A Microfounded Decomposition of Emerging Markets Sovereign Bond Spreads

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Version: November 2008 (Preliminary version)

We implement a microfounded decomposition of sovereign bond spreads with data from Emerging Markets (EMs) over 15 years. We find that the theoretically derived determinants of spreads are consistent with their recent evolution. We model trading strategies in a rational expectations model.

Changes in country fundamentals and in investors' attitudes towards risk explain the evolution of EM spreads through time. Among the latter, we find there is a liquidity premium, which is indeed priced in EM spreads. This is particularly relevant under periods of financial distress. Using high frequency data, we find evidence of strong comovement between EM spreads, as more than 50% of total variability is explained by a common factor. Episodes of financial distress affect spreads in two ways: i) they impact risk premia, through changing attitudes toward risk; ii) they have a level effect on EM spreads, thus reflecting commonality in EM risk premia.

Key Words: Microdecomposition of spreads; EM sovereign bonds; liquidity premium

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1. **INTRODUCTION**

What factors influence sovereign bond spreads between developed and emerging countries? Can we learn something about the "how, when or why" of the extreme market episodes observed in the last 15 years by focusing on the link between investors' attitudes toward risk, fundamentals and liquidity in emerging markets (EMs)? The purpose of this paper is to show how answers to questions like this can be obtained as derived results by rigorously modeling the trading strategy of informed and uninformed agents in a rational expectations (RE) model.

Given the link between sovereign spreads, capital flows to EMs and economic growth, understanding the drivers of EM sovereign spreads through time is an interesting research question. We address this issue in two stages. In the first stage, we provide a microfounded decomposition of spreads, by deriving them theoretically from a RE model. Secondly, we implement this decomposition and we test it with data from 18 EMs. Interestingly, we find that the theoretical model is indeed consistent with the market's behavior over the last 15 year.

There is a vast literature dealing with the determinants of EM sovereign spreads through time. However, generally speaking, work in this literature lacks micro foundation. Thus, estimating the -theoretically derived- determinants of EM sovereign spreads, which allows to put together recent evidence about EM country risk observed in the last 15 years, not only fills a current gap, but it also contributes to the understanding of its recent evolution. From a forward looking perspective, this methodology permits forecasting, as well as the assessment of potential impact of changes in global market conditions and countries' fundamentals on spreads.

Another contribution is that by departing from the macro-approach to analyzing spreads, which focuses on country-specific fundamentals, we find that global risk factors and specially, market liquidity are also key drivers of EM spreads through time. We account for a liquidity premium that is priced in EM securities, which is particularly relevant under periods of financial distress.

Extreme market episodes observed during the last 15 years deserves special consideration. Anecdotal evidence suggests that periods of distress across global financial markets coincide with reduced international appetite for risk. Changing risk preferences may either widen or narrow EM bond spreads. This raises the question about the existence of any commonality and/or contagion in EM securities. [2]. Using high frequency data, we find evidence of strong co movement between EM spreads, as more than 50% of total variability is explained by a common factor (first principal component). Our methodology allows us to test the relevance of these phenomena on EM sovereign bonds.

The spreads of EM sovereign bonds capture the risk premium attached to particular countries. A risk premium is defined as the expected return required to compensate investors for holding that asset when the quantity of risk (riskiness of the asset) is taken together with the unit price of risk, denoted as risk appetite. In the literature, the unit price of risk typically depends on factors that are constant across assets, such as the amount of credit available in the market and its volatility (liquidity risk), or investors' risk aversion. However, we show that risk appetite

[2] Contagion can be defined as a situation where disturbances in the financial market in one country or region trigger off a financial crisis in other countries and regions.

is not only affected by the former but also by asset specific factors, such as the incidence of issuer's default risk, as measured by the probability of default.

The main conclusions derived in the paper are the following: 1- Under normal conditions, EM sovereign spreads are driven by changes in country fundamentals and risk appetite. The microfounded decomposition of EM spreads provided here is consistent with the recent evolution of spreads. 2- Among changes in investors attitudes toward risk, the level of market liquidity and its volatility, together with investors' risk aversion are key drivers to explain spreads through time. 3-The default risk of the issuer affects risk premium both directly through the riskiness of the asset and indirectly through its impact on risk appetite. 4-There is a liquidity premium which is priced in EM securities, over and above changing attitudes toward risk. This liquidity channel allows us to reconcile within the same theoretical framework both periods of financial stability and distress situations. It can also be interpreted as flight to liquidity. 5- Episodes of financial distress affect spreads in two ways: on the one hand, they have a strong impact on risk premia, through changing attitudes toward risk. On the other hand, they have a direct impact or level effect on EM sovereign spreads, thus possibly reflecting commonality in EM risk premium.

The rest of the paper is organized as follows. In the first section, we present the model. In section 2 we derive EM sovereign bond spreads in equilibrium. In section 3 we present the empirical results. We describe the data set and the methodology. We discuss the alternatives to measuring risk appetite and we propose a methodology to implement this decomposition for a set of 18 EM during the period 1994 through 2006. We present the results obtained. In section 4 we conclude.

2. THE MODEL

The theoretical literature on this topic starts with the seminal paper of Kyle (1985, 1989).[3] One important generalization of Kyle's model is to allow multiple informed risk averse traders. In this context, Subrahmanyam (1991) presented an adverse selection model of market microstructure in which agents are assumed to be risk averse[4] In the following section, we present the model used to derive EM spreads. The model we use is standard in the literature, with some changes. Our specification follows closely the one presented in Vives 2008.

2.1. Assumptions

We consider a competitive noisy rational expectation model with assymmetric information. One risky asset is exchanged for a riskless asset among two types of agents: risk averse (informed and uninformed) traders and noise traders. Traders compete in demand schedules, with a uniform price schedule.

The single risky asset can take two values: $CF$with probability 1-q or $\widetilde{v}$ with probability q; where q is the probability of default, v the recovery value after default, CF are the cash flows of a bond of similar duration to the risk-free asset, in real terms. The real value of the CF are common knowledge. The recovery value if default is a random variable, characterised by $\widetilde{v} \sim N(v_0, \sigma_v^2)$.Thus, the expected payoff of the risky asset has mean $(1-q)CF + qv_0$ and variance=$q^2\sigma_v^2$.

The risky asset and the risk free asset (with unitary return) are traded by risk averse agents indexed in the interval [0,1] endowed with the Lebesgue measure and noise traders[5]. The utility derived by trader i from the profit $\pi_i = ((1-q)CF + q\widetilde{v} - p)X_i$ of buying Xi units of the risky asset at a price p is of the Constant Absolute Risk Aversion type (CARA) and is given by $U_i(\pi_i) = -\exp\{-\rho_i\pi_i\}$ where ρ_i is the coefficient of the constant absolute risk aversion. The non random initial wealth of traders is normalized to zero. Trader i may be informed, i.e.: have access to a private observation of the expost liquidation value of the risky asset, v; or uninformed, i.e.: inferring information only from the price. More precisely, there is a proportion μ of traders who are informed and a proportion (1-μ) who are uninformed, who can be considered market makers. The information set G is such that G={s,p} for an informed trader and G={p} for the uninformed[6]. In turn, noise traders are assumed to trade in the aggregate according to a random variable $\widetilde{L}$ such that $\widetilde{L} \sim N(0, \sigma_l^2)$(uncorrelated with the other random variables) They trade for exogenous liquidity reasons.

Informed traders observe a signal on the recovery value of the risky security if default, but with a noise $\widetilde{\varepsilon}$.The signal (s) is defined as $\widetilde{s} = \widetilde{v} + \widetilde{\varepsilon}$. where $\widetilde{v}, \widetilde{\varepsilon}$

[3] In particular, Kyle (1985) presents a noisy rational expectations model in which informed traders are risk neutral but strategic: they strategically choose their trades realising that their choices influence the price. This dynamic model of insider trading with sequential auctions is used to examine the informational content of prices, the liquidity characteristics of a speculative market and the value of private information to an insider. Indeed, the presence of agents with inside information has an important influence on liquidity and the price formation process.

[4] The paper focuses on the determination of price efficiency and market liquidity by strategic interaction between risk averse market participants.

[5] They only know the distribution of the recovery value if default. The distribution of their random demand is common knowledge.

[6] Since market makers can not distinguish the trading of the unformed from the trading of noise traders, noise traders in fact provides camouflage to the informed agent which enables him to make profits at their expense.

are uncorrelated, are also uncorrelated across agents and $\widetilde{\varepsilon} \sim N(0, \sigma_\varepsilon^2)$Thus, by observing this signal, he obtains private information on the true recovery value of the risky security if default. We assume all signals are of the same precision.

All random variables are normally distributed, thus, the model acquires a linear structure.

Given the symmetry assumptions, we will be interested in symmetric equilibria with traders of the same type using the same trading strategy. Denote $X_I(s_i, p)$ the trade of informed $i \in [0, \mu]$ and by $X_u(p)$ the trade of the uninformed $i \in (\mu, 1]$.

2.2. A RE model for sovereign bond spreads

2.2.1. ***Definition of REE***

A symmetric rational expectations equilibrium is a set of trades, contingent on the information traders have $X_I(s_i, p) fori \in [0, \mu]; X_u(p) fori \in (\mu, 1]$; and a measurable price function P(v, L) such that:

a) Market clears $\int_0^\mu X_i(s_i, p)di + \int_\mu^1 X_u(p)di + \widetilde{L} = 0$

b) Traders in [0,1] optimize:

$X_I(s_i, p) \in \arg\max E[U_I((\widetilde{v} - p)z/s_i, P)]$

$X_u(p) \in \arg\max E[U_u((\widetilde{v} - p)z/P)]$[7]

From the first order conditions, it yields

$X_i(G_i) = \frac{(1-q)CF + qE(v/G_i) - p}{q^2 \rho_i var(v/G_i)}$

where G={s,p} for an informed trader and G={p} for the uninformed.

We assumed a symmetric ex ante linear structure and risk aversion for informed traders. Thus, demand functions will be identical for the informed in equilibrum. The same is true for the uninformed.

To solve for a linear bayesian REE in demand schedules, a standard approach is the following. First, a linear price conjecture p=P(v,L) common for all agents is proposed. Second, based on this conjecture $E(v/G_i), var(v/G_i)$ for the informed and the uniformed are derived. Third, asset demands are computed. Finally, we identify the coefficients of the linear demands imposing consisteny between the conjectured and the actual strategies. The following proposition characterizes the linear Bayesian Equilibrium.

Proposition 1. *Let* $\rho_I > 0, \rho_U > 0$ *There is a unique Bayesian linear Equilibrium in demand functions with linear price function of the form P(v,L). It is given by:* $X_U(p) = -e_u(p - qv_0) + d_u; X_I(s_i, p) = h_I(qs_i - p) - e_I(p - qv_0) + d_I$ *where* e_u, d_u, h_I, e_I, d_I *are constants to be determined.*

(See the annex for a complete proof of the proposition)

Given the ex ante symmetric linear structure and risk aversion for informed and uninformed traders, the demand functions for the informed and the uninformed will be identical in each class:

$X_I(s_i, p) = \alpha s_i - c_I p + \widehat{b}_I$

[7]Maximization of the CARA utility function conditional on information set G

$E[U_i(\pi_i)/G_i] = E[-\exp\{-\rho_i \pi_i\}/G_i] = -\exp\{-\rho_i[E(\pi_i/G_i)X_i - \frac{\rho_i}{2} var(\pi_i/G_i)X_i^2]\}$

is equivalent to max $E(\pi_i/G_i)X_i - \frac{\rho_i}{2} var(\pi_i/G_i)X_i^2 = [E((1-q)CF + qv - p/G_i)X_i - \frac{\rho_i}{2} var((1-q)CF + qv - p/G_i)X_i^2$

$E(1-q)CF + E(qv - p/G_i)X_i - \frac{\rho_i}{2} var(qv - p/G_i)X_i^2 = [(1-q)CF + qE(v/G_i) - p]X_i - \frac{\rho_i}{2} q^2 var(v/G_i)X_i^2$

$X_U(p) = -c_U p + \widehat{b}_U$

From the optimization of the CARA utility of an uninformed trader we obtain $X_U(p) = \frac{(1-q)CF+qE(v/p)-p}{q^2\rho_U var(v/p)} = -c_U p + \widehat{b}_U$ and identifying coefficients we obtain that

$\widehat{b}_U = \frac{(1-q)CF\tau+q(\tau_v v_0-\mu\alpha\tau_L\lambda\widehat{b})}{q^2\rho_U}$; $c_U = \frac{\tau-\mu\alpha\tau_L\lambda^{-1}q}{q^2\rho_U}$

where $\widehat{b} = \mu\widehat{b}_I + (1-\mu)\widehat{b}_U; \lambda = \mu\widehat{c}_I + (1-\mu)\widehat{c}_U$.We define $\tau = (var(v/p))^{-1}$ as the precision incorporated in prices in the estimation of v. It is given by $\tau = \tau_v + (\mu\alpha)^2\tau_L$. τ is the sum of the precision of the prior and the precision of the public signal conditional on v. Similarly, $var(v/s_i,p)^{-1} = \tau + \tau_e = \tau_v + (\mu\alpha)^2\tau_L + \tau_e$ where τ_e is the precision of the private information.

From the optimization of the CARA utility of an informed trader, we obtain

$X_I(s_i,p) = \alpha s_i - c_I p + \widehat{b}_I$

$\widehat{b}_I = \frac{(1-q)CF(\tau+\tau_e)+q(\tau_v v_0-\mu\alpha\tau_L\lambda\widehat{b})}{q^2\rho_I}$; $c_I = \frac{\tau+\tau_e-\mu\alpha\tau_L\lambda^{-1}q}{q^2\rho_I}$; $\alpha = \frac{\tau_e}{q\rho_I}$;

From the former, it is possible to reexpress the demand for the informed as:

$X_I(s_i,p) = \frac{1}{q^2\rho_I}[(1-q)CF(\tau+\tau_e) + \tau_e(qs_i - p) - \tau_v(p - qv_0) - (\mu\alpha)^2\tau_L(p - v) + \mu\alpha\tau_L\widetilde{L}]$

Thus, associating the former with the general form in the proposition, we obtain $h_I = \frac{\tau_e}{q^2\rho_I}; e_I = \frac{\tau_v}{q^2\rho_I}; d_I = \frac{1}{q^2\rho_I}[(1-q)CF(\tau+\tau_e) - (\mu\alpha)^2\tau_L(p-v) + \mu\alpha\tau_L\widetilde{L}]$

Informed traders trade for different reasons: a) They speculate on their private information, depending on whether the price is higher or lower than the signal (weighted by the probability of default) according to their risk tolerance and precision of information; b) Market making capacity (third term), due to the discrepancy between the price and the expected mean recovery value if default; c) Market making capacity derived from their ability to camouflage on the noisy demand and their risk adjusted noise precision (α) (fourth term). The last two motives can be rephrased, if we express informed traders'demand as:

$X_I(s_i,p) = \frac{1}{q^2\rho_I}[(1-q)CF(\tau+\tau_e) + \tau_e(qs_i - p) - \tau(qE(v/s_i,p) - p)]$ Informed traders exploit the price discrepancies with public information on the fundamental value, weighted by $\frac{\tau}{q^2\rho_I}$.

We can follow the same analysis for the market maker, reexpressing their demands as

$X_U(p) = \frac{1}{q^2\rho_U}[((1-q)CF + qv)\tau - \tau_v(p - qv_0) - \mu\alpha\tau_L(\mu\alpha p - q\widetilde{L}) - q\tau_v v]$

Therefore $e_u = \frac{\tau_v}{q^2\rho_U}$ and $d_u = \frac{1}{q^2\rho_U}[((1-q)CF + qv)\tau - \mu\alpha\tau_L(\mu\alpha p - q\widetilde{L}) - q\tau_v v]$

Uninformed agents' demand does not depend on the private signal. In addition, the more noisy demand, the more market makers trade, weighted by the noise precision. Informed agents'"market making capacity " reduces uninformed demand. As before, the recovery value if default and its mean is weighted by the probability of default.

Prices equal the weighted average of investors expectations about the fundamental value plus a noise component reflecting the risk premium. This is the premia required for risk averse investors to absorb noise traders'demand. The weights are according to the risk adjusted information of the different traders. Indeed, from the equilibrium demands of the uninformed and the informed, together with the market clearing condition we can express prices as

$$p = (1-q)CF + \frac{(\tau+\tau_e)q(\rho_I)^{-1}\int_0^\mu E(v/s_i,p)di + q\frac{(1-\mu)}{\rho_U}\tau E(v/p) + q^2\widetilde{L}}{\mu(\rho_I)^{-1}(\tau+\tau_e) + (1-\mu)(\rho_U)^{-1}\tau}$$

If the uninformed traders are risk neutral then p tends to $qE(v/p)+(1-q)CF$ and prices reflect all public information.

With no informed traders prices are the average of the expectations of the uninformed plus a risk bearing term. $qE(v/p)+(1-q)CF+q^2\frac{\widetilde{L}\rho_U}{\tau_v}=p$

Similarly, with no uninformed traders, prices equal the average of the expectations of the informed $E(v/s_i,p)$ plus a risk bearing term.

$p=q\int_0^1 E(v/s_i,p)di+(1-q)CF+q^2\frac{\widetilde{L}\rho_I}{(\tau_v+\alpha^2\tau_L+\tau_e)}$

In the annex, we provide some comparative statics about the role of market depth and price informativeness and volatility.

2.3. Empirical predictions: spread functions

Spreads are defined as the expected excess return of a risky asset with respect to that available on a risk-free asset. In our notation $spreads=\frac{P(v,L)-P_0}{P_0}-\rho$ Given market efficiency at the initial period, there is certainty that $P_0=(1-q)CF+qv_0$

Expected return of the risky asset must exceed the risk-free rate, i.e. the asset must offer a risk premium. In the literature, the risk premium is typically decomposed into the quantity of risk, which depends on asset specific factors and the unit price of risk. Risk appetite—the willingness of investors to bear risk—is defined as the inverse of the price of risk, which is seen as depending on factors that are constant across assets. In general, it depends on the degree to which investors dislike uncertainty about their future consumption and on factors that determine the overall level of uncertainty surrounding consumption prospects. The degree of such uncertainty corresponds to risk aversion[8]. We will show that here there is no possible identification between the quantity and unit price of risk such that the asset specific factors (probability of default q and the variance of the asset value, σ_v^2) affect only one of them.

To define spreads, we start by expressing prices as $p=(1-q)CF+\frac{q\widehat{\rho}\tau_v v_0}{\tau\widehat{\rho}+\tau_e\mu(\rho_I)^{-1}}+\lambda\widetilde{L}+\lambda\mu\alpha v$

In equilibrium, EM sovereign bond spreads can be expressed as[9]

$$spreads=\frac{1}{P_0}\{\underbrace{q\frac{\tau_v\widehat{\rho}+(q+\mu\alpha\tau_L q\,\widehat{\rho})(\widetilde{L}+\mu\alpha v)}{\tau\widehat{\rho}+\tau_e\mu(\rho_I)^{-1}}}_{\text{Risk Appetite}}-\underbrace{qv_0}_{\text{Riskiness of asset}^{10}}]\}-\rho$$

where $\widehat{\rho}=\mu(\rho_I)^{-1}+(1-\mu)(\rho_U)^{-1}$

COROLLARY 1. ***The risk premium, denoted by $\varphi[.]$ is determined by asset specific factors (which are typically named as quantity of risk) and by the risk appetite of investors. There is a non linear relationship between the drivers of the quantity and the unit price of risk.***

There is no possible identification between the quantity and unit price of risk such that the probability of default q and the variance of the asset value, σ_v^2 affect only the quantity or the price of risk. Indeed, q, σ_v^2 are asset specific parameters,

[8] Since the more risk averse the investor, the more valuable is additional income in bad states of the world.

[9] Spreads are derived by replacing the equilibrium values of λ, $\widehat{b}, P_0$ on the definition of spreads obtained before.

[10] The decomposition followed here is arbitrary. The conclusions derived are independent of the particular decomposition we assume.

which through their influence on b_U, b_I also influence the unit price of risk or risk appetite. It reflects the non linear relationship between them. In addition, this contrasts with the existing literature -which traditionally measures risk premium as the simple product between them.[11]

COROLLARY 2. ***Our measure of risk appetite is a function of risk aversion***[12] ***(ρ_I, ρ_U) and the level of uncertainty about consumption prospects (global factors), i.e.: a) the precision of the private information (σ_e^2) and the noisy demand (σ_l^2) ; b) Level of asymmetry of information in the market, as measured by the discrepancy between v and v_0 ; c) Level of market liquidity, L. It also depends on the proportion of informed traders and on asset specific factors, as measured by q and σ_v^2.***

Not all of them are constant within assets. Global factors refer to the amount of global credit available in the financial system (level of liquidity demand, denoted by L), its volatility[13]*, the precision of the private information of insiders (σ_e^2). They are also a function of the proportion of informed traders, q and σ_v^2.At the same time, they are conditioned by the set of rules that characterises financial markets and the level of informational asymmetry, which is seen in the spread function by the discrepancy between signals v and the unconditional expected value of the asset, v_0. From now on, we will denote the risk appetite as $\psi(q, \sigma_v^2, \rho_I, \rho_U, q, \sigma_\varepsilon^2, \sigma_l^2, L, v - v_0)$*

COROLLARY 3. ***Risk appetite and market maker's response function and trading agressiveness (b_I, b_U) are determined by the same factors i.e.: q, σ_v^2, investors' ρ_i and σ_e^2, σ_l^2. The level of market liquidity (L) and the asymmetry of information only affect the risk appetite.***

The coefficients b_U, b_I-which define the market maker's response function and trading agressiveness, respectively- are functions of the following parameters: $b_U = f(q, \sigma_v^2, \rho_I, \rho_U, \mu, \sigma_e^2, \sigma_l^2); b_I = f(q, \sigma_v^2, \rho_I, \rho_U, \mu, \sigma_e^2, \sigma_l^2)$

The former expressions allow us to make some further comments:

1- The default risk of the issuer affects risk premia both directly, through the riskiness of the asset, and also indirectly through its impact on risk appetite.

2- Global factors and specially, market liquidity, constitute important determinants of EM spreads.

3- Even when assuming certainty about the price at the initial period (i.e. $P_0 = (1-q)CF + qv_0$), there is still a part of inefficiency that can not be ruled out from spreads, which is due to the assymmetry of information between agents.

We apply this theoretical decomposition to test the determinants of sovereing bond spreads. In the empirical part, we will discuss the alternatives to measure each component.

Summing up, we can express spreads as

$R - \rho = \left\{\varphi\left[q, \sigma_v^2, \psi(q, \sigma_v^2, \rho_I, \rho_U, \sigma_\varepsilon^2, \sigma_l^2, L, v - v_0)\right]\right\}$

where $\varphi\left[q, \sigma_v^2, \psi(q, \sigma_v^2, \rho_I, \rho_U, \sigma_\varepsilon^2, \sigma_l^2, L, v - v_0)\right]$ represents a compensation for bearing a risk, the risk premium, which is in turn a function of the riskiness of the asset as measured by q, σ_v^2 and the risk appetite $\psi(q, \sigma_v^2, \rho_I, \rho_U, \sigma_\varepsilon^2, \sigma_l^2, L, v - v_0)$.

[11] See for example, Gai and Vause (2006)

[12] Recall it depends on ρ_I and the weighted average of both type of traders' risk aversion coefficient, denoted as $\widehat{\rho}$.

[13] Bear in mind that investors prefer liquid instruments which can be transformed into other assets without a significant loss of value during times of stress.

3. EMPIRICAL RESULTS

3.1. Data set

The data for bond spreads in EMs is based on JP Morgan's EMBI+ country-specific indices, defined for the 33 emerging markets that compose the index. These indices contain U.S.dollar-denominated Brady bonds, Eurobonds and other traded loans issued by sovereigns which satisfy certain maturity and liquidity conditions[14].The spreads are calculated as the difference between the yield on the instruments and the yield on U.S. Treasury bonds of similar maturity[15]. The sovereign spreads include Argentina, Brazil, Bulgaria, Colombia, Ecuador, Mexico, Morocco, Panama, Peru, Philippines, Russia, South Africa, Turkey, Ukraine, and Venezuela. The data set is at a daily basis, during the period January 3, 1994 through December 31, 2006. In the annex, we present the descriptive statistic of the EMBI+ by country.

In addition to the EMBI+, the variables included in the set are the following: Long Term Credit Ratings and Outlook (Standard & Poors); Fed Fund target rate; US Fed Funds effective rate; US 10 year government bond yield, US corporate bond yield; implied yield on the 3 months ahead Fed Funds future rates; Chicago Board Options Exchange (CBOE) volatility index, denoted "VIX", based on S&P500; Westpac and Citi Risk Aversion Index and several dummy variables capturing distress events. In the annex, we present their descriptive statistics.

3.2. Methodology

In the following paragraphs we discuss the proxies used for each of the components of the EM bond spread functions.

We define spreads as

$R-\rho=\varphi\left[q(Ft)\sigma_v^2,\psi(q(Ft),\sigma_v^2,\rho_I,\rho_U,\sigma_\varepsilon^2,\sigma_l^2,L,v-v_0)\right]\phi(\rho(L),d_t^c)$

where $\varphi\,[.]$corresponds to the risk premia. We augment the theoretical expression for spreads by including an additional term, $\phi(.)$ which aims at capturing the impact, if any of extreme market episodes observed during the period. The aim is to test whether they have had an additional impact on spreads, over and above what is captured by changes in risk appetite and fundamentals. In particular, ϕ depends on the risk free rate, which is itself a function of the global level of liquidity in financial markets and each of the particular events, denoted as d_t^c. How we measure these episodes will be explained in the following paragraphs.

3.2.1. Risk Premium:$\varphi\left[\sigma_v^2,q(Ft),\psi(\sigma_v^2,q(Ft),\rho_I,\rho_U,\sigma_\varepsilon^2,\sigma_l^2,L,v-v_0)\right]$

The overall risk premium in global financial markets is itself not directly observable in one single indicator.The first two components of the risk premium belong to the quantity of risk, asset-specific attributes.

Riskiness of the asset

[14] In particular, the instruments must have a maturity greater than two and a half years, meet certain liquidity conditions and have a minimum issue size of US$500 million.

[15] Government bond indices are computed by DataStream

Default risk of the issuer: $q(Ft)$ q refers to the probability of default of each issuer, which is non observable, and thus, it needs to be proxied. This probability is indeed a function of country specific (in the case of sovereign debt) or firm-specific (in the case of corporate bonds) fundamentals[16].

In the estimations followed, measures of economic fundamental drivers are at place. However, given that our dataset has a daily frequency, while fundamentals at a country level are typically at monthly or quarterly basis, we proxy country fundamentals with Long Term Credit Ratings and Outlook. We also consider information about outlooks and/or the classification of countries among three groups (investment grades, first tier and second tier)[17].

The procedure has two steps. The first step requires estimating ratings as a function of outlooks, groups and their interactions. Positive outlooks and groups (investment grades, first tier and second tier) were the ones that mostly contribute to explain the daily evolution of numerical ratings [18] In the second step, we use this particular specification of country fundamentals for the bond spread functions.[19]

Firm specific fundamentals reflect changes in credit risk of international investors. The performance of big firms, operating at a national or international scale might affect, for example, the US economy and subsequently, EMs. This might also have an impact on the probability of default. We consider corporate bonds as substitutes to EM sovereign bonds. Thus, we should expect a positive sign with respect to EM spreads[20]. We proxy it by the US corporate bond yield[21].

Recovery value volatility (private information precision) σ_v^2 We compute the realised volatility of squared EMBI spreads by country in order to proxy the true (unobserved) continuous volatility. We estimate a GARCH model on the squared spreads from which we compute the predicted volatility assuming an ARMA (1,1) for the conditional variance equation. More specifically, the equation for the conditional volatility is the following: $\sigma_{v,t}^2 = w + \gamma e_{t-1}^2 + \delta\sigma_{v,t-1}^2$where $\sigma_{v,t}^2$is the one-period ahead forecast variance based on past information (conditional variance) It is a function of three terms: a constant term w; news about volatility from the previous period, measured as the lag of the squared residual from the mean equation: e_{t-1}^2 (the ARCH term) and the last period's forecast variance $\sigma_{v,t-1}^2$(the GARCH term). This conditional variance computed for each country is included as a regressor in the EM sovereign bond spread functions. We name it as sigmavvolat. We should expect the higher asset volatility, the higher EM spreads.

[16] This way, we are in line with other papers studying the incidence of the default risk of the issuer, q, itself a function of country-specific or firm-specific fundamentals (for example Yeyati, 2006).

[17] In order to account for the pitfalls of using ratings as proxies for the fundamentals.

[18] When computing credit rating categories, there were two possibilities i) a unique variable that take values from 1 to 3 corresponding to each group and/or ii) 2 dummies for the 3 groups. The second alternative was followed, based on better statistical properties.

[19] The predicted values of the first step regression were also computed in order to derive the predictive measure for ratings. Indeed, as a robustness check we estimate EM sovereign spread function including as regressor the predicted value of ratings, without any other variable capturing fundamentals. When following this alternative, the results and conclusions derived do not change.

[20] Higher returns in the corporate market should result in a substitution effect, draining funds for EM securities, thus reducing their demand and positively impacting on spreads.

[21] We argue that this measure effectively captures global credit concerns given that international investors are largely US based, or at least use US assets as benchmark in pricing risks and returns in international financial markets.

Risk appetite:$\psi(\sigma_v^2, q(Ft), \rho_I, \rho_U, \sigma_\varepsilon^2, \sigma_l^2, L, v - v_0))$ There is an extensive theoretical and empirical debate about the alternatives to model risk appetite. Broadly, three approaches have been adopted to measure it (see the annex for a survey) We theoretically derive the determinants of EM sovereign spreads. In order to keep a short distance with it, we proxy each determinant, following closely the index-inspired methodology. Two further arguments are at place:

Firstly, the theoretical model allows us to identify various components of risk appetite, which can indeed be measured by well known market indexes in a simple way. Thus, we keep consistency between our theoretical model, the empirical predictions and the methodological approach.

Secondly, it enables us to justify theoretically well known indexes used by market participants.

More specifically, in line with Gonzalez Hermosillo (2008), four different global market risk factors are assumed to reflect the degree of risk appetite of international investors: i) funding liquidity premium; ii) credit risk premium (already captured when measuring q); iii) market liquidity premium and iv) market volatility premium.

i) *Funding Liquidity Premium*, measures the amount of credit available in the financial system, affected by monetary conditions (L). It is proxied by the implied federal funds rate in futures markets, i.e., the 3-month-ahead Treasury Bill future rate, in order to capture anticipated changes in monetary policy at the time when they are anticipated. It is one of the instrument used by the U.S. Federal Reserve to affect monetary conditions. This rate can affect spreads through two channels.[22] We also include the contemporary Fed Funds rate, as measured by Fed Fund target rate or US Fed Funds effective rate[23].

ii) *Credit risk*, already considered when analysing q.

iii) *Market Liquidity Premium* (σ_l^2), as investors prefer liquid instruments which can be transformed into other assets without a significant loss of value during times of stress. Market liquidity may be particularly important during financial crises if a liquidity squeeze forces a generalized sale of assets, depressing their prices and resulting in additional default risks which may feed back into even more illiquidity. We use two proxies: a) the difference between the 10-year and 2-year U.S. Treasury benchmark bond (denoted as Market Liquidity premium 2); b) the difference between the yield on the 10-year and the 3-month U.S. Treasury bond, constant maturity (denoted as Market Liquidity premium 3). In both cases, since the two pair of bonds are default-free, their yield is simply the expected average of future yields on Treasury bills plus a liquidity premium. Their difference must then be equal to

$$i_{10t} - i_{2t} = E_t\left[\frac{i_{1,t+2} + \ldots + i_{1,t+10}}{8}\right] + LP_{10t} - LP_{2t}$$

We assume that expected average of future yields (first term) is fairly constant because of the long horizon of interest rates between them at these maturities, given

[22] A decline in the federal funds rate implies a lower cost of borrowing and therefore a rising level of funding liquidity in the economy. In addition, it reduces the return from safer assets. Everything else constant, these two channels would be expected to result in international investors seeking higher returns in risky assets. In contrast, higher expected interest rates make borrowing more expensive and drains funding liquidity from the system.

It implicitly captures a segment of the yield curve that is longer than the spot overnight federal funds rate, while also exhibiting more daily variation than the actual federal funds policy rate.

[23] We should observe the opposite signs between them, given that they are capturing expected changes in monetary policy with respect to current interest rates.

the current information. Thus, movements in this spread will be largely driven by movements in liquidity premiums[24].

iv) *Market volatility* (σ_e^2), measured in equity markets and in future interest rate contracts. It has been proxied by Chicago Board of Options Exchange (CBOE) Volatility Index, known as VIX. It measures the implied volatility from option prices on the S&P 500 equity index.

Risk Aversion coefficient ρ_I, ρ_U We use two measures of global risk aversion, i.e. The Citi Macro Risk Index and the West Pack Risk Aversion Index, as computed by Bloomberg[25] Both measure global risk aversion without distinguishing between informed and uninformed agents. We assume that the degree of investors risk aversion of both type of investors moves closely and the gap between them at a daily basis keeps constant in the short run. In addition, in both indexes, EM sovereign spreads is included as a category, thus resulting in some correlation with our dependent variable. However, we believe that this is negligible, since the risk aversion indices are computed by including the broad index of EMBI+. In contrast, as dependent variables, we consider each EM country sovereign spreads.

Regarding the level of assymmetry of information, we assume it keeps constant on the short run and thus it does not significantly change the daily evolution of spreads. Determinants are implicitely weighted by the proportion of informed and uninformed traders.

3.2.2. Global financial distress situations $\phi(\rho, d_t^c)$

Since mid-1990s growth of EM trading volumes and asset values have been subject to a sequence of crisis events that heightened the riskiness of investing in less developed countries. In our theoretical model, periods of global financial distress situations are captured by changes in risk appetite (global risk factors). However, we want to test if these distress events could also have a level effect on EM spreads, above and below what is captured by changes in risk appetite. In the annex, we present some graphs with the evolution of EMBI+ by selected countries, where it is seen that periods of excess volatility tend to coincide between countries.

With the exception of Argentina, there is an overall EM trend, shared between countries. As an example, the general compression in EM spreads since 2002.

In order to test their relevance, we include in the estimation dummy variables (taking the value of 1 during each period of reference) capturing these periods of global volatility. Thus, we consider: 1994 Mexican devaluation; the 1998 Russia 's Default and the LTCM Crisis; the 1999 Brazil's Crisis; the 2001 Turkey's crisis; the 2001 September 11th episode; the 2001 Argentina's default; the 2002 WorldCom Scandal and Brazil's Elections; 2004 U.S. Federal Reserve Tightening Cycle; 2004 Ford and General Motors downgrades and the 2006 Turkey's Crisis.

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[24] 10-year U.S. Treasury bonds are usually used as a benchmark in the pricing of other financial assets. Estimations will be done considering both measures of market liquidity.

[25] The Citi Macro Risk Index is an equally weighted index of EM sovereign spreads, US credit spreads, US swaps spreads and implied FX. The index is expressed in a rolling historical percentile and it ranges from 0 (low risk aversion) to 1 (high risk aversion). In turn, the West Pack Risk Aversion Index is calculated using five inputs sourced by Bloomberg, i.e. the average daily 3 month implied volatility for the euro (EUR), the Japanese Yen (JPY), the Swiss Francs (CHF), the Canadian Dollar (CAD) and the Australian Dollar (AUD) (versus USD), the VIX index, the US 10 Year bond- swap spreads, the JPM EM bond spreads and the daily USBB1 industrial bond spread. A base index is constructed from changes in these series. It is a rolling 60 day z score of the base index.

The exact time periods used is based on anecdotal evidence (see Gonzalez-Hermosillo, 2008) If these events are relevant, we should observe significant coefficients on the spread regression.

We followed a stepwise procedure to determine which were the most significant events for spreads' evolution. We included them one by one and we analyzed their impact based on informational criteria (AIC). The results showed that indeed the Mexican devaluation (-11%), 1994; Russia 's Default and the LTCM Crisis, 1998 (-0.6%); Brazil's Crisis, 1999 (-0.1); Argentina's devaluation and default, 2002 (-0.4%); Ford and General Motors downgrades, 2004 (-0.1%) and Turkey's crisis, 2006 (-1.7%) were the ones that mostly contributed to explain the evolution of EM spreads. Between parentheses, we provide the percentage change in AIC criteria when including them one by one. We will use this specification of dummies in the subsequent estimations [26][27]

The estimation procedure has two parts. In the first step (not shown), we focus on the estimation of the long term credit ratings and outlooks, as proxies for the issuers' fundamentals. In the second step, we use this specification of fundamentals to estimate EM sovereign spreads as a function of risk appetite, as measured by global factors; each issuer's fundamentals - captured by ratings, outlooks and groups- and dummies capturing episodes of financial distress. We use daily data for eighteen EMs during the period 1994-2006. In the annex we include a table which summarizes the variables used and constructed, together with their sources.

3.3. The estimation of EM sovereign bond spreads

Given the link between sovereign spreads, capital flows to EM and economic growth, understanding the drivers of EM sovereign spreads through time is a relevant research question. The goal of this section is to implement this decomposition and to test it with data for 18 EMs. We present the models estimated and we comment on the results. Here, we show the estimations using the CITI measure of risk aversion. In the annex, we present the same model but with the Westpac index. The results are consistent between them.

[26] The benchmark model used to follow this sensibility analysis for the dummies included as regressors: Long Term Credit Ratings and outlook, rating groups, vix, corporate bond index, market liquidity, sigmav volatility and 3 months ahead Fed Funds future rates.

[27] Throughout the stepwise procedure, the significance and the estimated coefficients of the core model were not affected by the inclusion of the different dummies, thus providing robustness to our methodological approach.

Log(EMBI+)	Coef.	Coef.	Coef.	Coef.	Coef.
US FedFund Ef rate	**0.010**	0.093	-0.044	0.069	0.057
Riskiness of asset					
Ratings	0.195	0.195	0.193	0.193	0.192
Ratings Group	0.002	0.002	0.002	0.002	0.002
Outlook Positive	-0.222	-0.227	-0.211	-0.222	-0.219
Sigmav vol	0.000	0.000	0.000	0.000	0.000
Global Risk factors					
Market volatility, VIX	0.016	0.025	0.029	0.040	0.089
CITIRAI	0.269	0.238	0.236	0.203	0.175
MKT liquidity premium 2		-0.238		-0.056	-0.182
MKT liquidity premium 3	-0.251		-0.278		
US Corporate Bond	0.491	0.322	0.558	0.252	0.202
Fund Liquidity level	-0.281	-0.257	-0.371	-0.211	-0.217
(VIX)2					-0.001
Fund Liq*MKT Liq			0.034	0.038	0.040
VIX*MKT Liq			-0.009	-0.010	-0.007
Per of Fin Distress					
Tequila					
Russia	0.391	0.316	0.293	0.205	0.267
Brasil	0.426	0.425	0.248	0.294	0.269
Ford	0.159	-0.019	0.086	-0.054	-0.095
Turkish Crisis	-0.277	-0.271	-0.237	-0.258	-0.285
Argentina Def	0.066	0.196	0.041	0.165	0.179
AIC	28646	28724	27161	27844	27349

All variables are significant at the 1% level, with the exception of the ones in bold: significant at 10%. EMBI+:Emerging Market Bond Index; Long Term Credit Ratings, as collected by Standard & Poors;. Credit Outlooks, Positive. US Fed Funds effective rate; US 10 Year Government Bond Yield; Chicago Board Options Exchange (CBOE) Volatility Index; US Corporate Bond Yield; Implied yield on the 3 months ahead Fed Funds future rates; Market Liquidity premium 2=10-year and 2-year U.S. Treasury benchmark bond; Market Liquidity premium 3=yield on the 10-year and the 3-month U.S. Treasury bond, constant maturity; Dummy variables for the different episodes considered. AIC: Akaike criteria.

The micro decomposition of spreads, derived theoretically, fits the recent evidence on EM spreads. EM sovereign spreads are driven by changes in fundamentals, as proxies for the country probability and the recovery value if default; changes in investors' attitudes toward risk. They are also affected by individual episodes of financial distress observed during the period. From the results obtained, it is worth to highlight the following:

Numerical ratings, positive outlook and groups -as proxies for the probability of default and the recovery value if default- are consistently relevant to explain the daily evolution of spreads. Their signs and coefficients estimated are stable along the different specifications [28]. With this specification, we were able to integrate with a satisfactory result daily data of spreads with typically longer frequency data measuring fundamentals.

[28] The specification used along the models is due to a stepwise procedure in order to get the best fit.

Regarding changes in investors' attitudes toward risk, we show that indeed global risk aversion -capturing the degree to which investors dislike uncertainty about future consumption prospects- together with global market factors -level of this uncertainty- are both relevant drivers. Indeed, we proxy global market conditions by the level of market liquidity (as measured by the 3-month-ahead Treasury Bill future rate) and its risk (two proxies used i.e.: 10-year and the 3-month U.S. Treasury bond, constant maturity and the difference between the 10-year and 2-year U.S. Treasury benchmark bond), together with market volatility (VIX index).

There is a liquidity premium which is indeed priced in EM securities, as measured by the market liquidity premium, in both alternative proxies. Indeed, this variable substantially improves the fit of the estimation. Not only priced, but it might have an additional impact, above and over what is captured by changing investors' attitudes toward risk. This liquidity premium seems to operate as a mechanism of transmission among countries, under extreme market episodes, reinforcing the extent and impact of the crisis within EMs, not mattering countries' fundamentals. This type of phenomena is named as flight to liquidity[29]. It is related with two further points: i) the interrelationship between market volatility and liquidity and ii) the conclusions derived for the dummy variables.

Concerning the first point, it is interesting to point out the significance of interactive terms between market volatility and liquidity. We find significant interactions between market volatility and liquidity premium on the one hand, and between liquidity level and its risk, on the other. This provides further evidence in favor of a liquidity channel, above and over what is captured by changing attitudes toward risk (i.e. each of its components entering linearly). In the literature, there is a current debate about whether it is the level of market liquidity or its volatility the key component to price securities. However, so far there is no consensus about which of them is more important. The evidence considered here shows that indeed both are relevant[30].

Secondly, variables measuring the impact of global financial distress situations, such as the Brazilian devaluation or the Russian declaration of default, contribute to explain the evolution of daily EM spreads (and they improve the fit). With some exceptions (e.g. the political Turkish crisis in 2006, whose coefficient is always negative), they all show a significantly positive relationship with spreads.

Put it differently, each episode has a direct impact on the level of spreads, above and below what is captured by changes in risk appetite and fundamentals. Indeed, their significance might reflect the existence of a common factor in EM risk premium and also a flight to liquidity effect when distress events take place. Under unstable periods, typically characterized by globally illiquid markets, investors generally liquidate their positions in EM markets, not mattering each country's fundamentals.

As a robustness check, we investigate the existence of a common factor between EM sovereign spreads. Interestingly, we find that no matter the sub period we consider, more than 50% of total variance on EM spreads is explained by a common factor (first principal component) which can be associated to global factors and/or extreme market episodes observed during the period of reference[31].

[29] Defined as a situation where investors experience a sudden and strong preference for more liquid assets.

[30] We have measured total market liquidity, without distinguishing liquidity at a security level. This constitutes the logical next step to extend the present framework.

[31] In order to derive that conclusion we perform a principal component analysis on EM sovereign

Two further comments are at place. Firstly, the role of risk aversion. Multiple approaches have been used to measure risk aversion. However, there is still no consensus about the best way to do it. Having to make strong assumptions for any alternative followed, we decided to use indices used by market participants, i.e. the index constructed by the Citibank and the one constructed by Bloomberg[32]. Being aware of their drawbacks, both of them contribute to explain the daily evolution of spreads[33]. Secondly, although we did not explicitly consider the asymmetry of information between agents, by including a proxy for σ_{ε}^{2} we try to partially account for this. Indeed, $\sigma_{\varepsilon}^{2}$is reflecting the existence of noisy signals, which are only perceived by informed traders and thus it is indirectly linked to the asymmetry of information between agents.

4. CONCLUSIONS

We implement a microfundated decomposition of sovereign bond spreads with data for Emerging Markets (EMs) over 15 years and indeed we find that the theoretically derived determinants of spreads were consistent with their recent evolution.

Using high frequency data, we assess the relative importance of aggregate risk factors and fundamentals in the evolution of EM sovereign spreads. We discuss the alternatives to measure risk appetite and we propose an empirical methodology to implement this decomposition for a set of 18 EM during the period 1994 through 2006. To measure risk appetite, we exploit the method of market indices. Four different global market risk factors are assumed to reflect the degree of risk appetite of international investors, i.e. a funding liquidity premium, a credit risk premium, a market liquidity premium and a market volatility premium.

The main conclusions derived in the paper are the following: 1- Under normal conditions, EM sovereign spreads are driven by changes in country fundamentals and risk appetite. 2- Among changing risk appetite, market liquidity level and its volatility, together with investors' risk aversion are key elements to explain spreads. 3-We enrich the existing literature which decomposes risk premium as the product of the quantity of risk and the unit price of risk by showing the non linear relationship between their determinants. 4- The default risk of the issuer affects risk premium both directly through the riskiness of the asset and also indirectly through its impact on risk appetite. 5- The micro decomposition of EM spreads provided here is consistent with the recent evolution of spreads. 6- The significance of market liquidity risk might be reflecting a phenomena named flight to liquidity. 8- Episodes of financial distress affect spreads in two ways: on the one hand, they have a strong impact on risk premium, through changing attitudes toward risk. On the other hand, they have a direct impact or level effect on EM sovereign spreads, thus possibly reflecting commonality in EM risk premium. 9-Although EM have largely been more volatile than mature economies, global financial market risk factors are important for all countries. Although some of the episodes of stress were resolved relatively quickly, they may have actually altered investors' risk appetite importantly.

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spreads and we analyzed the percentage of variance explained by the first 3 components.

[32] The Westpac index has as an input the VIX index. That is why we did not include in this case the VIX as a regressor in the spread functions.

[33] When including risk aversion, we were not able to distinguish empirically between type of traders, i.e. informed and uninformed. Implicitly, we are assuming that in the very short run, there is non significant change in the wedge between them.

5. ANNEX

5.1. Proof of Proposition 1

Given the ex ante symmetric linear structure and risk aversion for informed and uninformed traders who face a concave problem at a linear price equilibrum of the form P(v,L) we know that the demand functions for the informed and the uninformed will be identical in each class:

$X_I(s_i,p) = \alpha s_i - c_I p + \widehat{b}_I$

$X_U(p) = -c_U p + \widehat{b}_U$

From the market clearing condition yields $\int_0^\mu X_i(s_i,p)di + \int_\mu^1 X_u(p)di + \widetilde{L} = 0$

We define $\mu\widehat{b}_I + (1-\mu)\widehat{b}_U = \widehat{b}, \mu\widehat{c}_I + (1-\mu)\widehat{c}_U = \lambda$ provided $\mu\widehat{c}_I + (1-\mu)\widehat{c}_U > 0$ we obtain

$p = \lambda(\mu\alpha v + \widehat{b} + \widetilde{L})$

As it is done in Vives (2008), we define the random variable $\widehat{y} = v + \frac{\widetilde{L}}{\mu\alpha}$ It is informationally equivalent to p and $\widehat{y} = \frac{p-\lambda\widehat{b}}{\lambda\mu\alpha}$ Prices will be normally distributed since they are linear transformation of normal random variables. We have that $var(v/p) = var(v/\widehat{y})$. $\tau = (var(v/\widehat{y}))^{-1}$is the precision incorporated in prices in the estimation of v. It is given by $\tau = \tau_v + (\mu\alpha)^2\tau_L$. τ is the sum of the precision of the prior and the precision of the public signal conditional on v. Similarly, $var(v/s_i,p) = var(v/s_i,\widehat{y})$; then $(var(v/s_i,\widehat{y}))^{-1} = \tau + \tau_e = \tau_v + (\mu\alpha)^2\tau_L + \tau_e$ where τ_e is the precision of the private information. From the properties of gaussian distributions:

$E(v/p) = E(v/\widehat{y}) = \frac{\tau_v}{\tau}v_0 + (\mu\alpha)^2\frac{\tau_L}{\tau}\widehat{y} = \frac{\tau_v}{\tau}v_0 + \mu\alpha\frac{\tau_L}{\lambda\tau}(p-\lambda\widehat{b})$. Similarly,

$E(v/s_i,p) = \frac{\tau_v}{\tau+\tau_e}v_0 + \mu\alpha\frac{\tau_L}{\lambda(\tau+\tau_e)}(p-\lambda\widehat{b}) + \frac{\tau_e}{\tau+\tau_e}s_i$

From the optimization of the CARA utility of an uninformed trader we have that

$X_U(p) = \frac{(1-q)CF+qE(v/p)-p}{q^2\rho_U var(v/p)} = -c_U p + \widehat{b}_U$ and identifying coefficients we obtain that

$\widehat{b}_U = \frac{(1-q)CF\tau + q(\tau_v v_0 - \mu\alpha\tau_L\lambda\widehat{b})}{q^2\rho_U}$; $c_U = \frac{\tau-\mu\alpha\tau_L\lambda^{-1}q}{q^2\rho_U}$

From the optimization of the CARA utility of an informed trader, we obtain

$X_I(s_i,p) = \alpha s_i - c_I p + \widehat{b}_I$

$\widehat{b}_I = \frac{(1-q)CF(\tau+\tau_e)+q(\tau_v v_0 - \mu\alpha\tau_L\lambda\widehat{b})}{q^2\rho_I}$; $c_I = \frac{\tau+\tau_e-\mu\alpha\tau_L\lambda^{-1}q}{q^2\rho_I}$; $\alpha = \frac{\tau_e}{q\rho_I}$;

Let $\widehat{\rho} = \mu(\rho_I)^{-1} + (1-\mu)(\rho_U)^{-1}$ Given that we have defined $\lambda = \mu\widehat{c}_I + (1-\mu)\widehat{c}_U$ we obtain $\lambda = \frac{q^2+\mu\alpha\tau_L q\ \widehat{\rho}}{\tau\widehat{\rho}+\mu\tau_e(\rho_I)^{-1}}$ and $\widehat{b} = \frac{(1-q)CF}{\lambda} + \frac{q^{-1}\tau_v v_0\ \widehat{\rho}}{1+\frac{\mu\alpha\tau_L}{q}\widehat{\rho}}$

From the former, it is possible to reexpress the demand for the informed as:

$X_I(s_i,p) = \frac{1}{q^2\rho_I}[(1-q)CF(\tau+\tau_e) + \tau_e(qs_i - p) - \tau_v(p - qv_0) - (\mu\alpha)^2\tau_L(p - v) + \mu\alpha\tau_L\widetilde{L}]$

Thus, associating the former with the general form in the proposition, we obtain $h_I = \frac{\tau_e}{q^2\rho_I}; e_I = \frac{\tau_v}{q^2\rho_I}; d_I = \frac{1}{q^2\rho_I}[(1-q)CF(\tau+\tau_e) - (\mu\alpha)^2\tau_L(p-v) + \mu\alpha\tau_L\widetilde{L}]$

We can follow the same analysis for the market maker, reexpressing their demands as

$X_U(p) = \frac{1}{q^2\rho_U}[((1-q)CF + qv)\tau - \tau_v(p - qv_0) - \mu\alpha\tau_L(\mu\alpha p - q\widetilde{L}) - q\tau_v v]$

Therefore $e_u = \frac{\tau_v}{q^2\rho_U}$ and $d_u = \frac{1}{q^2\rho_U}[((1-q)CF+qv)\tau - \mu\alpha\tau_L(\mu\alpha p - q\widetilde{L}) - q\tau_v v]$

5.2. Some comparative statics

5.2.1. Market depth

The depth of the market is given by $\frac{1}{\lambda}$ which can be expressed as: $\frac{1}{\lambda} = \frac{\tau\widehat{\rho}+\mu\tau_e(\widehat{\rho}_I)^{-1}}{q^2+\mu\alpha\tau_L q\widehat{\rho}}$

A market is depth if a noise trader shock is absorbed without moving prices much, i.e. when is λ low. Market makers face an adverse selection problem and they protect themselves by reducing market liquidity when they are more risk averse and/or when there is less precise prior information about the fundamental value (τ_v) $\frac{1}{\lambda}$ also decreases with the probability of default q and with informed agents 'risk aversion. The more risk averse informed agents are, the less agressive they trade and this has a negative impact on market depth. The effect of the other parameters on $\frac{1}{\lambda}$ is ambiguos. In particular, the impact of τ_e on $\frac{1}{\lambda}$ depends on the sign of (qα-1). If $\frac{\tau_e}{\rho_I}$> 1 the relationship is direct.

5.2.2. Price informativeness and volatility

From the market clearing condition, we have obtained $p = \lambda(\mu\alpha v + \widehat{b} + \widetilde{L})$

This can also be expressed as

$p = \lambda\mu\alpha v + (1-q)CF + \lambda\widetilde{L} + \frac{q\tau_v v_0(\mu(\rho_I)^{-1}+(1-\mu)(\rho_U)^{-1})}{\tau(\mu(\rho_I)^{-1}+(1-\mu)(\rho_U)^{-1})+\mu\tau_e(\rho_I)^{-1}}$

Even if $E(\widetilde{L}) = 0$ there is a risk premium since $E(p) - qE(v) + (1-q)CF \neq 0$

Prices are biased, since $E(v/p) = \frac{1}{\tau}[\tau_v(v_0 - p) + \tau_L\mu a(\frac{1}{\lambda} - \mu a)p - \widehat{b}] \neq p$

In addition, volatility of prices, $var(p) = \lambda^2(\sigma_v^2 + \frac{1}{(\mu\alpha)^2}\sigma_L^2)$

Price precision in the estimation of v is given by $\tau = \tau_v + (\mu\alpha)^2\tau_L$ From the former, we can derive the following comparative statics. Price precision increases with market depth, with less volatility of fundamentals, with the precision of noisy demand, with the risk tolerance adjusted informational advantage of informed traders $\tau_e(q\rho_I)^{-1} = \alpha$ and with the proportion of informed traders. More informed traders means that prices are more informative, which can be interpreted as a strategic substituability in information acquisition. When private information is more precise, there are less incentives to acquire private signal. Here, we do not consider the case where information acquisition is costly, but if doing so the proportion of informed and uninformed would necessarily depend on this cost. Finally, price volatility decreases with market depth.

5.3. Existing methods to model and estimate risk appetite

The first approach to measuring changes in risk patterns is theoretically based, it comes from the consumption based asset pricing literature, where risk is identified through a dynamic optimization problem that predicts that the risk premia is a function of the quantity of risk and the price of risk. The quantity of risk is represented by the covariance between a set of factor shocks and the risk premia of the asset (Campbell, 1996; Cochrane, 2001; Cochrane and Piazzesi, 2001). This approach typically assumes that risk aversion is constant, or if risk preferences are allowed to vary over time, they end up being implausibly smooth and possibly nonstationary.

Secondly, there is a set of papers that use a non parametric approach to derive a measure of risk appetite by computing the variation in the ratio of risk-neutral to subjective probabilities used by investors in evaluating the expected payoff of an asset. This requires computing two probability density functions over future returns—one risk-neutral distribution and one subjective distribution—on an index such as S&P500 (Bollerslev, Gibson, and Zhou (2004), among others) Subjective probabilities about various states of the world are estimated there through observed returns and GARCH methodology. Adjusted probabilities are risk neutral and they can be inferred from the prices of options contracts on the underlying asset. In particular, the difference between the two standard deviations reflects what they define as "volatility risk premium". The higher the risk appetite, the smaller the degree to which implied (risk-neutral) volatilities derived from option prices will exceed realized (subjective) volatilities (Other references are Gai and Vause (2006); Tarashev, Tsatsaronis, and Karampatos (2003) and Hayes, Panigirtzoglou, and Shin (2003)).

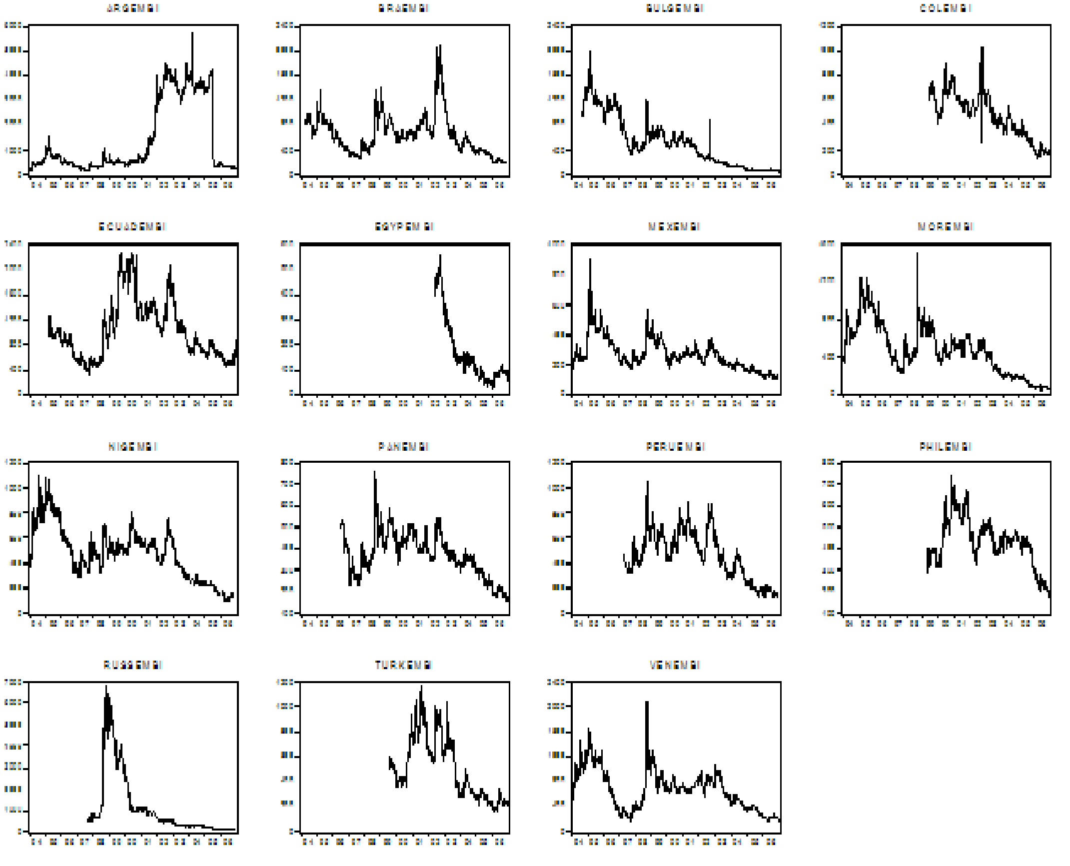
A third approach to measuring changes in global risk appetite, popular among market participants, is to construct a simple average of macro-finance variables (Bollerslev, et al. 2007). Such indexes are sometimes criticised for being too ad hoc to be reliable, while at the same time they might tend to be excessively and implausibly volatile. Related to this group, J.P. Morgan Chase Bank (2002) uses risk indices. More specifically, these indices identify various components of global risk including liquidity risk, credit risk, and volatility risk (LCVI). They have shown to be less volatile.

6. **DATA SET**

Variables constructed and sources of information

Spread Comp	Category	Variable used	Data source
Risk Premia	Funding Liquidity Premium	a) 3-month-ahead Treasury Bill futures rate	Datastream
	Credit Risk Premium	US corporate bond yield	Datastream
	Market Liquidity Premium 2(3)	Spread bw the yield on the 10-year U.S. Treasury benchmark bond and the yield on the 2-year (3 month) U.S. Treasury benchmark bond	Datastream
	Volatility Premium	Chicago Board Options Exchange (CBOE) Volatility Index, based on Standard&Poors 500	Datastream
Fundamentals	Long Term Credit Ratings	Numerical rating ranging from 1 to 22, with 22 the riskiest asset	Standard & Poors (Ratings Direct)
	Long Term Credit Outlooks	Stable (STB); Positive (POS) and Negative (NEG).	Standard & Poors (Ratings Direct)
	Group	Investment grade (from AAA to BBB-) and non investment grade: first tier (from BB+ to CCC+) and second tier (from CCC to SD)	Standard & Poors (Ratings Direct)
Fin. distress cond.		Value of 1 during the corresponding period and event	Own elaboration

Evolution of spreads by country



6.0.1. ***Time periods for dummy variables***

Tequila: during the period 1/12/94- 12/04/96,
Russia 's Default and the LTCM Crisis: 1/06/98- 14/10/98.
Brazil's Crisis: 13/01/99- 29/05/99.
Turkey's crisis: 19/02/01- 05/03/01.
September 11th: 17/09/01- 06/11/01.
Argentina's default: 15/08/01- 01/06/05
WorldCom Scandal and Brazil's Elections: 25/06/02- 29/10/02.
U.S. Federal Reserve Begins Tightening Cycle: 02/04/04- 30/06/04.
Ford and General Motors downgrades: from March to June 2004
Turkey's Crisis (2006): 11/05/06- 24/07/06

6.0.2. Model estimation with the Westpac index of risk aversion

Log(EMBI+)	Coef.	Coef.	Coef.	Coef.
US FedFund Ef rate	**-0.011**	0.038	0.032	-0.292
Riskiness of asset				
Ratings	0.193	0.198	0.196	0.198
Ratings Group	0.001	0.001	0.002	0.001
Outlook Positive	-0.150	-0.262	-0.249	-0.267
Sigmav vol	0.000	0.000	0.000	0.000
Global Risk factors				
Market volatility, VIX				
RAI		0.018	0.018	0.010
MKT liquidity premium 3	-0.460	-0.496	-0.608	-0.420
US Corporate Bond	0.795	0.800	0.793	0.600
Fund Liquidity level	-0.481	-0.558	-0.589	
(VIX)2				
Fund Liq*MKT Liq			0.040	0.030
VIX*MKT Liq				0.003
Per of Fin Distress				
Tequila	0.647			
Russia	0.567	0.529	0.544	0.707
Brasil	0.538	0.493	0.498	0.642
Ford	0.285	0.246	0.136	0.032
Turkish Crisis	-0.232	-0.263	-0.244	-0.256
Argentina Def	-0.032	-0.028	0.037	0.183
AIC	**35518**	**27041**	**26163**	**28713**

All variables are significant at the 1% level, with the exception of the ones in bold: significant at 10%. EMBI+:Emerging Market Bond Index; Long Term Credit Ratings, as collected by Standard & Poors;. Credit Outlooks, Positive. US Fed Funds effective rate; US 10 Year Government Bond Yield; Chicago Board Options Exchange (CBOE) Volatility Index; US Corporate Bond Yield; Implied yield on the 3 months ahead Fed Funds future rates; Market Liquidity premium 2=10-year and 2-year U.S. Treasury benchmark bond; Market Liquidity premium 3=yield on the 10-year and the 3-month U.S. Treasury bond, constant maturity; Dummy variables for the different episodes considered. AIC: Akaike criteria.

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