalent maturity of 11 US Treasury bonds. The columns are coded BRA (Brazil), CH (Chile), CO (Colombia), MEX (Mexico) and VEN (Venezuela). The maturity of the spread pairs ranged from 2007 (07) to 2027 (27).

	BRA08	BRA09	BRA20	BRA27	BRA30	CHI09	COL07	COL08	COL09	COL20	MEX07	MEX08	MEX09	MEX16	MEX26	VEN07	VEN18	VEN27
Mean	6.91	7.65	7.77	7.25	7.81	1.36	4.27	4.59	4.87	5.74	1.69	1.92	2.08	2.43	2.68	7.30	7.91	6.90
Median	5.87	6.90	7.11	6.84	7.32	1.40	4.46	4.56	4.56	5.79	1.65	1.84	2.06	2.38	2.61	7.33	8.33	7.64
Maximum	25.40	26.15	23.12	19.32	21.82	2.60	11.69	11.42	11.48	10.32	3.97	3.97	4.29	4.31	5.06	17.97	13.55	10.62
Minimum	1.09	1.35	2.57	2.78	3.14	0.50	0.35	0.72	0.93	2.47	-0.21	0.40	0.54	0.83	1.29	1.46	2.82	2.63
Std. Dev.	4.93	4.73	3.74	3.14	3.51	0.61	2.54	2.38	2.20	1.70	1.12	1.02	1.06	0.94	0.71	3.98	2.40	2.02
Skewness	1.67	1.54	1.58	1.38	1.55	0.11	0.33	0.35	0.38	0.27	0.19	0.19	0.16	0.08	0.14	0.32	-0.20	-0.43
Kurtosis	5.57	5.52	5.56	4.92	5.52	1.57	2.33	2.38	2.71	2.26	1.52	1.54	1.49	1.61	1.95	2.38	2.26	2.01

Table 3: Regression of Changes in Credit Spreads on Changes in Interest Rate Factor and Asset Factor – Whole Sample

For each of the 18 Latin American bonds we estimate the following GARCH(1,1) specification of the regression $\Delta S = a + b\Delta Y + c\Delta I + AR(1) + MA(1) + \varepsilon$, $\sigma^2 = \alpha + \beta\, \varepsilon^2_{t-1} + \gamma\sigma^2_{t-}$. The term ΔS is the change in credit spread (Spreads are generated by comparing the yields of risky Latin American sovereign with the yields of US bench mark bond of the same maturity), ΔY is the change in the daily yield of US government Treasury Bonds with the same maturity, ΔI_t is the daily logarithmic return of Brazil, Chile, Colombia, Mexico and Venezuela stock markets, AR(1) and MA(1) are autoregressive and moving average terms at 1-lag. Regression coefficients together with Z-statistics and their associated *p* values are reported.

$\Delta S_t^i = a + b\Delta Y_t + c\Delta I_t + AR(1)\ MA(1) + \varepsilon$, $\sigma^2 = \alpha + \beta\, \varepsilon^2_{t-1} + \gamma\sigma^2_{t-}$											
	a	B	C	AR(1)	MA(1)	α	β	γ	AR^2	F	SSE
	BRAZIL										
	-0.009	-0.738	-2.054	-0.991	0.992	0.000	0.146	0.870	0.031	7.801	212.886
BRA 08	-2.737	-11.088	-7.740	-125.170	121.030	1.526	5.090	34.349			
	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.127)	(0.000)	(0.000)		(0.000)	
	-0.006	-0.620	-2.545	-0.994	0.994	0.000	0.107	0.912	0.038	9.348	177.377
BRA 09	-2.067	-10.109	-13.382	-50.025	54.724	0.291	3.800	52.592			
	(0.039)	(0.000)	(0.000)	(0.000)	(0.000)	(0.771)	(0.000)	(0.000)		(0.000)	
	-0.007	-0.560	-2.255	-0.894	0.912	0.000	0.153	0.870	0.030	7.500	147.523
BRA 20	-2.626	-10.818	-12.929	-9.472	10.616	1.173	2.890	25.269			
	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.241)	(0.004)	(0.000)		(0.000)	
	-0.005	-0.504	-2.556	0.994	-0.997	0.003	0.244	0.680	0.030	7.606	139.838
BRA 27	-3.150	-5.329	-8.118	148.107	-190.255	4.796	3.126	11.382			
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)		(0.000)	
	-0.003	-0.540	-2.449	0.209	-0.235	0.000	0.129	0.885	0.034	8.450	137.507
BRA 30	-1.176	-9.539	-10.752	0.165	-0.186	1.679	4.042	39.012			
	(0.240)	(0.000)	(0.000)	(0.869)	(0.852)	(0.093)	(0.000)	(0.000)		(0.000)	
	CHILE										
	-0.001	-0.217	-0.235	-0.014	-0.300	0.000	0.175	0.855	0.197	52.991	4.390
CHIL 09	-0.979	-12.929	-1.134	-0.089	-2.080	1.508	4.419	36.941			
	(0.328)	(0.000)	(0.257)	(0.929)	(0.038)	(0.132)	(0.000)	(0.000)		(0.000)	
	COLOMBIA										
	-0.009	-0.863	-0.154	0.203	-0.385	0.000	0.249	0.801	0.088	21.383	57.836
COL 07	-2.933	-16.903	-0.743	0.967	-1.738	1.784	5.273	33.439			
	(0.003)	(0.000)	(0.458)	(0.334)	(0.082)	(0.075)	(0.000)	(0.000)		(0.000)	

	-0.006	-0.756	-0.487	-0.994	0.993	0.000	0.195	0.841	0.068	16.421	56.901
COL 08	-2.202	-15.237	-1.596	-43.546	39.654	1.272	5.997	28.652			
	(0.028)	(0.000)	(0.110)	(0.000)	(0.000)	(0.203)	(0.000)	(0.000)		(0.000)	
	-0.010	-0.695	-0.408	-0.809	0.858	0.000	0.223	0.830	0.013	3.734	82.016
COL 09	-4.035	-16.993	-2.226	-6.639	9.071	1.017	3.391	19.359			
	(0.000)	(0.000)	(0.026)	(0.000)	(0.000)	(0.309)	(0.001)	(0.000)		(0.001)	
	-0.011	-0.710	-0.686	-0.241	0.404	0.000	0.261	0.810	0.073	17.635	36.740
COL 20	-4.516	-8.754	-2.648	-0.962	1.731	2.372	2.537	22.395			
	(0.000)	(0.000)	(0.008)	(0.336)	(0.084)	(0.018)	(0.011)	(0.000)		(0.000)	
	MEXICO										
	-0.001	-0.614	-0.839	0.181	-0.234	0.000	0.072	0.917	0.292	88.348	8.281
MEX 07	-0.298	-15.792	-4.204	0.506	-0.657	1.767	3.392	36.518			
	(0.766)	(0.000)	(0.000)	(0.613)	(0.511)	(0.077)	(0.001)	(0.000)		(0.000)	
	-0.001	-0.585	-0.744	-0.275	0.226	0.000	0.118	0.883	0.316	98.657	6.908
MEX 08	-0.720	-22.876	-4.821	-0.533	0.432	2.410	4.990	46.363			
	(0.472)	(0.000)	(0.000)	(0.594)	(0.666)	(0.016)	(0.000)	(0.000)		(0.000)	
	-0.001	-0.505	-0.969	-0.231	0.186	0.000	0.114	0.887	0.254	73.051	8.105
MEX 09	-0.903	-20.772	-7.113	-0.752	0.592	2.401	3.657	31.970			
	(0.367)	(0.000)	(0.000)	(0.452)	(0.554)	(0.016)	(0.000)	(0.000)		(0.000)	
	-0.002	-0.519	-0.763	0.663	-0.614	0.000	0.143	0.842	0.276	81.449	5.783
MEX 16	-1.233	-16.909	-5.730	3.715	-3.253	3.867	3.722	25.589			
	(0.218)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)		(0.000)	
	-0.002	-0.507	-1.137	-0.920	0.984	0.000	0.218	0.825	0.108	26.554	9.669
MEX 26	-1.077	-17.558	-5.273	-22.232	434.263	1.422	4.339	36.784			
	(0.282)	(0.000)	(0.000)	(0.000)	(0.000)	(0.155)	(0.000)	(0.000)		(0.000)	
	VENEZUELA										
	0.073	-0.915	-0.008	0.076	-0.353	0.029	0.251	0.523	0.060	14.518	152.966
VEN 07	1.096	-10.002	-1.210	0.479	-2.221	1.334	1.957	3.862			
	(0.273)	(0.000)	(0.226)	(0.632)	(0.026)	(0.182)	(0.050)	(0.000)		(0.000)	
	-0.008	-0.758	-0.225	0.913	-0.883	0.000	0.118	0.889	0.098	23.861	30.389
VEN 18	-3.074	-17.460	-1.246	14.085	-11.643	2.252	4.979	51.365			
	(0.002)	(0.000)	(0.213)	(0.000)	(0.000)	(0.024)	(0.000)	(0.000)		(0.000)	

VEN 27	-0.006 -2.593 (0.010)	-0.625 -13.675 (0.000)	-0.458 -2.641 (0.008)	0.275 0.876 (0.381)	-0.182 -0.568 (0.570)	0.000 2.593 (0.010)	0.140 6.886 (0.000)	0.866 56.317 (0.000)	0.077	18.722 (0.000)	21.189