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Do Country Fundamentals Explain Emerging Market Bond Spreads?

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Abstract: This paper shows that emerging market eurobond spreads after the Asian crisis can be almost completely explained by market expectations about macroeconomic fundamentals and international interest rates. Contrary to the claim that emerging market bond spreads are driven by market variables such as stock market volatility in the developed countries, it is found that this did not play a significant role after the Asian crisis. Using panel data techniques, it is shown that the determinants of bond spreads can be divided into long-term structural variables and medium-term variables which explain month-to-month changes in bond spreads. As relevant medium-term variables, "consensus forecasts" of real GDP growth and inflation, and international interest rates are identified. The long-term structural factors do not explicitly enter the model and show up as fixed or random country-specific effects. These intercepts are highly correlated with the countries' credit rating.

Keywords: Emerging Markets, Bond Spreads

JEL classification: F34

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1 Introduction

After the severe turbulences in the Asian capital markets in 1997/98, the Russian default of September 1998 and the Brazilian devaluation of early 1999, emerging bond prices have been recovering. The spread of the EMBI+, a weighted bond index of the major issuers computed by J.P. Morgan, narrowed from more than 1500 basis points to levels in the range of 700-800 basis points. Although it is often argued that the market is paying little attention to country fundamentals and throws all emerging markets in one basket, there is substantial cross-country variation in the performance of sovereign bonds in this period. While the spreads of some issuers declined in line with the whole emerging bond market, others did not. For example, the spread on Brazilian sovereign bonds recovered from their crisis level at the beginning of 1999 roughly in line with the EMBI+ index and narrowed to levels around 600 basis points. Venezuelanian sovereigns, however, did not perform as well. The spread over U.S. interest rates did not leave the range of 800 basis points by August 2000. As Venezuela's macroeconomic performance was rather disappointing in 1999 and 2000, while the Brazilian economy returned to dynamic growth after the devaluation, this example suggests that financial markets do indeed anticipate the macroeconomic performance of the bond issuer and that spreads on emerging market bonds reflect at least in part the associated sovereign risk. But is there a systematic relationship between country fundamentals and spreads which holds across countries and over time?

Existing literature has examined emerging market bond spreads empirically as a function of a bulk of solvency variables. Standard macroeconomic variables such as real GDP growth and inflation, various debt ratios, trade figures, the real exchange rate, international reserves and so forth have been found to be significant. Characteristics of the bonds and international variables are also included in these studies. Although there are theoretical reasons to include all these variables, they are all somehow related to the probability of default of a country, these results are of little use for a medium-term assessment. Most of the data are available only on an annual or quarterly basis and are changing only slowly. Moreover, some of these variables are highly correlated, so that problems of multicollinearity can arise.

This paper shows that it is feasible to explain most of the monthly variance of spreads over time and across countries by a much more parsimonious specification if one distinguishes between short-term, medium-term and long-term determinants of bond spreads. A fixed and random effect estimation of a panel of the major emerging market issuers shows that monthly consensus *forecasts* of real GDP growth and inflation are primarily driving monthly spread movements. International interest rates further add to the explanation of spreads. Stock market volatility in developed markets, however, did not play a statistically significant role in driving emerging market bond spreads.

The remainder of the paper is organized as follows: Section 2 reviews existing empirical studies of emerging market bond spreads. Section 3 presents an alternative approach of classifying determinants of bond spreads into categories of different time horizons and proposes a parsimonious parameterization for monthly spread movements. Section 4 includes a detailed description of the data and describes transformations of the variables considered. Section 5 presents the results of a fixed and a random effect estimation. Section 6 concludes.

2 Related Literature

In the literature, there are a few recent studies which examine the determinants of emerging market bond spreads.[1] Like this paper, most of the academic research focuses on the question of how much economic fundamentals matter. There are also studies carried out by major investment banks which are rather interested in making forecasts of bond spreads and computing a "fair value" of sovereign bonds.

In all studies, numerous variables are found to be significant which change only slowly over time. Table 1 gives an overview of the existing studies.

Min (1998) uses a cross-country sample of more than 500 Latin American and Asian "launch spreads", i.e. the spread for a bond is computed only once at the time of issuing. The time dimension is introduced by observing launch spreads of different bonds over time. The study identifies mainly country-specific solvency variables and macroeconomic factors as the driving forces of bond spreads in the first half of the 1990s.[2] Since bonds with different issue

[1] The literature on the determinants of sovereign ratings is related to the research on bond spreads. However, ratings change very slowly over time so that econometric methods that can be applied are limited. See e.g. Cantor and Packer (1996).

[2] In the literature, the distiction between short-term illiquidity and long-run insolvency is often made. It has been proven to be difficult to give an operational definition of these two concepts. No such distinction is made in this paper. Alternatively, it is proposed to distinguish different time horizons of solvency variables which correspond to their evolvement over time, i.e. how often they change and thus provide new information to the market.

	Eichengreen and Mody (1998)	**Min (1998)**	**Cline and Barnes (1997)**	**J. P. Morgan (1995)**	**Goldmann Sachs (2000)**
Type of Bond Spread	Launch spreads of government and corporate issuers	Launch spreads of government and corporate issuers	3-month averages of Eurobond spreads of specific bonds	Quarterly stripped Bradybond spreads	Monthly averages of Eurobond spread of specific bonds
Region	Latin America, Asia, Europe, Middle East, Africa	Latin America and Asia	Latin America, Asia, Eastern Europe, Africa, Western Europe	Latin America, Asia Eastern Europe, Africa	Latin America, Asia, Eastern Europe
Period	1991 – 1996	1991 - 1995	1992 - 1996	1992 - 1995	1996 - 2000
Exogeneous Variables:	Variables considered: 13 Significant: 11	Variables considered: 18 Significant: 11	Variables considered: 9 Significant: 7	Variables considered: 9 Significant: 8	Variables considered: 8 Significant: 8
Liquidity / solvency	Debt / GNP* (+) Debt service / exports* (+) Credit rating residual* (-)	External debt / GDP* (+) Int. reserves / GDP* (-) Debt service / exports* (+) Growth rate of imports* (+) Growth rate of exports (-) Current account / GDP Net foreign assets	 Reserves / imports (-) Debt / exports* (+) Fiscal balance Current account / exports* (-)	Debt / GDP* (+) Reserves / imports* (-) Debt service / exports* (+) Fiscal balance / GDP* (-)	External debt / GDP* (+) Amort. / reserves* (+) Budget balance* (-)
Macroeconomic	Growth rate of GDP	Growth rate of GDP Terms of trade* (-) Inflation* (+) Real exchange rate* (+)	Growth rate of GDP* (-) Inflation* (+)	Growth rate of GDP* (-) Per capita GDP* (-)	Real GDP growth* (-) Openness of the economy* (-) Real exchange rate Misalignment* (+)
External	International interest rates* (-)	International interest rates Real oil price	U.S. treasury rate	U.S. long term bond yield* (+)	Long-run LIBOR* (+)
Bond characteristics	Issued amount* (-) Maturity* (+) Private issue Public issue* (-) Private placement* (+)	Issued amount* (-) Maturity* (-) Private issuer* (+)		 Spread variance Covariance with EMBI* (+)	
Dummy Variables	Debt restructure dummy* (+) Latin American issuer* (+) Israel dummy* (-)	 Latin American issuer Mexican crisis	Bradydummy* (+) Industrial country* (-)		Debt restructure dummy* (+)
Estimation Method	Simultaneous estimation of determinants of bond spreads and decision to issue (avoids selectivity bias)	Pooled OLS	Pooled OLS	Fixed effect	Dynamic Panel estimation

Table 1: Existing Studies on Emerging Market bond spreads; *: significant at least at the 10 percent level

size and maturity are included in the sample, these characteristics are also included as regressors. A negative yield curve effect, i.e. longer maturities corresponding to lower spreads, and a negative liquidity effect on spreads is found.[3] Interestingly, international factors such as international interest rates and the real oil price are found to be insignificant.

Eichengreen and Mody (1998) examine launch spreads of nearly 1000 emerging market bonds. By estimating the issue decision of debtors and the pricing of bonds jointly, they avoid a selectivity bias. Among the solvency variables, the study adds to standard debt ratios the "credit rating residual" which is the part of sovereign ratings which is not explained by variables which enter separately the regression.[4] The surprising finding of a negative effect of international interest rates on bond spreads is due to joint estimation of the probability to issue and the determinants of bond spreads. As international interest rates rise, less emerging market borrowers come to the market. Consequently, the supply of emerging market debt is reduced so that its price goes up, or, equivalently, the spread is going down. Since the analysis uses different types of bonds, there is the need to control for various bond characteristics and dummy variables which have intuitive signs.[5] However, contrary to the study by Min, a positive yield curve effect is found.

Cline and Barnes (1997) use a cross-section time-series sample of 12 emerging market and 6 industrial country eurobonds. Applying pooled OLS 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.

The Emerging Markets research groups of investment banks also carry out research on emerging market bond spreads. J.P. Morgan (1995) estimates a fixed-effect model of stripped Brady bond spreads. However, the coefficients of the fixed effects are not reported. The study finds standard solvency and macroeconomic indicators to be significant. It is also tested for the hypothesis that the variance of spreads is increasing spread levels. This hypothesis can be rejected. Hence, simple mean-variance optimization does not play a role. However, it is found that a higher correlation of the bond with the whole emerging bond market (measured by the EMBI index) is increasing

[3] "Liquidity" here means the depth of the bond market which is characterized by the issued amount. It should not be confused with short-term liquidity of a country.

[4] Otherwise, the ratings would be highly correlated with the other explanatory variables. The authors use the residuals from Cantor and Packer (1996).

[5] The dummy for Israelian bonds is included because they are guaranteed by the U.S. government.

spreads. This finding suggest that investors demand a higher spread if the debt instrument exhibits a higher market risk.

The study of Goldman Sachs (2000) uses a panel of eurobonds issued by major market participants. The advantage of this study is that dynamic panel estimation methods are used. In an error-correction type framework, the short-run coefficients can vary across countries while the long-run coefficients are restricted to be the same. After sorting out 16 variables which tend to be highly correlated with the ones included in the benchmark specification, the model arrives at a relatively parsimonious specification with 8 variables.[6] As in other studies, standard solvency variables are significant. Among the macroeconomic forces, the openness of the economy as a spread-reducing factor is worth noting.[7] International interest rates are significant in this study. However, like in the other studies, structural variables are included in the regression. Based on an analysis of this type, it is possible to determine if the current spread level is at its "fair value". But for a medium-term assessment, some of the variables included in the regression are changing too slowly over time. For example, the degree of openness of an economy is unlikely to provide new information to the market within time horizons of a year or less.

3 Determinants of Emerging Market Bond Spreads

In theory, the spread on emerging market bonds over U.S. treasuries compensates investors for the higher credit risk.[8] The risk mainly consists of the probability of default of the country, i.e. the chance that the issuing country stops paying interest and /or principal on the bond.[9] But there is no commonly accepted complete model of country default. The probability of default is a complex phenomenon which is related to the notion of "vulnerability ". This term is discussed extensively in the literature on the financial crisis in 1997/1998. For example, Alba, Bhattacharya, Claessens, Gosh, and

[6] Among the excluded variables is, for example, inflation.

[7] It is argued that more open economies tend to be better able to absorb external shocks.

[8] The spread can also reflect liquidity risk. By selecting only sovereign bonds with a liquid market, a liquidity premium is unlikely to be relevant in this analysis.

[9] Option models of default risk show that buying a sovereign bond is equivalent to writing a put option on the value of the borrower's assets. According to this approach, the equlibrium yield spread of risky debt is a function of the variance of the borrower's assets.

Hernandez (1999) show how the build-up of financial vulnerability was associated with "reinforcing dynamics between capital flows, macro policies and weak financial and corporate sector institutions" (p.10). The problem of quantifying the chance of defaulting gets even more complicated if one takes into account that some defaults are triggered rather by the unwillingness of a government to meet its debt obligations. Nevertheless, there is a set of variables which play a role in theoretical models of country defaults and, as was shown in the previous section, which perform well in empirical studies of spread determinants.[10] For simplicity, these variables are referred to as *solvency variables*.

3.1 Distinction of time horizons

This paper distinguishes three different time horizons for which different solvency variables are important: the short-run, the medium-run and the long run.

Anecdotal evidence strongly suggests that the *short-run*, i.e. daily and intraday emerging market bond spread movements, are driven by supply and demand factors, technical factors and political news that often do not have a lasting effect on the credit standing of the country. Therefore, it is unlikely that macroeconomic fundamentals that change at best on a monthly basis can systematically explain day-to-day changes of bond spreads. Hence, the focus of this paper is on monthly data which are obtained by taking monthly averages of daily data. This averaging should smooth out technical factors and potential overreactions of the market to short-lived political news.

The approach pursued here links *medium-run* spread movements, i.e. monthly changes in bond spreads to macroeconomic fundamentals and key market variables. The *long-run* determinants of spreads movements with a lower frequency of one year or more are not modeled explicitly. For long-run spread levels, slowly evolving economic and structural variables are relevant. These are, for example, debt ratios, the long-run growth potential, the savings rate of the economy, economic and political freedom, literacy rates etc.

3.2 Determinants of medium-run spread movements

In this paper, no attempt is made to derive the determinants of medium-term bond spreads from a theoretical model. Alternatively, a parsimonious specification for the medium-run is proposed which rests on plausible assumptions

[10] The theoretical foundations of solvency variables and early empirical evidence is due to Edwards (1984) and Edwards (1986).

about the impact of country fundamentals, international interest rates and market variables.

3.2.1 Country fundamentals

Three assumptions about country fundamentals driving bond spreads are made.

Hypothesis 1: Bond spreads are driven by the *expected* probability of default of the issuing countries.

Hypothesis 2: The market is likely to pay attention to solvency variables which can be monitored frequently.

Hypothesis 3: Current bond spreads reflect market expectations of the medium-term path of the solvency variables.

Hypothesis 1 simply restates the claim that spreads compensate for the sovereign risk and adds the assumption that the market is taking a forward-looking perspective. Hypothesis 2 is a corollary of hypothesis 1 and the efficient market hypothesis that states that market movements are triggered only by *new* information. A lot of variables which are released quarterly or annually and with long time lags such as debt ratios or indicators of banking system weaknesses are therefore not likely to drive spreads in the medium run. Hypothesis 3 is a refinement of the market's time horizon. Forecasts for macroeconomic variables relate always to a specific time period. Hypothesis 3 states that the market takes a "medium-term view" of the future path of relevant variables. As described in more detail in the next section, hypothesis 1-3 are jointly tested by using a specifically weighted average of market *forecasts* of key macroeconomic variables. *Consensus Forecasts Inc.* publishes monthly market forecasts for real GDP growth, inflation and the current account deficit.[11]

Real GDP growth can be expected to lower bond spreads since higher growth increases the country's tax revenues and thus raises its ability to pay back sovereign debt. Thus, higher growth should be associated with lower spread levels.

The domestic inflation rate is often used as a proxy for the quality of economic management.[12] As a tight fiscal and monetary policy stance is mirrored by low inflation rates, higher domestic inflation points to imprudent monetary and fiscal policies such as excessive public borrowing. Therefore,

[11] Figures for other variables of interest such as the public deficit are not available for all countries in the sample.

[12] See, for example, Min (1998, p. 6).

high inflation signals that the risk of default is higher. Hence higher inflation rates should be associated with higher spreads.

The current account deficit is often quoted for being at the root of balance-of-payment crises. However, whether a large current account deficit is actually increasing the sovereign risk is a complex question which depends at least on two key issues:[13] Firstly, it is crucial to consider the sources of the imbalance, i.e. whether primarily consumption or investment is financed. Secondly, it depends on the type of external financing. FDI has historically been the least volatile component of capital flows while portfolio flows and bank lending have been often subject to sharp reversals during a financial crisis. If an expected current account deficit can reasonably be expected to be financed mostly by FDI, a large deficit does not have to be a concern for the bond investor.[14] This line of reasoning is in line with existing empirical evidence: Hawkins and Klau (2000, p. 4) survey the vast literature on indicators of currency and banking crises and conclude that the "current account deficit is one of the most commonly tested variables but tends to be statistically insignificant". Consequently, mixed results for the current account can be also expected when emerging market bond spreads are analyzed.

3.2.2 International interest rates and market variables

International interest rates are a common determinant of the bond spreads of all issuers because higher international interest rates raise the cost of new borrowing.[15] Therefore, rising international interest rates increase the probability of default of emerging markets. Notice, however, that the positive relationship between international interest rates and spreads may break down during a financial crisis: during a time of financial market turbulence with exploding emerging market bond spreads, the leading central banks might lower interest rates in order to prevent a global liquidity crunch. This is what happened in fall of 1998.[16] At that time, rising spreads and falling

[13] Calderon, Loayza, and Serven (1999) argue that external sustainability should be analyzed in an equilibrium framework where the portfolio decisions of international and domestic investors are explicitly modeled.

[14] Nevertheless, there is a high degree of substitution between the flows so that only looking at the labels of flows might be misleading as well. See Claessens, Dooley, and Warner (1995).

[15] Debt servicing becomes more expensive as well if the country uses debt instruments with variable interest rates to raise capital.

[16] In November 2000, concerns about a potential default of Argentina were also said to feed back again into the Fed's monetary policy. Thus, over a longer time horizon, the relationship of international interest rates and emerging market bond spreads is ambigious. As major central banks anticipate the adverse effects of a tight monetary policy on

international rates could be observed. Moreover, as described on page 5, Eichengreen and Mody (1998) argue that high levels of international interest rates can drive some borrowers completely out of the market so that average observed bond spreads actually fall. Within the time period under investigation however, no international liquidity problems and no extreme hike in U.S. interest rates occurred, so that the familiar positive impact of international interest rates on spreads can be expected.

It is often claimed that **market variables** are also affecting emerging market bond spreads and even dominate the influence of country fundamentals. This line of reasoning points out that the global risk appetite and hence the demand for high yield emerging market bonds depends on the performance of other high yield assets such as high tech stocks. In this context, it is often referred to observed correlations between the Nasdaq index and emerging market bonds. A more accurate measure of global risk appetite and financial market uncertainty is an indicator of expected stock market volatility in developed markets. Such a measure is included in the analysis in order to test whether global financial market uncertainty such as the rise in expected volatility after the correction of the Nasdaq index in March 2000 played a significant role in driving emerging market bond spreads. A rise in expected volatility should increase the spreads on emerging market bonds.

4 Data

4.1 The dependent variable

A panel of 9 emerging market eurobond spreads for the period from December 1998 to August 2000 is used for the econometric analysis. Non-Brady eurobonds account for about a third of the trading of emerging debt (see figure 1). They were preferred over Brady bonds as not all countries which are major bond issuers have Brady bonds. Since the pay-off structure of Brady bonds require a special procedure to extract the implied probabilities of default, the spreads are not strictly comparable to the spread on a eurobond.[17]

All major sovereign issuers are included in the sample, and no particular region is excluded. All together, the issuers in the sample account for more than 80% of total emerging debt trading and more than 70% of outstanding

the solvency of emerging markets, they might adjuste their policy stance under extreme circumstances.

[17]For an analysis of implied default probabilities in Brady bonds, see Izvorski (1998).

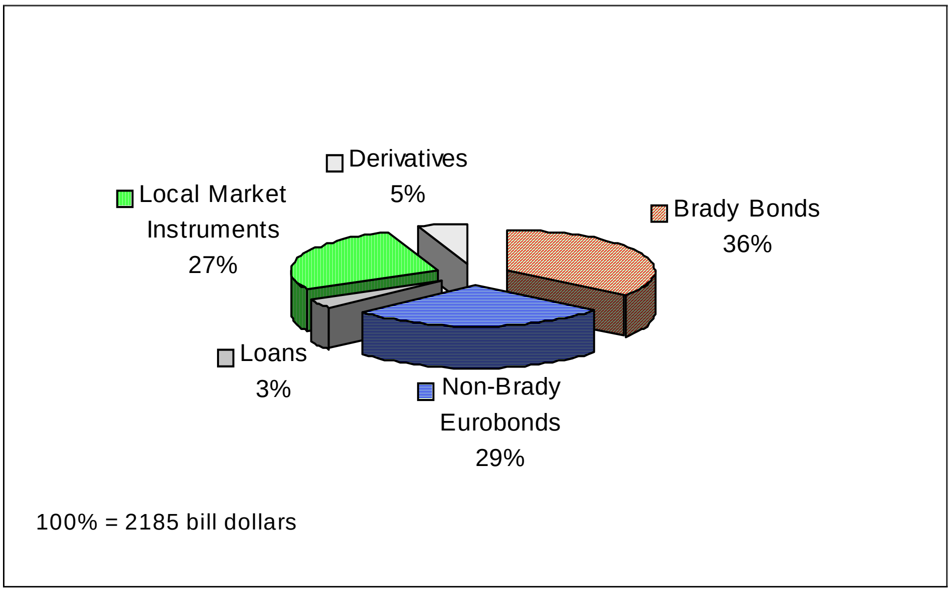

Figure 1: Shares of financial instruments in total emerging market debt trading as of 1999. Source: Emerging Markets Traders' Association

eurobond debt.[18]

For every country, a particular bond for which a liquid market exists was chosen. All the bonds in the sample do not mature before 2006 so that bond prices do not converge to their par value within the observation period.[19] Table 2 gives an overview of the bonds that are used and provides some descriptive statistics. All bonds are denominated in U.S. dollars.

The spread is calculated from daily Bloomberg data as absolute difference[20] between the yield and roughly comparable U.S. generic interest rates.[21]. Monthly figures are obtained by averaging.

[18] These figures are computed from data provided by the Emerging Markets Trader's Association and Bondware.

[19] Cline and Barnes (1997, p. 7) present a computation that changes in spreads prior to 3 years to maturity are rather small and can be neglected. The bias towards measuring a declining spread when tracking an unchanged bond within this period is approximately 7 basis points per year.

[20] Relative spreads, i.e. the ratio of emerging market yields and U.S. rates, are also computed and used as dependent variable. The results (not reported) are not substantially different from the estimates presented in this paper.

[21] U.S. generic rates are available for some selected maturities only. The 10 year and the 30 year rate is used here, depending on which is closer to the maturity of the emerging market bond. Although it would be preferable to compute the spread for every bond with

	Bond Characteristics		Spread over U.S. interest rates, in basis points			
Country	**Maturity**	**Coupon, in %**	**Mean**	**Maximum**	**Minimum**	**Std. Dev.**
Argentina	2017	11.375	645	801	550	73
Brazil	2008	09.375	758	1240	555	177
Colombia	2007	07.625	628	845	468	102
Indonesia	2006	07.750	629	1018	414	183
Korea	2008	08.875	231	463	118	73
Mexico	2008	08.625	389	531	304	71
Russia	2028	12.750	1942	4167	833	1127
Turkey	2007	10.000	534	708	414	88
Venezuela	2027	09.250	890	1117	758	110

Table 2: Characteristics and descriptive statistics of the eurobonds in the sample, Dec. 1998 - August 2000

4.2 The independent variables

4.2.1 Country fundamentals

As outlined in the last section, market forecasts of country fundamentals are used. *Consensus Economics Inc.* gathers forecasts from banks, corporations and independent consultants around the world and publishes their arithmetic average, the "consensus". The pooling is eliminating most behavioral biases of individual forecasters.[22] Among the panelists are major investment banks and corporations which devote substantial resources to macroeconomic analysis[23]. Moreover, most of the panelists are based in the country they forecast. Therefore, the consensus figures are a suitable measure of the market expectations, given all available information. Batchelor (2000) even shows for industrialized countries that *Consensus Economics* forecasts are even more accurate than the ones made by the IMF and the OECD. This does not imply, of course, that this assessment is correct about the actual figures which are known at the end of the year or even later. Figure 2 shows monthly GDP forecasts for 1999 in the case of Russia.

regard to a benchmark bond with exactly the same maturity, this approximation has been adopted because the benchmark bonds often have a different issue date which makes the construction of a longer spread history quite complicated. It should be stressed, however, that the difference of U.S. rates at different maturities is very small compared to the yields on emerging market bonds.

[22] See Batchelor (2000, p. 5) and the references given there.

[23] As an example, table 6 in Appendix A provides a list of participants of the consensus poll for Russia. The number of panelists and their affiliation varies by country.

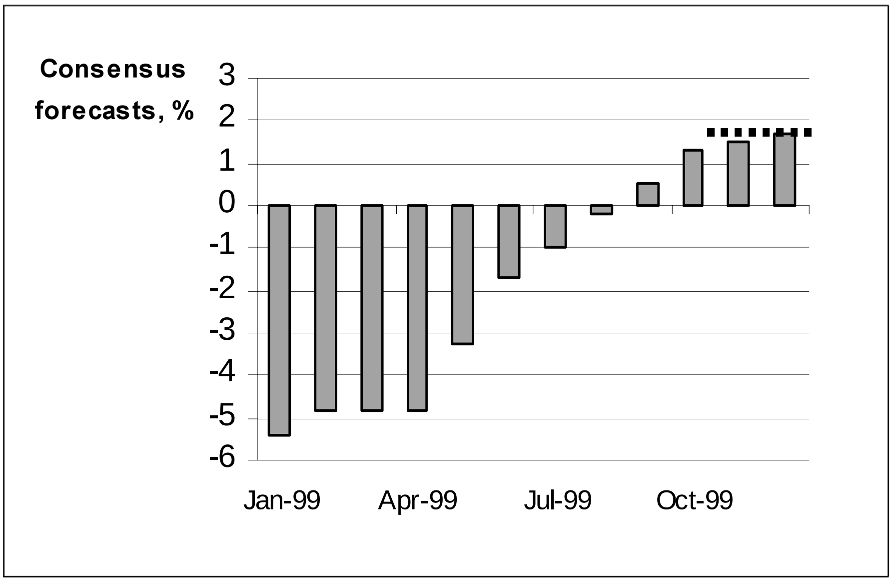

Figure 2: Monthly consensus forecasts for real annual GDP growth in Russia. The dashed line shows the actual figure for 1999 at 1.9%.

But notice that the forecasts are likely to be correlated with actual figures which have been released already. These are, for example, monthly releases of industrial production, CPI and trade figures.

Every month *Consensus Economics* publishes the mean forecast for real GDP growth, inflation and the current account[24]. For these variables, a forecast for the current and the following year is available. A weighted average is computed from these two figures as follows[25]: the monthly forecasts for the annual figures for this year x_a^e and next year x_{a+1}^e are weighted according to

$$x_t = \frac{(12-t)\, x_a^e + t x_{a+1}^e}{12}, \quad t = 1...12$$

where we call the weighted average x_t *medium-term forecasts*.[26]

The medium-term figures are used for two reasons: Firstly, they are less sensitive to business cycle fluctuations than the forecast for the current year.

[24] For countries in Latin America and in Emerging Europe, only bimonthly polls are carried out. For these cases, monthly figures are compiled by linear interpolation.

[25] A time lag of about 2 weeks for surveying and processing the data is assumed.

[26] For example, the medium-term expectation for May 1999 ($t = 5$) is

$$x_{May} = \frac{7x_{1999}^e + 5x_{2000}^e}{12}$$

By December 1999, the forecast for the current year 1999 is already irrelevant and the forecast for 2000 gets full weight ($t = 12$).

Consider a country which experiences, say windfall gains due to a temporarily high oil price. The forecast for real GDP growth for the current year is high, but analysts do not expect this pace to be sustainable the year after. For an assessment of credit risk and hence the default probability of a country, the medium-term figure is more appropriate.[27] Secondly, the increasing of the weight of the subsequent year as time goes by reflects the fact that x^e_{a+1} is very uncertain at the beginning of year a and becomes more and more certain as time goes by. Since this is likely to be anticipated by the market, it seems reasonable to assume that the medium-term figure x_t is more relevant for the market than the single annual figures x^e_a or x^e_{a+1}.[28]

4.2.2 International interest rates and Market Variables

In order to proxy international interest rates, the LIBOR (3-month in U.S. dollars) is included as independent variable. A suitable measure of financial market uncertainty is obtained from the Chicago Board Options Exchange which provides a volatility index (VIX).[29] The VIX measures the implied volatility from options contracts on the Standard and Poor's 100 (S&P 100) index. It is based on a hypothetical option with one month to expiration and can be interpreted as the market expectation of the volatility of the S&P 100 index in the subsequent month.

5 Panel Estimation of the Model

5.1 Fixed effects

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 lead to these intercepts in the sample. The fixed effects in this model thus represent structural solvency variables.

[27] The major credit ratings agencies also stress that their rating is forward-looking and not sensitive to the business cycle. Since the spreads are strongly correlated with the ratings, it is reasonable that the market takes at least a medium-term view.

[28] Notice that x_t is a synthetic figure which refers to a time period of changing length. Therefore, it should not be interpreted as an average 2-year figure.

[29] See Dueker (1999) for a brief description of the VIX. He suggests to use this indicator as a barometer of financial market uncertainty. It is also the standard variable for empirical analysis of corporate bond spreads.

The fixed effect model is estimated in semi-logarithmic form:

$$\log(spread_{it}) = \alpha_i + \sum_{k=1}^{3} \beta_k x_{k_{it}} + \sum_{j=1}^{2} \delta_j w_{j_t} + \varepsilon_{it} \tag{1}$$

where $i = 1$ to 9 countries, $t = 1$ to 21 monthly observations, $x_{k_{it}}$ are the medium-term forecasts for the 3 macroeconomic variables which vary across countries and time, and w_{j_t} represents the LIBOR and the VIX which vary only over time. Notice that in this model, the coefficients β_k and δ_j are restricted to be the same across countries.

5.2 Results of the benchmark regression

Table 3 gives an overview about the benchmark fixed-effect estimation.

The adjusted R^2 suggests that more than 90% of the variance can be explained by the model. The standard F-Test for the significance of the regression is significant at the 1% level. The fixed-effect specification seems appropriate: an F-test for the significance of country-specific intercepts shows that the null hypothesis of a common intercept ($\alpha_i = \alpha$ for all i) can be clearly rejected.[30] The Durbin-Watson statistic points to positive serial correlation. Therefore, the standard errors of the estimates are corrected with the White procedure. This correction of the variance does not significantly change the t-Statistics of the estimated coefficients. Table 4 shows that these general observations do not change if one excludes the phase of extreme bond spreads from December 1998 to April 1999.

[30] The restricted model (R) for the F-test is pooled OLS with a common intercept. The unrestricted model (U) is the fixed-effect formulation. The test statistic is

$$F(i-1, iT-i-K) = \frac{\left(R_U^2 - R_R^2\right)/i-1}{\left(1-R_U^2\right)/\left(iT-i-K\right)}$$

where K is the number of regressors. The critical value at the 1% level is $F(8, 175) = 2.51$. The test statistic at 64.87 clearly exceeds this number. The R_R^2 from the pooled OLS regression (not reported here) is only 0.77.

	Dependent Variable: Log ($spread_{it}$)			
	Coefficient	**Percentage Change of Spreads**	***t*-Statistic**	**White Heteroskedasticity-Consistent *t*-Statistic**
Real GDP Growth	-0.078	-7.50%	-6.51***	-6.66***
Inflation	0.013	1.33%	6.52***	6.17***
Current Account	0.006	0.56%	2.53***	2.11**
LIBOR	0.108	11.43%	3.73***	3.63***
VIX	0.003	0.33%	0.76	0.87
Fixed Effects	**Coefficient**	**In basis points**		
Argentina	5.905	366.88		
Brazil	5.956	385.98		
Colombia	5.722	305.48		
Indonesia	5.678	292.48		
Korea	4.916	136.46		
Mexico	5.421	226.01		
Russia	6.215	500.14		
Turkey	5.124	167.95		
Venezuela	5.764	318.61		
Total Panel Observations (N=9, T=21)	189			
F-Test for Significance of Regression	716.74***			
Adjusted R^2	0.939			
F-Test for Significance of Fixed Effects	64.87***			
Durbin-Watson	0.53			

Table 3: Fixed Effect Estimation 1998:12 - 2000:8; *, **, ***: significant at the 10, 5, 1 % level

	Dependent Variable: Log ($spread_{it}$)			
	Coefficient	**Percentage Change of Spreads**	***t*-Statistic**	**White Heteroskedasticity-Consistent *t*-Statistic**
Real GDP Growth	-0.089	-8.50%	-4.02***	-3.79***
Inflation	0.013	1.30%	3.53***	4.17***
Current Account	0.001	0.08%	0.22	0.23
LIBOR	0.121	12.82%	2.64***	2.76***
VIX	0.001	0.07%	0.15	0.18
Fixed Effects	**Coefficient**	**In basis points**		
Argentina	5.937	378.87		
Brazil	5.951	384.04		
Colombia	5.740	311.07		
Indonesia	5.733	308.89		
Korea	5.092	162.78		
Mexico	5.389	219.08		
Russia	6.284	535.98		
Turkey	5.140	170.64		
Venezuela	5.823	337.89		
Total Panel Observations (N=9, T=16)	144			
F-Test for Significance of Regression	440.68***			
Adjusted R^2	0.924			
F-Test for Significance of Fixed Effects	40.74***			
Durbin-Watson	0.54			

Table 4: Fixed Effect Estimation 1999:05 - 2000:8; *, **, ***: significant at the 10, 5, 1 % level

5.2.1 GDP growth and inflation

As can be seen from table 3, the medium-term forecasts for real GDP growth and inflation have the expected signs and are significant at the 1% level. This result turns out to be robust to a change in the time span considered (see table 4). In the semi-log specification, the estimated coefficients can be transformed into percentage changes of the dependent variable: a rise by one percentage point in medium-term growth forecasts lowers the spread by 7.5% according to the model estimated for the full sample. For a spread level of, say 645 basis points which is the mean level for Argentina in the observation period, this would be a decrease by almost 50 basis points. A rise by one percentage point in the medium-term forecasts for inflation raises the spread by 1.33%, or, in our example, by 8.5 basis points.

5.2.2 Current account

The coefficient of the current account forecasts is statistically significant, but does not have the expected sign. A rise in the external balance, i.e. a smaller deficit or a larger surplus raises the spread by 0.56%. It can be shown, however, that this effect is due to the specific circumstances after the financial crisis of 1997/98, in particular in Korea: the crisis lead to a contraction of the economy. Imports consequently collapsed as well while exports, facilitated by the weak exchange rate, did not fall substantially. Sizable current account surpluses were the consequence. The current account surplus has been declining as the economy recovered in 1999 and 2000. Since this development coincidenced with an improved credit standing and declining bond spreads, there is a substantial positive correlation between the current account and spreads which is detected by the model. Table 4 reveals that the effect of the current account on bond spreads is not robust: if the period of declining surpluses which were built up during the financial crisis is excluded, the variable is not significant. Moreover, the same is true if Korea is excluded from the sample (see table 7 in Appendix B). These results rather confirm that the current account deficit has an ambiguous effect on bond spreads. Considering the ambiguous theoretical effect of the current account on sovereign risk and previous empirical evidence (see pp. 8), this is not a surprising finding.

5.2.3 International interest rates

The coefficient of the LIBOR is statistically significant and has the expected positive sign. This means that higher international interest rates tend to raise emerging market bond spreads because they increase the cost of borrowing. Thus, although in the observation period international interest rates have a rising trend while emerging market bonds are falling, the multivariate analysis is detecting the positive relationship between the variables which can be expected from economic theory. After controlling for improved country fundamentals, there is a positive effect of rising rates on bond spreads.

Interestingly, the coefficient indicates that a rise in international rates by one percentage point (or 100 basis points) leads to a substantial increase of emerging market bond spreads by more than 11%. For a bond with a spread in the 600 basis point range, this would mean an absolute rise by more than 60 basis points. The result for the coefficient of the LIBOR is robust to changes in the time period and to the country sample (see table 4 and table 7 in Appendix B).

5.2.4 Financial market uncertainty

The VIX as a measure of global financial market uncertainty is not significant in the panel regression (see table 3). Although there are periods where a close correlation between developed stock markets and emerging debt markets can be observed, there is no evidence that this is a systematic effect. After controlling for country fundamentals and international interest rates, stock market uncertainty is no driving force for bond spreads. This result is robust to changes in the time period and the sample of countries (see table 4 and table 7 in Appendix B).[31]

5.2.5 Fixed Effects as structural factors

The model specified in equation (1) does not take into account many structural variables which have an effect on the probability of default of a country. These factors are modeled as fixed effects and hence determine implicitly the absolute country-specific spread range. As can be seen from table 3, the estimated coefficients of the intercepts translate into spread levels in basis points which are roughly in line with the credit standing of the countries. The credit rating of a country summarizes much of the structural variables not considered here.

A closer look at the credit rating of the countries reveals that there is a strong positive correlation between the fixed effects and the rating. The correlation coefficient between the fixed effects and the rating published by the Institutional lnvestor in September 1999 is -0.75, i.e. a higher rating

[31] Instead of the VIX, the monthly percentage change of the Nasdaq index is also considered as independent variable proxying stock market uncertainty. The results (not reported) do not change, i.e. the change in the Nasdaq index is not significant.

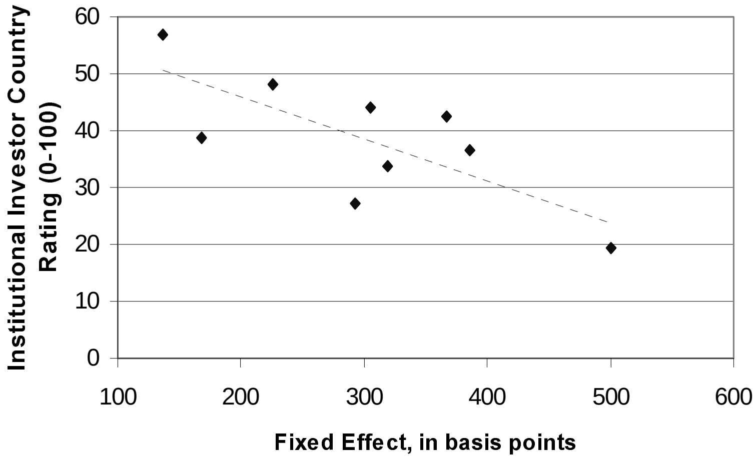

Figure 3: Fixed effects from table 3 and the Institutional Investor country rating as of September 1999

score is associated with a lower absolute spread level (see figure 3).[32]

Cantor and Packer (1996) show that the sovereign ratings assigned by Moody's and Standard and Poor's prior to the Asian crisis can be explained by six factors. These are per capita income, GDP growth, inflation, external debt, level of economic development and default history. Hence, sovereign ratings are likely to contain also some information of the explanatory variables considered in this framework. As ratings are a mix of structural and medium-term solvency variables, the correlation with the fixed effects of this model cannot be expected to be perfect. But the correlation coefficient of -0.75 suggests that the main ingredients of sovereign ratings are rather structural factors.

5.3 Random effects

One could argue that a random effect specification of equation (1) is worth considering. In the fixed-effect model, we implicitly assumed that the cross-country differences in the intercepts are parametric shifts of the regression

[32] The magazine "Institutional Investor" polls twice a year the major internatioanl banks about their opinion about the credit standing of over 100 countries. The advantage of using this survey data instead of the ratings by the major rating agencies is that it is changing more frquently than most ratings. It is highly correlated with the ratings by Moody's Investor's Service and Standard & Poors.

function. This is appropriate if we think that the model applies only to the countries included in the sample. However, if we think that the countries are randomly drawn from a large population of countries for which the model also holds, a random effect formulation is more appropriate.

As argued above, the major bond issuers accounting for almost the whole emerging bond market are included in the sample. However, it is not reasonable to assume that a close relationship of country fundamentals and international market variables should not hold for other issuers which are not included in the analysis. Hence, a random-effect specification of the form

$$\log\left(spread_{it}\right) = \alpha + \sum_{k=1}^{3} \beta_k x_{k_{it}} + \sum_{j=1}^{2} \delta_j w_{j_t} + u_i + \varepsilon_{it} \tag{2}$$

is also considered. Here, it is assumed that there is a common intercept α, and u_i is a country-specific random disturbance which is constant through time. It is assumed that u_i is a well-behaved disturbance which is uncorrelated with the error ε_{it}.[33] The model in (2) can be estimated using the feasible GLS procedure. In Appendix D.1, a LM test shows that the variance of the disturbance u_i cannot be assumed to be zero.

Table 5 shows the results of the random effects estimation.

There are no substantial deviations from the fixed effect results. The signs of the coefficients and their significance levels are the same as in the fixed effect case. The current account has again not the expected sign. Table 8 and 9 in Appendix C show that this effect is again not robust to a change of the time period and the country sample without Korea. Financial market uncertainty as measured by the VIX is insignificant in all random effect specifications. The common constant is highly significant. Adding up the random effects and the common intercept, i.e. $\alpha + u_i$, yields country-specific

[33] Formally, the standard assumptions for the random effect model are

$$\begin{aligned} E\left[\varepsilon_{it}\right] &= E\left[u_i\right] = 0 \\ E\left[\varepsilon_{it}^2\right] &= \sigma_\varepsilon^2 \\ E\left[u_i^2\right] &= \sigma_u^2 \\ E\left[\varepsilon_{it} u_j\right] &= 0 \quad \forall\, i, t, j \\ E\left[\varepsilon_{it} \varepsilon_{js}\right] &= 0 \quad \text{if } t \neq s \text{ or } i \neq j \\ E\left[u_i u_j\right] &= 0 \quad \text{if } i \neq j. \end{aligned}$$

	Dependent Variable: Log($spread_{it}$)		
	Coefficient	**Percentage Change of Spreads**	***t*-Statistic**
Constant	5.608		25.62***
Real GDP Growth	-0.090	-8.56%	-7.62***
Inflation	0.012	1.18%	6.03***
Current Account	0.004	0.40%	1.85*
LIBOR	0.124	13.24%	4.20***
VIX	0.003	0.30%	0.68
Random Effects	**Coefficient**	**Random Effects + Constant in basis points**	
Argentina	0,220	339,61	
Brazil	0,282	361,49	
Colombia	0,059	289,25	
Indonesia	0,030	280,73	
Korea	-0,646	142,86	
Mexico	-0,211	220,69	
Russia	0,592	492,85	
Turkey	-0,446	174,50	
Venezuela	0,119	307,10	
Total Panel Observations (N=9, T=21)	189		
GLS Regression Statistics			
Adjusted R^2	0.934		
Durbin-Watson	0.480		

Table 5: Random Effect Estimation 1998:12 - 2000:8; *, **, ***: significant at the 10, 5, 1 % level

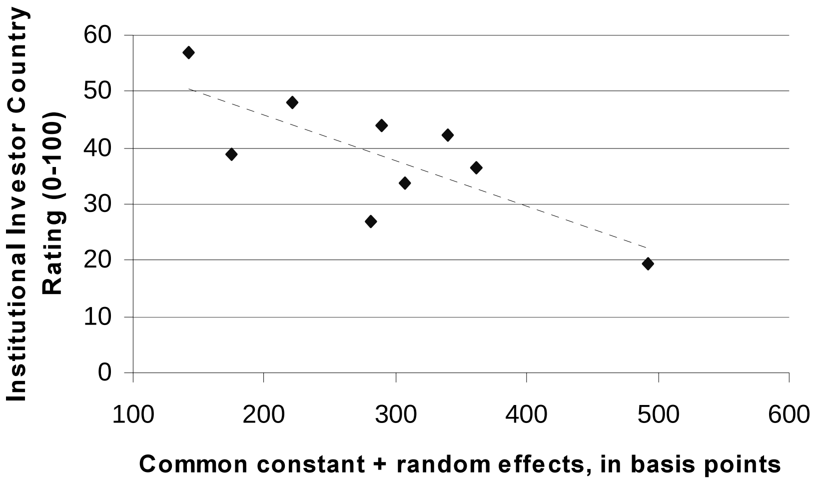

Figure 4: Constant + Random effects and the Institutional Investor country rating as of September 1999.

spread levels comparable to the fixed effects α_i of the previous section. These are highly correlated with the Institutional Investor country rating as well. The correlation coefficient for the random effects of table 5 and the ratings is -0.77. Figure 4 illustrates that, as in the fixed effect case, higher values of $\alpha + u_i$ correspond to lower rating scores.

The econometric literature on the estimation of models for panel data points out that it is not straightforward to determine whether cross-section effects should be treated as fixed or random.[34] Since both specifications can be justified on theoretical grounds and lead to the same results, discriminating between the two is not crucial here. Nevertheless, a Hausman test is performed in order to test whether the GLS procedure of the random effect model leads to consistent estimates (see Appendix D.2). The test indicates that the random effect estimation is consistent and should therefore be preferred on efficiency grounds.

6 Conclusion

This paper has shown empirically that emerging market bond spreads after the Asian crisis can be almost completely explained by market forecasts about

[34] See, for example, Hsiao (1999, pp. 41).

macroeconomic fundamentals and international interest rates. With a much more parsimonious specification than in previous studies, the model yields a remarkably high degree of explanation of the variance of bond spreads.

Contrary to the claim that emerging market bond spreads are *not* driven by country fundamentals but by market variables such as stock market volatility in the developed countries, it is found that this did not play a significant role after the Asian crisis. In a panel of 9 major bond issuers, a fixed and a random effect model show that determinants of bond spreads can be divided into long-term structural variables and medium-term variables which explain month-to-month changes in bond spreads. The long-term structural factors do not explicitly enter the model and show up as fixed or random country-specific effects. These intercepts are highly correlated with the countries' credit rating. As new information about structural variables does not arrive frequently, they are unlikely to explain monthly changes in bond spreads.

Theoretically, the model is suitable to perform medium-term forecasts for bond-spreads if reliable forecasts for the exogenous variables are available. However, two points should be kept in mind: Firstly, structural solvency variables are treated as constant over time. Any structural change in the creditworthiness of a country is not captured by the model. Deviations from the estimated relationship can therefore reflect a shift of the intercept rather than a mispricing of the bond. This could be corrected by using an intercept correction for the forecast.[35] Secondly, the forecast of the exogenous macroeconomic variables must be "a forecast of a forecast". According to the model, the macroeconomic assessment of the forecaster must also become the consensus of the market if it is to determine future bond spreads.

Further research should explore whether the estimated relationship is stable over a longer time period. A longer data set over time would allow to test whether the suggested exogenous variables are able to explain bond spreads throughout the whole Mexican and Asian crisis.

[35] For a description of intercept correction techniques, see Clements and Hendry (1998, ch. 8).

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A Participants of the Consensus Poll

ABN AMRO Bank
Alfa Bank
Brunswick Warburg
Credit Suisse First Boston
Creditanstalt
Deutsche Bank Research
Dresdner Bank
FAZ Institut
Goldman Sachs
HypoVereinsbank
ING Barings Moscow
Institut für Wirtschaftsforschung Halle
J.P. Morgan
Kopint-Datorg
Nikoil
Raiffeisen Zentralbank
Troika Dialog
United Financial Group
Vienna Institute - WIIW

Table 6: Panelists of Eastern Europe Consensus Forecasts for Russia

B Further Fixed Effect Regression Results

	Dependent Variable: Log ($spread_{it}$)			
	Coefficient	**Percentage Change of Spreads**	***t*-Statistic**	**White Heteroskedasticity-Consistent *t*-Statistic**
Real GDP Growth	-0.065	-6.26%	-5.38***	-5.97***
Inflation	0.014	1.46%	7.31***	6.44***
Current Account	0.003	0.35%	0.50	0.44
LIBOR	0.085	8.88%	2.95***	2.87***
VIX	0.003	0.34%	0.81	0.84
Fixed Effects	**Coefficient**	**In basis points**		
Argentina	6.005	405.31		
Brazil	6.047	422.90		
Colombia	5.809	333.36		
Indonesia	5.776	322.41		
Mexico	5.476	238.86		
Russia	6.315	552.83		
Turkey	5.145	171.52		
Venezuela	5.862	351.32		
Total Panel Observations (N=8, T=21)	168			
F-Test for Significance of Regression	490.80***			
Adjusted R^2	0.921			
F-Test for Significance of Fixed Effects	44.04***			
Durbin-Watson	0.53			

Table 7: Fixed Effect Estimation 1998:12 - 2000:8 without Korea; *, **, ***: significant at the 10, 5, 1 % level

C Further Random Effect Results

	Dependent Variable: $Log(spread_{it})$		
	Coefficient	**Percentage Change of Spreads**	***t*-Statistic**
Constant	5.614		19.20***
Real GDP Growth	-0.108	-10.23%	-5.04***
Inflation	0.011	1.07%	3.23***
Current Account	0.001	0.06%	0.17
LIBOR	0.146	15.75%	3.23***
VIX	0.001	0.09%	0.18
Random Effects	**Coefficient**	**Random Effects + Constant in basis points**	
Argentina	0.205	336.61	
Brazil	0.242	349.53	
Colombia	0.027	281.82	
Indonesia	0.042	286.05	
Korea	-0.533	160.94	
Mexico	-0.272	208.92	
Russia	0.606	502.85	
Turkey	-0.445	175.76	
Venezuela	0.128	311.74	
Total Panel Observations (N=9, T=16)	144		
GLS Regression Statistics			
Adjusted R^2	0.924		
Durbin-Watson	0.500		

Table 8: Random Effect Estimation 1999:05 - 2000:8; *, **, ***: significant at the 10, 5, 1 % level

	Dependent Variable: Log($spread_{it}$)		
	Coefficient	**Percentage Change of Spreads**	***t*-Statistic**
Constant	5.784		26.73***
Real GDP Growth	-0.073	-7.01%	-6.15***
Inflation	0.013	1.36%	7.25***
Current Account	0.006	0.62%	0.95
LIBOR	0.095	9.96%	3.27***
VIX	0.003	0.34%	0.78
Random Effects	**Coefficient**	**Random Effects + Constant in basis points**	
Argentina	0.189	392.41	
Brazil	0.236	411.61	
Colombia	0.004	326.21	
Indonesia	-0.044	310.89	
Mexico	-0.306	239.34	
Russia	0.483	526.44	
Turkey	-0.606	177.20	
Venezuela	0.044	339.68	
Total Panel Observations (N=8, T=21)	168		
GLS Regression Statistics			
Adjusted R^2	0.918		
Durbin-Watson	0.496		

Table 9: Random Effect Estimation 1998:12 - 2000:8 without Korea; *, **, ***: significant at the 10, 5, 1 % level

D Specification Tests

D.1 Breusch-Pagan-LM-test for random effects

The presence of random effects can be tested with a Langrange multiplier test based on the residuals of the OLS regression.[36] In the random effect model (2), σ_U^2 denotes the variance of the random effects. Under the null hypothesis, it is assumed that this variance is zero:

$$\begin{aligned} H_o &: \sigma_U^2 = 0 \\ H_1 &: \sigma_U^2 \neq 0. \end{aligned}$$

Under H_o, the LM test statistic

$$LM = \frac{iT}{2(T-1)} \left[\frac{T^2 \overline{e}' \overline{e}}{e'e} - 1 \right]^2$$

is distributed as χ^2 with one degree of freedom. Here, $e'e$ is the sum of squared residuals of the OLS regression, and $\overline{e}'\overline{e}$ is the sum of squared cross section mean residuals.[37] From the OLS regression (not reported), we get $e'e = 14.75825$ and $\overline{e}'\overline{e} = 0.328825$. With $i = 9$ and $T = 21$, we have

$$LM = 368.05$$

which clearly exceeds the 99 percent critical value of $\chi^2(1) = 6.63$. Hence, the hypothesis $\sigma_U^2 = 0$ can be rejected. Notice however, that H_1 is also consistent with the fixed effect model so that discriminating between fixed and random effects requires a further test which is described in the next section.

D.2 Fixed versus random effects - Hausman test

If there is no correlation between the country-specific effects and the other regressors, both the fixed effect and the random effect model yield consistent estimates, but the fixed effect OLS procedure is inefficient. The GLS random effect procedure should be applied instead. However, if there is correlation,

[36] The Breusch-Pagan test is peformed as described in Greene (2000, p. 573).

[37] The vector $\overline{e}$ has the dimension $i \times 1$ and is containing the time averages of the cross section residuals of the OLS regression.

OLS is consistent and GLS is not. In such a case, the Hausmann test can be applied. It is based on the test statistic

$$W = \chi^2(K) = \left[\widehat{\beta}_{FE} - \widehat{\beta}_{RE}\right]' \widehat{\Sigma}^{-1} \left[\widehat{\beta}_{FE} - \widehat{\beta}_{RE}\right]$$

where $\widehat{\beta}_{FE}$ is the $K \times 1$ vector of estimated coefficients from the fixed effect model, $\widehat{\beta}_{RE}$ is the vector of coefficients from the random effect model, and $\widehat{\Sigma}$ is a $K \times K$ matrix defined as the difference of the estimated covariance matrices of the fixed effect and of the random effect model (without the constant). The test statistic is 0.34. It is asymptotically distributed as χ^2 with K degrees of freedom. The critical value of the χ^2 distribution with 5 degrees of freedom is 9.24 at the 10% level. Hence the null hypothesis that there is no correlation between country-specific effects and other regressors cannot be rejected. Hence, the random effect model is consistent and more efficient than the fixed effect model.