

***“Global Risk Perceptions and Expectations on Fundamentals:
Emerging Market Bond Spreads Drivers”***

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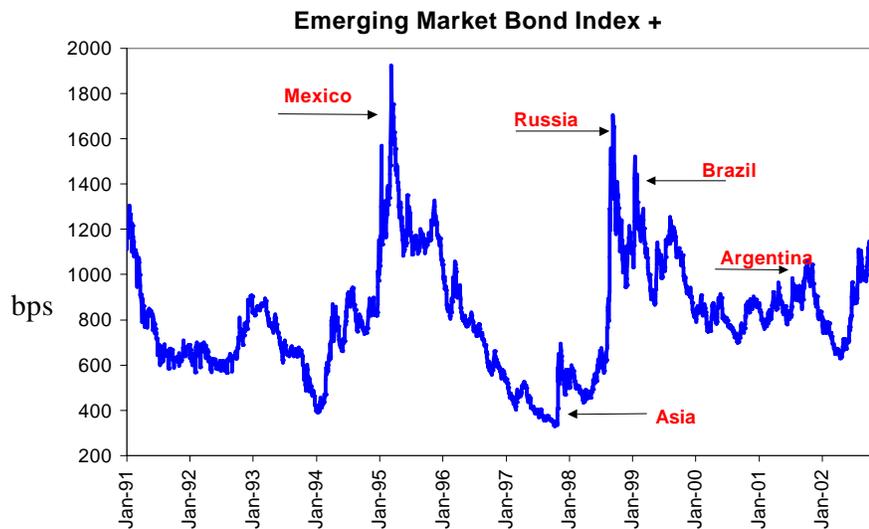
Abstract

This paper analyzes the determinants of Emerging Market Bond Spreads for the period from January of 1998 to December of 2002. Using panel data techniques, it is found that changes in emerging market bond spreads are driven by the level of investor’s risk aversion, medium term market expectations of macroeconomic variables and sovereign credit ratings. By introducing an index of global risk perception, the paper explores empirical support to analyze the behavior of financial markets and the effects on asset prices, particularly on emerging market bonds.

1. Introduction

The market for emerging market debt was created after the international debt crisis of 1982, when many countries were hit by falling commodity prices and were unable to service their commercial bank loans. In 1989 the Brady Plan¹ was introduced by the US Treasury as a mechanism by which indebted countries could repackage large amounts of the debt into easily tradable bonds. The 1990's were characterized by large and volatile private international capital flows towards emerging markets as well as frequent financial crises as reflected in the market's erratic yield spread pattern (Graph 1). Many have questioned whether globalization in international markets, possibly due to informational and technological advances, has increased considerably and rapidly. This has generated an extensive literature around the factors that determine the trend in credit spreads on emerging market debt instruments. After the Russian crisis in 1998, emerging market bond spreads as measured by the EMBI² spread index, a weighted bond index of the major issuers computed by J.P. Morgan, narrowed from 1600 basis points in late 1998 to levels of around 600 basis points by the beginning of 2002.

Graph 1. EMERGING MARKET BOND INDEX + AND EMERGING MARKET CRISES



Source: JP Morgan

¹ Named after then US Secretary of the Treasury Nicolas F. Brady

² EMBI = Emerging Market Bond Index.

Various factors have been cited for the decline in spreads during this period, such as, the continuing process of globalisation, the low level of industrial countries short-term interest rates and the improvement in the creditworthiness of emerging market borrowers, (Kamin and Kleist, 1999). However the decline of spreads did not come through to all the issuers of emerging market bonds. While Brazilian sovereign spreads recovered from their crisis level of 1400 basis points at the beginning of 1999 to 600 basis points by the beginning of 2001 (thanks to a return to dynamic growth after devaluation) in line with the EMBI index, Venezuelan spreads did not break the range of 800 basis points in the same period (due to weak macroeconomic performance between 1999 and 2000). Since the beginning of 2001, when economic and financial problems in Argentina started to be more evident, emerging bond spreads were again hit by the uncertainty of a possible contagion to the rest of the emerging economies. Although there were some indirect effects on neighbouring countries (e.g. the financial system in Uruguay was severely affected by the measures taken in Argentina to prevent the falling of deposits), the important role of both the discriminating and the domestic investor according to the IMF³, limited the adverse effects on other developing countries.

All in all, this suggests that market participants differentiate between sovereign risks among countries and that spreads reflect how global investors perceive the macroeconomic performance of a particular economy. This raises three questions which this paper tries to answer: First, how emerging markets are naturally influenced by events in mature markets, second, is there a systemic relationship between country fundamentals and spreads and third, does this relationship hold across countries and time. So far, empirical studies have identified emerging bond spreads as a function of solvency and liquidity variables⁴, and macroeconomic variables such as inflation, terms of trade and exchange rate. Other literature also considers external shocks through international

³ IMF, "Global Financial Stability Report – Market Developments and Issues". June 2002

⁴ See definition in Chapter 2.

interest rates and oil prices. In addition there are studies which incorporate dummy variables to test the influence of political events or economic crisis on spreads. All these explanatory variables are usually of low frequency and only actual data (mainly on a yearly basis) rather than expectational data is taken into account to determine annual spread levels. This approach ignores that market participant's expectations about key determinant variables are the real spread drivers.

This paper performs an empirical analysis for yield-spread determination and shows that emerging market bond spreads during the period of January 1998 and December 2002 can be explained by the level of global financial risk uncertainty, market expectations of macroeconomic fundamentals, and sovereign credit ratings. Using panel data techniques it is found that uncertainty in global financial markets as measured by the Risk Aversion Index (RAI) may affect emerging markets bond spreads in the short term. Medium term expectations of real GDP growth, Inflation and Current account balance play a significant role in determining changes in sovereign yield over the medium term horizon. Structural variables, as measured by sovereign credit ratings are relevant to explain long term spread movements.

The paper is organized as follows: Chapter 2 reviews existing empirical studies of emerging market bond spread determination. Chapter 3 presents an alternative approach by introducing a measure of global risk uncertainty and market expectations on fundamentals. A description of the data is also included in this chapter. Chapter 4 presents the specification of the model and the analysis of the results. Finally the conclusions are shown in Chapter 5.

2. Literature Review

The spread of Emerging Markets bond yields over U.S. Treasuries is often used as an indicator of sovereign risk. Interpreted in such a way, they are a useful tool to judge market assessment of a country's political and economic fundamentals and as a proxy for capital market access. Hence changes in these fundamentals in addition to changes in investor's risk assessment for individual countries could be monitored by developments in emerging market bond spreads.

The variables commonly used in most literature of the determinants of emerging market bond spreads, may be classified into:

- *Liquidity variables*: These variables include components of balance of payments that reflect a country's short-run financing conditions. Typically, they are in the form of ratios that proxy capital in-and outflows. The most important examples are (i) the debt service to export ratio, (ii) the interest service ratio (i.e., the ratio of interest payments to exports during a given period), and (iii) the liquidity gap ratio (i.e., one year short term debt minus current account balance as a ratio to available funding (capital flows)). Most empirical studies have found the debt service to export indicator to be the most significant of the above indicators.
- *Solvency variables*: These are related to the liquidity variables in that they are intended to measure for a country's medium to long term ability to service its debt. Examples include: (i) the reserves to imports ratio, (ii) export fluctuations (usually expressed as export growth as deviation from trend), (iii) the debt to GDP ratio.
- *Macroeconomic fundamentals*: These variables reflect a country's long run prospects and are used to assess the quality of a country's government and the economic dynamics within an economy. Examples include: (i) the inflation rate, (ii) the real exchange rate, (iii) the GDP growth rate, (iv) the growth rate of exports.

- *External shocks*: Variables of this kind include: (i) changes in US Treasury interest rates and (ii) changes in the real oil price.

Cantor and Packer (1996), analyse the determinants of sovereign bond spreads for 49 countries in 1995. They relate spreads to income per capita, GDP growth, inflation, the fiscal balance, the external balance, external debt, indicators of economic development, the country's default history, and Moody's and Standard and Poor's sovereign credit ratings. The paper shows that sovereign ratings effectively summarize and supplement the information contained in macroeconomic indicators and are therefore strongly correlated with market determined credit spreads. Using similar explanatory variables, Cline and Barnes (1997) use a cross section time series sample of 12 emerging markets and six industrial country Eurobonds. Applying pooled OLS estimation without allowing for country specific fixed or random effects, they find that standard liquidity and macroeconomic variables are significant in explaining differences in spreads across countries and over time prior to the Asian crisis. The current account is significant in the study while international interest rates are not. Investment Banks like J.P. Morgan (1995) and Goldman Sachs (2000) also carry out research on emerging market bond spreads. J.P. Morgan (1995) estimates a fixed-effect model of stripped Brady bonds spreads. The study finds standard solvency and macroeconomic indicators to be significant. Goldman Sachs (2000) uses a panel of eurobonds issued by major market participants. In this study, standard solvency variables are significant and a variable capturing the openness of the economy as a spread-reducing factor is also relevant.

Developments in the exchange rate policy as well as the openness of an economy to other markets are seen to be relevant to differentiate the spread levels across the emerging markets. Sachs (1985) investigated the role of various macroeconomic policies and fundamentals for the debt-crisis and provided the empirical rationale for using certain economic fundamentals in the determination of the risk-premium in international capital markets. In particular, he emphasized the importance of trade and

exchange rate policy for a developing country's performance. Haque et al (1996) investigated the economic determinants of developing country creditworthiness for some 60 developing countries and found that economic fundamentals – the ratio of nongold foreign exchange reserves to imports, the ratio of the current account to GDP, growth and inflation - explain a large amount of variation in credit ratings and all developing country ratings were adversely affected by increases in international interest rates, independent of domestic economic fundamentals. Eichengreen and Mody (1998) examine the launch spreads of nearly 1000 emerging market bonds. The results show that the higher the credit quality the more likely the country to go to the debt market with lower spreads. The paper finds that observed changes in fundamentals explain only a fraction of the spread compression in the period leading up to the 1998 emerging market crisis.

The following variables are also considered for their influence on emerging markets bond spreads: external shocks (e.g. international interest rates or oil prices) and characteristics of the bond issue (size, floating vs. fixed etc.). Kamin and Kleist (1997) develop measures of emerging market credit spreads for the 1990s to identify the impacts of credit ratings, maturity and currency denomination on spreads. The paper finds important regional differences in spreads across the developing world. Min (1998) finds that variations in industrial country short-term interest rates explain relatively little of the behaviour of emerging market spreads. The study uses a cross-country sample of more than 500 Latin American and Asian “launch spreads” and identifies mainly country-specific solvency variables and macroeconomic factors as the driving forces of bond spreads in the first half of the 1990s. Since bonds with different issue size and maturity are included in the sample, these characteristics are also included as regressors. In this paper, international factors such as international interest rates and the real oil price are found to be insignificant.

In contrast to the IMF's views, which highlights the important role of investors discriminating between debtor countries in limiting contagion during the recent Argentinean crisis, Mauro et al (2000) show that sharp changes in spreads today tend to be mostly related to global events, whereas country specific events played a bigger roll in other periods. The paper analyses yield spreads on sovereign debt issued by emerging markets using modern data from the 1990s and newly-collected historical data on debt traded in London during 1870-1913. Applying several empirical approaches, the paper shows that sharp changes in spreads today tend to be mostly related to global events, whereas country specific events played a bigger role in 1870-1913.

The research cited above has found some determinants to explain emerging market bond spreads. However these results are mainly useful to establish long-term relationships. The reason is that most of the dataset is available only at annual or quarterly frequency. In this context, Beck (2001) provides an interesting contribution to the research of emerging spreads. Using high frequency data and differentiating between time horizons, Beck (2001) shows that emerging market Eurobond spreads after the Asian crisis can be almost explained by market expectations about macroeconomic fundamentals and international interest rates. Contrary to the results found in this study, Beck (2001) finds that external factors like stock market volatility in the developed countries did not play a significant role after the Asian crisis. However, the research in Beck (2001) implicitly identifies points that merit further discussion. Firstly, the model uses only monthly data for the sample 1998:12 to 2000:8 and can not prove whether the estimated relationship is stable over a longer time period. Therefore further research into the stability of the results appears warranted. Secondly, the paper's conclusions regarding the importance of current account deficits could be driven by the specific definition of the current account variable. In order to properly analyse the influence of the current account on bond spreads, it is necessary to normalize the variable to compare across countries and time. In Beck (2001) this variable is defined as the level of the nominal current account balance, which could

explain the ambiguous results of the study. Finally, financial market uncertainty, as measured by the VIX⁵ (Volatility Index), is not significant in determining changes in bond spreads according to Beck (2001). Hence, this study will particularly try to shed further light on the influence of the current account variable by employing a different variable definition and at the same time will introduce a measure of global risk uncertainty to test the effects of investor's risk appetite on bond spreads performance.

⁵ Introduced by the Chicago Board Of Exchange in 1993, VIX is a weighted measure of the implied volatility for 8 OEX put and call options. The 8 puts and calls are weighted according to time remaining and the degree to which they are in or out of the money. The result forms a composite hypothetical option that is at-the-money and has 30 days to expiration. (An at-the-money option means that the strike price and the security price are the same.) VIX represents the implied volatility for this hypothetical at-the-money OEX option.

| Table 1. Literature on Emerging Market Bond Spread | Period | Dependent | Explanatory Variables | | | | | Estimation | Region |
|--|--|---|--|--|---|--|---|--|--|
| | Data Frequency | Variable | Liquidity/Solvency | Macroeconomic | External | Others | Dummy Variables | Method | |
| | | Type of Bond Spread | | | | | | | |
| Cantor and Packer (1996) | 29-Sep-95 Daily | Eurodollar bonds for countries | Fiscal Balance (-) External Balance (-) External Debt (+) | Per capita Income (-) Growth rate of GDP (-) Inflation (+) | | Average ratings** (-) | Economic development (-) Default history (+) | OLS | Latin America Asia, Europe Middle East Africa |
| Cline and Barnes (1997) | 1992-1996 | 3-month average of Eurobonds spreads specific bonds | Reserves/imports (-) Debt/exports* (+) Fiscal balance Current account/exports* (-) | Growth rate of GDP* (-) Inflation* (-) | US treasury rate | | Brady* (+) Industrial country*(-) | Pooled OLS | Latin America Asia, Eastern Europe Western Europe and Africa |
| Kamin and Kleist (1997) | 1991-1997 Semianual | Debt instruments, bonds and loans | | | 3-month US treasury rate | Rating* (-) Maturity | New Issue Loan Currency Period effects | Pooled OLS | Latin America Eastern Europe Middle East Africa |
| Eichengreen and Moody (1998) | 1991-1996 Quarterly (Interpolation of annual data) | Launch spreads of government and corporate issuers | Debt/GNP* (+) Debt service/exports* (+) Credit rating residual* (-) | Growth rate of GDP | International Interest Rate* (-) | Issued amount* (-) Maturity* (+) Private issue Public issue* (-1) Private placement* (+) | Debt restructure* (-) Lat. Amer. Issuer* (+) | Simultaneous estimation of determinants of bond spreads and decision to issue. | Latin America Asia, Europe Middle East Africa |
| Min (1998) | 1991-1995 Annual | Launch spreads of government and corporate issuers | External Debt/GDP* (+) Int. Reserves/GDP* (-) Debt service/exports* (+) Growth rate imports* (+) Growth rate exports* (+) Current Account/GDP Net Foreign assets | Growth rate of GDP Terms of trade* (-) Inflation* (-) Real Exchange Rate* (-) | International Interest Rate Real oil price | Issued amount* (-) Maturity* (-) Private issuer* (-) | Lat. Amer. Issuer Mexican Crisis | Pooled OLS | Latin America and Asia |
| Beck (2001) | Dec/98 - Aug/00 Monthly | Eurobonds | | GDP Growth**(-) Inflation* (+) Current Account | Libor* (+) | Volatility Index | | Pooled OLS | Latin America Asia, Eastern Europe |

Notes:

* Significant at least at 10% level

** Significant at 1% level

3. Emerging Market Bond spreads: Horizons and determinants

The purpose of this paper is to determine the economic and financial determinants of yield spreads for the US dollar denominated debt instruments issued by emerging market sovereign and quasi-sovereign entities during the period of January 1998- December 2002. The model uses monthly data for 11 emerging countries for all emerging regions (Latin America, Emerging Europe and Asia). These countries are Argentina, Brazil, Colombia, South Korea, Malaysia, Mexico, Philippines, Poland, Russia, Turkey and Venezuela.

3.1.1 Dependent Variable

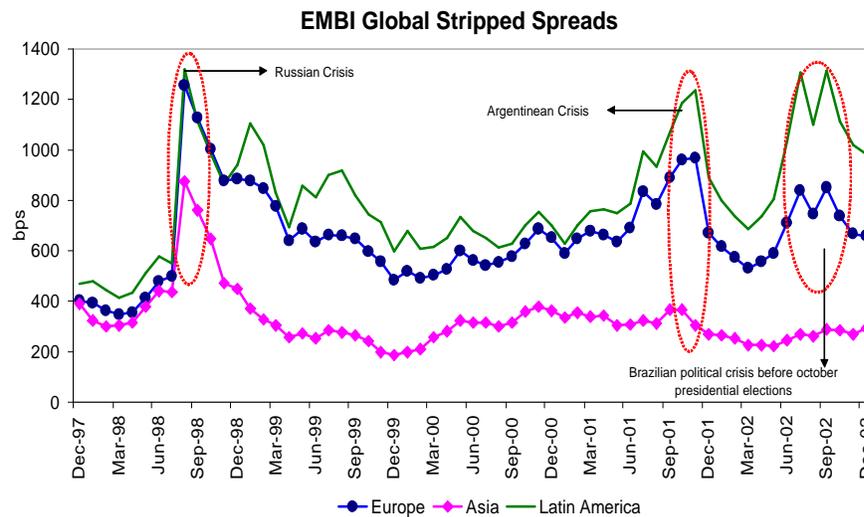
For the econometric analysis, this paper uses the data on emerging market spreads on sovereign bonds as compiled by J.P. Morgan in its EMBIG⁶ stripped spread index. This measure, a closely watched indicator of emerging market spreads by market participants, tracks the yield spread between U.S. dollar-denominated Brady Bonds, Eurobonds, traded loans and local market debt instruments issued by sovereign and quasi-sovereign entities and US Treasury Bonds of comparable maturity. As of August 30 of 2002, the EMBIG included 147 instruments representing 33 countries, with a market capitalization of US\$186 billion.⁷ The spread data is available at daily frequency and is a weighted average of spreads on a variety of bonds including Brady and Non-Brady bonds. In order to find the underlying sovereign credit risk, this study uses the stripped spreads, which refer to spreads once the estimated effects of the collateral on these spreads are removed.⁸

⁶ EMBIG = Emerging Market Bond Index Global

⁷ The emerging market debt universe as represented by the EMBIG has a face value of outstanding bonds exceeding US\$217 billion. This is not far from the market capitalization of the JPMorgan High Yield Index of US\$288 billion.

⁸ For most Brady bonds the principal payment is secured by an irrevocable pledge of US treasuries to pay the full principal at maturity. For further analysis to calculate the stripped spreads see "The New Dynamics of Emerging Markets Investment (1997), Chapter 2: "A quantitative framework for emerging bonds" by Keneth L Telljohann.

Graph 2. EMBI GLOBAL STRIPPED SRPEADS IN EUROPE ASIA AND LATIN AMERICA
Source: JP Morgan



3.1.2 Explanatory variables

The explanatory variables incorporated in the model are thought to represent short, medium and long-term determinants of changes in emerging market bond spreads.

Global risk perception:

One of the drivers for short-term movements in emerging market bond spreads is the investor's risk appetite/aversion regarding different markets. The events of the last few years have highlighted the importance of understanding how events can change global risk perceptions and in that way how performance of different asset classes, including emerging bond market, can be affected. More recently, in the second quarter of 2002 and early in the third, global financial markets were buffeted by a series of disconcerting events that undermined investor confidence. The most significant event was a financial restatement in late June by WorldCom, a large US telecommunications firm. The fear of more widespread corporate problems precipitated a slump in equity markets in both the United States and Europe. The negative sentiment even spilled over into the once

resilient corporate bond market, where issuance slowed as credit spreads widened. In August, an absence of further bad news seemed to restore a degree of confidence. There were signs that investors were returning to the equity markets and corporate bond markets.

The financial sector did not fare as well in this latest short period of market weakness as in previous episodes. Banks in Europe and finance companies in the United States not only lost market value but also saw the spreads on their senior debt widen sharply. These developments threatened to constrain financial intermediation, possibly adding to the difficulties of non-financial firms in raising money.

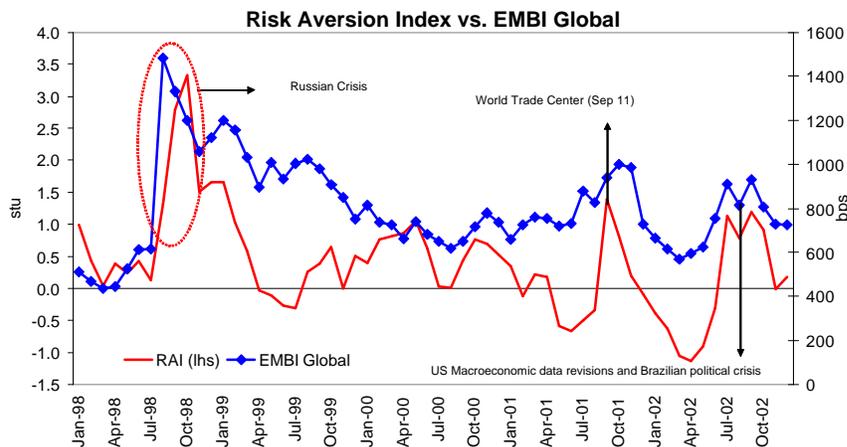
Several emerging market countries found their domestic economic and political problems exacerbated by the global rise in risk aversion. Investors punished most those countries for which questions about the sustainability of debt burdens coincided with political uncertainty (see Graph 3). At the same time, sovereign debt spreads tended to widen with those on low-rated corporate bonds. Nonetheless, while bond issuance by emerging market borrowers slowed in July, the stronger credits among them maintained access to the market.

That said, it is clear that daily and intraday movements in the spread levels, are driven by various factors (supply and demand factors, technical factors and political news) that rarely have a permanent effect on the credit standing of the country. For instance, portfolio adjustments by “crossover investors” due to reduction or elimination of holding of emerging markets assets can exacerbate price volatility in emerging markets⁹. Such reallocation of the portfolio can lead to an abrupt expansion or contraction of market access from emerging markets that can be unrelated to changes in emerging market fundamentals. For that reason, it is unlikely that macro fundamentals that change on a monthly basis can explain day-to-day changes of bond spreads. By introducing a measure of global risk

⁹See IMF, World Economic Outlook (WEO). “International Financial Contagion”. May 1999

aversion¹⁰, which has historically shown significant day-to-day variation, this study contributes to the understanding of short-term spread variations. The motivation to analyse this variable also coincides with the comments made by Kamin and Kleist (1999) from the Federal Reserve who consider that “.....It should be noted that we have not seen any research establishing a theoretical justification for the “appetite for risk” argument. That is, it is not obvious that the positive relationship between industrial country interest rates and emerging market spreads posited by that argument is consistent with rational, maximizing behaviour in financial markets. However, given the prominence of the “appetite for “risk” argument in much financial commentary, we still believe it to be worthwhile to explore empirical support for this argument.....(pg. 21)”.

Graph 3. Risk Aversion Index (RAI): Author’s calculations (See appendix); EMBI Global: JP Morgan.



In order to assess investor’s risk appetite levels, for this study we introduce the Risk Aversion Index (RAI). The RAI is constructed by extracting a common factor from a large number of market series. These time series are drawn from three broad categories: (i) bond market, (ii) equity market, (iii) foreign exchange markets. All series entering the index are stationary and seasonally adjusted and are expressed in standardised units. The RAI comprises 32 daily market activity variables beginning in January 1995. The idea behind the measure is a simple one. When

¹⁰ Using Principal Components analysis, we calculate a measure of global risk aversion with bond, equity and currency market data. See Appendix.

investors are risk lovers, they are more likely to increase their exposure to risky assets. This in turn will lower the risk premium (i.e. the yield on emerging market bonds) required to hold the asset in question. Risk aversion in turn will tend to raise the risk premium as investors become less willing to enter risky investment positions. Consequently, spread of risky assets will tend to increase. A full list of the series and the econometric procedure to calculate the RAI is described in the Appendix.

Graph 3 shows how during the Russian crisis in October of 1998, risk aversion surged. This reflected investors' search for safe haven to limit their exposure to risk: Investors sold high-risk assets (e.g. emerging market bonds) while buying low-risk assets (e.g. US Treasuries). More recently, the RAI has illustrated the increase in risk aversion in the global markets after the World Trade Centre attacks and the uncertainty generated from the US stock market and the corporate scandals during 2001-2002. The more the index is above (below) the zero line, the more risk averse (risk loving) global investors are. Once the index reaches values close or equal to zero, the appetite for risk is in neutral territory.

Market expectations on fundamentals:

To identify the relevance of the variables to explain sovereign yields, there are three main assumptions about country fundamentals driving bond spreads. First, bond spreads reflect the probability of default of the issuing countries. Assuming the market is forward looking, the spreads compensate for the sovereign risk implied by a specific country. Second, in order to limit the exposure to risky countries and determine the probability of default, markets monitor the current macroeconomic performance of the issuing country through solvency variables. Under an efficient market hypothesis¹¹ bond spreads movements are triggered only

¹¹ The efficient market hypothesis says that the price of a financial asset reflects all the information available and responds only to unexpected news. Thus prices can be regarded as optimal estimates of true investment value at all times.

by new information. Third, the current level of bond spreads reveals market medium term expectations of key macroeconomic variables.

Market forecasts of the main country fundamentals are used to measure the medium term expectations on fundamentals, particularly for real GDP, Inflation and Current Account Balance. For this purpose this paper uses Consensus Economics Inc. data, which compiles the forecasts of these variables from market participants (major investment banks, corporations, local firms and independent consultants around the world), which is commonly known as “Consensus”¹². The group of forecasters forming the “Consensus” is a group of big players in the market, which dedicates considerable resources to macroeconomic analysis. In that sense, they represent an appropriate measure of market expectations¹³.

On a monthly basis, Consensus Economics Inc. publishes the mean forecast for real GDP growth, inflation and current account ¹⁴ for the current and following year. For the purpose of this study and to be consistent across all the countries considered in the sample, we constructed the market expectations on current account balance to nominal GDP ratio rather than simply the current account balance itself¹⁵. In order to reduce the sensitivity to business cycle fluctuations of the forecast of the current year and to increase the weight of the forecast as the end of the period gets closer, a *medium term forecast* is computed as follows:

$$c_t = \frac{(12-t)x_a^e + tx_{a+1}^e}{12}, t = 1...12$$

¹² The arithmetic average of all the forecasters is generally called as “consensus”.

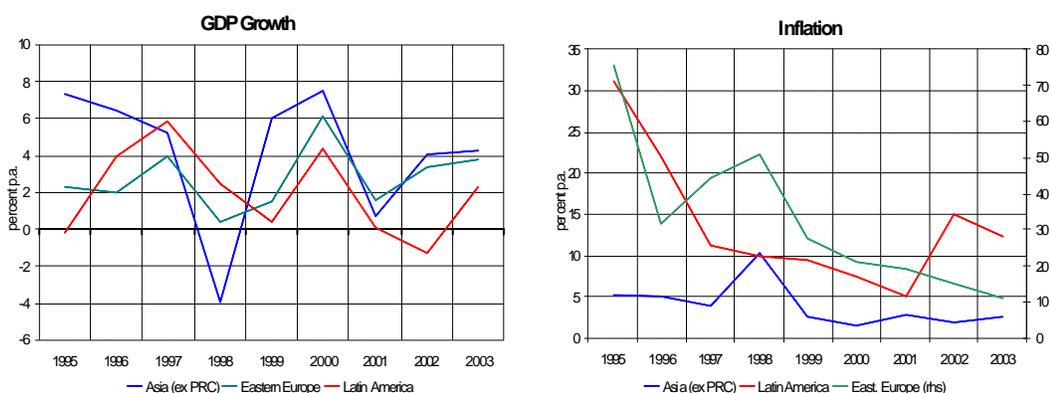
¹³ Batchelor (2000) shows that for industrialised countries the “Consensus” forecasts are even better than those published by International Institutions like the IMF and the OECD.

¹⁴ For Latin American and Emerging Europe the survey is carried out bimonthly. Monthly figures are obtained by using balanced panel techniques.

¹⁵ The nominal GDP expectations data are not published by Consensus Economics Inc. However using the observed level of real GDP and the expectations of CPI and real GDP, we can calculate the level of nominal GDP. See Appendix.

x_a^e and x_{a+1}^e are the “consensus” forecast for the current year and next year respectively and t is the number of the current month (i.e January = 1, February =2...December = 12).

Graph 4. Consensus GDP growth and inflations expectations
Source: Author's calculations and Consensus Economic Forecasts.



Sovereign Credit Ratings

Macroeconomic fundamentals reflect a country’s long run prospects and are used to assess the quality of a country’s government and the economic dynamics within an economy. Most prior analyses of emerging market debt spreads have used various country performance variables as measures of borrower creditworthiness. However the study by Cantor and Packer (1996) suggests that the credit ratings assigned to sovereign borrowers by Moody’s and S&P, include all the information contained in the country’s performance measures and in fact, add information relative to those measures in explaining sovereign debt spreads. The study compares the results of two regressions: (i) bond spreads against the average of Moody’s and S&P ratings and (ii) bond spreads against a vector that comprises macroeconomic variables, solvency and liquidity variables¹⁶. The results show that more than 92 percent of the variation of bond spreads could be explained by country’s rating against 85% by the vector of macroeconomic variables. The same study claims that “credit

¹⁶ These variables are: Per capita income, GDP growth, inflation, fiscal balance external debt, external balance, indicator for economic development and indicator for default history.

ratings appear to have some independent influence on yield over and above their correlation with other publicly available information”. This finding would imply that the ratings lead rather than lag the financial markets, by acquiring advance knowledge of superior information that has subsequently been transmitted to market participants.

A further advantage of using credit ratings as a measure of creditworthiness is that these credit ratings take into account many attributes that are specific to the issuer and which are, in most of the cases, difficult to differentiate among countries. Furthermore, in their statements on rating criteria, Moody’s and Standard and Poor’s (S&P) list numerous economic, social and political factors that underlie their sovereign credit ratings. Like any other credit ratings, sovereign ratings are assessments of the relative likelihood that a borrower will default on its obligation.

Table 2 presents the conversion of these measures into numerical rankings, with 20 being the best credit risk and 1 the worse. Moody’s rating was chosen since all the countries in our sample have been rated by this agency since the beginning of the sample period.

Table 2

| V a l u e | M o o d y ' s |
|------------------|----------------------|
| 20 | A a a |
| 19 | A a 1 |
| 18 | A a 2 |
| 17 | A a 3 |
| 16 | A 1 |
| 15 | A 2 |
| 14 | A 3 |
| 13 | B a a 1 |
| 12 | B a a 2 |
| 11 | B a a 3 |
| 10 | B a 1 |
| 9 | B a 2 |
| 8 | B a 3 |
| 7 | B 1 |
| 6 | B 2 |
| 5 | B 3 |
| 4 | C a a 1 |
| 3 | C a a 2 |
| 2 | C a a 3 |
| 1 | C a |

For estimation purposes, the study considers a panel of the JP Morgan EMBI Global stripped spreads for the countries mention above for the period from January 1998 to December 2002. The sample and the period were chosen for three main reasons: (i) the sample of these 11 emerging economies considers the major sovereign issuers of the emerging market universe. In that way, the sample accounts for more than 80% of total emerging debt market capitalization and more than 80% of outstanding debt; (ii) the dependent variable is only available from January of 1998 and (iii) the macroeconomic expectations data and sovereign credit ratings are fully balanced for all the countries of the sample from January 1998 onwards.

4. Panel Estimation of the Model

The class of models that can be estimated using panel data can be written as:

$$y_{it} = \mathbf{a}_{it} + x'_{it} \mathbf{b}_i + \mathbf{e}_{it}$$

Where y_{it} is the dependent variable and x_{it} and \mathbf{b}_i are k –vectors of non-constant regressors and parameters for $i = 1, 2, \dots, N$ cross-sectional units. Each cross-section units is observed for dated periods $t = 1, 2, \dots, T$.

We can view these data as a set of cross-section specific regressions so that we have N cross-sectional equations of the form:

$$y_i = \mathbf{a}_i + x_i \mathbf{b}_i + \mathbf{e}_i$$

with T observations, stacked on top of one another. \mathbf{a} , X and \mathbf{b} incorporate any restrictions on the parameters between cross-sectional units. The basic specification treats the pool specification as a system of equations and estimates the model using system OLS. This specification is appropriate when the residuals are contemporaneously uncorrelated and time-period and cross-section homoskedastic.

The econometric literature on panel data estimation emphasizes that it is not straightforward to determine whether cross-section effects should be treated as fixed or random. For the purpose of this study both fixed and random effects are considered.

4.1 Fixed Effects Model – (FEM)

The estimation is first specified as a fixed-effects model. This is appropriate if we can expect that country-specific intercepts represent different levels of spreads reflecting time-invariant factors, and if we think that no random process has led to these intercepts in the sample. The fixed effect model is estimated as:

$$\log[EMBIGspread] = \mathbf{a}_i + \mathbf{d} w_t + \sum_{k=1}^3 \mathbf{l}_k x_{kit} + \mathbf{f} z_{it} + \mathbf{e}_{it} \quad (1)$$

where $i = 1$ to 11 countries, $t = 1$ to 60 monthly observations, x_{kit} are the medium-term forecasts for the 3 macroeconomic variables which vary across countries and time, w_t represents the RAI which varies only over time and z_{it} Credit Rating which vary across countries and time. The coefficients \mathbf{d} and \mathbf{f} are restricted to be the same across countries.

4.1.2 Results of the panel estimation

Table 3

| Fixed effects model: Period 1998:01 - 2002:12 | | |
|---|-------------|-------------|
| Dependent variable: log (Spread) | | |
| Method: Pooled Least Squares | | |
| White Heteroskedasticity - Consistent Standard Error & Covariance | | |
| | Coefficient | t-statistic |
| GDP | -0.08 | -12.55 |
| CPI | 0.01 | 4.78 |
| CA/GDP | -0.01 | -1.90 |
| Rating | -0.20 | -16.48 |
| RAI | 0.11 | 10.37 |
| Fixed Effects | | |
| Argentina | 8.12 | |
| Brazil | 8.19 | |
| Colombia | 8.37 | |
| Korea | 8.07 | |
| Malaysia | 8.31 | |
| Mexico | 8.30 | |
| Philippines | 8.39 | |
| Poland | 8.13 | |
| Russia | 8.42 | |
| Turkey | 7.74 | |
| Venezuela | 8.02 | |
| R-squared | 0.90 | |
| F-statistic | 146.75 | |
| Durbin-Watson sta | 0.49 | |
| Total panel obs. | 660 | |

The results of the estimation can be seen in Table 3. The value of the R-squared implies that the specification of the model can explain 90% of the variance. The fixed effect specification of the model is appropriate and satisfies the condition of country specific factors to explain bond spread changes. This can be verified as the standard F-Test for the significance of the regression is significant at the 1% level¹⁷. According to the Durbin Watson test, there is positive autocorrelation in the disturbances. This violation of the OLS assumptions is corrected with the White procedure. This correction of the variance does not change significantly the *t-statistics* of the estimated coefficients.

¹⁷ The critical value at the 1% level is $F(8.175) = 2.51$. The test statistic at 146.751 clearly exceeds this number.

Table 4 shows that even excluding 1998, a period of high spreads the Russian crisis, these general observations do not change.

| Table 4 | | |
|--|-------------|-------------|
| Fixed effects model: Period 1999:01 - 2002:12 | | |
| Dependent variable: log (Spread) | | |
| Method: Pooled Least Squares | | |
| | Coefficient | t-statistic |
| GDP | -0.07 | -9.06 |
| CPI | 0.01 | 3.87 |
| CA/GDP | -0.01 | -2.14 |
| Rating | -0.22 | -18.55 |
| RAI | 0.10 | 6.84 |
| Fixed Effects | | |
| Argentina | 8.27 | |
| Brazil | 8.40 | |
| Colombia | 8.60 | |
| Korea | 8.32 | |
| Malaysia | 8.47 | |
| Mexico | 8.55 | |
| Philippines | 8.65 | |
| Poland | 8.44 | |
| Russia | 8.45 | |
| Turkey | 7.99 | |
| Venezuela | 8.17 | |
| R-squared | 0.92 | |
| F-statistic | 164.47 | |
| Total panel obs. | 528 | |

- Real GDP growth (GDP), Inflation (CPI) and Current Account (CA):

The coefficients for medium – term forecasts for the macroeconomic fundamentals are intuitively signed and are significant at the 1% level. First, a relatively high GDP growth expectation implies that a country's existing debt burden will become easier to service over time. In that sense, the higher the economic growth expectations the lower the bond spreads of a specific country. According to the results, an increase of 1% in GDP medium term forecast reduce the spread level by around 8%.

Second, a high rate of inflation points to structural problems in the government's finance. When a government appears unable or unwilling to pay for current budgetary expenses through taxes or debt issuance, it must resort to inflationary money finance. Public dissatisfaction with inflation may in turn lead to political instability (Cantor and Packer 1996). This unhealthy macroeconomic situation causes an increase in the yield spread. A rise of 1% in CPI medium term forecast raises the spread level by 0.7%.

Third, a large current account deficit indicates that the public and private sectors together rely heavily on funds from abroad. Current account deficits that persist could result in growth in foreign indebtedness, which may become unsustainable over time (Cantor and Packer 1996). High external deficits render and make country's debt capacity questionable which in turn translates into higher spreads levels. Table 3 indicates that the effect of the current account on bond spreads is robust over time: if the period of high emerging market bond spreads (1998) is excluded, the variable is still significant at 1%.

Interestingly this result contrast with existing empirical evidence. Hawkins and Klau (2000) after analysing indicators of currency and banking crises, concluded that the "current account deficit is one of the most commonly tested variables but tends to be statistically insignificant". Furthermore, Beck (2001) reveals that the effect of the current account on bond spreads is ambiguous and not robust. However in Beck (2001)¹⁸, the current account variable is not expressed as a percentage of nominal GDP. The readings of the variable are therefore not comparable across countries. This might explain the weak correlation between external imbalances and bond spreads movements. From the results shown in Table 2, a cut by 1% in the medium term forecast for current account balance to GDP ratio, increases the spread by 1%.

¹⁸ See: "International Capital Markets" August 2001.

- Sovereign Credit Ratings (RAT)

The estimation results indicate that the spread and credit ratings variables are negatively correlated. According to the estimates of the model, the credit ratings are highly relevant for the spread performance. All else equal, the model predicts that a deterioration of credit ratings by one notch¹⁹ leads to an increase in the spread level of 20%. These results are highly consistent with those estimated by Cantor and Packer (1996), who examined secondary market spreads on 35 sovereign bonds in a single day in 1995. They estimated an elasticity of 0.22, implying that one-notch deterioration in sovereign credit ratings raises spreads by around 25%.

- Risk Aversion Index (RAI)

The Risk Aversion Index as a measure of global financial risk uncertainty is significant and has the expected sign. In times of high volatility in global financial markets, investors tend to reduce the exposure to high-risk assets and capital flows go towards safe haven investments. This “flight to quality” among investors makes emerging market debt vulnerable since it is generally deemed a high risk asset class. This type of investment behaviour can provide a channel for the transmission of the effects of developments in mature markets to emerging markets and help explain the “on-off” nature of emerging market borrowers even in periods where emerging market fundamentals are not changing or even improving. For instance, during 2000 average emerging market credit quality continued the improvement that had been evident since the Russian crisis of 1998. However abrupt changes in market access experienced during this period were not associated with sharp changes in market perceptions about emerging market fundamentals as a whole (IMF 2001)²⁰.

According to the estimated results, one standard deviation unit increase in the RAI will raise the spread by 11.5%. This result contrast with existing

¹⁹ Refer to Table 2 for more information.

²⁰ See IMF “International Capital Markets – Developments, Prospects and Key Policy issues”. August 2001.

empirical evidence. Kamin and Kleist (1999), studied the effects of short term interest rates on “appetite for risk” to explain changes in emerging market bond spreads. However the study fails to find strong, robust and positive linkage between industrial country interest rates and spreads on emerging bond. Furthermore, Beck (2001) concluded that global financial market uncertainty, as measured by the VIX, is not a driving force for bond spreads. The same study obtains the same results using monthly percentage changes of the Nasdaq index as independent variable. Both the VIX and the Nasdaq index are not significant in explaining short term movements in bond spreads.

- Fixed effects

The fixed effects capture the omitted variables that may lead to changes in the cross-section and time-series disturbances. These factors determine implicitly the absolute country-specific spread range. The decision to add dummy variables or fixed effects can be made on the basis of statistical testing.

Since the Ordinary Least Squares (OLS) model includes more parameter restrictions:

$$\log[EMBIGspread] = \mathbf{a} + \mathbf{d} w_t + \sum_{k=1}^3 \mathbf{I}_k x_{kit} + \mathbf{f}_2 z_{it} + \mathbf{e}_{it} \quad (\text{Common intercept})$$

than does the Fixed – effects model (FEM):

$$\log[EMBIGspread] = \mathbf{a}_i + \mathbf{d} w_t + \sum_{k=1}^3 \mathbf{I}_k x_{kit} + \mathbf{f} z_{it} + \mathbf{e}_{it} \quad (\text{Unrestricted model})$$

we would expect the error sum of squares to be higher for the ordinary least-squares model. If the sum of squares changes substantially, we opt for the fixed-effects model. If the increase in the error sum of squares is not significant when restrictions are added, we conclude that the

restrictions are proper and OLS can be applied. The appropriate test statistic is:

$$F_{i-1, iT-i-K} = \frac{(R_{OLS}^2 - R_{FEM}^2) / i - 1}{(1 - R_{FEM}^2) / (iT - i - K)}$$

where K is the number of regressors. The critical value at the 1% level is $F(8, 175) = 2.51$. The t-statistic at 146.7518 clearly exceeds this number²¹. Therefore the decision to add fixed effects is justified.

4.2 Random Effects Model

Although those major bond issuers which account for most of the emerging bond market are included in the sample, it is reasonable to assume that the relationship of country fundamentals and international market variables also hold for other economies²². If the countries are randomly drawn from a large population, a random-effect specification could be justified. This specification is given by:

$$\log[EMBIGspread] = \mathbf{a} + \mathbf{d} w_{1t} + \sum_{k=1}^3 \mathbf{l}_k x_{kit} + \mathbf{f} z_{2it} + \mathbf{h}_i + \mathbf{e}_{it} \quad (2)$$

Where \mathbf{a} is the common intercept and \mathbf{h}_i is a country-specific random disturbance which is constant through time²³.

When comparing the results of the two estimated models, there are no substantial deviations between them. The signs of the coefficients and

²¹ The R-squared from the pooled OLS regression is 0.86

²² Applying Hausman test we can test the efficiency of a Fixed Effects against Random Effects models. See Appendix C for further details.

²³ Formally the standard assumptions for the random effect model are:

$$E[\mathbf{e}_{it}] = E[n_i] = 0; E[\mathbf{e}_{it}^2] = \mathbf{s}_e^2; E[n_i^2] = \mathbf{s}_n^2; E[e_{it}n_j] = 0 \forall i, t, j; E[e_{it}e_{js}] = 0 \text{ if } t \neq s \text{ or } i \neq j; E[n_i e_j] = 0 \text{ if } i \neq j$$

their significance are the same as in the fixed effect specification. Table 5 shows the results of the random effects estimation.

In order to verify the robustness of the random effect, we estimate the model for a different time period and we change the number of elements of the sample by eliminating one country of the sample. The results shown in Table 6 and 7 in Appendix (b) validate that there is no change even under such circumstances.

Table 5

Random effects model: Period 1998:01 - 2002:12
 Dependent variable: log (Spread)
 Method: GLS (Variance Components)

| | Coefficient | t-statistic |
|--------------------------|-------------|-------------|
| Cst | 8.17 | 72.76 |
| GDP | -0.08 | -15.14 |
| CPI | 0.01 | 6.69 |
| CA/GDP | -0.01 | -1.98 |
| Rating | -0.20 | -19.80 |
| RAI | 0.11 | 9.43 |
| Fixed Effects | | |
| Argentina | -0.05 | |
| Brazil | 0.01 | |
| Colombia | 0.18 | |
| Korea | -0.12 | |
| Malaysia | 0.09 | |
| Mexico | 0.11 | |
| Philippines | 0.19 | |
| Poland | -0.06 | |
| Russia | 0.22 | |
| Turkey | -0.41 | |
| Venezuela | -0.16 | |
| R-squared | 0.89 | |
| Total panel obs. | 660 | |

5. Conclusions

In this paper we have described the determinants of emerging market bond spreads. By introducing a measure of global risk uncertainty, we have shown how behaviour of financial markets in the short term and market medium term expectations on fundamentals can affect emerging market asset prices. Based on the research described in this paper, we can draw the following conclusions.

First, contrary to recent literature cited earlier in this paper, it is found that uncertainty in global financial markets as measured by the RAI may affect the emerging markets bond spreads. The statistical analysis above establishes that the risk appetite of global investors is a significant driver of bonds spreads. This can be explained by different factors: (i) emerging market securities are regarded as a relatively risky asset class and movements in the RAI could be seen as providing an indicator of the willingness of investors to take on relatively risky/safety investing positions, including buying/selling emerging market holdings; (ii) according to the IMF (2001)²⁴, “crossover investors” who are judged by a benchmark which excludes emerging markets, but who may choose to opportunistically hold emerging market assets for a pickup in returns, have tended to retreat to their benchmark and hence away from emerging markets during times of volatility. Moreover, such investors tend to use Value at Risk, stress testing and similar models to limit their exposure to risk and hence, have intended to reduce riskier positions, including emerging market assets when asset price volatility increases. This type of investment behaviour can provide a channel for the transmission of the effects of developments in mature markets to emerging markets and help explain the “on-off” nature of emerging market borrowers even in periods where emerging market fundamentals are not changing or even improving. A good example can be seen when sharp declines in the U.S. Nasdaq index could impose large losses on crossover investors’ portfolios that

²⁴ See: “International Capital Markets” August 2001.

could in time lead them to adopt a more defensive portfolio strategy involving greater holdings of relatively “safe assets” (such as U.S. Treasury securities) and reduced holdings of what are viewed as relatively risky asset (including emerging market bond and equities) (IMF 2001). During these periods a surge in the RAI coincided with a surge in emerging market spreads and did create a difficult environment for international financial markets. That said, this study contributes to understand, using a measure of global risk aversion, how greater uncertainty in the global economy and financial markets tend to increase investor’s exposure to safe haven assets leaving high – risk assets vulnerable and less attractive.

Second, expectations of macroeconomic fundamentals are found to be significant in explaining bond spreads. The variables considered in the model can be understood as measures of the soundness of a country’s policy making. i) High economic growth will reduce the risk of default as fiscal revenues could improve and debt becomes easier to sustain. Assuming that the market is forward looking, higher growth expectations will tend to lower spread levels. ii) Monetary policy by Central Banks can be monitored through inflation developments. Since 1998, at the same time as inflation expectations in emerging markets considerable started to improve, spread levels have reduced from levels of 1200 bps to 700 bps by the end of 2002. iii) Using expectational data to construct the ratio of Current Account Balance to nominal GDP, the results show the robustness and statistical significance of the variable to explain changes in bond spreads. This finding contrasts with the claim that “current account deficit is one of the most commonly tested variables but tend to be statistically insignificant” (Hawkins and Klau, 2000 p.4). Countries with considerable current account deficits should exercise caution when contemplating an economic development strategy that relies on continuous inflows of foreign capital intermediated by the international bond market. Large quantities of foreign credit may be available when market sentiment shifts in their favour, but it can equally shift them for reasons beyond their control,

making it impossible to finance large current account deficits and forcing a difficult adjustment (Eichengreen and Mody 1998).

Third, the sovereign credit rating is a common measure of long-term structural factors. Governments generally seek to ease their own access to international capital markets through these credit ratings, while global investors prefer rated securities over unrated securities. This strong impact on credit ratings on emerging market bond spreads underlines the importance of long term structural factors in determining emerging market investor's allocation decisions. Using panel data analysis this paper presents econometric evidence that changes in credit rating have a significant impact on sovereign yields. However, this causality has merited some discussion in the literature of emerging markets. Larrain et al (1997) using Granger causality test, found that it is not clear whether ratings cause yield spreads and vice versa. That said, whatever the precise causality, the message seems to be that the market rewards improved ratings and fundamentals in emerging markets with both lower borrowing costs and greater financing flows (IMF 2000).

Appendix

a. Computation of the RAI Index

The RAI comprises 32 monthly market variables beginning in January 1995. A full list of the series is given in below. In deriving the indicator we use the following notation:

- The $T \times N$ matrix of standardised data comprising $i=1 \dots N$ market variables observed over $t=1 \dots T$ months is denoted X . As X has some missing elements (mainly due to series beginning on different dates) the panel is “unbalanced”. We denote the i, t th element of X by x_{it} if the data point is available and x_{it}^* if it is missing. One part of the estimation procedure involves finding estimates of the x_{it}^* . The $T \times 1$ columns of X are denoted \mathbf{x}_i and the $1 \times N$ rows are denoted \mathbf{x}_t .
- The individual elements of the unobserved $T \times 1$ common factor are denoted $\{f_t\}_{t=1}^T$ and the complete series is denoted $\mathbf{f} = (f_1, \dots, f_T)'$.
- The $N \times 1$ vector of weights on the \mathbf{x}_i is denoted $\mathbf{B} = (\mathbf{b}_1, \dots, \mathbf{b}_N)'$ and satisfies $\sum_{i=1}^N \mathbf{b}_i = 1$.

Estimation

Estimation involves solving for \mathbf{f}, \mathbf{B} , and the unobserved elements x_{it}^* of X . The available information set is the panel of observations x_{it} . We obtain estimates of the unknown quantities $\{\mathbf{f}, \mathbf{B}, x_{it}^*\}$ by solving the non-linear least squares problem

$$\min_{\{\mathbf{B}\}} \left[(NT)^{-1} \sum_{i=1}^N \sum_{t=1}^T (f_t - \bar{x}_{it})^2 \right] \quad (1a)$$

Where:

$$\bar{x}_{it} = x_{it} : i, t \text{ th element of } X \text{ observed} \quad (1b)$$

$$\bar{x}_{it} = x_{it}^* : i, t \text{ th element of } X \text{ not observed} \quad (1c)$$

Subject to

$$x_{it}^* = f_t \quad (1d)$$

$$f_t = \mathbf{x}_t \mathbf{B} = \sum_{i=1}^N \bar{x}_{it} \mathbf{b}_i \quad (1e)$$

Equation (1a) says that the optimal estimate of the common factor \mathbf{f} is that $T \times 1$ vector that minimises the total distance (in terms of the Euclidean norm) between \mathbf{f} and all N vectors of observations \mathbf{x}_t . The minimisation problem cannot be solved directly, however, since the unknown quantities are jointly dependent. Thus an iterative solution is required.

To begin the iterative procedure we insert values $x_{it}^* = 0$ for the missing elements of X in (1d). This allows (1c) to be solved. The minimisation (1a) is then solved with respect to \mathbf{B} after substituting (1e) for f_t (this minimisation is performed by computing the eigenvector associated with the largest eigenvalue of the matrix $X'X$). An estimate of \mathbf{f} is then obtained from (1e), which is then used to update the estimates of x_{it}^* in (1d).²⁵ The sequence of steps is then repeated for iterations $j=1,2,3,\dots$ until convergence, defined as

$$|\mathbf{B}^{(j+1)} - \mathbf{B}^{(j)}| < a \quad \forall j > J.$$

²⁵ The estimator (1d) can be justified on the grounds that it gives an unbiased estimate of the unknown elements of X at time t . Formally, assuming in period t we observe only the first $K < N$ elements of the vector \mathbf{x}_t (ie, there are $N-K$ missing values), the estimator is unbiased because

$$\lim_{j \rightarrow \infty} \left[\sum_{i=K+1}^N f_t (1 - \sum_{i=1}^K \mathbf{b}_i) + \sum_{i=1}^K x_{it} \mathbf{b}_i \right] = f_t \text{ for iterations } j.$$

For $a = 1 \times 10^{-20}$ and a full set of variables available for the current month, this gives $J \approx 25$ and takes about 20 seconds.

Final estimates are denoted $\{\mathbf{f}^{opt}, \mathbf{B}^{opt}, X^{opt}\}$. The indicator \mathbf{f}_t^{opt} has the property that it is the \mathbf{B} -weighted linear combination of columns of X that maximises the explained variance of \mathbf{x}_i , $i=1 \dots N$, among all possible \mathbf{B} .

State Space modelling and the Kalman Filter

Having obtained a raw estimate for the CF over the full sample, the series is filtered to remove the noise. This is performed using the State Space form described by the ARMA (1,1) model:

$$\begin{aligned} cf_t^{opt} &= c\tilde{f}_t^{opt} + \mathbf{e}_t & \mathbf{e}_t &\sim N(0, \mathbf{s}_e^2) \\ c\tilde{f}_t^{opt} &= c\tilde{f}_{t-1}^{opt} + \mathbf{h}_t & \mathbf{h}_t &\sim N(0, \mathbf{s}_h^2) \end{aligned}$$

where $cf^{opt} = (cf_1^{opt}, \dots, cf_T^{opt})'$ is the filtered estimate of the CF and the unknown parameters $\{\mathbf{s}_e^2, \mathbf{s}_h^2\}$ are estimated using the Kalman Filter.

State space models involve specifying equations in which an observed dependent variable (in this case the Common Factor of the RAI) is expressed as the sum of a set (vector) of unobserved state variables, and the state variables evolve according to exogenous dynamic process. The equation for the dependent variable is referred to as signal equations (measurement equations) while the equations for the state variables are referred to as the *state equations*²⁶ (transition equations).

The state can be interpreted either as unobserved components or as time-varying parameters. These unknown parameters are estimated using Kalman Filter which is a recursive algorithm for computing the optimal

²⁶ This is the way is referred in EViews.

estimate of the unobserved state vector at each point of time, given information up to that point in time.

To implement the Kalman Filter and the fixed interval smoother, we must first replace any unknown elements of the system matrices by their estimates. Under the assumption that the \mathbf{e}_t and \mathbf{h}_t are Gaussian, the sample log likelihood,

$$\ln[\ell(\mathbf{p}|\tilde{\mathbf{y}})] = \frac{-NT}{2} \ln 2\mathbf{p} - \frac{1}{2} \sum_{t=1}^T \ln |F_t| - \frac{1}{2} \sum_{t=1}^T \mathbf{n}'_t F_t^{-1} \mathbf{n}_t$$

may be evaluated using the Kalman filter. Using numeric derivatives, standard iterative techniques may be employed to maximize the likelihood with respect to the unknown parameters.

- Series used for RAI calculation

| <u>Series No.</u> | <u>Description</u> | <u>DS - Blmg</u> |
|-------------------|---------------------------------|------------------|
| 1 | Junk Spread | Blmg |
| 2 | On/Off (5-10) | Blmg |
| 3 | TED US | Blmg |
| 4 | TED EURO | Blmg |
| 5 | AAA-A3 | Blmg |
| 6 | BBB1-BBB3 | Blmg |
| 7 | BB1-B3 | Blmg |
| 8 | AA3-A3 | Blmg |
| 9 | BBB | Blmg |
| 10 | BBB-B | Blmg |
| 11 | BBB1-BBB3 | Blmg |
| 12 | SPX Index | Blmg |
| 13 | DAX Index | Blmg |
| 14 | UKX Index | Blmg |
| 15 | CAC Index | Blmg |
| 16 | HIS Index | Blmg |
| 17 | MIB 30 Index | Blmg |
| 18 | SMI Index | Blmg |
| 19 | AS51 Index | Blmg |
| 20 | MCI Europe (Large / small caps) | DS |
| 21 | MCI World | DS |
| 22 | MCI UK | DS |
| 23 | MCI US | DS |
| 24 | Emerging Market Free | DS |
| 25 | World (Defensive / Cyclical) | DS |
| 26 | Euro/US\$ | Blmg |
| 27 | Euro/Yen | Blmg |
| 28 | US\$/Yen | Blmg |
| 29 | GBP/US\$ | Blmg |
| 30 | CHF/US\$ | Blmg |
| 31 | AUS/EURO | Blmg |
| 32 | CHF (cal) | Blmg |

Variables definitions:

1. Dependent Variable

- Log(Spread): EMBIG stripped spread index expressed in log terms.

2. Independent Variables

- GDP (x_{kit}): Consensus real GDP growth – Medium term forecast.
- CPI (x_{kit}): Consensus year on year change in Consumer Price Index – Medium term forecast.
- CA / GDP (x_{kit}): Consensus current account balance to nominal GDP (*NomGDP*) ratio – Medium term forecast.

Where:

$$NomGDP_t = RealGDP(level) * (1 + CPI_t + GDP_t)$$

RealGDP(level): Corresponds to the observed level of real GDP of the previous year; t is the current month medium term forecast.

- Rating (z_{it}): Long term sovereign credit rating
- RAI (w_t): Risk Aversion Index.
- FED: Federal Funds Rate – Banks may lend federal funds to each other on an overnight basis at the federal funds rate. Funds deposited by commercial banks at Federal Reserve Banks, including funds in excess of bank reserve requirements.
- OIL: Brent oil prices. Global measure of dollars per barrel.

b. Other Random effects results:

Table 6

| Random effects model: Period 1998:01 - 2002:12 | | |
|---|-------------|-------------|
| Dependent variable: log (Spread) | | |
| Poland not included in the sample | | |
| Method: GLS (Variance Components) | | |
| | Coefficient | t-statistic |
| Cst | 8.27 | 67.21 |
| GDP | -0.08 | -13.77 |
| CPI | 0.01 | 6.37 |
| CA/GDP | -0.01 | -1.90 |
| Rating | -0.21 | -19.00 |
| RAI | 0.11 | 8.87 |
| Fixed Effects | | |
| Argentina | -0.08 | |
| Brazil | -0.02 | |
| Colombia | 0.18 | |
| Korea | -0.10 | |
| Malaysia | 0.12 | |
| Mexico | 0.12 | |
| Philippines | 0.20 | |
| Russia | 0.20 | |
| Turkey | -0.44 | |
| Venezuela | -0.19 | |
| R-squared | 0.89 | |
| Total panel obs. | 660 | |

Table 7

| Random effects model: Period 1999:01 - 2002:12 | | |
|---|-------------|-------------|
| Dependent variable: log (Spread) | | |
| Method: GLS (Variance Components) | | |
| | Coefficient | t-statistic |
| Cst | 8.37 | 67.22 |
| GDP | -0.07 | -9.56 |
| CPI | 0.01 | 3.74 |
| CA/GDP | -0.01 | -1.96 |
| Rating | -0.22 | -20.36 |
| RAI | 0.10 | 6.93 |
| Fixed Effects | | |
| Argentina | -0.11 | |
| Brazil | 0.01 | |
| Colombia | 0.19 | |
| Korea | -0.09 | |
| Malaysia | 0.04 | |
| Mexico | 0.14 | |
| Philippines | 0.23 | |
| Poland | 0.03 | |
| Russia | 0.16 | |
| Turkey | -0.38 | |
| Venezuela | -0.22 | |
| R-squared | 0.93 | |
| Total panel obs. | 528 | |

c. Results of other variables tested:

FED: As a proxy of global uncertainty.

Table 8

| Fixed effects model: Period 1998:01 - 2002:12 | | |
|---|-------------|-------------|
| Dependent variable: log (Spread) | | |
| Method: Pooled Least Squares | | |
| White Heteroskedasticity - Consistent Standard Error & Covariance | | |
| | Coefficient | t-statistic |
| GDP | -0.08 | -10.21 |
| CPI | 0.01 | 5.08 |
| CA/GDP | -0.01 | -2.50 |
| Rating | -0.20 | -15.41 |
| FED | 0.00 | 1.15 |
| Fixed Effects | | |
| Argentina | 8.15 | |
| Brazil | 8.22 | |
| Colombia | 8.42 | |
| Korea | 8.17 | |
| Malaysia | 8.42 | |
| Mexico | 8.34 | |
| Philippines | 8.47 | |
| Poland | 8.17 | |
| Russia | 8.47 | |
| Turkey | 7.73 | |
| Venezuela | 8.05 | |
| R-squared | 0.88 | |
| F-statistic | 127.85 | |
| Durbin-Watson st | 0.49 | |
| Total panel obs. | 660 | |

Oil: As a proxy of external factor.

Table 9

| Fixed effects model: Period 1998:01 - 2002:12 | | |
|---|-------------|-------------|
| Dependent variable: log (Spread) | | |
| Method: Pooled Least Squares | | |
| White Heteroskedasticity - Consistent Standard Error & Covariance | | |
| | Coefficient | t-statistic |
| GDP | -0.08 | -11.50 |
| CPI | 0.02 | 6.05 |
| CA/GDP | -0.03 | -4.14 |
| Rating | -0.20 | -17.01 |
| OIL | 0.00 | 4.70 |
| Fixed Effects | | |
| Argentina | 7.99 | |
| Brazil | 8.05 | |
| Colombia | 8.26 | |
| Korea | 8.09 | |
| Malaysia | 8.37 | |
| Mexico | 8.20 | |
| Philippines | 8.39 | |
| Poland | 8.02 | |
| Russia | 8.37 | |
| Turkey | 7.55 | |
| Venezuela | 7.91 | |
| R-squared | 0.89 | |
| F-statistic | 132.46 | |
| Durbin-Watson st | 0.52 | |
| Total panel obs. | 660 | |

d. Hausman test

When trying to determine which model is better between the Fixed Effects (FEM) and the Random Effects model (REM), this mainly depends on the context of the data and for what the results are to be used. On the one hand, if the sample is as big as the population, then the fixed effects estimation is reasonable. On the other hand, if the dataset is randomly drawn from a large population, a random-effect specification could be justified²⁷.

We use the Hausman test to test the correlation between the error and the regressors. This is applied to establish whether the REM is appropriate (i.e. produces consistent estimates). We know that the OLS FEM estimate is consistent under both the null and the alternative hypothesis and the REM estimate is consistent only under the null hypothesis. The null hypothesis refers to the no correlation between the error and the regressors of the model. We can identify the consistency of both models by applying the test:

$$X^2(K) = [\hat{\mathbf{b}}_{FEM} - \hat{\mathbf{b}}_{REM}]' \Pi^{-1} [\hat{\mathbf{b}}_{FEM} - \hat{\mathbf{b}}_{REM}]$$

Where $\hat{\mathbf{b}}_{FEM}$, $\hat{\mathbf{b}}_{REM}$ are vectors of coefficients of dimensions (K*1) of the Fixed Effects (FEM) and Random Effects Model (REM) respectively. Π is a K*K matrix defined as the difference of the estimated variance – covariance matrices of the FEM and REM. According to the results the test statistic: $X^2(K) = 0.59654$. The critical value to reject the null hypothesis with 5 degrees of freedom is 9.24 at the 10% level. Therefore, given the low X^2 value drawn by the test, the null hypothesis can not be rejected. Hence the REM is applicable and its GLS estimator is consistent and efficient. This is in line with the results shown in tables 4 and 5.

²⁷ See Kennedy, Peter; “A Guide to Econometrics”. Third edition. The MIT press.

e. Multicollinearity and Panel Data

Multicollinearity occurs when explanatory variables are very highly correlated with each other, so one variable can be expressed as a function of the others. In this extreme case we could not compute the OLS estimator (we could not invert $X'X$). Multicollinearity is common in the case of time series data where there often exists the same common trend in two or more regressors in the regression equation. Panel data sets for economic research possess several major advantages over conventional cross-sectional or time – series data sets. Panel data usually gives the researcher a large number of data points, increasing the degrees of freedom and reducing the collinearity among explanatory variables – hence improving the efficiency of econometric estimates. More importantly, longitudinal data allow a researcher to analyze a number of important economic questions that cannot be addressed using cross-sectional or time series data sets. Although there are no definite guides or remedial measures for multicollinearity, panel data analysis is commonly regarded as an alternative to reduce collinearity among the independent variables.

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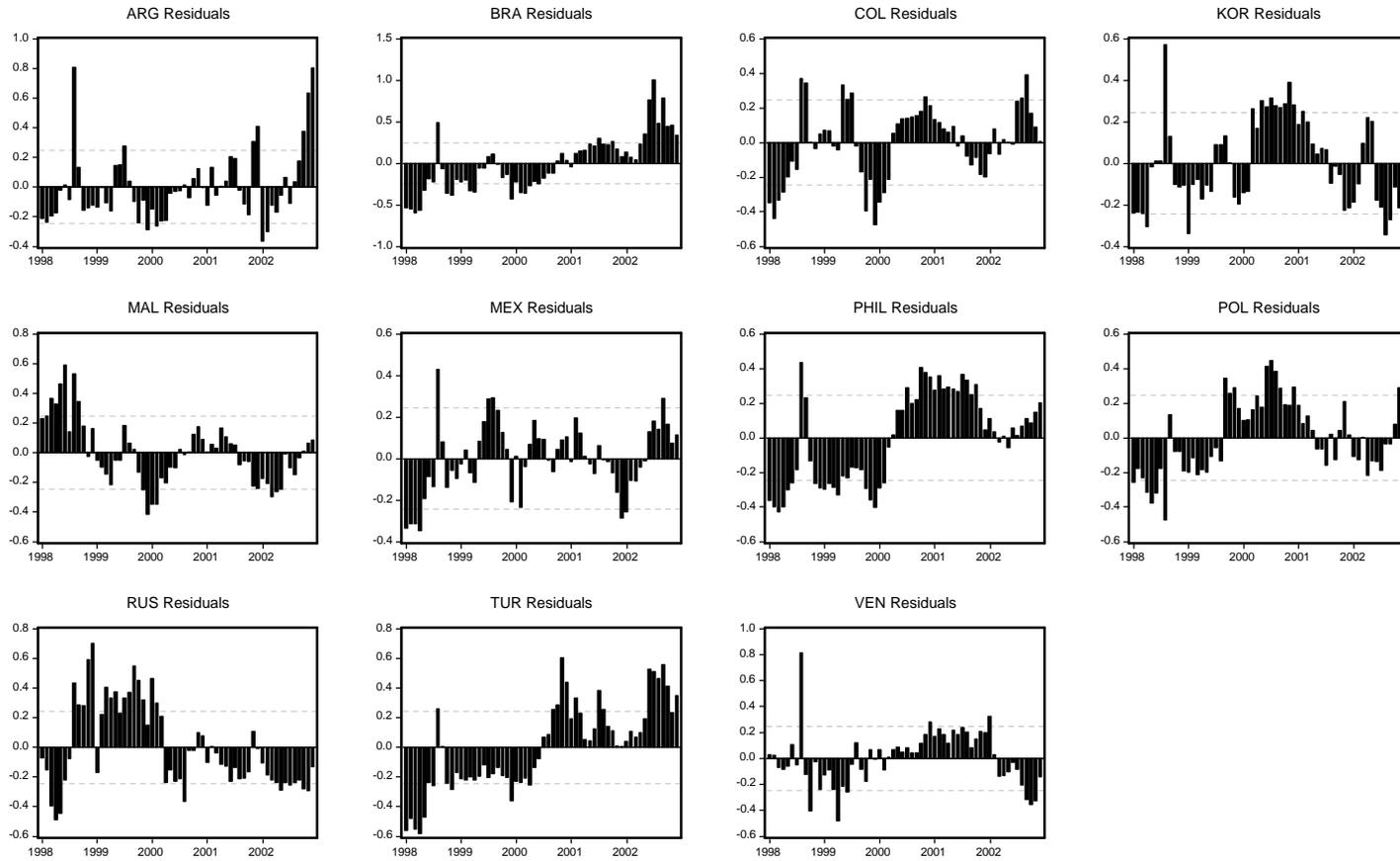
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Residuals from the panel data regression of log spreads

- Fixed effects model -



Residuals from the panel data regression of log spreads

- Random effects model -

