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THE RELEVANCE OF CURRENCY MISMATCH INDICATORS: AN ANALYSIS THROUGH DETERMINANTS OF EMERGING MARKET SPREADS

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ABSTRACT. We study the impact of currency mismatches on changes in emerging sovereign bond spreads using new currency mismatch indicators, both at the aggregate level and for the banking sector, for 25 emerging countries. We use first a panel data estimation of EMBI secondary market spreads and a set of standard variables related to debt sustainability to construct a basic model of determinants of emerging sovereign spreads. Then we include our currency mismatch indicators to test their relevance in emerging spread determination. We find these indicators play a significant role for the determination of emerging sovereign bond spreads. Finally, we can conclude that these indicators should be considered more consistently in analyses of emerging market vulnerabilities.

JEL Classification: E44; F34; G15.
Keywords: Currency Mismatches; Emerging Markets; Sovereign Spreads.

RÉSUMÉ. L'objet de cette étude est d'évaluer l'impact des déséquilibres en devises sur la variation des *spreads* souverains émergents, en utilisant de nouveaux indicateurs de déséquilibres en devises, à la fois au niveau agrégé de l'économie et du secteur bancaire, pour un ensemble de vingt-cinq pays émergents. La première étape consiste à estimer en données de panel un modèle de base des *spreads* EMBI sur le marché secondaire en utilisant comme déterminants des variables standard relatives à la soutenabilité de la dette. Nous introduisons ensuite dans le modèle les indicateurs de déséquilibres en devises afin de tester leur pertinence. Les résultats montrent que ces indicateurs jouent un rôle significatif dans la détermination des *spreads* souverains émergents. En définitive, nous pouvons conclure qu'il est important de considérer ces indicateurs de manière plus systématique dans l'analyse des vulnérabilités auxquelles sont soumis les pays émergents.

Classification *JEL* : E44 ; F34 ; G15.
Mots-clés : Déséquilibres en devises ; marchés émergents ; *spreads* souverains.

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Introduction

Crises in the 1990s demonstrated the vulnerability of emerging countries' real economies to changes in global financial markets. The event of these crises as well as their magnitude – in particular the Asian financial crisis of 1997 – led economists to build "third-generation" financial crisis models that give greater weight to fragilities of the private sector and the banking sector in particular, through an analysis of balance sheets weaknesses.

More specifically, these models have shown that the presence of external liabilities denominated in foreign currencies was a major source of vulnerability, leading to severe losses in the event of a real depreciation of the domestic currency. Developed mainly by Krugman (1999), but also by Corsetti, Pesenti and Roubini (1999), Cespedes, Chang and Velasco (2000) and Aghion, Bacchetta and Banerjee (2001), these third-generation crisis models have consequently introduced the notion of "currency mismatches" to take into account these economies' vulnerability to exchange-rate shocks through a balance-sheet approach. From a theoretical point of view, the authors built upon the open economy financial accelerator proposed by Bernanke, Gertler and Gilchrist (1994) to show that the accumulation of foreign currency external liabilities creates financial fragility in that a real depreciation reduces the net worth of the borrower, through a balance-sheet effect, that may increase the cost of capital.

Several studies have shown that currency mismatches[2] in emerging markets have been a key element in almost financial crisis episodes during the past decade, on the one hand by making these countries vulnerable to shifts in market expectations and on the other hand, by raising dramatically the cost of devaluation (Allen *et alii*, 2002; Eichengreen, Hausmann and Panizza, 2003). However, few studies have attempted to assess empirically the importance of these currency mismatches in evaluating the vulnerability of emerging markets to a depreciation of the domestic currency. At the micro economic level, Bleakley and Cowan (2005) focused on the effects of a real depreciation on investment for a sample of Latin American non financial firms with a large amount of external liabilities denominated in foreign currency. They have found no significant interaction between foreign currency debt and exchange rate depreciation. These results are confirmed by Bonomo, Martins and Pinto (2003) and Benavente, Johnson and Morande (2003). On the contrary, Cowan, Hansen and Herrera (2005) have shown, more in line with recent literature on balance sheet effects, that currency mismatches matter by increasing credit constraints and lowering investment opportunities for a set of Chilean corporations in case of real depreciation. However, these studies focused on investment and output but not on the cost of borrowing as opposed to our work.

In the same way, at the macroeconomic level, the early literature about vulnerabilities of emerging market countries to a real depreciation and their consequences on the cost of borrowing do not take into account precisely the currency structure for debt. According to

2. According to Goldstein and Turner (2004), currency mismatches are defined as "the sensibility of net worth or of the present discounted value of net income to changes in the exchange rate" taking into account external and domestic composition of assets and liabilities.

these previous works, the external borrowing cost proxied by sovereign bond spread, which can be considered as a measure of default risk perception (Edwards, 1984; Ferrucci, 2003), is determined among others by liquidity and solvency factors but in any case by currency mismatch indicators. To our knowledge, only two studies have attempted to test empirically the impact on sovereign risk premium of balance sheet effects. Berganza and Garcia-Herrero (2004) have shown more specifically that country risk is affected by external as well as domestic balance sheets, owing to an increase in the value of foreign currency external and domestic debt after a depreciation of the domestic currency. Even though this paper helps to better understand vulnerabilities of emerging markets to a depreciation through sovereign spread changes, it does not evaluate directly the effects of currency mismatches in emerging markets on the country risk premium. Instead, it provides strong support for the implication of a depreciation through a balance sheet channel on sovereign yield spreads. Remolona, Scatigna and Wu (2007) have investigated, by following credit risk literature, the determinants of a measure of expected loss from default, including currency mismatch indicator, and have found that the coefficient associated to this variable was significant.

In line with these works, our study examines empirically the importance of currency mismatches in determining default risk of emerging sovereigns, once we have controlled for standard macroeconomic and external variables that are relevant in theoretical and empirical literature on emerging bond spreads. Until now, only comprehensive data on external debt of emerging countries were available, although recently, few authors have attempted to fill this gap by collecting data on domestic debt structures (Mehl and Reynaud, 2005) or on the currency composition of corporate debt in Latin America (Kamil, 2004). Our database focus more precisely on currency composition of both assets and liabilities issued abroad and domestically for the banking sector of 30 emerging countries over the period 1990-2005. We have made efforts to collect data from national sources (central banks essentially) and to provide comprehensive data of both external and domestic debt denominated in foreign currency for emerging market countries. To our knowledge, it is the first database to provide such a currency breakdown in emerging economies' banking sector over three zones (Latin America, Central and Eastern Europe and Asia).

In order to show the relevance of currency mismatch indicators in determining default risk of emerging sovereigns, we have built original indicators of currency mismatches by using our new database. First, we have build currency mismatch indicators for the banking sector of each country of our study, both at the domestic and external level in order to assess the degree of currency risk exposure of this institutional sector. Second, we have followed Goldstein and Turner (2004) to build an aggregate effective currency mismatch indicator for each country of our study which determines the net currency position at the aggregate level of the economy by using BIS data and IFS (International Financial Statistics) published by the International Monetary Fund. As a result, this new set of indicators gives a precise level of detail on the structure of foreign currency-denominated debt of emerging economies.

This paper attempts to show the role of currency mismatches by using these original indicators for a set of twenty-five emerging countries over the period 1993-2005 in market participants' perception of default risk. The main objective is to investigate the issue empirically by including our currency mismatch indicators in standard models of emerging yield spreads. By using pooled OLS with fixed-effects estimations, our results clearly show that currency mismatches are relevant indicators to determine changes in emerging bond spreads, as the include of these indicators improve the fit of the model with respect to models of standard determinants of sovereign emerging spreads. This approach which takes into account the debt structure of these countries by using both aggregate and, domestic and external currency mismatch indicators allow to highlight more precisely vulnerabilities with which emerging countries are faced, and gives us a better idea of the consequences of a depreciation of the domestic currency.

It differs from the previous papers on several points. First, as we said, we construct new currency mismatch indicators for each emerging country of our study, both for the whole economy and for the banking sector. A more in-depth study of the banking sector in emerging countries seems essential as, in line with literature on third-generation crisis models, this institutional sector plays a key role in the outbreak or contagion of financial crises. Second, our indicators are built in order to take into account both foreign currency-denominated liabilities and assets held by non-residents (external currency mismatch indicators) and residents (domestic currency mismatch indicators), whereas previous studies have considered only foreign currency external debt. Third, while others have attempted to evaluate the impact of a real depreciation on external borrowing costs through currency mismatches channel, we are able, given our indicators, to evaluate directly the impact of these currency mismatches on sovereign bond spread changes. Fourth, by conciliating two strands of literature, *i.e.* theoretical literature on third-generation crisis models which have introduced the notion of currency mismatch and empirical literature on the vulnerability of emerging markets through an evaluation of sovereign credit risk, we show empirically the importance of these currency mismatches.

After a brief review in section II of existing theory on the decisive factors behind emerging spreads, this article will show in section III that taking into account currency mismatch indicators improves the fit of the model when compared with standard external debt sustainability variables. Section IV concludes.

Literature review

From a theoretical point of view, emerging sovereign spreads[3] represent investors' perception of the likelihood of a borrower defaulting, which depends negatively on the sustainability of external debt. The main limitation of this rationale concerning the perception of

3. Emerging sovereign bond spread can be define as the yield spread between a bond issued by an emerging country to borrow on the Eurobond market, and a "risk-free" bond with the same characteristics issued by a developed country.

default lies in the fact that it is a complex situation that introduces the notion of vulnerability through the concept of debt sustainability. In terms of external debt, this assumes that the borrower is considered to be solvent – *i.e.* that he is able to repay its long-term liabilities – and liquid, *i.e.* that he is able to refinance its debt in the short term. In other words, the yield spread between an emerging sovereign bond and a "risk-free" bond with the same maturity is a function of the default probability which is linked to the sustainability of external debt, measured by liquidity and solvency indicators (Ferrucci, 2003).

Following the literature on sovereign credit risk, empirical studies have tried to determine fundamental and external factors that might explain changes in emerging sovereign spreads and to evaluate the relative importance of each factor. The first empirical studies of spread determinants concerned the influence of international interest rates (push factors) on emerging sovereign spreads. However, the authors could not identify any real correlation between the two (Cline and Barnes, 1997; Min, 1998; Kamin and Von Kleist, 1999; Eichengreen and Mody, 1998). More recent studies have revealed a positive and statistically significant correlation between US short-term interest rates and emerging sovereign spreads in line with theory (Arora and Cerisola, 2000; Ferrucci, 2003; Kashiwase and Kodres, 2005). It also appears that the influence of external factors on emerging spreads is greater than in the 1990s (IMF, 2004).

The aforementioned authors have also carried out empirical tests to assess the influence of country-specific fundamentals (pull factors) (Cantor and Packer, 1996; Eichengreen and Mody, 1998; Kamin and Von Kleist, 1999; Sy, 2002; Rowland and Torres, 2004; Rowland, 2004). In a context of debt sustainability, these empirical studies have shown that debt related indicators of external vulnerability are important factors to gauge risks associated with adverse shocks on domestic exchange rate. The most common debt indicators used are, among others, ratios of external debt-to-GDP, debt-to-exports, debt servicing-to-GDP and short term external debt-to-reserves. Authors have shown that all are significant and have theoretically expected sign in determining emerging sovereign spread changes.

However, we consider that they suffer from certain drawbacks, particularly because they fail to assess precisely vulnerabilities of these economies to a real depreciation. According to us, it seems first crucial to take into account foreign-currency domestic liabilities which are not included in common debt ratios. Second, these foreign currency-denominated liabilities should be viewed at the same time with foreign currency assets, in order to evaluate hedging opportunities. These common indicators are useful measures to evaluate the repayment capacity of the country or the reserve adequacy, but they are not currency mismatch indicators. Third, a sectoral analysis of currency mismatches, and particularly in the banking sector, is also important owing to its highly leverage and its implication in the last financial crisis in emerging markets.

Berganza and Garcia-Herrero (2004) have tried to overcome these drawbacks by testing channels of influence of domestic exchange rate changes on country risk premium in a

dynamic panel study. They show that both external and domestic balance sheet effects stemming from domestic currency depreciation increase the yield spread. To our sense, it is a first step in improving previous research, but their study takes into account neither country specific fundamentals nor external factors in line with credit risk literature. They aim to show that currency depreciation negatively influences sovereign spreads by a balance-sheet effect. The study of Remolona, Scatigna and Wu (2007) is more in line with our paper since on the one hand, they follow the credit risk literature and on the other hand, they use a measure of currency mismatch in an empirical analysis of determinants of a measure of expected loss for emerging sovereigns. The currency mismatch indicator is an aggregate one for each country but fails to take into account domestic currency-denominated assets and liabilities. The authors show that external aggregate currency mismatches matter in evaluating sovereign risk.

Except these two previous studies, empirical works on emerging sovereign risk tried to determine a number of decisive country-specific fundamentals (pull-factors[4]) and external factors (push-factors[5]) related to debt sustainability which can explain sovereign spread changes. However, the studies did not enable us to clearly identify the relative significance of currency mismatch in determining the emerging country risk premium.

Role of currency mismatch indicators in the determination of emerging spreads: Empirical results

Data description

We draw the data from IMF's International Financial Statistics but also from JPMorgan and Bloomberg in order to compile database for standard determinants of emerging spreads. We use variables suggested previously in the literature on emerging bond spreads to build a baseline model which captures the most important standard factors of a country's macroeconomic vulnerability. The determinants used are the following:

External and global factors

We decide to use indicators of investors' risk appetite proxied by the implied volatility of the S&P500 index (hereafter VIX) and the US corporate high-yield spread[6] and an index showing a flight to liquidity, represented by the TED spread[7] variable. As a result, a change in market sentiment resulting in greater risk aversion or a flight to liquidity will first lead to a widening

4. Pull-factors can be divided into solvency and liquidity variables (like ratios of total debt-to-exports, debt servicing-to-exports, short-term debt-to-reserves, exports-to-GDP and reserves-to-GDP, as well as real GDP growth, inflation rate, real exchange rate, terms of trade, degree of openness, current-account and budget balances-to-GDP among others).
5. Push-factors make reference to those that capture external shocks to the economy (like US short- and long-term interest rates, the LIBOR rate, the VIX volatility index and the US high-yield spread among others).
6. High-yield spread is referring to the yield spread between a high yield bond issued by a US corporate which has a rating of less than 'BBB' and a government bond with the same maturity.
7. Difference between US Treasury Bill rate and the Eurodollar rate represented by the LIBOR rate.

of the US high-yield spread or the TED spread before affecting emerging sovereign bonds. The risk related to these securities will lead investors to reassess the probability of emerging issuers defaulting, pushing the emerging spread higher. Consequently, the expected relationship between these external variables and the emerging sovereign spread is positive.

We use Brent oil prices as a global indicator. It seemed appropriate to include this index in the analysis given its influence on country's solvability. Oil prices may affect emerging sovereign spreads in two opposite ways. First, higher oil prices improve creditworthiness by increasing trade surpluses for oil exporter countries and should be associated with lower risk premia. On the contrary, for oil importer countries, higher oil prices worsen country's solvability by affecting negatively the trade balance which should increase sovereign bond spreads.

We include the degree of openness as an external factor (Goldman Sachs, 2000). This variable can influence a country's ability to service its debt. In particular, a high degree of openness allows a country to generate foreign currency flows to repay its external debt in foreign currencies. So the expected sign is negative.

We include as well interest rates of industrialised countries[8] with different maturities. From a theoretical point of view, the interest rate problem is particularly important if we consider that emerging spreads are highly sensitive to changes in US interest rates (more sensitive than corporate bonds, for example). This lies in the fact that emerging economies incur large amounts of debt denominated in "hard" currencies, particularly in US dollar. If interest rates on hard currencies rise, borrowing conditions and therefore emerging countries' financial net worth worsen, especially when this interest rates rise coincides with an appreciation of hard currencies, which increases the debt burden and stretches spreads even more. The expected sign is positive.

Specific fundamental factors

Following previous literature on emerging sovereign bond spreads, we include also variables that refer to solvency and liquidity problems resulting from a changing investors' perception of the external debt sustainability.

We use real GDP growth as a high GDP growth usually generates stronger fiscal positions which raise the government's ability to service its debt obligations over time and improve its creditworthiness.

Current-account and budget balances as a percentage of GDP are also considered. These two ratios are used to control for a country's solvency. Large current account imbalances involve an accumulation of gross foreign liabilities which may become unsustainable in the long run: cumulative current account deficits result in an increase in the sovereign spread. The budget balance-to-GDP ratio is expected to reflect the ability of the government to raise

8. The FED Funds rate, 1 month and 3 month LIBOR rates, the 3month T-Bill rate and the 10Y US Treasury yield.

taxes to service debt and to reduce the debt stock. A decrease in this ratio implies a higher probability that the government may default on its obligations, increasing sovereign spreads.

We include foreign debt as a percentage of exports. A growing ratio indicates that external resources are scarce to service debt making countries with large debt-to-exports ratios more vulnerable to external shocks. Therefore this variable should impact positively sovereign bond spreads.

Previous literature emphasizes that illiquidity risk may lead to default situations, and must be taken into account in models determining emerging sovereign spreads.

We include the inflation rate as it can be viewed as a good indicator of government discipline (Min, 1998): higher inflation rate is associated with higher default risk and higher yield spreads.

We use as well the weight of exports in GDP, as larger current receipts make countries less vulnerable to external shocks resulting in lower bond spreads, and the ratio of official reserves-to-external debt. The higher the ratio of official reserves to external debt, the lower the likelihood of a liquidity crisis as the country will be able to face an external shock (the expected sign is negative). We include the ratio of short-term external debt-to-official reserves as this is an important indicator of reserve adequacy and liquidity position which captures the ability of a country to face sudden reversal in capital flows. A country with a high ratio may be more vulnerable to speculative attacks, which impact positively sovereign spreads.

Finally, we decide to use debt service to GDP ratio as higher debt service implies that a country might face problems in repaying its obligations in the short run which does increase the investors' perception of default. The expected sign is positive.

These two sets of variables have been widely used in empirical studies to explain changes in emerging bond spreads. However, according to us, it seems essential to evaluate precisely the debt structure of emerging economies at an aggregate level and also in the banking sector, in order to assess vulnerabilities of these countries to a depreciation of the domestic currency. In particular, we aim at investigate to what extent emerging spreads are influenced by these currency mismatches, that's why we propose a new set of indicators which contribute to give a first answer to this issue.

Aggregate currency mismatch indicator

As we said in a first part, we have followed previous works of Goldstein and Turner (2004) to build an aggregate effective currency mismatch indicator, hereafter called AECM (Aggregate Effective Currency Mismatch)[9] for each country of our study, by using BIS Data and International Financial Statistics over the period 1990-2005 (annual data). This aims to provide a measure of emerging country vulnerability in the event of a sharp depreciation in the exchange rate, by considering the currency breakdown of external and domestic assets and liabilities in the different institutional sectors of the economy.

9. Cf. APPENDIX 1 for more precisions.

More precisely, this indicator takes three variables into account: net assets in foreign currencies, exports (or imports) of goods and services, and external and domestic debt denominated in foreign currencies as a percentage of total debt. AECM indicator has the advantage of taking into account changes in revenue flows net of interests following a movement in the exchange rate through export (or import) variables. Furthermore, it measures the economy's ability to service its debt denominated in foreign currencies (Goldstein and Turner, 2004).

Finally, this indicator, which provides an individual measure of the net currency position, allows us to assess the extent of currency mismatches at the aggregate level of the economy. Countries for which AECM indicator is negative are considered as net currency borrowers with "standard" currency mismatches, and are vulnerable to a depreciation of their domestic currencies. On the contrary, countries for which AECM indicator is positive are said to be net currency creditor with "inverse" currency mismatches. Consequently these countries suffer from a risk of appreciation of their domestic currency. The study of this indicator allows cross-country and time-series comparisons. The expected sign associated with this variable is negative: an increase in the AECM value indicates lower aggregate currency mismatches and implies an improvement of country's solvability, narrowing the spread.

Banking sector currency mismatch indicators

Following theoretical literature on third-generation crisis models, we are specifically interested in the banking sector by constructing several original indicators for each country to assess the presence of external and domestic currency mismatches. For this, we have collected data, for each country of our study from national sources, on currency composition of assets and liabilities held by residents and non-residents in this domestic institutional sector. These currency mismatch indicators[10] allow us to quantify the currency risk exposure in this sector by assessing precisely the currency breakdown of assets and liabilities, both at the domestic and external level. We distinguish between domestic currency mismatch indicators and external currency mismatch indicators.

The *IS1* and *IS2* indicators reflect the banking sector's domestic vulnerability to a depreciation in the national currency. An increase in these ratios means that the banking sector is more exposed to variations in the exchange rate.

IS3 is the indicator of currency mismatch. It measures to what extent domestic liabilities (proxied by domestic deposits) in foreign currencies are hedging by domestic assets (proxied by domestic loans) in foreign currencies. A ratio below 1 implies the presence of currency mismatches as assets in foreign currencies are no longer enough to cover liabilities in foreign currencies. If the domestic currency depreciates, the value of liabilities in local currency increases by more than the value of assets in local currency, exposing the banking sector to a significant exchange-rate risk. Expected signs are positive for the IS1 and IS2 indicators and negative for the IS3 indicator.

10. Cf. APPENDIX 2 for more precisions about definitions of these indicators.

The *IS4* indicator measures the banking sector's external exposure to variations in the exchange rate. A high ratio means that the banking sector is heavily dependent on external loans.

IS5 is the indicator of external currency mismatches. A ratio below 1 implies that external assets cover the share of liabilities denominated in foreign currencies, which protects the banking sector from the exchange-rate risk. The expected sign is positive for both indicators.

Consequently, we use IS1, IS2 and IS3 indicators (domestic indicators), and IS4 and IS5 indicators (external indicators) to test the relevance of currency mismatches in the banking sector for each country of our study in the determination of emerging sovereign spreads.

Dependent variable

We decide to use the JPMorgan's Emerging Market Bond Index Global (EMBIG) to proxy for the external cost of borrowing for each country for several reasons. On the one hand the EMBIG index has been widely used in previous literature on emerging sovereign spreads[11] as it is readily available and constitutes a benchmark. On the other hand, its coverage of emerging countries is broader than previous index provided by JPMorgan (EMBI and EMBI+ index). The EMBIG spread for each country is calculated as the average of yield spreads over US government bond (with a comparable issue date and maturity) of external debt instruments[12] issued by sovereign and quasi-sovereign entities, weighted by the market capitalisation of these instruments (JPMorgan, 1999).

The data set covers twenty-five countries (see TABLE 1) across different emerging zones, with a quarterly periodicity, for the period between Q4 1993 and Q4 2005. In most cases, fundamental variables (notably external debt or official reserves) are only available on a yearly basis. Consequently, all annual data have been converted to a quarterly basis using linear interpolation[13].

Table 1 - Set of emerging countries

Asia	Latin America		Central and Eastern Europe countries	Others
China	Argentina	Mexico	Bulgaria	Russia
South Korea	Brazil	Panama	Croatia	Tunisia
Indonesia	Chile	Peru	Hungary	Turkey
Malaysia	Colombia	Uruguay	Poland	South Africa
Philippines	Ecuador	Venezuela	Ukraine	
Thailand				

11. See Ferrucci, 2003; Rowland and Torres, 2004; Kashiwase and Kodres, 2005; Luengnaruemitchai and Schadler (2007) among others.
12. The EMBI Global index covers US dollar denominated Brady bonds, Eurobonds, Traded bonds and local market debt instruments issued by sovereign and quasi-sovereign entities.
13. Linear interpolation has been already used in previous works (Goldman Sachs, 2000; Dell'Ariccia, Schnabel and Zettelmeyer, 2002) and is quite appropriate for stock variables such as debt and reserve ratios which vary rather slowly over time.

The aim of the paper is to show that the reference framework used in common literature to evaluate determinants of emerging bond spreads is incomplete, and to this, we will proceed in two steps: as a starting point, we construct a basic model that determines the leading indicators (fundamental and external factors) which are relevant in determining emerging sovereign bond spreads in line with previous literature on country risk, by using panel econometric tests. Second, we estimate the same model by including our currency mismatch indicators to exhibit the relevance of these variables in analysing emerging economies' vulnerability.

Basic model of emerging sovereign bond spreads

Following the theoretical framework proposed by Edwards (1986), we consider the following econometric model for sovereign bond spreads:

$$Log(spreads_{it}) = \alpha + \sum_{j=1}^{J} \beta_j x_{ijt} + \sum_{k=1}^{K} \gamma_k y_{kt} + u_i + \varepsilon_{it} \quad (1)$$

where :

– $spreads_{it}$ refers to the EMBIG variables which vary across countries i and time t;

– x_{ijt} refers to the J fundamental explanatory variables which vary across countries i and time t (country-specific factors and currency mismatch variables);

– β_j refers to the corresponding coefficients;

– α is an exogenous constant term which may be associated to log(1 + i^*), where i^* is the risk-free world interest rate;

– y_{kt} represents external and global factors which vary only over time (international interest rates, Brent oil prices, variables measuring market sentiment);

– γ_k are the corresponding coefficients;

– u_i are individual country-specific effects which are constant through time, and ε_{it} is the independently distributed error term.

In order to determine this specification, we ran several econometric tests. First, a Wald test on restricted coefficients indicates that we can reject[14] the null hypothesis of jointly homogeneous slope coefficients and intercepts across countries (H_0 : $\beta_{ij} = \beta_j$ and $u_i = u$).

We then assume that slope coefficients are the same across all countries ($\beta_{ij} = \beta_j$) and that cross-sectional variations come from intercept terms (country-specific effects). An *F*-test for the significance of these country-specific intercepts show that we can obviously reject the joint null hypothesis that intercept coefficient are not significantly different from zero (H_0 : $u_i = 0$).

Finally, a Hausman test of fixed *versus* random individual effects (at the 5% level) concludes that fixed effects should be more efficient in this model (H_0 : *random effects*)[15]. From an economic point of view, this specification is consistent as one may consider that investors would apply the same risk model to this class of countries: spreads' reaction to a change of funda-

14. We run a pooled OLS with cross-section specific coefficients, including intercepts, and then a Wald test on jointly restricted coefficients. The estimated F-test is 3669: it exceeds the theoretical value at 1% level F(48,857) = 1,38.
15. Cf. APPENDIX 3 for details of the two tests.

mental or external variables is assumed to be the same for all countries (Rowland and Torres, 2004). However, several structural factors relating to political or socio-economic factors (like political risk, corruption, economic development) which are not taken into account in specific fundamental variables are reflected in country-specific fixed effects. According to Rowland and Torres (2004), these fixed-effects can be viewed as the minimum spread that an emerging borrower should pay to compensate investors for the risk of holding such issued bonds.

We have also controlled the stationarity properties of the variables through unit root tests (not reported here).[16] For all estimations, we run White heteroskedasticity-consistent estima-

Table 2 - Basic model of (log) spreads determination

Variable	Regression (1) 1993Q4-2005Q4	Regression (2) 1997Q4-2005Q4	Regression (3)* 1993Q4-2005Q4
Constant	1.5901*** (0.611)	2.4520*** (0.487)	2.086*** (0.611)
Real growth	–0.020*** (0.007)	–0.014*** (0.007)	–0.020** (0.009)
Current account balance (%GDP)	0.045*** (0.007)	0.032*** (0.006)	0.053*** (0.009)
Debt / Exports	0.007*** (0.0006)	0.006*** (0.0005)	0.007*** (0.0006)
International reserves/ debt	–0.0031*** (0.0006)	–0.006*** (0.0008)	–0.00305*** (0.006)
Spread high yield	0.599*** (0.077)	0.503*** (0.060)	0.492*** (0.076)
Oil prices	–0.340*** (0.063)	–0.338*** (0.064)	–0.308*** (0.062)
TED spread	0.219*** (0.033)	0.193*** (0.029)	0.194*** (0.035)
Adjusted R-squared	0.828099	0.829728	0.825092
Prob(F-statistic)	0.000000	0.000000	0.000000

Fixed Effects (Cross) (Regression (1))			
AF—C	0,111166	MY—C	–0,203251
AR—C	–0,412235	PA—C	0,722283
BG—C	0,501975	PE—C	–0,484643
BR—C	–0,2217	PH—C	0,302449
CL—C	–0,903228	PO—C	–0,328384
CN—C	–0,296816	RU—C	0,362057
CO—C	0,03514	TH—C	–0,824671
CR—C	0,163263	TK—C	0,110303
EQ—C	0,744311	TU—C	–0,359803
HU—C	–0,953396	UK—C	0,940863
IN—C	0,107569	UR—C	–0,488194
KO—C	–0,391629	VE—C	0,671956
MX—C	0,446179		

* without South-Africa, Panama, Ukraine, Venezuela and Tunisia.

Notes: ***, **, *: significant at 1%, 5% and 10% level.

Figures in the parentheses are White's heteroskedasticity-consistent standard errors.

Source: author's estimates.

16. The tests used (and available close to the author) are those of Im, Pesaran and Shin and also those of Maddala and Wu. The model is over-all stationary, *i.e.* I (0).

tions by pooled OLS with country-fixed effects. TABLE 2 reports the results of the benchmark fixed-effect estimation for emerging spreads.

All estimated coefficient are significant at the 1% level and have the expected signs. In particular, improved country-specific fundamentals, such as lower debt-to-export ratio and stronger growth rate help to lower emerging spreads. As expected, higher international reserves-to-debt ratio leads to lower emerging yield spreads. However, the current account as a percentage of GDP is significant but with an unexpected sign (positive sign meaning that an improvement in the current-account balance leads to an increase in the spread). According to Beck (2001), this is due to specific circumstances in emerging countries after successive crises. The rationale is the following: crises lead to a contraction of the economy which implies a decline in imports as well as a rise in exports due to the depreciation in the national currency. Current account surpluses generated after the crisis end up shrinking at the same time as credit quality improves and spreads narrow, in line with the economic recovery. Consequently, the estimated coefficient for the current account is positive. Given the significance of this variable in different regressions, we decided to keep it in the model.

External and global factors are also significant and have the expected signs. A widening of the TED spread, which implies a flight to liquidity, leads to a widening of emerging spreads. For example, in the first regression, an increase of TED spread by 10% raises the sovereign spreads by 2.2% (*i.e.* an increase of 11bp for an average spread of 500bp). The oil price variable is very significant and presents a negative sign. When oil prices rise, trade surpluses generated in oil-exporting countries make it easier to service debt and therefore ward off a default situation: sovereign spreads narrow. Finally, the largest estimated coefficient is associated to the high yield spread variable: an increase by 10% of this indicator in regression (1) leads to an increase of 6% of the spreads (*i.e.* an increase of 30bp for an average spread of 500bp). All these results are robust to changes of time period and country sample (Regressions 2 and 3).[17]

As for the other variables, results are not so good, especially for international short-term interest rates (1/3-month Libor rates, 3-month T-Bill and Fed Funds rates). Estimated coefficients are not significant for the inflation rate and for the ratios of short-term debt-to-reserves and budget balance-to-GDP, and present an unexpected sign for the debt-servicing-to-GDP ratio, the 10-year interest rate and exports-to-GDP ratio. We decide to exclude them from our model.

These results are consistent with those of previous theoretical and empirical studies about determinants of emerging sovereign spreads. However, as we said, debt indicators suffer from several limitations. Indeed, it seems that domestic foreign-currency liabilities, as well as external and domestic foreign-currency assets (external or domestic), should be taken into account to assess the economy's vulnerability to domestic currency depreciation.

17. We have estimated the model over others sub-periods (1993Q4 – 1999Q4, 1999Q4 – 2005Q4). Results do not change significantly.

Through the use of others indicators, we will show that analyses of emerging economies' vulnerabilities which only take into account "standard" debt sustainability indicators are incomplete.

Impact of currency mismatch variables on emerging market spreads

In the second step of our study, we include in the regression several currency mismatch indicators, both at an aggregate level of the economy and for the banking sector.

First of all, we include the AECM indicator for each country in the panel regression. From a methodological point of view, we replace standard debt variables by the AECM variable for each country in the panel equation to avoid any multicolinearity problems.

The new results with the aggregate currency mismatch indicator are reported in TABLE 3.[18]

As expected, all explanatory variables are significant at the 1% level, except the estimated coefficient of real growth which is significant at the 5% level in the first regression. Again, standard fundamental variables have the expected signs except for the current account balance. In particular, high growth rate and high international reserves-to-debt ratio implies an improvement in macroeconomic situation which lower emerging spreads. The current-account balance (% of GDP) remains significant with the opposite sign to that expected (see Beck, 2001), as in the basic model.

Table 3 - Impact of the AECM indicator on emerging spreads (logs) (fixed-effects estimation)

Variable	Regression (1) 1993Q4-2005Q4	Regression (2) 1993Q4-2003Q4	Regression (3) 1999Q4-2005Q4
Constant	2,50*** (0.651)	2.329*** (0.699)	2.789** (1.168)
Real growth	–0.018** (0.009)	–0.030*** (0.009)	–0.027*** (0.01)
Current account balance (%GDP)	0.038*** (0.009)	0.032*** (0,009)	0.056*** (0.007)
AECM indicator	–0.014*** (0.0014)	–0.011*** (0.0014)	–0.019*** (0.0027)
International reserves/ debt	–0.003*** (0.0009)	–0.005*** (0.0011)	–0.004*** (0.0012)
Spread high yield	0.634*** (0.087)	0.689*** (0.116)	0.6098*** (0.118)
Oil prices	–0.499*** (0.082)	–0.516*** (0.123)	–0.559*** (0.144)
TED spread	0.286*** (0.033)	0.289*** (0.0362)	0.239*** (0.039)
Adjusted R-squared	0.832591	0.832426	0.904042
Prob(F-statistic)	0.000000	0.000000	0.000000

Notes: ***, **, *: significant at 1%, 5% and 10% level.

Figures in the parentheses are White's heteroskedasticity-consistent standard errors.

Source: author's estimates.

18. Fixed-effects are not reported in the TABLE 3 because we are precisely interested in the impact of specific fundamentals and currency mismatch indicators on sovereign spreads, not on structural minimum spreads of emerging sovereigns viewed through fixed-effects.

The AECM indicator is also significant at the 1% level and has the expected negative sign. An improvement in the AECM implies a decrease in currency mismatches at the aggregate level of the economy for each country and stronger ability to cope with a depreciation of the domestic currency. Consequently, an increase of AECM variable lowers the default risk perception, so emerging yield spreads decrease. Furthermore, the estimated coefficient of this indicator is twice as large as the estimated coefficient of debt-to-exports ratio in regression (1) (-0.014 against-0.006). These results confirm our intuition about the consequences of currency mismatches on credit risk in emerging countries: countries that exhibits currency mismatches at the aggregate level of their economy are more sensitive to exchange rate depreciations leading to an increase in the yield spread.

As for external variables, oil prices and the TED spread remain clearly significant with expected signs. The spread of emerging sovereigns increases with a higher TED spread, which means a flight to liquidity, and with lower oil prices, as in the basic model. Again, the estimated coefficient of the US high-yield spread is the largest coefficient in the panel regression with a positive expected sign. These results are robust to alternative specifications (regression 2 and 3).[19]

These results are consistent with empirical previous works on emerging sovereign spreads and more precisely with the study of Remolona, Scatigna and Wu (2007) which have included a currency mismatch indicator to measure sovereign credit risk. As the authors, we find that currency mismatches at the aggregate level matter in determining emerging yield spread. However, our currency mismatch indicator for each country is more precise than their variable as it takes into account foreign-currency liabilities and assets of all institutional sectors of the economy. The overall fit of the model is as well better than in the basic model, which confirms the importance of such indicators to assess vulnerabilities of emerging countries.

Finally, our results show that the AECM indicator has a greater impact than "standard" debt ratios to explain emerging sovereign spreads, which is an interesting result. However, given the implication of the banking sector in past emerging crises, it would be interesting to include in our sovereign risk model currency mismatch indicators (both external and domestic) for the banking sector, by using IS_i indicators for each country.

TABLE 4 and TABLE 5 present the results from the pooled OLS regressions with fixed-effects[20] with currency mismatch indicators, both aggregate and for the banking sector.

Results show that all explanatory variables are statistically significant at the 1% level. The F-tests for the significance of regressions are also significant at the 1% level. Again the use of currency mismatch indicators at the aggregate level and for the banking sector improve the overall fit by yielding a higher R-squared of 0.86 (for the two models) relative to the R-squared of 0.82 obtained with the basic model.

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19. We have estimated the model with AECM indicator over the sub-period 1994Q4 – 2002Q4, and also over the 1993Q4-2005Q4 period without several countries (South-Africa, Panama, Ukraine, Malaysia, Argentina). Results do not change significantly.
20. Fixed-effects are not reported in these tables.

Table 4 - Estimates of currency mismatch indicators for the banking sector

Variable	Coefficient	Std. Error	*t*-Statistic
Constant	0.603038	0.940239	0.641367
Real growth	0.040258***	0.014820	2.716446
Current account balance (%GDP)	0.054327***	0.015797	3.439144
AECM indicator	–0.011496***	0.002031	–5.661654
External CM* indicator (IS5)	0.519526***	0.069781	7.445047
Domestic CM* indicator (IS3)	–0.030292***	0.005976	–5.068599
Spread high-yield	0.82575***	0.122754	6.726883
Oil prices	–0.810617***	0.133727	–6.061717
TED spread	0.419238***	0.066368	6.316856
R-squared	0.877301	F-statistic	105.0161
Adjusted R-squared	0.868947	Prob(F-statistic)	0.000000

* CM is for currency mismatch.

Note: ***, **, *: significant at 1%, 5% and 10% level.

Source: author's estimates.

Table 5 - Further estimates with currency mismatch indicators for the banking sector

Variable	Coefficient	Std. Error	*t*-Statistic
Constant	1.974522**	0.782140	2.524512
Debt / Exports	0.008859***	0.001637	5.413622
Current account balance (%GDP)	0.049680***	0.016611	2.990763
External CM indicator (IS5)	0.513496***	0.072288	7.103426
Domestic CM indicator (IS3)	-0.026092***	0.005651	-4.616853
Spread high-yield	0.513341***	0.104306	4.921511
Oil prices	-0.817730***	0.145491	-5.620496
TED spread	0.337663***	0.062439	5.407896
R-squared	0.871304	F-statistic	108.7750
Adjusted R-squared	0.863293	Prob(F-statistic)	0.000000

Note: ***, **, *: significant at 1%, 5% and 10% level.

Source: author's estimates.

In particular, currency mismatch indicators for the banking sector are significant at the 1% level and present the expected signs (positive for IS5 and negative for IS3) in the two specifications. This means that countries with external currency mismatches, both external (foreign-currency liabilities held by non-residents) and domestic (foreign-currency liabilities held by residents), in their banking sector are more vulnerable to a domestic currency depreciation implying higher sovereign spreads. The addition of these indicators does not disrupt the results obtained previously; in particular, the signs obtained for standard variables do not change.

The estimated coefficients for the IS1, IS2 and IS4 indicators have unexpected signs even if they are significant. This could be due to the lack of available banking data for some emerging countries. We decided not to use them in the analysis.

In the first estimate, adding external and domestic currency mismatch indicators of the banking sector alongside external and country-specific fundamental variables gives us a better idea of changes in the risk premium on emerging markets. Previous results confirm the involvement of the banking sector and its debt structure in determining spreads. However, to our knowledge, our study is the first that include currency mismatch indicators for the banking sector to help to explain changes in emerging sovereign risk premium. Clearly, in the second model, we have confirmation that the presence of currency mismatches on banking-sector balance sheets is sanctioned by the increased risk premium on emerging sovereign issuers.

Finally these results confirm our intuition that we should consider other variables related to currency mismatches to investigate the determinants of sovereign spreads. In particular, it seems that both aggregate currency mismatches and external and domestic currency mismatch indicators for the banking sector significantly contribute to measure emerging default risk. The presence of currency mismatches in the banking sector increases vulnerability to a shock and supports contagion from one institutional sector to another due to the crucial role plays by this sector in financing economy. This is why it seems necessary to reconsider the standard framework, based on the sustainability of external debt in foreign currencies, to analyse the vulnerabilities of emerging economies. Other explanatory variables that provide new information on the currency denomination of liabilities and assets should be taken into account in addition to that obtainable from standard analyses.

Conclusion

The aim of this paper was to show empirically the relevance of currency mismatches in the determination of emerging market sovereign spreads. For this study, we have collected data from national sources for a set of emerging countries that focus on currency composition of assets and liabilities for all institutional domestic sectors, and more precisely for the banking sector. By using this new database, we have built original currency mismatch indicators, both at the aggregate level of the economy and for the banking sector for each country of our study, in order to evaluate in particular the degree of currency risk exposure of these countries to a depreciation of their domestic currency.

The first step of this analysis was to identify, following previous theoretical and empirical literature, the main fundamental and external factors driving country risk premium. By using a panel data study and JPMorgan EMBI Global index for 25 emerging countries as the endogenous variable, we have established a reference equation which confirms previous findings about determinants of emerging bond spreads. Results show in particular that the debt-to-

exports ratio, real growth and the current-account balance for fundamental variables, and oil price, the TED spread and the high-yield spread for external factors are significant for the bond spreads determination.

In the second step, we include our currency mismatch indicators in order to determine empirically their significance, once we have controlled for standard variables that are relevant in previous studies. We find evidence that these currency mismatch indicators, both at the aggregate level and for the banking sector significantly raise the default risk perception. Results show that AECM indicator has the expected sign and is very significant in all our regressions, meaning that countries with net foreign currency positions are more vulnerable to a real depreciation which increase yield spreads. More interesting, it appears that banking sector currency mismatch indicators are significant in determining country risk premium. Our results emphasize the importance of debt structure of this institutional sector, in line with theoretical literature on third generation crisis model.

Standard spread determination studies have two objectives: to determine which standard macroeconomic variables and external factors are relevant to the analysis; and to determine the relative importance of each type of factors. Our approach is somewhat different in that our spread determination models now include new vulnerability indicators built using data from institutional sector balance sheets.

We show that aggregate and banking sector currency mismatches in the equation improves the overall fit of previous models. Accordingly we may conclude that traditional studies on the vulnerability of emerging economies should take other variables into account for an optimal analysis of the fragilities with which these countries are faced. The use of a balance-sheet approach and consideration of currency mismatches now seems essential, although we still have to introduce specific fundamental variables as well as external factors.

For further research, it would be interesting to test the impact of the latter in the light of countries' credit ratings. The information therein seems more complete than that held in fundamental variables, which is why we feel it appropriate to test the soundness of mismatch indicators while taking ratings variables into account.

S. P.[21]

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Appendix 1

Definition of AECM indicator (Goldstein and Turner, 2004)

$$AECM = \frac{NFCA}{XGS} * FC\%TD \quad \text{if} \quad NFCA \leq 0^{22}$$

$$AECM = \frac{NFCA}{MGS} * FC\%TD \quad \text{if} \quad NFCA \geq 0$$

with *NFCA* (Net Foreign Currency Assets) = Net Foreign Currency Assets (taking all sectors together) defined as the difference between the total of assets and the total of liabilities in foreign currencies for all sectors.

$$NFCA = NFAMABK + NBKA\$ - NBKL\$ - IB\$$$

with:
NFAMABK = Net foreign assets of the monetary authorities and deposits money banks.
NBKA$ = Foreign-currency assets of non-banks (cross-border) held with BIS reporting banks.
NBKL$ = Foreign-currency liabilities of non-banks (cross-border) to BIS reporting banks.
IB$ = International debt securities (bonds) outstanding denominated in foreign currency.
XGS et *MGS* = Exports and imports of goods and services respectively.

with *FC%TD* = Foreign currency share of total debt

$$FC\%TD = \frac{NBKL\$ + BKL\$ + DCP\$ + IB\$ + DB\$}{NBKL + BKL + DCP + IB + DB}$$

$ refers to debt denominated in foreign currency.
BKL = Liabilities of banks (cross-border) to BIS reporting banks in all currencies.
DCP = Domestic credit to private sector.
DB = Domestic debt securities (bonds) outstanding in all currencies.

(Restrictive) Hypothesis : in the baseline calculations all domestic bonds and domestic bank loans (domestic credit) are assumed to be denominated in domestic currency – that is DB$/DB and DCP$/DCP = 0.

According to Goldstein and Turner (2004), FC%TD must fall between zero and plus one.

Note: Estimates of the AECM indicator invite time-series and cross-country comparisons of currency mismatch for a considered period. When AECM is above 0 the country is globally *net creditor* (in foreign currency) and inversely, when the AECM indicator is below 0, the country is viewed as *net debtor* (in foreign currency).

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22. When there is a net liability position ($NFCA \leqslant 0$), an exchange rate depreciation induces a negative "balance-sheet effect" (net worth falls) and a positive "competitive effect" (exports rise and imports fall); the competitive effect offsets the balance-sheet effect and makes the effective mismatch smaller. In contrast, when there is a net asset position in foreign currency ($NFCA \geqslant 0$), the balance-sheet effect (net worth rises) and the competitive effect (exports rise and imports fall) go in the same direction – that is, the competitive effect reinforces the balance-sheet effect and makes the mismatch larger.

Appendix 2

Definitions of currency mismatch indicators for the banking sector

The currency mismatch indicators are built as follows:

Domestic indicators:

– Ratio of domestic banking sector debt[23] in foreign currencies-to-total domestic debt (%) (IS1 indicator);

– Ratio of deposits in foreign currencies-to-total deposits (%) (IS2 indicator);

– Ratio of domestic loans in foreign currencies-to-domestic deposits in foreign currencies (IS3 indicator).

External indicators:

– Ratio of external liabilities in foreign currencies-to-total liabilities (as %) (IS4 indicator);

– Ratio of external liabilities-to-external assets denominated in foreign currencies (IS5 indicator).

Data were collected from national sources, essentially from national central banks, for each country of our study over the period 1990-2005 with monthly periodicity.

Appendix 3

Redundant fixed effects tests and Hausman test

Table A3.1 - Redundant fixed effects tests

Pool: Spreads – Test cross-section fixed effects

Effects Test	Statistic	Prob.
Cross-section F	37.189722	0.0000
Cross-section Chi-square	636.170520	0.0000

Table A3.2 - Correlated Random effects – Hausman test

Pool: Spreads – Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Prob.
Cross-section random	11.236702	0.0240

23. Domestic debt of the banking sector represents all liabilities in foreign currencies of the banking sector held by residents.

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