Doctoral (Ph.D.) Dissertation

Determinants of Sovereign Bond Spreads in Emerging Markets

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UNIVERSITY OF DEBRECEN

Doctoral School of Economics

Debrecen, 2014

Doktori (Ph.D.) értekezés

Determinants of Sovereign Bond Spreads in Emerging Markets

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DEBRECENI EGYETEM

Közgazdaságtudományi Doktori Iskola

Debrecen, 2014

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A disszertáció védésének időpontja:

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Acknowledgements

I would like to express my gratitude to my supervisor, Professor Julius Horvath, for his continuous support and encouragement during the last four years. He has always been very helpful during my studies.

I would also like to thank my colleagues. I could always count on my supervisor, Iryna Ivaschenko. She encouraged and supported me both in my work and studies. I am also grateful to Alejandro Guerson, Nir Klein, Ceyda Oner, Vahram Stepanyan and Thanos Arvanitis for their continuous support and valuable comments.

I would like to thank Róbert Lieli who was very helpful with econometric questions related to Chapter 2 of the dissertation.

I would also like to thank Júlia Király and Péter Pete for their valuable comments as well as Judit Kapás, Pál Czeglédi and József Gáll for their comments and continuous support throughout my studies.

1. Introduction

Emerging market sovereign debt has become an increasingly important asset class for investors in the last two decades, especially in the 2000s. The continuous expansion of both the local and hard currency emerging sovereign bond market was driven by a number of factors.[1] First, U.S. Treasury secretary Nicholas Brady announced a debt restructuring program in 1989 that was aimed at addressing the less-developed-countries' debt crisis that started in 1982, mostly in Latin America. By re-negotiating the terms of their loans with external lenders, participating countries reduced their debt level and regained access to external financing. Furthermore, they also adopted a number of structural reforms with the goal of improving their long-term creditworthiness. Second, following a series of emerging market crisis episodes such as the Tequila crisis of 1994, the Asian crisis of 1997, the Russian default of 1998, Ecuador defaulting on its Brady bonds in 1999 and the Argentine default of 2001, emerging market governments conducted sounder macroeconomic policies that enhanced growth outlook, led to lower and more stable inflation, as well as improved their external and fiscal position. The growing interest of foreign investors in emerging market debt stemming from their better macroeconomic fundamentals also allowed these countries to extend the maturity profile of their public debt, reduce the issuance of floating-rate debt and increase the issuance of local currency debt.

The increasing reliance of emerging markets on external private financing and the increasing holding of emerging market debt by investors made it essential for both policymakers and investors to understand the main determinants of sovereign bond yields. For policymakers, although increased external financing diversified their funding structure, potential capital flow reversals during crisis periods raised liquidity risk. Furthermore, policymakers need to understand whether prevailing bond yields are in line with their fundamentals and global conditions. First, they may want to increase issuance at favorable yields, i.e. when yields are smaller than the level justified by macroeconomic fundamentals. Second, it is of primary importance to analyze whether the prevalence of favorable funding conditions is the result of sound macroeconomic fundamentals or supportive global environment. In the latter case, low bond yields should not prevent policymakers from focusing on reducing vulnerabilities, as weak

[1] See *Anderson et al.* [2010] and *Arslanalp and Takahiro* [2014].

fundamentals, which may be "overlooked" by investors during tranquil times, can amplify the negative effects on their economies of an adverse shift in global market sentiment. As *El Erian and Spence* [2012] note, it is important for policymakers to have an appropriate design and use of ex ante and ex post circuit breakers that could "prevent the evolution of structures that amplify feedback loops and break the serial contamination of expectations, the real economy, and market linkages, thereby interrupting the often disruptive dynamic that leads to a sequence of bad equilibriums".

For investors, the most important issues include the misalignment of yields, i.e. the difference between actual yields and the ones justified by macroeconomic fundamentals and global conditions, the sensitivity of yields to changes in global conditions as well as the co-movement of yields across countries. First, they may want to increase their holdings of emerging market debt when it is perceived to be underpriced, i.e. when yields are higher than the level justified by domestic and external factors. Second, the sensitivity of yields to global conditions indicates the riskiness of a given country. Even if prevailing yields seem attractive, a high sensitivity could lead to a spike in yields in the case of a deterioration of global market sentiment. Third, although investing in a large number of countries could reduce the risk profile of a portfolio consisting of emerging market sovereign bonds given the historical co-movements between them, cross-country correlations tend to be time-varying. Specifically, during periods of increased correlation, diversification benefits may be eroded, thereby leaving investors exposed to possible adverse shifts in global conditions.

In this dissertation, we aim at investigating the main drivers of emerging market sovereign bond spreads as well as their time-varying co-movement across countries. In Chapter 2 and 3, we analyze the relationship between spreads and country-specific and global factors in a number of emerging market countries. Specifically, in Chapter 2 and 3 we investigate whether the relative importance of macroeconomic fundamentals and global conditions differs in the short- and long-run, and under different regimes of volatility in financial markets, respectively. Chapter 2 uses the Pooled Mean Group estimator in order to distinguish between the short- and long-run drivers of spreads. Chapter 3 applies a two-step procedure. First, by estimating a Markov-switching

Autoregressive Conditional Heteroskedasticity (ARCH) model on VIX index[2], which indicates the degree of risk aversion in financial markets, we identify low-, medium- and high-volatility regimes. Second, we regress spreads on the interactions of regime probabilities with several county-specific and global variables with the aim of understanding whether the relationship between spreads and their determinants differs across regimes. Furthermore, we also show whether and how the strength of macroeconomic fundamentals affects the sensitivity of spreads to global market conditions. In Chapter 2, we employ two approaches. First, in the fixed effects panel estimation, after splitting the sample into countries with weak and strong fundamentals, we compare the estimated sensitivities of spreads to global conditions between the two groups of countries. Second, in the pooled mean group estimation, we analyze whether country-specific short-term coefficients of global conditions are related to country-specific fundamentals. In Chapter 3, we analyze whether fitted spreads of countries with weak, average and strong fundamentals change when there is a shift from low- to medium- or high-volatility regimes.

In Chapter 3 and 4, we also investigate the time-varying cross-country co-movement of bond spreads. In Chapter 3, we apply a two-step procedure. Following the identification of low-, medium- and high-volatility regimes using the Markov-switching ARCH model, we compare regime-specific cross-country correlations of spreads. In Chapter 4, we estimate a Dynamic Conditional Correlation GARCH model with the aim of understanding the time-varying co-movement of spreads.

Table 1-1. Structure of the Dissertation

Determinants of spreads	Country-specific vs. global factors	Chapter 2&3
	Short vs. long run	Chapter 2
Impact on spreads of country-specific and global factors, conditional on...	... volatility in financial markets	Chapter 3
	... the strength of country-specific fundamentals	Chapter 2&3
Decomposition of changes in spreads and estimation of the misalignment of spreads in the pre-crisis period and during the crisis		Chapter 2
Changes in the co-movement of spreads		Chapter 3&4

Source: author's compilation

[2] The Chicago Board Options Exchange Volatility Index (VIX) measures the implied volatility of S&P index options. It is used as a proxy for investors' risk appetite.

2. Determinants of Sovereign Spreads in Emerging Markets: Local Fundamentals and Global Factors vs. Ever-Changing Misalignments[3]

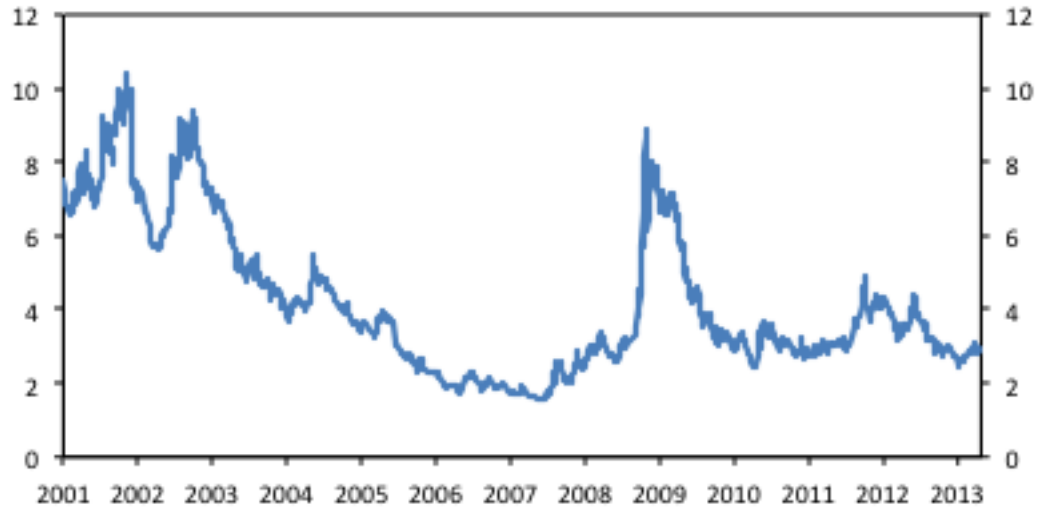
2.1. Introduction

After an extended period of heightened volatility, emerging market sovereign spreads narrowed steadily in the second half of 2012 (**Figure 2-1**). The strengthening of the emerging market debt performance came on the back of improving global market sentiment against the backdrop of exceptionally low yields and ample liquidity provision in the industrial countries. Market sentiment improved dramatically as concerns decreased about the Euro Area debt crisis resolution and central banks in the developed countries announced several additional liquidity-enhancing measures. Specifically, the European Central Bank announced the Outright Monetary Transactions (OMT) program in September that includes the conditional purchase of the Euro Area sovereign bonds in unlimited amounts at the secondary market. The Federal Reserve started a new bond purchase program and committed to keep interest rates at exceptionally low levels at least until the mid-2015. The Bank of Japan also announced further monetary easing. Market sentiment was also supported by the outcome of Greek elections in the middle of the year and the favorable ruling of the German constitutional court regarding the European Stability Mechanism in September.

As a result of exceptionally low yields in the industrial countries and ample liquidity, emerging markets experienced a significant inflow of funds, pushing emerging market sovereign debt costs down. During the second half of 2012–beginning of 2013 emerging market bond funds experienced an inflow of almost US$ 1 billion per week on average (**Figure 2-2**), while the EMBI Global spread decreased by around 180 basis points between early June 2012 and late January 2013. However, this was followed by a small correction due to increasing risk aversion related to uncertainty in Cyprus.

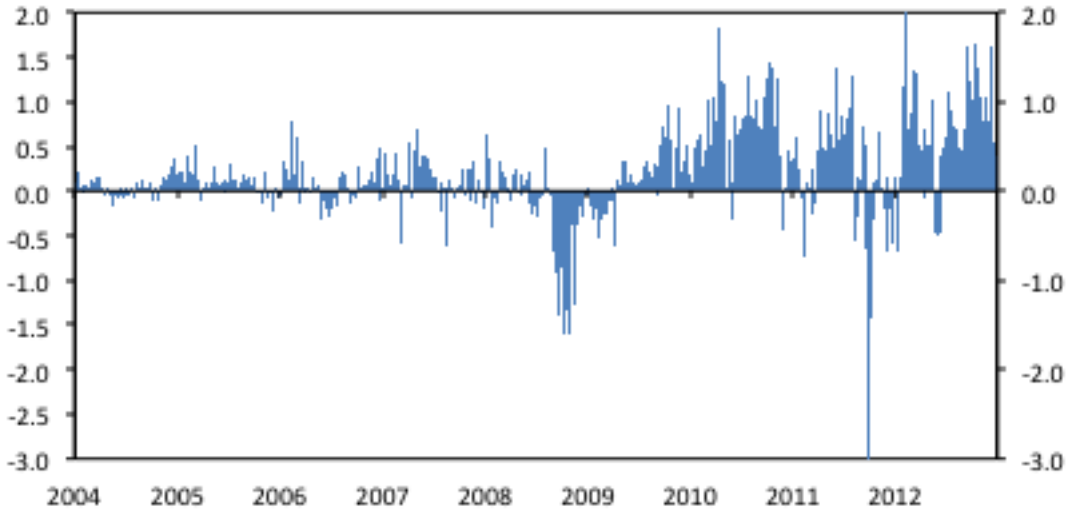
[3] The chapter was published as an IMF Working Paper (see *Csontó and Ivaschenko* [2013]).

Figure 2-1. Emerging Market Bond Spreads
(EMBI Global, percentage point)



Source: J.P. Morgan

Figure 2-2. Emerging Market Bond Fund Flows
(weekly net flows in billions of US$)



Source: EPFR Global

In this paper, we analyze the relationship between global and country-specific factors and country spreads from three different angles.

First, we analyze the changes in emerging market debt spreads with the aim to disentangle the effect of global and country-specific developments. We find that while both country-specific and global developments are important determinants of spreads in the long run, it is mostly the global factors that determine spreads in the short run. This finding is intuitive, consistent with the literature, and sheds lights with the recent developments described above. First, the asset-pricing theory predicts that all relevant

information shall be included in asset prices (or spreads) and hence both global factors and the strength of country-specific fundamentals should be reflected in the long-run, equilibrium, level of bond prices (spreads). Second, since country-specific fundamentals change slowly over time—as macroeconomic policies and structural reforms take time to bear fruit—it is the variation in global factors that should be more important in driving country spreads in the short run. This finding may explain why during the second half of 2012-beginning of 2013 all emerging markets experienced significant narrowing in sovereign bond spreads, seemingly irrespective of country-specific fundamentals. The liquidity boat lifted all boats, both sturdy and shaky ones, in the short-term, but leaves shaky ones vulnerable to eventual correction when spreads revert to their long-term fundamental values.

Second, we investigate whether and how the strength of fundamentals is related to the sensitivity of spreads to global factors. In order to do so, we employ two approaches. First, in the fixed effects panel estimation, we split the sample into countries with weak and strong fundamentals. Second, in the pooled mean group estimation, we analyze whether country-specific short-term coefficients of global conditions are related to country-specific fundamentals. We find that countries with stronger fundamentals tend to have lower sensitivity to changes in global risk aversion. This finding not only supports the results described above, but is also important from the policy-making perspective as it highlights the premium on good policies, suggesting that solid domestic fundamentals do provide some cushion against sudden shifts in the global market sentiment.

Third, we also decompose changes in spreads in seven periods over the last decade in order to understand whether they are driven by improving fundamentals and/or global factors, and what role the unexplained part of changes plays. To our knowledge, such a comprehensive analysis has not been performed in the existing literature. For example, *Hartelius et al.* [2008] and *Dumicic and Ridzak* [2011] decomposed changes in spreads for one and two periods, respectively, but compared actual and fitted changes without analyzing changes in residuals. In this chapter, in addition to the breakdown of fitted changes in spreads into the contribution of fundamentals and global factors as common in the literature, we also decompose changes in the residual into correction of initial misalignment and increase/decrease in misalignment in the given period.

Based on the average results across all emerging markets, the sample period can be divided into 7 sub-periods characterized by a general decrease or increase in spreads

across countries, as compared to the previous period. Specifically, we find that models explain about half of the tightening of spreads during the pre-crisis period (up to August 2007), with both global factors and country-specific fundamentals playing an important role. The unexplained part of the tightening was driven both by the correction of earlier misalignment (in this case, underpricing of emerging market debt) left over after the crises that plagued markets in the late 1990s–early 2000s, as well as an accumulation of misalignment during the boom years.

The changes in spreads during the crisis follow periods of tightening and widening which are well-explained by the model and are intuitive. In addition, the dynamics of the components of the unexplained residual intuitively follow all the major developments of the current crisis that in turn impact market sentiment: the 2007–early Fall 2008 period when the crisis was mostly contained to the mature financial systems; the period after the Lehman bankruptcy when the "mature market crisis" turned into a full-blown "confidence and growth crisis" and spilled over to the emerging markets, especially in Europe; some thawing of market conditions and improvement in fundamentals in 2009–early 2010; followed by the many nerve-wrecking twists and turns of the Eurozone debt crisis from the spring 2010 to mid-2012; and the spectacular improvement in global market sentiment between mid-2012 and early 2013 as monetary policy decision-makers relieved concerns about the tail risk of the Eurozone debt crisis.

In general we find that in periods of severe market stress and general lack of public understanding of country-specific developments, such as during the intensive phase of the Eurozone debt crisis, global factors tend to drive the changes in spreads and misalignment tends to increase in magnitude and its share in actual spreads increases. We also find that a spectacular performance of emerging market sovereign debt in 2012 was mainly driven by an improvement in global factors, both risk perception and liquidity. The small unexplained part mostly reflected the correction of the undervaluation of emerging market debt, but some misalignment started to build up by early 2013; however, the latter broadly disappeared due to increasing uncertainty related to Cyprus. The detailed results are presented and explained later in the chapter.

The rest of the chapter is organized as follows. Section 2.2 reviews the literature on the determinants of emerging market bond spreads. Section 2.3 describes the data, and Section 2.4 presents the estimation methodologies. Section 2.5 estimates the models, using two different methodologies for the whole sample, as well as split across

regions, Section 2.6 analyses the dynamic of actual versus fitted spreads, Section 2.7 analyses the decomposition of changes in spreads, and Section 2.8 concludes.

2.2. Related Literature

Over the past two decades a vast number of empirical studies examined the relationship between emerging market sovereign debt spreads and both country-specific and global factors. The studies could be grouped along the following lines: (i) what estimation technique is used (i.e. factor or principal component analysis, individual country or panel regressions[4]), and (ii) what is the choice of country-specific and global explanatory variables. The literature is also split in how the dependent variable, the country risk premium or spread, is measured (i.e. local or foreign currency).

The literature has established several explanatory variables, both global and country-specific, which affect spreads. Specifically:

Applying panel estimation, the seminal paper of *Edwards* [1985] finds that key drivers of spreads are country-specific fundamentals such as external debt, debt service and investment ratio[5]. In addition to the effect of country fundamentals, *Eichengreen and Mody* [1998] show that the external interest rate environment is also an important determinant of spreads. *Luengnaruemitchai and Schadler* [2007] and *Hartelius et al.* [2008] further expand the list of global factors and county-specific fundamentals that have significant effect on spreads. As regards global factors, in addition to the level of international interest rates they find that the uncertainty about the level of rates and global risk aversion are also important determinants of spreads. Specifically, they find that an increase (decline) in either the level or the volatility of the U.S. Federal fund futures rates and a higher (lower) global risk aversion are associated with higher (lower) country risk premium. As regards country-specific factors, they find that country fundamentals—as captured by economic, financial and political indicators—as well as a

[4] In this chapter, we focus on individual country and panel regressions. For studies applying factor analysis, see *McGuire and Schrijvers* [2003], *Kennedy and Sløk* [2004], *Ciarlone et al.* [2007], *Kisgergely* [2009], *Kocsis and Nagy* [2011], or *Kocsis* [2013].

[5] Investments have an impact on spreads through their impact on growth outlook. However, as the coefficient of debt and investment is of roughly the same magnitude in the bank loans spread equation, it is also concluded that debt-financed investments do not result in lower spreads.

sovereign credit rating outlook also significantly affect spreads. *Jaramillo and Tejada* [2011] also find credit rating to be a significant determinant of spreads even after accounting for fundamentals, with movements across the investment grade threshold having a bigger effect on spreads than rating changes within each asset class. *Kocsis and Mosolygó* [2006] also find a significant relationship between spreads and credit ratings, with this relationship being stronger in lower-rated countries. *Peiris* [2010] finds that tighter (looser) global liquidity, weaker (stronger) domestic fundamentals and tighter (looser) domestic monetary conditions are associated with higher (lower) country spreads, while higher (lower) foreign participation in the domestic bond market tends to result in lower (higher) yields. In this paper global liquidity is measured by the level of long-term U.S. Treasury yields while the country-specific fundamentals include inflation, fiscal deficit and current account balance. *Levy-Yeyati and Williams* [2010] find that global risk aversion, liquidity and U.S. Treasury supply shocks that result in the steepening of the U.S. yield curve all affect country bond spreads, while the U.S. Federal funds rate does not have a significant direct impact in the baseline specification.

Using country regressions, *Arora and Cerisola* [2001] and *Nickel et al.* [2009] find that while global factors are important drivers of spreads in almost every country, the significance of fundamentals differs across countries. Similarly, *Ebner* [2009] shows that the effect and importance of country-specific factors varies across countries and concludes that external risk aversion is "the single most important explanatory factor" of spreads.

There is also an extensive literature that analyzes whether the coefficient of the impact of the country-specific and global factors on spreads is in turn a function of global market conditions and the strength of country fundamentals, and whether this relation changes depending on the time horizon. To summarize, the studies find that: (i) global liquidity and risk factors do affect the strength and sometimes the direction of the effect which country-specific fundamentals have on spreads; (ii) stronger country-specific fundamentals reduce the effect of the global factors on spreads; (iii) country fundamentals determine spreads in the long-term, while global factors are important drivers of spreads both in the short- and the long-term.

- To assess the effect of global conditions on the strength of the country-specific coefficients, the studies use two techniques. They either split the sample into periods of low and high global risk aversion or include the interaction of

fundamentals with dummies of high global risk perception. *Baldacci et al.* [2008] show that the impact of fiscal indicators increases during high-volatility periods. *Dumicic and Ridzak* [2011] find that macroeconomic indicators and global factors drive spreads in the CEE countries at all times, while sovereign risk and external solvency indicators become significant only during crisis periods. Applying a panel threshold estimation, *Jaramillo and Weber* [2012] find that fiscal variables determine spreads in the periods of high risk aversion, while macro variables become important determinants of spreads during low risk-aversion periods. *Comelli* [2012] finds that the size and significance of the coefficient of country fundamentals and global factors varies across regions and over time. In particular, he shows that in the period of "abundant global liquidity" the coefficient of the short-term U.S. Treasury yield turns negative, possibly because low global interest rate environment leads to an excess supply of bonds and hence higher spreads. This paper also finds that the long-term U.S. yield has become insignificant post-2003 suggesting that investors' focus switched to country-specific factors.

- To evaluate the effect of the strength of country fundamentals on the sensitivity of spreads to explanatory variables, the studies usually split the sample into countries with weak and strong fundamentals or use the interaction of explanatory variables with dummy variables capturing the strength of fundamentals. *Alexopoulou et al.* [2009] find that the importance of country-specific and global factors differs among countries with weak and strong fundamentals. Spreads are driven by a different set of country-specific factors in the two groups of countries, while the common factor of Euro Area equity market volatility is a significant determinant of spreads in both groups of countries, albeit with different sign: it has negative and positive coefficient in countries with strong and weak fundamentals, respectively. *Levy-Yeyati and Williams* [2010] find that the magnitude and sometimes the sign of the coefficient of global factors differ between investment-grade and speculative-grade countries, and between distressed and tranquil times. Investment-grade countries tend to have lower sensitivity of spreads to changes in long-run U.S. rates and global liquidity preferences than speculative-grade countries. They also find that the coefficient of the U.S. Federal funds rate switches from negative in distressed periods to positive in tranquil times, while it increases and

decreases in the case of long-run U.S. rates and VIX, respectively, during tranquil periods. *Baldacci and Kumar* [2010] analyze the possible non-linear impact of fiscal policy on spreads. They find that the size of the impact depends on initial fiscal, institutional and structural conditions, as well as spillovers from global financial markets. For example, the coefficient of fiscal balance becomes larger in absolute terms for countries that had high initial deficit or debt, low private saving ratios or faster population aging, while it is mitigated by lower global risk aversion or better global liquidity conditions. *Jaramillo and Tejada* [2011] find that investment-grade countries have lower spreads, lower sensitivity to external debt and reserves, and a higher sensitivity to growth than speculative-grade countries. They also show that the effect on coefficients is higher when the country's credit rating is moving between the investment grade and speculative-grade asset classes than when the rating is changing within each asset class.

- To analyze whether the effect of country-specific and global factors differs in the short and long term, the literature uses error correction model and pooled mean group estimator, with the latter also allowing for different short-term coefficients across countries. *Ferrucci* [2003] finds that both country-specific and global factors are significant in the long term. As regards the latter, he finds that the slope of the US yield curve is the main driver of spreads: spreads increase when the curve flattens suggesting that leveraged investors tend to decrease their demand for emerging market bonds when global borrowing costs are high. *Alexopoulou et al.* [2009] find that fundamentals and global factors are significant both on the short- and the long-term in the CEE countries. *Bellas et al.* [2010], applying both fixed-effects and pooled mean group estimation, find that country fundamentals are significant only in the long-term, while the global risk aversion affects spreads both in the short- and the long-term. *González-Rozada and Levy-Yeyati* [2005], using an error correction model to separate short- and long-term drivers of spreads, show that credit rating and global factors are significant determinants in both time horizons. They also conclude that fundamentals are determinants of the exposure to external shocks rather than that of borrowing costs.

2.3. Model

As a common practice in the literature[6], we follow *Edwards* [1985] to construct the empirical model on sovereign debt spreads. The equilibrium condition for a risk-neutral investor lending to a country that has non-zero probability of default and is a price-taker in global debt markets is the following[7]:

Equation 2.1

$$(1-p)(1+i^*+s) = (1+i^*)$$

where p, i^* and s denote the probability of default by the borrowing country, the global risk-free interest rate and the country-risk premium, respectively. Based on the equilibrium condition, the investor requires the borrower to provide compensation for the non-zero probability of default in the form of country-risk premium calculated as follows:

Equation 2.2

$$s = \frac{p}{1-p}(1+i^*)$$

where the country-risk premium is positively related to the probability of default and the global risk-free interest rate. Assuming that the probability of default has the following logistic form:

Equation 2.3

$$p = \frac{\exp(\sum_i \beta_i X_i)}{1+\exp(\sum_i \beta_i X_i)}$$

where the X_i and β_i are the determinants of the probability of default and the corresponding coefficients, respectively, the spread equation take the following form:

---

[6] See *Akitoby and Stratmann* [2006], *Comelli* [2012], *Jaramillo and Tejada* [2011], and *Luengnaruemitchai and Schadler* [2007].

[7] The equation assumes zero recovery rate in the case of default.

Equation 2.4

$$\ln(s) = \ln(1 + i^*) + \sum_i \beta_i X_i$$

where X_i is assumed to capture both country-specific fundamentals and global market conditions. We use two different techniques to estimate Equation 2.4: the fixed effects and the pooled mean group estimation.

As indicated above, an important determinant of spreads is the probability of default and the expected loss given default with the latter assumed to equal zero in our model. Unlike in the case of corporate bankruptcy, the probability of sovereign default depends on both the debtor's ability and willingness to pay:[8]

- A country's ability to pay can be best described by its solvency position. However, solvency is not a straightforward concept. The theoretical solvency criterion states that "the discounted value of primary balance should be at least equal to the initial public debt" (*Roubini* [2001]). Due to its difficult operational use, this criterion is usually replaced by the sustainability of public finances that typically requires a non-increasing debt-to-GDP ratio in the medium term, an appropriate composition of debt and the stabilization of debt "at a level consistent with an acceptably low rollover risk and with preserving growth" (*IMF* [2013])[9]. First, the requirement of non-increasing debt implies either that real GDP growth exceeds real interest expenditures with zero primary fiscal balance or that a primary surplus compensates for the positive differential between real interest rate and real GDP growth. The main macroeconomic factors affecting debt sustainability are thus real interest rates, real GDP growth and primary fiscal balance as well as exchange rate changes in the case of foreign currency-denominated debt. Second, debt sustainability is affected by the composition of debt. For example, a high share of short-term debt

[8] See *Eaton and Gersovitz* [1981] who were among the first to distinguish between ability and willingness.

[9] See also *Blanchard et al.* [1990], *Garcia and Rigobon* [2004] or *Ghosh et al.* [2011] for sustainability analysis.

increases rollover risks. Similarly, a high proportion of debt held by foreign investors might increase rollover risks in the case of a deterioration in global market sentiment. Third, the level of debt affects both rollover risks and the economy's vulnerability to external factors. Specifically, an increase in interest rates or a decrease in growth might have to be compensated for by larger fiscal adjustment in the case of high debt-to-GDP ratio.

- The sovereign's willingness to pay (or rather the lack thereof) seems the main determinant of default in most crisis episodes (*Reinhart and Rogoff* [2009]). Specifically, they show that "most country defaults happen long before a nation literally runs out of resources" as default is usually the result of a cost-benefit analysis that involves several non-economic considerations as well. Willingness to pay thus strongly depends on a country's cultural, social and institutional characteristics. Sovereign default is also facilitated by the non-existence of a supranational legal framework that could ease the enforcement of debt service payments. On the other hand, countries have strong incentives to meet their obligations stemming from debt issuance. *Eaton and Gersovitz* [1981] emphasized the benefits associated with preserving access to international capital markets, while *Bulow and Rogoff* [1989] showed that creditors might have the ability to seize the debtor's assets in a third country.

In the dissertation, we analyze the drivers of spreads of sovereign bonds denominated in foreign currency. The main differences between local and foreign currency debt in terms of credit risk are at least threefold. First, the sovereign's ability to print money results in lower credit risk associated with sovereign debt denominated in domestic currency. Second, even if monetary policy is credible (i.e. it is not willing to finance fiscal deficit), credit risk of foreign currency denominated debt is enhanced by potential adverse exchange rate movements. In other words, by increasing its foreign currency debt service expressed in local currency, the depreciation of the domestic currency could lead to the inability of the sovereign to meet its payment obligations. Third, the government's willingness to pay might be affected by the share of domestic ownership of debt. Given that domestic ownership tends to dominate in the case of debt denominated in local currency, political considerations could result in higher willingness to meet payment obligations on local currency debt.

2.4. Data

We have an unbalanced panel dataset of 147 monthly observations between January 2001 and March 2013 for 18 emerging markets in three regions[10]. As the measure of sovereign risk/spread, we calculated monthly averages of daily Emerging Market Bond Index Global (EMBIG) sovereign spreads downloaded from J.P. Morgan's research and market data website (MorganMarkets) for each country in the sample.[11] The EMBIG spread is a market-capitalization-weighted average of spreads on US$-denominated Brady bonds, Eurobonds and traded loans issued by sovereign and quasi-sovereign entities. It is a widely accepted measure of spread on foreign currency denominated public debt in the literature.

We use the following country-specific fundamentals and global factors as explanatory variables:

1. Country-specific fundamentals:[12] Like *Luengnaruemitchai and Schadler* [2007] and *Comelli* [2012], we use risk indicators of the International Country Risk Guide (ICRG) database that contains monthly data on economic, financial and

[10] Countries included in the sample are the following: Asia: China, Indonesia, Malaysia, Pakistan, Philippines; Central and Eastern Europe: Bulgaria, Hungary, Poland, Russia, Turkey, Ukraine; Latin America: Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela.

[11] Our choice of using EMBIG spreads over credit default swap (CDS) spreads was motivated by findings in the literature on that some market frictions such as counterparty risk and market illiquidity caused deviations between CDS and bond spreads during the crisis (*Arce et al.* [2011]). *Varga* [2009] also showed that CDS spreads and foreign currency bond spreads might deviate due to microstructural factors, while *Horváth et al.* [2013] demonstrated what an impact regulatory changes could have on CDS spreads. See also *Andritzky and Singh* [2006], *Fontana and Scheicher* [2010] or *Bilal and Singh* [2012].

[12] In principle, the market infrastructure characteristics—such as depth, liquidity or turnover—could also influence the sensitivity of spreads to global factors. This is taken care of, in part, by the inclusion criteria for debt instruments applied in constructing the EMBIG spreads. For example, only issuances larger than US$ 500 million are included, which in part takes care of the depth and liquidity.

political risk in 140 countries[13]. Based on 22 variables, the following three composite ratings are available[14]:

- *Economic Risk Rating (ERR):* the weighted average of risk points assigned to GDP per capita, real GDP growth, inflation, fiscal balance (percent of GDP) and current account balance (percent of GDP).
- *Financial Risk Rating (FRR):* the weighted average of risk points related to foreign debt (percent of GDP), foreign debt service (percent of exports), current account (percent of exports), official reserves (months of imports) and exchange rate stability (appreciation/depreciation against the US$ over the most recent 12-month period).
- *Political Risk Rating (PRR):* the weighted average of the risk rating of the following components: government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucracy quality.

The ERR, the FRR, and the PRR can take any value between 0–50, 0–50, and 0–100, respectively. Low values signal higher risk. As such, these indicators are expected to have a negative relationship with spreads.

2. Global factors:

- *Global risk aversion:* The Chicago Board Options Exchange Volatility Index (VIX), which measures the implied volatility of S&P index options, is used as a proxy for investors' risk appetite. The source of data is Bloomberg. VIX is expected to be positively associated with spreads.
- *Global liquidity conditions:* The U.S. Federal funds rate is used as a proxy for global liquidity conditions. Data was downloaded from the

[13] The ICRG composite risk ratings have the advantage of being readily available and capturing several economic, financial and political variables. A detailed description of the methodology is available at PSR Group's website (http://www.prsgroup.com/PDFS/icrgmethodology.pdf).

[14] The use of aggregate indicators imposes a limit on the understanding of the impact on spreads of specific economic, financial and political indicators. However, the main goal of the chapter is to distinguish between domestic and global determinants that does not require a detailed distinction among domestic factors.

website of Federal Reserve. As lower Fed funds rate is assumed to be associated with higher liquidity, it is expected to have a positive relationship with spreads. To some extent VIX also captures global liquidity conditions, especially during crisis periods and especially near the zero-bound when non-conventional monetary policy is being employed. In fact, massive liquidity provision via the balance sheet expansion by major central banks (the Fed, the ECB, BOE, and BoJ) during the recent crisis helped to moderate market risk aversion. In addition, VIX is forward-looking because it tends to react to the announcements of the future measures by the central banks—for example, the VIX moderated dramatically after the ECB announced its OMT program, although this program has not been utilized as of now.

Table 2-1 shows descriptive statistics of the variables, while Table 2-2 contains their correlation matrix. The correlation matrix reveals that EMBIG spreads are negatively correlated with each risk rating variable and the U.S. Federal funds rate, while they are positively correlated with VIX, with correlations being significantly different from zero in each case. The correlation between risk rating indicators is always positive, albeit insignificant between FRR and PRR, suggesting that countries with higher economic risk tend to have higher financial and political risk as well. VIX has a significant negative correlation with each risk rating variable, suggesting that higher (lower) global risk aversion is associated with worse (better) country fundamentals.

Table 2-1. Descriptive Statistics

Variable		Mean	Standard Deviation	Min	Max
embig	EMBI Global spread (percentage point)	4.42	7.30	0.14	68.47
err	Economic Risk Rating	36.27	4.01	17.50	45.50
frr	Financial Risk Rating	38.24	4.89	15.50	48.50
prr	Political Risk Rating	65.10	9.31	40.00	84.50
vix	VIX (percentage point)	21.70	9.19	10.82	62.64
us ffr	U.S. Federal funds rate (percent)	1.92	1.85	0.07	6.01

Source: J.P. Morgan, ICRG, Bloomberg, Fed, authors' calculations

Table 2-2. Pairwise Correlations

	embig	err	frr	prr	vix	us ffr
embig	1.0000					
err	-0.4440 (0.0000)	1.0000				
frr	-0.4686 (0.0000)	0.5363 (0.0000)	1.0000			
prr	-0.5298 (0.0000)	0.3410 (0.0000)	0.0183 (0.3464)	1.0000		
vix	0.3822 (0.0000)	-0.2002 (0.0000)	-0.1798 (0.0000)	-0.0566 (0.0036)	1.0000	
us ffr	-0.1606 (0.0000)	0.2135 (0.0000)	-0.0583 (0.0027)	0.0805 (0.0000)	-0.3326 (0.0000)	1.0000

Note: Correlations are calculated between the logs of these variables. P-values are in parenthesis.
Source: authors' calculations

2.5. Estimation Methods

2.5.1. Fixed Effects Estimation

Following the literature, we first use the most widely applied method of estimating the spread equation, the fixed effects panel regression[15]:

Equation 2.5

$$\ln(embig_{it}) = \gamma'_1 \ln(X_{it}) + \gamma'_2 \ln(Z_t) + \mu_i + \varepsilon_{it}$$

where $embig_{it}$, X_{it}, and Z_t denote EMBIG spread, and a $(k_1 \times 1)$ and a $(k_2 \times 1)$ vector of country-specific (ERR, FRR and PRR) and global explanatory variables (VIX and U.S. Fed funds rate), respectively, while μ_i, γ_1 and γ_1 are the country fixed effect, and $(k_1 \times 1)$ and $(k_2 \times 1)$ vectors of coefficients, respectively.

[15] The Hausman test rejected the random effects model in each specification.

2.5.2. Pooled Mean Group Estimation

In order to accommodate the heterogeneity in the panel and the possible dynamic nature of the problem, we then also use the pooled mean group (PMG) estimator developed by *Pesaran, Shin and Smith* [1999].

As an intermediate technique between panel and individual country regressions, the pooled mean group estimator has several advantages. First, in contrast with panel regressions, it allows short-run coefficients to differ among countries. This is crucial when explaining spreads across a heterogeneous set of countries. Second, as the variation in time of country-specific fundamentals is usually much lower than that of sovereign spreads, individual country regressions tend to underestimate the role of fundamentals in explaining spreads. By constraining long-run coefficients to be homogeneous across countries, the pooled mean group estimator involves the cross-country dimension as well, thereby capturing the impact of different country-specific fundamentals on the level of spreads in a given point of time.

Following *Pesaran, Shin and Smith* [1999], our starting point is an ARDL (p,q,…,q) model:

Equation 2.6

$$\ln(embig_{it}) = \sum_{j=1}^{p} \lambda_{ij} \ln(embig_{i,t-j}) + \sum_{j=0}^{q} \delta'_{1ij} \ln(X_{i,t-j}) + \sum_{j=0}^{q} \delta'_{2ij} \ln(Z_{t-j}) + \mu_i + \varepsilon_{it}$$

where λ_{ij}, δ_{1ij} and δ_{2ij} are a scalar, a $(k_1 \times 1)$ and a $(k_2 \times 1)$ vector of coefficients, respectively.

The ARDL model can be re-parameterized in the following way:

Equation 2.7

$$\Delta \ln(embig_{it}) = \phi_i \left[\ln(embig_{i,t-1}) - \beta'_{1i} \ln(X_{it}) - \beta'_{2i} \ln(Z_t)\right] + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta \ln(embig_{i,t-j}) + \sum_{j=0}^{q-1} \delta^{*\prime}_{1ij} \Delta \ln(X_{i,t-j}) + \sum_{j=0}^{q-1} \delta^{*\prime}_{2ij} \Delta \ln(Z_{t-j}) + \mu_i + \varepsilon_{it}$$

where

$$\phi_i = -(1 - \sum_{j=1}^{p} \lambda_{ij}),$$

$$\beta_{1i} = \frac{\sum_{j=0}^{q} \delta_{1ij}}{1-\sum_{j=1}^{p} \lambda_{ij}},$$

$$\beta_{2i} = \frac{\sum_{j=0}^{q} \delta_{2ij}}{1-\sum_{j=1}^{p} \lambda_{ij}},$$

$$\lambda_{ij}^{*} = -\sum_{m=j+1}^{p} \lambda_{im} \text{ for } j = 1,2,\dots,p-1, \text{ and}$$

$$\delta_{ij}^{*} = -\sum_{m=j+1}^{p} \delta_{im} \text{ for } j = 1,2,\dots,q-1.$$

Introducing homogeneity restrictions on the long-run coefficients ($\beta_{1i} = \beta_1$ and $\beta_{2i} = \beta_2$) yields the following equation:

Equation 2.8

$$\Delta \ln(embig_{it}) = \phi_i\left[\ln(embig_{i,t-1}) - \beta'_1 \ln(X_{it}) - \beta'_2 \ln(Z_t)\right] + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \Delta \ln(embig_{i,t-j}) + \sum_{j=0}^{q-1} \delta_{1ij}^{*\prime} \Delta \ln(X_{i,t-j}) + \sum_{j=0}^{q-1} \delta_{2ij}^{*\prime} \Delta \ln(Z_{t-j}) + \mu_i + \varepsilon_{it}$$

By setting $p = 1$ and $q = 1$, we estimate the following model:

Equation 2.9

$$\Delta \ln(embig_{it}) = \phi_i\left[\ln(embig_{i,t-1}) - \beta'_1 \ln(X_{it}) - \beta'_2 \ln(Z_t)\right] + \delta_{1i}^{*\prime} \Delta \ln(X_{it}) + \delta_{2i}^{*\prime} \Delta \ln(Z_t) + \mu_i + \varepsilon_{it}$$

Before estimating Equation 2.5 and Equation 2.9, we first test whether the variables are stationary. Results of the Im-Pesarad-Shin and the Fisher-type augmented Dickey-Fuller tests are mixed for the EMBIG spread, while they reject the null hypothesis that all panels contain unit roots for each country-specific explanatory variable. As regards global factors, VIX is found to be stationary, while the U.S. Federal funds rate appears to follow a unit root process. When applying the cointegration test developed by *Westerlund* [2008], however, we find that there is no cointegrating relationship among these variables. As *Phillips and Moon* [2000] show, the pooled regression of two nonstationary variables that are not cointegrated is not spurious but yields consistent estimates of the long-run average regression coefficient as N and T become large. Therefore, following the literature, we proceed first with the fixed effects estimation.

2.6. Estimation Results[16]

2.6.1. Fixed Effects Estimation

Whole-sample estimates

First, we estimate Equation 2.5 on the whole sample. The regression results indicate that both country-specific fundamentals and global factors are significant drivers of sovereign bond spreads (Table 2-3).

Table 2-3. Fixed Effects Estimation Results[17]: All Countries
(Dependent variable: Log of EMBIG spread)

	(1)	(2)	(3)	(4)	(5)
err	-0.4973**	-0.6039**	-0.5929**	-1.8791***	
	(0.2249)	(0.2516)	(0.2841)	(0.3707)	
frr	-2.9078***	-2.7956***	-3.5403***		-3.1331***
	(0.3315)	(0.2937)	(0.3636)		(0.3015)
prr	-2.3547***	-2.5079***	-2.3432***	-2.9620***	-2.4202***
	(0.4038)	(0.4371)	(0.4726)	(0.4622)	(0.3995)
vix	0.6553***	0.6849***		0.8186***	0.6593***
	(0.0714)	(0.0553)		(0.0787)	(0.0713)
us ffr	-0.0242		-0.0836**	0.0339	-0.0332
	(0.0254)		(0.0348)	(0.0271)	(0.0254)
constant	21.1792***	21.7060***	25.7334***	17.6065***	20.4759***
	(1.9737)	(2.2921)	(2.1013)	(2.1823)	(1.8857)
Overall R-Squared	0.57	0.57	0.49	0.46	0.57
Observations	2,587	2,587	2,587	2,587	2,587

Note: *, ** and *** indicate significance at the 1, 5 and 10 percent level, respectively. Driscoll-Kraay robust standard errors are in parenthesis. Explanatory variables are in logs.
Source: authors' calculations

As expected, each country-specific risk rating indicator has a significantly negative coefficient, indicating that stronger country-specific fundamentals are associated with lower spreads. The size of the coefficients of country-specific fundamentals suggests that country spread is the most sensitive to changes in financial

[16] Both estimations were done in Stata.

[17] As the LM test developed by *Breusch and Pagan* [1980] suggests the presence of error cross-sectional dependence, we follow *Comelli* [2012] and estimate regressions with *Driscoll and Kraay* [1998] standard errors that are robust to heteroskedasticity, serial correlation and cross-sectional dependence.

and political risk. Specifically, a 1 percent increase (i.e. improvement) in the financial risk rating lowers spreads by 2.8–3.5 percent, while a 1 percent increase in the political risk rating lowers spreads by 2.3–2.5 percent, compared with a 0.5–0.6 percent impact of the economic risk rating in the specifications (1)–(3). This result may not be fully explained by the lower variability of ERR, as it is only somewhat lower across countries and, for some countries, over time (**Table 2-1** and **Table 2-4**). Hence the results suggest that, at least in the short-term, investors tend to pay more attention to the country's political risk and liquidity situation such as reserve coverage and foreign debt service (captured by PRR and FRR, respectively) than to solvency indicators such as growth, fiscal and current account balance (captured by ERR). As the run-up to the current crisis illustrated that it usually takes long time for the worsening macroeconomic performances to build up into full-fledged market concerns about sovereign solvency, there may be possibility for non-linear relation between ERR and the spreads. We explore it in our next paper.

The results show that an increase in the global risk aversion drives country spreads up, and this relationship is strongly significant. The coefficient of VIX is positive and significant: a 1 percent increase in global risk aversion is associated with a 0.7 percent increase in spreads. Liquidity conditions have a negative sign, albeit significant in one specification only: the coefficient on the U.S. Federal funds rate is negative but becomes insignificant when VIX is included. This result suggests that the U.S. monetary policy decisions at least partially reflect global risk aversion, in addition to domestic economy considerations, hence U.S. Federal funds rate becomes insignificant when the measure of risk aversion is included (as we discussed earlier, the U.S. Federal funds rate has negative and significant correlation with VIX). We also checked 3-month and 10-year US Treasury yields as proxies for global liquidity conditions but none of them was found to be a significant driver of spreads. This may be due to that Treasury yields are driven by both U.S. monetary policy and global risk aversion, thus the effect of Treasury yields is already captured by the inclusion of the U.S. Federal funds rate and VIX. The sign of the impact of U.S. Treasury yields may also be switching depending on the risk aversion regime, with a negative sign during the high risk aversion periods, as markets flock to save heavens, and a positive sign during the low risk aversion periods when markets search for yield.

The chosen country-specific and global factors explain spreads well. The model's explanatory power is satisfactory with an overall R-squared around 0.5–0.6 in the three specifications.

To test for the possibility that country-specific explanatory variables may be a function of spreads, we test the model as follows. We regress the spreads on the up to five lags of each explanatory variable in order to control for possible endogeneity between spreads and country-specific risk ratings. We also include lags of global variables, although the intuition would suggest that global variables are not dependent on emerging markets country spreads. The sign, magnitude and significance of all variables, except U.S. Federal funds rate, remained broadly the same, suggesting no endogeneity.

As ERR and FRR are strongly correlated (**Table 2-2**), we also estimate Equation 2.5 with one of the two explanatory variables omitted to analyze whether it affects estimation results. When FRR is excluded the sensitivity of spreads to PRR and VIX increases somewhat, while the U.S. Federal funds rate remains insignificant. The coefficient on ERR increases four-fold, albeit its significance weakens, while the model's overall explanatory power falls. In contrast, the exclusion of ERR does not affect substantially either the magnitude of the coefficients of other explanatory variables or the model's explanatory power. This suggests that while ERR and FRR contain a similar set of fundamentals, the information content of FRR, relevant for the determination of the country credit risk, is broader and/or has more variation. In fact, an analysis of the composition of the two indices reveals that while the ERR, naturally, contains slowly-changing economic variables, the FRR contains both slow-changing and more volatile components such as exchange rate, which must be an important factor in investor's decision-making process.

To test for the possibility that country-specific fundamentals could be at least partially explained by the global factors, we proceed in two steps. First, we regress domestic fundamentals on the global factors; the results indicate that global factors, while being significant, explain only a very small fraction of the variation in the domestic fundamentals. Nevertheless, in the second step we estimate Equation 2.5 replacing country-specific fundamentals with respective residuals from the previous step (plus the country-specific fixed effects). The results are broadly the same as in **Table 2-3**.

Split-sample estimates

In order to check whether the sensitivity of spreads to global factors depends on the strength of country-specific fundamentals, we split the sample into two groups of countries according to whether they have low or high risk rating indicators and estimate Equation 2.5 for both groups[18]. The results are presented in **Table 2-5**.

Both FRR and PRR remain significant with negative coefficients in each specification, while ERR loses its significance in *high ERR* and *high PRR* specifications. The size of the coefficients of FRR and PRR is of roughly the same magnitude as in the baseline specification (specification 2 in **Table 2-3**), which suggests that investors remain sensitive to political risk and liquidity factors once country fundamentals have been taken into account and classified as either strong or weak. The insignificance of the macroeconomic fundamentals in *high ERR* and *high PRR* specifications suggests that either the economic conditions do not differ significantly across countries with strong economic fundamentals and low political risk or that markets may not be paying attention to small variations in fundamentals for the countries perceived as strong and politically stable. The lower significance of the economic fundamentals for the countries with high liquidity risk suggests that markets concerns about liquidity could entail increases in funding costs for even economically solid and solvent sovereigns—which is consistent with recent experiences in Europe.

[18] Similarly to *Alexopoulou et al.* [2009], we split countries based on whether the average value of their fundamentals are better or worse than the median of the individual country averages. However, instead of constructing two groups of countries based on the overall strength of fundamentals, we construct two groups based on each country-specific factor. A shortcoming of the methodology is that it assumes constant grouping of countries based on average fundamentals, while fundamentals change continuously that could thus lead to different grouping each year. However, we found that time-varying grouping based on annual average ERR, FRR and PRR is the same as grouping based on total average ERR, FRR and PRR in the case of 82, 78 and 88 percent of total observations, respectively. We also estimated the model using "dynamic grouping methodology" that allows the grouping to change every month for each country based on its fundamentals. However, due to the changing groups every month the results are inconclusive.

Table 2-4. Country-specific Variables: Descriptive Statistics

	EMBIG				ERR				FRR				PRR			
	Mean	Standard Deviation	Min	Max	Mean	Standard Deviation	Min	Max	Mean	Standard Deviation	Min	Max	Mean	Standard Deviation	Min	Max
Argentina	21.05	21.34	2.02	68.47	36.89	4.48	24.00	41.50	33.44	7.06	15.50	41.50	66.21	4.40	54.50	77.50
Brazil	4.63	4.00	1.43	20.57	36.06	2.22	31.50	41.00	35.71	5.24	23.50	45.50	66.74	2.09	60.00	70.50
Bulgaria	2.51	1.81	0.56	7.81	34.08	2.54	27.50	37.50	34.74	2.61	27.50	38.50	70.10	3.04	64.50	76.00
Chile	1.39	0.63	0.55	3.83	40.19	2.71	33.00	45.00	38.64	1.79	34.00	41.00	78.14	2.43	73.00	83.00
China	1.10	0.61	0.37	2.87	39.86	1.31	36.50	42.00	46.74	1.34	44.50	48.50	66.28	3.39	58.50	70.50
Colombia	3.31	1.91	1.08	9.86	34.97	1.87	29.50	38.50	37.76	2.33	31.50	42.00	57.20	3.50	46.00	63.00
Hungary	1.78	1.70	0.14	6.50	34.42	2.08	29.00	40.00	34.25	2.51	28.00	38.00	77.72	3.28	71.50	84.50
Indonesia	2.88	1.50	1.44	8.91	36.47	1.34	33.50	38.50	37.44	2.99	29.50	41.50	55.48	5.62	40.00	63.00
Malaysia	1.50	0.67	0.68	4.28	40.50	2.32	31.50	43.00	42.40	0.99	40.00	44.00	73.36	2.49	66.00	77.50
Mexico	2.21	0.86	0.98	4.63	36.63	2.82	26.50	40.00	39.57	2.40	34.50	43.00	71.21	2.60	67.00	77.50
Pakistan	7.06	4.88	1.38	21.37	32.71	2.51	27.00	37.50	37.12	3.33	28.00	42.50	46.54	2.07	41.50	51.50
Peru	3.05	1.83	1.04	8.16	37.87	2.18	32.50	42.00	40.34	2.39	37.00	44.00	63.56	1.93	61.00	72.50
Philippines	3.30	1.43	1.20	6.58	37.25	1.52	33.00	40.00	39.01	2.79	34.00	44.50	63.39	2.67	57.00	69.00
Poland	1.40	0.77	0.39	3.25	36.25	1.79	33.00	40.00	36.89	2.80	28.50	40.00	77.27	2.32	73.00	81.50
Russia	3.26	2.35	0.95	10.80	39.52	4.85	24.00	45.50	43.50	2.56	38.00	47.50	63.99	3.28	54.00	69.00
Turkey	4.00	2.36	1.62	10.55	31.60	4.37	17.50	36.00	31.87	2.97	23.50	37.00	60.92	4.46	53.00	70.50
Ukraine	6.72	5.96	1.40	31.58	33.84	4.24	21.50	39.50	37.34	3.32	28.50	42.50	63.53	3.93	54.50	70.50
Venezuela	8.28	3.82	1.87	17.89	33.83	5.60	24.50	41.50	41.59	4.06	33.00	47.00	50.15	3.80	44.50	63.00

Source: J.P. Morgan, ICRG, authors' calculations

The coefficient of VIX is positive and significant in each group. Countries with higher economic and financial risk (low ERR and low FRR) tend to have higher sensitivity to changes in global risk aversion. This finding is important from the policy-making perspective as it highlights the premium on good policies, suggesting that solid domestic fundamentals do provide some cushion against shifts in the global market sentiment. The coefficient of VIX is of the same magnitude for countries with low and high political risk.

To sum up, the estimation results are in line with our prior expectations, i.e. countries with weaker fundamentals tend to have higher sensitivity to changes in global risk aversion. However, as differences in the coefficient of VIX between country groups are small, we look for further evidence in the next chapter.

Table 2-5. Fixed Effects Estimation Results: Different Groups of Countries
(Dependent variable: Log of EMBIG spread)

	All	Low ERR	High ERR	Low FRR	High FRR	Low PRR	High PRR
err	-0.6039**	-0.9754***	0.0036	-0.5382*	-0.6913**	-1.1058***	0.5969
	(0.2516)	(0.2951)	(0.3186)	(0.3205)	(0.3277)	(0.3326)	(0.4492)
frr	-2.7956***	-2.6009***	-2.9929***	-2.7626***	-2.8675***	-2.6523***	-2.9567***
	(0.2937)	(0.2590)	(0.4011)	(0.3599)	(0.3325)	(0.2724)	(0.3710)
prr	-2.5079***	-2.7513***	-2.1863***	-2.7863***	-2.1910***	-1.4701***	-4.4165***
	(0.4371)	(0.5659)	(0.5183)	(0.5330)	(0.5671)	(0.3936)	(0.7095)
vix	0.6849***	0.7475***	0.6378***	0.7035***	0.6709***	0.6926***	0.6963***
	(0.0553)	(0.0723)	(0.0619)	(0.0654)	(0.0579)	(0.0759)	(0.0454)
constant	21.7060***	22.9787***	19.1682***	22.3910***	21.0794***	18.7949***	26.0062***
	(2.2921)	(3.1251)	(3.0612)	(2.7252)	(2.3816)	(1.9357)	(3.4532)
Overall R-Squared	0.57	0.58	0.68	0.50	0.69	0.49	0.66
Observations	2,587	1,304	1,283	1,264	1,323	1,264	1,323

Note: *, ** and *** indicate significance at the 1, 5 and 10 percent level, respectively. Driscoll-Kraay robust standard errors are in parenthesis. The groups with low and high risk ratings include countries with average risk rating below and above the median of country-average ratings, respectively. Explanatory variables are in logs.
Source: authors' calculations

We also split the sample into three groups of countries based on their location in order to analyze whether the valuation of debt differs across regions (**Table 2-6**). While ERR is not significant in Europe, it remains significant in other regions. At the same time, FRR and PRR are significant in each region, but their relative importance differs across regions: FRR is more important driver of spreads in Asia and Europe, while it is of roughly the same magnitude of importance as PRR in Latin America, which is intuitive. The coefficient of VIX remains broadly the same, with European countries

being the most exposed to changes in global risk aversion. The U.S. Federal funds rate is significant with negative coefficient in Asia.

Table 2-6. Fixed Effects Estimation Results: Regional Differences
(Dependent variable: Log of EMBIG spread)

	Asia	Europe	Latin America
err	-1.1189**	-0.3287	-0.7036*
	(0.4324)	(0.2751)	(0.3843)
frr	-4.2037***	-3.2113***	-2.4535***
	(0.5809)	(0.4365)	(0.3544)
prr	-1.9832***	-2.7213***	-2.4988***
	(0.5723)	(0.8213)	(0.6545)
vix	0.5981***	0.7576***	0.5738***
	(0.0709)	(0.0980)	(0.0909)
us ffr	-0.0704***	-0.0279	0.0211
	(0.0202)	(0.0368)	(0.0272)
constant	26.7862***	22.7008***	21.3576***
	(4.5149)	(4.0136)	(2.6008)
Overall R-Squared	0.81	0.46	0.62
Observations	676	882	1,029

Note: *, ** and *** indicate significance at the 1, 5 and 10 percent level, respectively. Driscoll-Kraay robust standard errors are in parenthesis. Explanatory variables are in logs.
Source: authors' calculations

2.6.2. Pooled Mean Group Estimation

Whole-sample estimates

We estimate Equation 2.9 on the whole sample. We find that both country-specific and global developments are important determinants of spreads in the long run, while it is mostly the global factors that determine spreads in the short-run (**Table 2-7**). These findings are intuitive and are consistent with market behavior in the run-up to and during the recent crisis.

In the long run, both country-specific fundamentals and global factors are important drivers of spreads. The long-run coefficients of FRR and PRR remain negative and significant in the baseline specification (specification 1 in **Table 2-7**), indicating that stronger fundamentals are associated with lower equilibrium risk premia.

Surprisingly, the coefficient of ERR changed its sign in each model compared to the results of the fixed effects estimation, and now suggests that stronger economic fundamentals are associated with higher spreads in the long-term. However, ERR's short-term coefficient is negative, which is consistent with previous results, albeit not significant.

As regards the long-run impact of global factors, VIX has significant and positive effect on spreads. The result is again intuitive and consistent with expectations, suggesting that higher risk aversion is associated with higher equilibrium level of spreads. The U.S. Federal funds rate is not found to be a significant driver of spreads in specifications (1)-(3), which is largely consistent with the results of the fixed effects estimation.

The error correction coefficient is significant, albeit low, implying that the spread's deviation from its long-run equilibrium value is corrected at a slow rate.

In the short-run, the estimations show that each global factor has a significant effect on spreads. While VIX has positive effect both in the short- and long-run, the U.S. Federal funds rate has insignificant long-run impact with ambiguous sign and significantly negative short-run effect, i.e. a monetary policy tightening in the U.S. lowers spreads in the short-run but does not fundamentally affect them in the long-run in the specifications where all country-specific fundamentals are accounted for. Regarding country-specific fundamentals, the ERR is not significant in any specification, while the FRR and the PRR are found to be significant drivers of spreads in only one specification. The relative importance of global factors in the short-term may be due to the fact that country-specific fundamentals change slowly over time, as macroeconomic policies and structural reforms take time to bear fruit — therefore, it is the variation in global factors that should be more important in driving country spreads.

In order to assess whether the strong correlation of ERR and FRR affects their estimated coefficients, we run regressions excluding one of these variables. After the exclusion of FRR, the sign of ERR remains positive. At the same time in the specification excluding ERR, FRR becomes not significant in the long term, while remaining significant in the short term. In addition, in this specification the coefficient of the U.S. Federal funds rate becomes significantly positive in the long term, perhaps due to the fact that global liquidity conditions are partially reflected in the now-omitted country-specific fundamentals.

As the pooled mean group estimation yields country-specific short-term coefficients, it also allows for analyzing whether the sensitivity of spreads depends on country-specific fundamentals. Figure 2-3 plots the country-specific short-term coefficient of VIX against country average risk ratings. It shows that countries with higher average risk ratings (i.e. better fundamentals) tend to have lower sensitivity to changes in global risk aversion, which is in line with the previous section's findings.

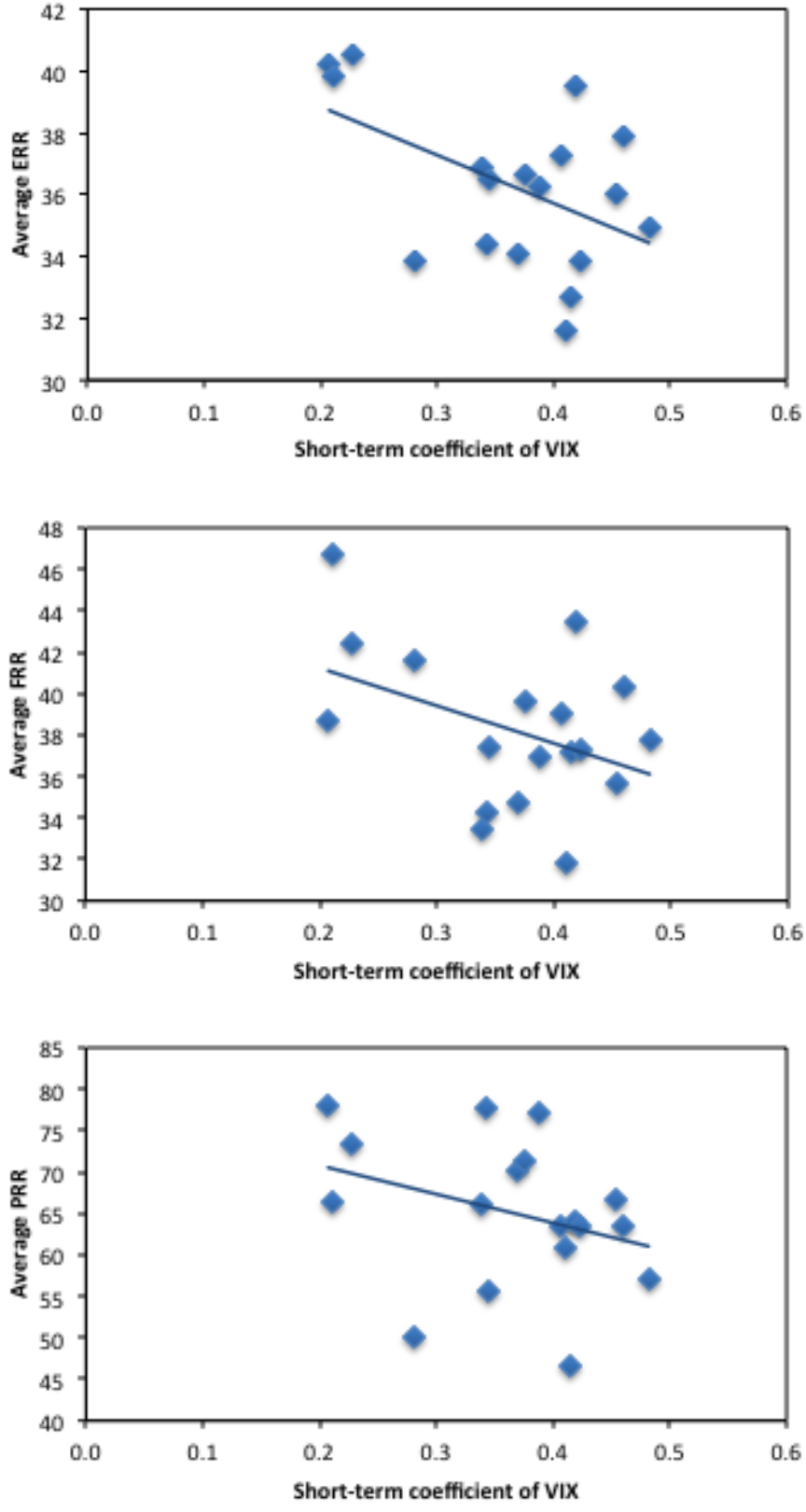
The estimation results suggest that countries could benefit by improving their fundamentals in the form of both lower spreads and lower sensitivity to adverse changes in the global market sentiment.

Table 2-7. Pooled Mean Group Estimation Results
(Dependent variable: Log of EMBIG spread)

	(1)	(2)	(3)	(4)	(5)
Long-term coefficients					
err	1.1523***	1.7997***	2.4315***	1.2230***	
	(0.3686)	(0.4558)	(0.8617)	(0.3825)	
frr	-0.9512*	-1.4589***	-3.2735***		-0.5276
	(0.5024)	(0.5385)	(0.7720)		(0.4669)
prr	-2.3541***	-0.4515	-0.1350	-2.7111***	-2.4120***
	(0.5367)	(0.7301)	(1.0524)	(0.5453)	(0.5098)
vix	1.0921***	1.8636***		1.1641***	1.0529***
	(0.0795)	(0.1366)		(0.0772)	(0.0710)
us ffr	0.0288		-0.0102	0.0446**	0.0357**
	(0.0191)		(0.0340)	(0.0188)	(0.0169)
Average short-term coefficients					
error correction	-0.0620***	-0.0514***	-0.0480***	-0.0587***	-0.0650***
	(0.0109)	(0.0070)	(0.0057)	(0.0110)	(0.0118)
d.err	-0.1668	-0.1911	-0.2393	-0.2207	
	(0.1664)	(0.1701)	(0.2055)	(0.1597)	
d.frr	-0.2517	-0.1894	-0.4079**		-0.3499***
	(0.1647)	(0.1774)	(0.1704)		(0.1244)
d.prr	-0.2079	-0.3410**	-0.3454	-0.1728	-0.1740
	(0.1523)	(0.1597)	(0.2245)	(0.1509)	(0.1622)
d.vix	0.3645***	0.3539***		0.3681***	0.3673***
	(0.0198)	(0.0184)		(0.0205)	(0.0204)
d.us ffr	-0.1546***		-0.2028***	-0.1530***	-0.1571***
	(0.0164)		(0.0169)	(0.0145)	(0.0160)
constant	0.4090***	-0.2057***	0.2124***	0.2410***	0.6229***
	(0.0704)	(0.0311)	(0.0261)	(0.0439)	(0.1120)
Observations	2,568	2,568	2,568	2,568	2,568

Note: *, ** and *** indicate significance at the 1, 5 and 10 percent level, respectively. Explanatory variables are in logs.
Source: authors' calculations

Figure 2-3. Risk Rating Indicators and the Short-term Coefficient of VIX



Note: The charts plot country-average risk ratings against country-specific short-term coefficients of VIX (see **Table A 2.1** for country-specific short-term coefficients). The exclusion of the three most risky countries according to the ERR (top panel) would make the relationship less negative, as expected.
Source: authors' calculations

Table 2-8. Pooled Mean Group Estimation Results: Regional Differences
(Dependent variable: Log of EMBIG spread)

	Asia	Europe	Latin America
Long-term coefficients			
err	-0.2052	2.7300***	2.1076***
	(0.4975)	(0.7625)	(0.7175)
frr	1.6726	-2.1669**	-0.4138
	(1.1565)	(0.8989)	(0.8712)
prr	-3.5921***	2.2175*	-2.8207**
	(0.6739)	(1.3144)	(1.3914)
vix	1.0017***	1.7064***	1.0864***
	(0.0883)	(0.1887)	(0.1501)
us ffr	0.0601**	-0.0747	0.0120
	(0.0236)	(0.0459)	(0.0392)
Average short-term coefficients			
error correction	-0.0937***	-0.0611***	-0.0478***
	(0.0347)	(0.0155)	(0.0169)
d.err	-0.7103	0.0931	-0.0086
	(0.4702)	(0.1840)	(0.0984)
d.frr	-0.3029	-0.2088	-0.2517***
	(0.5357)	(0.2595)	(0.0949)
d.prr	-0.3928	-0.2232	-0.0886
	(0.3836)	(0.2931)	(0.2102)
d.vix	0.3128***	0.3648***	0.3767***
	(0.0507)	(0.0173)	(0.0384)
d.us ffr	-0.1392***	-0.1595***	-0.1413***
	(0.0185)	(0.0391)	(0.0230)
constant	0.6570**	-0.9639***	0.1551***
	(0.2541)	(0.2517)	(0.0499)
Observations	670	876	1,022

Note: *, ** and *** indicate significance at the 1, 5 and 10 percent level, respectively. Explanatory variables are in logs.
Source: authors' calculations

Split-sample estimates

Although the pooled mean group estimation allows short-term coefficients to differ across countries, we split the sample to three regions of countries in order to assess whether the long-term valuation of sovereign debt is also different across these regions (**Table 2-8**). In the long run, VIX is significant in each region, with the highest

coefficient in Europe, while the U.S. Federal funds rate becomes significantly positive in Asia, suggesting that a U.S. monetary loosening tends to be associated with declining spreads of Asian countries. The FRR is significant only in Europe, while the PRR has a significantly negative coefficient in Asia and Latin America and a surprisingly positive, albeit weakly significant, coefficient in Europe. The results suggest that investors pay more attention to liquidity indicators in Europe and to political risk factors in Asia and Latin America. The coefficient of ERR remains positive similarly to the baseline specification and loses significance in Asia. In the short run, both VIX and the U.S. Federal funds rate are significant in each specification with positive and negative coefficient, respectively, i.e. increasing global risk aversion and loosening U.S. monetary policy conditions are associated with rising spreads. The size of the coefficients of global factors is broadly the same across regions. As regards country-specific fundamentals, only FRR is significant in Latin America. The error correction term suggests that misalignment is corrected at the highest speed in Asia followed by Europe and Latin America.

2.7. Comparison of Actual and Estimated Spreads

To analyze the misalignment in the valuation of emerging market sovereign debt, we compare actual and fitted spreads for each country, using the coefficients obtained from the fixed effects (specification 2 in Table 2-3) and pooled mean group estimation (specification 1 in **Table 2-7**). The latter estimates spreads based on the long-term coefficients of Equation 2.9. The actual and fitted spreads from the fixed effect model are presented on **Figure A 2.1** and a similar chart for pooled mean group estimation is presented on **Figure A 2.2**.

This comparison has interesting practical application, as it allows us to investigate whether emerging market bond prices were in line with their fundamentals at any given moment in time and see whether model-generated predictions of misalignment overlap with anecdotally well-established market risk-on and risk-off periods, periods of exuberance and crises. For this purpose we define misalignment as the difference between actual and fitted spreads. We expect that during risk-on periods there would be more country examples with negative misalignment—that is, countries where bond spreads were tighter than would be suggested by fundamentals. Conversely, during

persistent risk-off periods, or crisis periods, there could be more cases with positive misalignment, suggesting a more cautious market pricing behavior.

Visual analysis of results in **Figure A 2.1** and **Figure A 2.2** suggest that for the entire emerging market universe we can establish three main sub-periods, which are in line with our initial hypothesis and with the actual market experience in the recent decade:

a) *Pre-crisis period, before 2007*: our estimates show that most emerging markets had positive residuals with the exception of Bulgaria, Chile, China, Hungary, Poland and Ukraine where markets tended to require lower spreads than justified by domestic and global factors. An example of Hungary is a notable case of misalignment, as the country was running twin deficits well into high single digits for the good part of mid-2000s, while enjoying low spreads on market financing.
b) *Crisis mostly confined to industrial country financial systems, 2007– fall 2008*: most emerging market countries had negative residuals. This is possibly reflecting the fact that during the initial part of the crisis, up until the fall of 2008, it was believed that the crisis could be confined to the industrial country financial systems and emerging markets were successfully decoupling. Hence markets put a positive premium on emerging market sovereign debt.
c) *Broad-based crisis, since late 2008*: the majority of emerging market countries has had positive residuals, suggesting an increasingly cautious pricing behavior of market participants.[19] In the fall of 2008, or roughly after the Lehman collapse, the crisis that was initially confined to industrial country financial systems has broadened dramatically: global growth tumbled and crisis spread to emerging markets, especially Emerging Europe due to its strong trade and financial ties with Developed Europe as well as accumulated domestic imbalances in many countries. Again, there were a few countries such as Indonesia and Turkey that had negative residuals in this period based on the

[19] According to the fixed effects estimation, roughly half of the countries had positive residuals, while the pooled mean group estimation found an overwhelming majority of countries to have positive misalignment.

results of both models, consistent with anecdotal evidence that markets were placing positive premiums on perceived top performers or safe heavens within the emerging market universe.

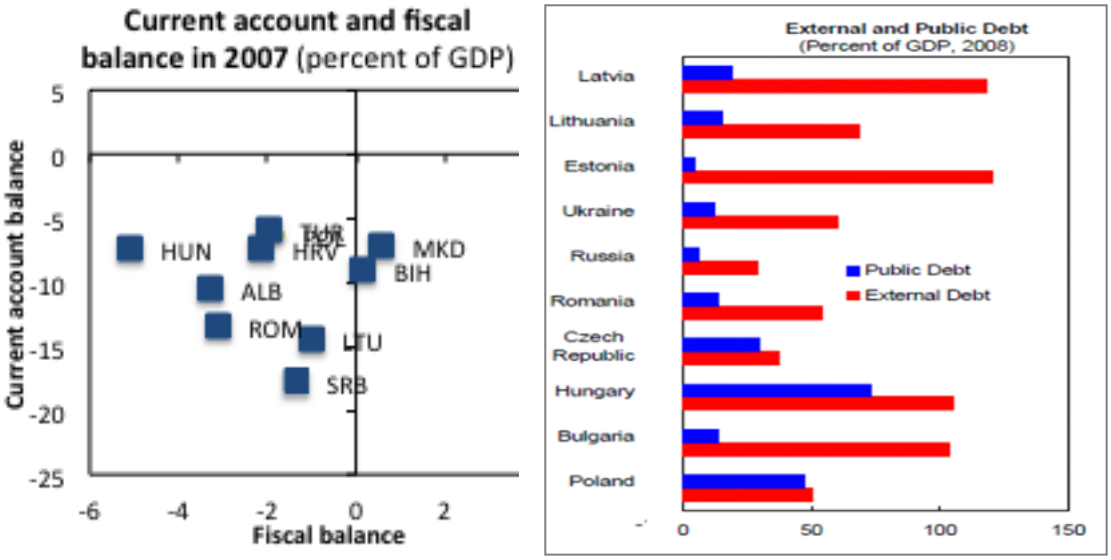
The emerging market universe, however, is rather heterogeneous in terms of fundamentals and experiences in the run-up to the crisis. In particular, while most emerging markets enjoyed strong growth pre-crisis, Emerging Europe was one of the fastest-growing regions, on the back of strong capital inflows, which boosted domestic demand, and in many cases increased public and/or private sector leverage. As a result, many European countries entered the crisis with significant macroeconomic imbalances, weak public finances, and relatively modest reserve coverage (**Figure 2-4**) and were hit hard by a sudden stop in capital inflows. At the same time, emerging markets in Asia and Latin America were running current account and fiscal surpluses and accumulating fiscal and external buffers and thus were more sheltered from the crisis (**Figure 2-5**).

Hence, it would be interesting to analyze market pricing behavior across different regions:

a) In the case of the *Latin American* countries, we see two distinct periods for Brazil, Colombia and Peru: actual spreads were higher than predicted ones between 2001 and 2006, with the difference turning into negative or decreasing to around zero in the FE and PMG estimation, respectively, between 2006 and 2012. *Comelli* [2012] argues that the switch of misalignment from negative to positive in the CEE region and from positive to negative in these Latin American countries between the first and second half of the decade may suggest that international bond investors shifted their portfolio from the first to the latter region. Neither Chile nor Mexico had sizeable misalignment throughout the whole period. Estimation results are inconclusive for Argentina in 2002 and 2003, i.e. at the beginning of the debt restructuring period, and show positive residual in the second part of the this period. The residual becomes negative between 2005 and 2011 in line with the valuation of the sovereign debt of other regional countries; before turning into positive territory again in 2012, possibly reflecting increased uncertainty about domestic policies. Like most Latin American countries, Venezuela also had negative residual in 2006 and 2007;

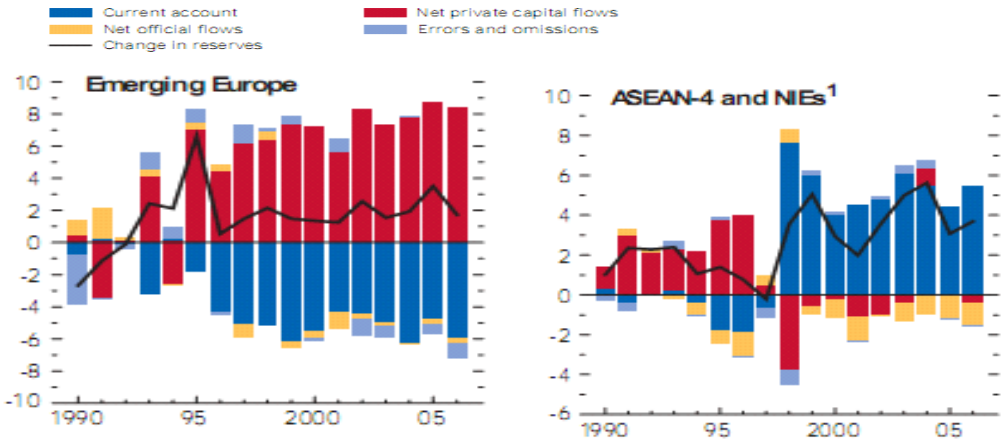
however, it followed Argentina with sizeable positive residual at the end of the estimation period. Estimation results are inconclusive in other periods.

Figure 2-4. Emerging Europe: Pre-Crisis Imbalances



Source: IMF

Figure 2-5. Balance of Payments: Emerging Markets in Asia and Europe



1ASEAN-4 countries include Indonesia, Malaysia, the Philippines, and Thailand. Newly industrialized Asian economies (NIEs) include Hong Kong SAR, Korea, Singapore, and Taiwan Province of China.

Source: IMF

b) In *Asia*, Indonesia and Malaysia did not have substantial misalignment in the estimation period. Philippines followed the same pattern as Brazil, Colombia and Peru, i.e. the residual was strongly positive and negative/slightly positive in the first and second half of the decade, respectively. China and Pakistan had lower than predicted spreads in the period preceding the crisis, while their spreads increased to above the level implied by fundamentals and global factors between 2010 and 2012.

c) In the *CEE region*, Bulgaria, Hungary and Poland had lower spreads than the fitted ones in the 3-4-year period before the crisis. *Luengnaruemitchai and Schadler* [2007] call this phenomenon the "EU Halo" effect suggesting that risk perception was lowered by several benefits that market participants associated with the European Union membership. Since 2007, the results are inconclusive as regards the sign of misalignment in Bulgaria, while Poland and Hungary had positive residuals during this period. An important difference is that while the misalignment was small in Poland, Hungary showed substantial residual in the short period following the bankruptcy of Lehman and after 2010. In the first period, there was an intense market pressure on Hungary that resulted in the country resorting to the EU and the IMF. In the second period, the authorities introduced a set of unorthodox policy measures that resulted in an uncertain business environment, an important factor that is not easily incorporated into conventional measures of economic or political fundamentals. [20] Developments in spreads in Turkey were similar to those in Brazil, Colombia, Peru and Philippines in terms of the sign of misalignment. The results are inconclusive for

[20] For example, there was a spike in misalignment in the autumn of 2011 when a scheme was introduced that allowed households to repay their foreign currency denominated mortgage loans at preferential exchange rate, thereby causing a sizeable loss for the banking sector. Due to retroactive unilateral revisions of private contracts, the scheme raised concerns about the rule of law in Hungary. Such a development would not be captured by either ERR, which includes economic indicators only, or PRR, which includes such conventional measures of political risk as, for example, government instability or the risk of internal or external conflicts, all of which are low in Hungary. *Monostori* [2012, 2013] found that the widening of spreads on Hungarian government bonds in the autumn of 2011 was mostly driven by increasing country-specific credit risk and concerns about the Euro Area, while liquidity risk had a smaller contribution than during the early stage of the crisis.

Russia and Ukraine with the two models showing opposite signs of residuals since 2009.

The results show that the sign of misalignment is similar in the case of the fixed effects and pooled mean group estimations in most countries[21], but the magnitude of misalignment is sometimes different.

2.8. Decomposition of Changes in Spreads

Based on the estimated models, we also decompose changes in spreads in order to understand whether the substantial decline in the second half of 2012 was due to improving fundamentals and/or global factors. In addition to the breakdown of fitted changes in spreads into the contribution of fundamentals and global factors as common in the literature, we also decompose changes in the residual into correction of initial misalignment and increase in misalignment. The rationale is that the change in residual can reflect either an increase in the absolute value of the residual (increase in misalignment), a decrease in the absolute value of the residual (correction of misalignment), or their combination (see **Table 2-9**). For example, the interpretation of a decrease in the residual is different if it declines from a higher to a lower positive value or if it falls from positive to negative territory: debt remains undervalued in the previous case, while it becomes overvalued from undervalued in the latter case.

Table 2-9. Decomposition of Changes in the Residual

Sign of the regression residual			Contribution to change in spread	
Base period		Current period	Correction of misalignment	Increase in misalignment
+	>	+	$e_t - e_0$	0
+	<	+	0	$e_t - e_0$
-	>	-	0	$e_t - e_0$
-	<	-	$e_t - e_0$	0
+		-	$-e_0$	e_t
-		+	$-e_0$	e_t

[21] The sign of misalignment is the same in the case of 72 percent of total observations.

Note: e_0 and e_t denote the difference between actual and fitted spreads in the base and current period, respectively.

Table 2-10, **Table 2-11**, **Figure 2-6** and **Figure 2-7** show the decomposition of changes in spreads based on the FE and the PMG estimation, respectively. The country-by-country decompositions of changes in spreads are presented in the Appendix (**Table A 2.2** and **Table A 2.3**). We divided the sample period into 7 sub-periods characterized by a general decrease or increase in spreads across countries, as compared to the previous period (incidentally, the periods identified in this analysis also correspond to the periods in the previous section). Specifically:

- *In the pre-crisis period (January 2001–August 2007),* the models explain just above half of the average compression in emerging market spreads. The model-based spread decline was driven by both improving domestic and global factors, with FE estimate associating larger improvement with country-specific and PMG with global factors. The excessive spread compression—the part not explained by either fundamentals or global factors or misalignment—reflected: (i) a correction of a significant undervaluation of emerging market debt that existed at the beginning of 2001, most probably related to events such as the burst of the dotcom bubble and/or emerging market crisis episodes of the end-1990s, and (ii) an overvaluation that emerged during an extended period of favorable global market environment, which lasted until the unfolding of the sub-prime crisis in the middle of 2007.
- *Between July 2007 and late summer of 2008,* emerging market spreads increased somewhat, most likely reflecting the then-existing expectation that the emerging markets would be immune to the sub-prime crisis that engulfed industrial country financial markets. The two models explain between 30 and 50 percent of spread increases, driven by both deteriorating global factors and domestic fundamentals. The unexplained part of the increase in spreads was driven by the elimination of the initial overvaluation and the emergence of undervaluation, with the latter likely explained by increasing market concerns about the riskiness of emerging market debt.
- *The default of Lehman Brothers in 2008* marked a pivotal turn in the global crisis, turning it from a mature-market crisis to a global growth crisis. Amid

soaring global risk aversion, rapidly collapsing financial flows and import demand from industrial countries depressed growth prospects in emerging markets, especially in Europe. This, coupled with accumulated macroeconomic imbalances in many emerging markets economies, led to sharp increases in borrowing costs and, in some cases, market dislocations, banking sector problems and concerns about sovereign solvency. Emerging market spreads increased sharply. Our two models explain 76 and 93 percent of this increase, respectively, driven mostly by the sharp deterioration in global factors as well as worsening country fundamentals. The small unexplained part was mostly due to increasing undervaluation, perhaps as most of the earlier misalignment was corrected in the previous period.

Table 2-10. Fixed Effects Estimation: Decomposition of Changes in Spreads
(percentage points)

	01/2001-07/2007	07/2007-08/2008	08/2008-12/2008	12/2008-04/2010	04/2010-07/2011	07/2011-06/2012	06/2012-03/2013
Actual	-4.83	1.65	5.50	-6.18	0.62	1.32	-1.14
Model	-2.46	0.83	4.18	-4.19	-0.29	0.50	-0.88
Fundamentals	-1.64	0.50	1.05	-0.55	-0.49	0.30	0.07
Global factors	-0.82	0.33	3.13	-3.64	0.20	0.20	-0.95
Residual	-2.37	0.81	1.32	-2.00	0.90	0.82	-0.26
Correction of misalignment	-1.79	0.45	0.19	-1.44	0.47	0.13	-0.30
Increase of misalignment	-0.58	0.36	1.13	-0.55	0.44	0.69	0.05

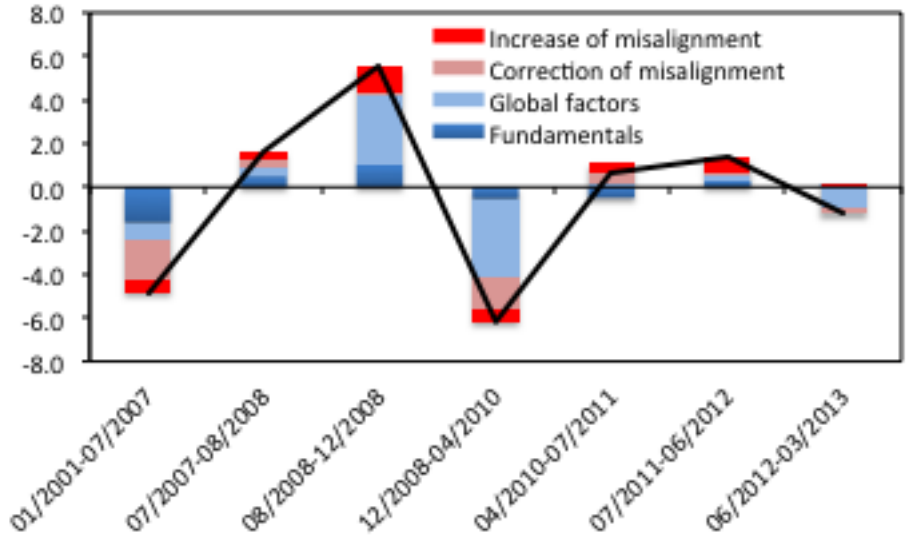
Note: The decomposition is based on specification 2 in **Table 2-3** and is calculated as the average of the contribution of fundamentals and global factors across countries. Changes in spreads are calculated as compared to the previous period.
Source: authors' calculations

Table 2-11. Pooled Mean Group Estimation: Decomposition of Changes in Spreads
(percentage points)

	01/2001-07/2007	07/2007-08/2008	08/2008-12/2008	12/2008-04/2010	04/2010-07/2011	07/2011-06/2012	06/2012-03/2013
Actual	-4.83	1.65	5.50	-6.18	0.62	1.32	-1.14
Model	-1.59	0.48	5.13	-5.84	0.23	0.50	-1.19
Fundamentals	-0.33	0.03	0.36	-0.45	0.03	0.17	0.03
Global factors	-1.25	0.45	4.77	-5.39	0.20	0.33	-1.22
Residual	-3.24	1.17	0.37	-0.34	0.39	0.82	0.05
Correction of misalignment	-2.69	0.57	-0.08	-0.55	-0.05	0.12	-0.33
Increase of misalignment	-0.55	0.60	0.44	0.21	0.44	0.70	0.39

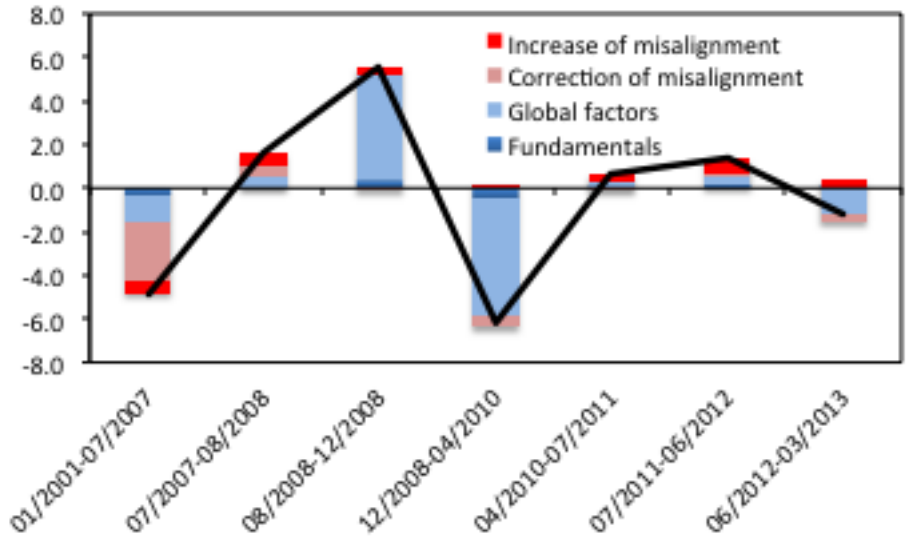
Note: The decomposition is based on specification 1 in **Table 2-7** and is calculated as the average of the contribution of fundamentals and global factors across countries. Changes in spreads are calculated as compared to the previous period.
Source: authors' calculations

Figure 2-6. Fixed Effects Estimation: Decomposition of Changes in Spreads
(percentage points)



Source: authors' calculations

Figure 2-7. Pooled Mean Group Estimation: Decomposition of Changes in Spreads
(percentage points)



Source: authors' calculations

- *The period from early 2009 to April 2010* is characterized by substantial spreads tightening, retracting from the post-Lehman peaks. The two models explain 70 and over 90 percent the tightening, respectively. The correction reflected mostly an improvement in global market sentiment, with some impact of improving fundamentals. In fact, during that period many countries in Emerging Europe—the emerging region most affected by the crisis—were making progress at

correcting macroeconomic imbalances and reducing vulnerabilities, several of them under the EU-IMF programs. As regards the unexplained part, it was mostly driven by the reduction in the undervaluation, which is also intuitive.

- During the following period, *April 2010 to June 2012*, the emerging markets experienced a substantial increase in spreads. This period coincides with flaring up of the Eurozone debt crisis, with its many ups and downs. During the first half of this period, up to mid-2011, the spreads increased more moderately driven by deteriorating global risk perception and country-specific fundamentals. In fact, during this period the European debt crisis took on many different turns, with Greece, Ireland, and Portugal all asking for the EU-IMF assistance, which at first supported market confidence albeit at already weak levels. Starting mid-2011, the spreads increased sharply, driven by the worsening global risk perception and weakening domestic fundamentals as well as a substantial increase in misalignment. It is notable that the share of the increases in spreads explained by the model is lower in this period, around forty percent, while the importance of misalignment is the highest. This may be due to the fact that the Eurozone crisis took on many cliff-hanging twists and turns, especially during the period between April 2011 and June 2012. In fact, during that period, Greece was increasingly underperforming in its first official bailout program and eventually needing a second IMF-EU program, which was negotiated in February 2012; this turbulent period was followed by the restructuring of the private sector debt to Greece, then by the elevated uncertainty about Greek euro-membership after inconclusive elections in May 2012; and by Spain requesting an EU program to deal with its banking sector issues by mid-2012.
- *Starting from June 2012 up to the end of our sample in March 2013*, spreads narrowed substantially across emerging markets. The fixed effects estimation explains around three quarters of the decrease in spreads while the PMG model explains the entire tightening. It is notable that, according to both models, this tightening is almost entirely driven by an improvement in the global factors. As regards the small unexplained part of the fall, it mostly reflected the correction of the misalignment (in this case undervaluation) of emerging market debt but also led to a slight overvaluation in some countries (**Table A 2.2** and **Table A**

2.3). These results are in line with an observed improvement in global market sentiment reflecting decreasing worries about the Euro Area debt crisis and several liquidity-enhancing measures by developed countries' central banks. In particular, the European Central Bank's announced of the Outright Monetary Transactions (OMT) program in September that includes the conditional purchase of Euro Area sovereign bonds in an unlimited amount at the secondary market. The Federal Reserve also resorted to a new bond purchase program and to keeping rates at exceptionally low level at least until the middle of 2015. The Bank of Japan also announced further monetary easing. Market sentiment was also supported by the outcome of Greek elections in the middle of the year and the ruling of the German constitutional court regarding the European Stability Mechanism in September. As a result of improving market sentiment and ample global liquidity due to the easy monetary policy stance in industrial countries, emerging market debt experienced a remarkable rally. At the very end of the sample, in January-March 2013, there was a small increase in spreads, most likely due to the rising concerns about the situation in Cyprus.

2.9. Conclusions

Using a database consisting of 18 emerging markets around the world, we find that both country-specific fundamentals and global factors are important determinants of spreads on foreign currency denominated sovereign debt; however, the relative importance of global factors is much more important in the short run. We also find that beyond its impact on the level of spreads, the strength of fundamentals also affects the sensitivity of the given country's risk premium to global factors: countries with stronger economic and financial indicators tend to have lower sensitivity to changes in global risk aversion.

The analysis of the decomposition of changes in spreads into model-based part and misalignment shows that improvements in global factors and country-specific fundamentals explain just more than a half of the tightening of the spreads during the pre-crisis period. The other half of the tightening was driven both by the correction of the earlier misalignment (in this case, underpricing of emerging market debt), as well as an accumulation of misalignment during the boom years.

The changes in spreads during the crisis follow periods of tightening and widening which are well-explained by the model and are intuitive. In addition, the dynamics of the components of the unexplained residual intuitively follow all the major developments of the current crisis that in turn impact market sentiment. We find that in periods of severe market stress and general lack of understanding of country-specific developments, such as during the intensive phase of the Eurozone debt crisis, global factors tend to drive the changes in spreads and misalignment tends to increase in magnitude and drive actual spreads.

We also analyzed whether the decline in emerging market spreads in the second half of 2012 was driven by an improvement in country-specific or global factors. On average across emerging markets, the decrease in spreads implied by the pooled mean group estimation is broadly in line with actual decline between the middle of 2012 and the beginning of 2013. The fixed effects estimation explains around three quarters of the decrease in spreads and reveals that the unexplained fall mostly reflected the correction of the undervaluation of emerging market debt at the beginning of this period but also led to a small overvaluation in some countries. These countries should therefore be cautious when interpreting the recent massive inflow of funds and the decline in spreads, as (i) the fall in spreads reflects an improvement in fundamentals only up to a small extent; (ii) spreads are lower than implied by domestic and global conditions in some countries; (iii) the sensitivity of spreads to global factors is high, especially in the case of countries with weak fundamentals, implying that an eventual withdrawal of monetary stimulus by the industrial central banks and/or sentiment reversal can lead to a reversal of the decline in spreads. Despite recent favorable global conditions, countries should thus continue to focus on improving their fundamentals that can be beneficial in the form of both lower sovereign spreads and lower sensitivity of spreads to possible adverse changes in the global environment.

Appendix

Table A 2.1. Pooled Mean Group Estimation: Short-term Coefficients[22]

	error correction	d.err	d.frr	d.prr	d.vix	d.us ffr	constant
Argentina	-0.0341*	-0.0359	0.0587	-0.1592	0.3381***	-0.2127**	0.2807
	(0.0195)	(0.3989)	(0.2747)	(1.1768)	(0.1031)	(0.1015)	(0.1974)
Brazil	-0.0151	-0.1775	-0.4762**	-0.4626	0.4545***	-0.1095***	0.0989
	(0.0120)	(0.2914)	(0.1888)	(0.4644)	(0.0418)	(0.0405)	(0.0996)
Bulgaria	-0.0792***	0.2835	-0.6380	0.0667	0.3699***	-0.2327***	0.5151**
	(0.0186)	(0.4321)	(0.4219)	(0.7597)	(0.0568)	(0.0516)	(0.2585)
Chile	-0.1436***	0.3307	-0.4784	-0.5964	0.2075***	-0.0576	0.9229*
	(0.0332)	(0.2360)	(0.3679)	(0.7455)	(0.0484)	(0.0404)	(0.4944)
China	-0.0643**	-2.1903**	1.9864	-0.2759	0.2121***	-0.1284*	0.3813
	(0.0285)	(0.8643)	(2.0029)	(1.0022)	(0.0755)	(0.0716)	(0.2591)
Colombia	-0.0326**	0.2504	-0.3178	1.0391***	0.4817***	-0.1216***	0.2039
	(0.0161)	(0.3642)	(0.2949)	(0.3751)	(0.0469)	(0.0446)	(0.1482)
Hungary	-0.0130	0.9061*	-0.9982*	0.9586	0.3433***	-0.2096**	0.0867
	(0.0176)	(0.5317)	(0.5455)	(1.3662)	(0.0954)	(0.0923)	(0.1192)
Indonesia	-0.1585***	-1.4993***	-0.7302**	-0.3172	0.3450***	-0.1030**	1.0486*
	(0.0350)	(0.5043)	(0.3602)	(0.6165)	(0.0582)	(0.0434)	(0.5449)
Malaysia	-0.1504***	-0.1233	-0.1420	-0.0564	0.2279***	-0.1064***	0.9655*
	(0.0330)	(0.1813)	(0.6147)	(0.6801)	(0.0479)	(0.0389)	(0.5219)
Mexico	-0.0797***	-0.0402	-0.2199	-0.5356	0.3767***	-0.0811**	0.5403*
	(0.0233)	(0.1489)	(0.2841)	(0.5687)	(0.0387)	(0.0330)	(0.2951)
Pakistan	-0.0310*	-0.0157	-0.9851*	-1.8320***	0.4154***	-0.1844***	0.2043
	(0.0187)	(0.5582)	(0.5227)	(0.5791)	(0.0650)	(0.0608)	(0.1562)
Peru	-0.0288*	-0.4364	-0.4216	0.0803	0.4602***	-0.1857***	0.1828
	(0.0160)	(0.3944)	(0.7271)	(0.6635)	(0.0504)	(0.0491)	(0.1405)
Philippines	-0.0148	0.1454	-0.7360*	0.4070	0.4062***	-0.1524***	0.0912
	(0.0123)	(0.2756)	(0.3891)	(0.4471)	(0.0386)	(0.0372)	(0.0958)
Poland	-0.0693***	-0.7298	-0.0442	-0.6312	0.3872***	-0.1313**	0.4390*
	(0.0234)	(0.6561)	(0.2877)	(0.9727)	(0.0670)	(0.0612)	(0.2516)
Russia	-0.0701***	0.0831	-0.8702**	-0.1741	0.4198***	-0.2058***	0.4661*
	(0.0161)	(0.1271)	(0.4006)	(0.5395)	(0.0436)	(0.0382)	(0.2535)
Turkey	-0.0308**	-0.0647	-0.2720	-0.8384**	0.4105***	-0.0458	0.2071
	(0.0136)	(0.1015)	(0.1772)	(0.3758)	(0.0471)	(0.0456)	(0.1323)
Ukraine	-0.0563***	0.1011	0.6211*	-0.3909	0.4227***	-0.3216***	0.4075*
	(0.0187)	(0.2211)	(0.3763)	(0.5452)	(0.0648)	(0.0641)	(0.2262)
Venezuela	-0.0437***	0.2097**	0.1326	-0.0246	0.2819***	-0.1938***	0.3195*
	(0.0136)	(0.1010)	(0.1582)	(0.2930)	(0.0416)	(0.0388)	(0.1681)

[22] Specification 1 in **Table 2-7**

Table A 2.2. Fixed Effects Estimation: Decomposition of Changes in Spreads[23]

	01/2001-07/2007	07/2007-08/2008	08/2008-12/2008	12/2008-04/2010	04/2010-07/2011	07/2011-06/2012	06/2012-03/2013	01/2001-07/2007	07/2007-08/2008	08/2008-12/2008	12/2008-04/2010	04/2010-07/2011	07/2011-06/2012	06/2012-03/2013
				Argentina							Brazil			
Actual	-3.46	3.13	11.60	-11.99	-0.35	5.34	0.78	-5.48	0.66	2.44	-3.03	-0.12	0.54	-0.39
Model	-10.10	2.94	9.49	-11.25	-1.50	1.68	-0.75	-4.78	0.49	4.89	-6.01	0.56	0.74	-1.52
Fundamentals	-7.58	2.05	1.24	-2.37	-1.93	1.27	1.51	-3.67	0.16	1.72	-2.91	0.42	0.57	-0.77
Global factors	-2.53	0.89	8.25	-8.88	0.42	0.41	-2.26	-1.11	0.33	3.17	-3.10	0.14	0.18	-0.75
Residual	6.64	0.19	2.11	-0.74	1.16	3.66	1.53	-0.70	0.16	-2.45	2.98	-0.69	-0.20	1.13
Correction of misalignment	6.64	0.19	2.11	0.00	0.74	0.00	0.00	0.00	0.16	0.00	2.98	0.00	0.00	0.93
Increase of misalignment	0.00	0.00	0.00	-0.74	0.42	3.66	1.53	-0.70	0.00	-2.45	0.00	-0.69	-0.20	0.20
				Bulgaria							Chile			
Actual	-6.31	1.60	4.63	-5.36	0.63	0.58	-1.81	-1.21	0.83	1.78	-2.40	0.18	0.48	-0.32
Model	-1.30	1.07	3.29	-3.54	0.29	-0.36	-0.71	-0.93	0.27	1.99	-2.09	0.39	0.12	-0.63
Fundamentals	-0.84	0.85	0.90	-0.84	0.14	-0.50	-0.17	-0.61	0.15	0.74	-0.65	0.31	0.02	-0.22
Global factors	-0.47	0.22	2.39	-2.70	0.15	0.14	-0.54	-0.32	0.12	1.26	-1.44	0.08	0.10	-0.40
Residual	-5.01	0.53	1.34	-1.82	0.34	0.94	-1.09	-0.28	0.56	-0.21	-0.31	-0.21	0.36	0.31
Correction of misalignment	-4.45	0.53	0.02	-1.33	0.34	0.15	-0.78	-0.28	0.00	-0.21	-0.31	-0.06	0.15	0.00
Increase of misalignment	-0.55	0.00	1.33	-0.50	0.00	0.78	-0.31	0.00	0.56	0.00	0.00	-0.15	0.21	0.31
				China							Colombia			
Actual	-0.84	0.91	0.79	-1.92	1.25	1.08	-1.23	-5.90	0.86	3.16	-3.65	-0.31	0.31	-0.31
Model	-0.67	0.13	0.75	-0.74	0.23	0.08	-0.35	-2.27	0.05	3.49	-4.40	-0.16	0.04	-0.38
Fundamentals	-0.42	0.03	0.00	0.16	0.17	0.01	-0.02	-1.29	-0.31	0.67	-1.56	-0.29	-0.08	0.17
Global factors	-0.25	0.10	0.75	-0.90	0.07	0.07	-0.33	-0.98	0.36	2.81	-2.84	0.13	0.12	-0.55
Residual	-0.17	0.78	0.04	-1.18	1.02	1.00	-0.89	-3.63	0.81	-0.33	0.75	-0.14	0.27	0.07
Correction of misalignment	-0.06	0.11	0.00	-0.70	0.48	0.00	-0.89	-2.14	0.81	0.00	0.75	0.00	0.27	0.07
Increase of misalignment	-0.11	0.67	0.04	-0.48	0.53	1.00	0.00	-1.50	0.00	-0.33	0.00	-0.14	0.00	0.00
				Hungary							Indonesia			
Actual	-0.54	0.87	3.34	-3.31	1.37	2.92	-2.07		1.67	4.87	-6.43	-0.08	1.04	-0.78
Model	-0.16	0.11	1.41	-1.20	-0.24	1.14	-0.98		0.31	3.23	-3.13	0.03	0.86	-1.28
Fundamentals	0.11	-0.02	0.30	0.22	-0.32	1.03	-0.42		0.04	0.89	-0.31	-0.13	0.68	-0.42
Global factors	-0.28	0.13	1.11	-1.42	0.08	0.10	-0.56		0.26	2.34	-2.82	0.16	0.18	-0.86
Residual	-0.37	0.75	1.92	-2.11	1.61	1.78	-1.09		1.37	1.64	-3.30	-0.11	0.18	0.50
Correction of misalignment	-0.06	0.31	0.00	-2.11	0.00	0.00	-1.09		0.16	0.00	-2.84	0.00	0.18	0.39
Increase of misalignment	-0.31	0.45	1.92	0.00	1.61	1.78	0.00		1.21	1.64	-0.46	-0.11	0.00	0.11
				Malaysia							Mexico			
Actual	-1.46	0.76	2.40	-2.74	0.21	0.39	-0.60	-2.66	0.82	2.63	-3.01	0.00	0.59	-0.42
Model	-1.04	0.28	1.40	-1.56	0.21	0.12	-0.41	-1.53	0.35	2.50	-2.46	-0.05	1.02	-1.26
Fundamentals	-0.66	0.14	0.18	-0.19	0.12	0.03	0.01	-1.03	0.16	0.76	-0.38	-0.16	0.88	-0.61
Global factors	-0.37	0.14	1.23	-1.37	0.08	0.09	-0.42	-0.50	0.18	1.73	-2.08	0.11	0.14	-0.65
Residual	-0.43	0.48	1.00	-1.18	0.00	0.27	-0.19	-1.14	0.47	0.13	-0.55	0.05	-0.43	0.84
Correction of misalignment	-0.19	0.23	0.00	-1.18	0.00	0.00	-0.19	-0.99	0.14	0.00	-0.46	0.05	0.00	0.47
Increase of misalignment	-0.23	0.25	1.00	0.00	0.00	0.27	0.00	-0.14	0.33	0.13	-0.09	0.00	-0.43	0.36
				Pakistan							Peru			
Actual		5.91	12.53	-16.57	3.89	2.53	-1.13	-5.30	0.66	3.28	-3.80	0.27	0.17	-0.49
Model		5.18	7.07	-12.16	0.55	0.69	-0.67	-1.87	0.49	2.46	-2.72	-0.08	0.17	-0.73
Fundamentals		4.34	-1.15	-5.06	0.22	0.34	1.15	-1.19	0.23	0.26	-0.25	-0.22	0.04	-0.13
Global factors		0.84	8.22	-7.10	0.33	0.36	-1.82	-0.68	0.26	2.20	-2.47	0.14	0.14	-0.60
Residual		0.73	5.46	-4.41	3.34	1.84	-0.46	-3.43	0.17	0.83	-1.08	0.35	0.00	0.25
Correction of misalignment		0.73	0.87	-4.41	0.00	0.00	-0.46	-2.84	0.17	0.42	-0.41	0.35	0.00	0.25
Increase of misalignment		0.00	4.60	0.00	3.34	1.84	0.00	-0.59	0.00	0.41	-0.67	0.00	0.00	0.00
				Philippines							Poland			
Actual	-4.65	0.94	3.03	-3.77	-0.21	0.56	-0.78	-1.59	0.69	1.78	-1.97	0.65	0.61	-1.11
Model	-3.61	0.23	4.61	-5.09	-0.44	0.30	-0.94	-0.35	0.17	1.56	-1.54	0.34	-0.24	-0.37
Fundamentals	-2.48	-0.15	1.35	-1.50	-0.60	0.14	-0.28	-0.07	0.04	0.42	-0.16	0.25	-0.33	-0.02
Global factors	-1.13	0.38	3.25	-3.59	0.16	0.15	-0.67	-0.28	0.13	1.14	-1.37	0.09	0.09	-0.35
Residual	-1.04	0.72	-1.57	1.33	0.23	0.27	0.16	-1.24	0.52	0.21	-0.44	0.31	0.85	-0.74
Correction of misalignment	0.00	0.72	0.00	1.33	0.23	0.27	0.16	-0.92	0.32	0.00	-0.41	0.03	0.00	-0.74
Increase of misalignment	-1.04	0.00	-1.57	0.00	0.00	0.00	0.00	-0.32	0.20	0.21	-0.03	0.29	0.85	0.00
				Russia							Turkey			
Actual	-9.69	1.00	6.45	-6.95	0.61	0.88	-1.18	-5.43	1.11	2.87	-3.86	0.12	1.14	-1.25
Model	-4.09	0.36	2.37	-2.37	0.09	0.98	-1.24	-2.62	0.70	6.59	-7.05	0.33	0.98	-2.26
Fundamentals	-3.20	0.11	0.27	0.12	-0.07	0.80	-0.37	-1.71	0.35	2.86	-2.91	0.13	0.75	-1.36
Global factors	-0.89	0.26	2.10	-2.48	0.15	0.18	-0.88	-0.91	0.35	3.73	-4.15	0.19	0.23	-0.90
Residual	-5.60	0.63	4.08	-4.58	0.52	-0.10	0.06	-2.81	0.41	-3.71	3.20	-0.21	0.16	1.01
Correction of misalignment	-4.82	0.63	0.14	-3.94	0.52	0.00	0.06	-2.30	0.41	0.00	3.20	0.00	0.16	0.66
Increase of misalignment	-0.78	0.00	3.94	-0.64	0.00	-0.10	0.00	-0.51	0.00	-3.71	0.00	-0.21	0.00	0.35
				Ukraine							Venezuela			
Actual	-17.15	3.73	20.31	-21.15	0.28	4.35	-3.67	-5.52	3.46	11.07	-9.37	2.67	0.26	-3.74
Model	-3.06	0.65	13.17	-12.23	0.91	0.65	-3.17	-0.92	1.21	4.96	4.20	-6.65	0.00	1.78
Fundamentals	-1.78	0.15	7.16	-4.53	0.52	0.23	-1.48	0.18	0.65	0.30	13.29	-7.36	-0.50	4.59
Global factors	-1.27	0.50	6.01	-7.70	0.39	0.42	-1.69	-1.09	0.56	4.66	-9.09	0.72	0.49	-2.81
Residual	-14.09	3.09	7.14	-8.92	-0.63	3.70	-0.50	-4.60	2.26	6.12	-13.57	9.32	0.26	-5.52
Correction of misalignment	-12.17	1.92	0.00	-8.30	0.00	1.25	-0.50	-4.04	0.57	0.00	-7.81	5.76	0.00	-3.82
Increase of misalignment	-1.92	1.16	7.14	-0.62	-0.63	2.45	0.00	-0.57	1.69	6.12	-5.76	3.56	0.26	-1.70

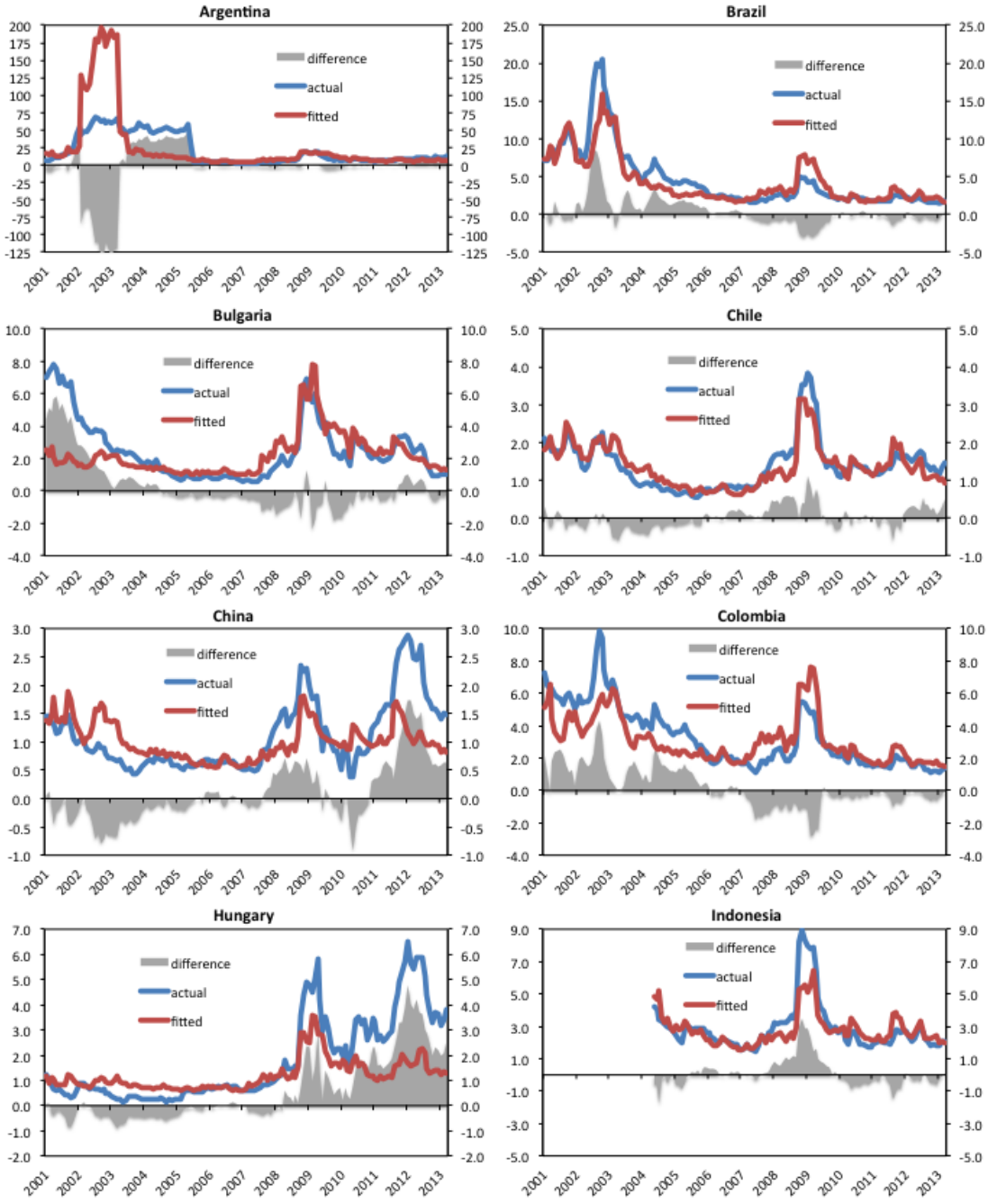
[23] Based on specification 2 in **Table 2-3**

Table A 2.3. PMG Estimation: Decomposition of Changes in Spreads[24]

	01/2001-07/2007	07/2007-08/2008	08/2008-12/2008	12/2008-04/2010	04/2010-07/2011	07/2011-06/2012	06/2012-03/2013	01/2001-07/2007	07/2007-08/2008	08/2008-12/2008	12/2008-04/2010	04/2010-07/2011	07/2011-06/2012	06/2012-03/2013
	Argentina							Brazil						
Actual	-3.46	3.13	11.60	-11.99	-0.35	5.34	0.78	-5.48	0.66	2.44	-3.03	-0.12	0.54	-0.39
Model	-6.61	2.41	19.41	-21.88	0.51	0.27	-3.24	-1.57	0.26	3.62	-4.32	0.28	0.29	-0.89
Fundamentals	-1.69	0.70	0.87	-0.59	-0.28	-0.93	1.11	-0.57	-0.06	0.30	-0.77	0.16	0.08	-0.15
Global factors	-4.92	1.71	18.54	-21.28	0.78	1.19	-4.35	-1.00	0.31	3.32	-3.55	0.12	0.21	-0.74
Residual	3.14	0.72	-7.81	9.89	-0.86	5.07	4.02	-3.91	0.40	-1.18	1.29	-0.40	0.25	0.50
Correction of misalignment	3.14	0.72	0.00	9.89	0.00	3.67	0.00	-3.84	0.07	-0.33	0.85	-0.40	0.00	0.00
Increase of misalignment	0.00	0.00	-7.81	0.00	-0.86	1.40	4.02	-0.07	0.33	-0.85	0.44	0.00	0.25	0.50
	Bulgaria							Chile						
Actual	-6.31	1.60	4.63	-5.36	0.63	0.58	-1.81	-1.21	0.83	1.78	-2.40	0.18	0.48	-0.32
Model	-1.28	0.18	2.53	-2.76	0.44	0.18	-0.86	-0.71	0.17	2.45	-2.75	0.29	0.13	-0.63
Fundamentals	-0.50	-0.06	0.09	0.13	0.32	-0.04	-0.08	-0.13	-0.03	0.29	-0.29	0.19	-0.04	-0.07
Global factors	-0.78	0.24	2.44	-2.89	0.13	0.22	-0.78	-0.58	0.20	2.16	-2.46	0.09	0.16	-0.56
Residual	-5.03	1.42	2.10	-2.60	0.19	0.39	-0.95	-0.50	0.66	-0.67	0.35	-0.11	0.35	0.31
Correction of misalignment	-4.41	0.63	0.00	-2.60	0.00	0.00	-0.88	-0.28	0.22	-0.44	0.23	-0.11	0.00	0.00
Increase of misalignment	-0.63	0.80	2.10	0.00	0.19	0.39	-0.07	-0.22	0.44	-0.23	0.12	0.00	0.35	0.31
	China							Colombia						
Actual	-0.84	0.91	0.79	-1.92	1.25	1.08	-1.23	-5.90	0.86	3.16	-3.65	-0.31	0.31	-0.31
Model	-0.61	0.19	1.48	-1.68	0.23	0.12	-0.47	-1.52	-0.06	3.02	-3.80	0.11	0.28	-0.51
Fundamentals	-0.19	0.05	0.00	0.02	0.16	-0.01	-0.02	-0.40	-0.40	-0.09	-0.57	0.00	0.10	0.22
Global factors	-0.42	0.14	1.48	-1.70	0.07	0.13	-0.45	-1.12	0.34	3.10	-3.22	0.11	0.18	-0.72
Residual	-0.24	0.71	-0.69	-0.25	1.02	0.96	-0.77	-4.39	0.91	0.14	0.14	-0.42	0.03	0.20
Correction of misalignment	-0.08	0.15	-0.56	0.00	0.38	0.00	-0.77	-3.67	0.71	0.00	0.00	-0.42	0.00	0.00
Increase of misalignment	-0.15	0.56	-0.13	-0.25	0.64	0.96	0.00	-0.71	0.20	0.14	0.14	0.00	0.03	0.20
	Hungary							Indonesia						
Actual	-0.54	0.87	3.34	-3.31	1.37	2.92	-2.07		1.67	4.87	-6.43	-0.08	1.04	-0.78
Model	-0.96	0.37	2.98	-3.39	0.44	0.37	-0.98		0.56	4.18	-4.89	0.32	0.91	-1.52
Fundamentals	-0.26	0.12	0.26	-0.33	0.32	0.14	-0.17		0.15	-0.07	-0.14	0.14	0.57	-0.23
Global factors	-0.70	0.24	2.72	-3.06	0.12	0.23	-0.80		0.41	4.25	-4.75	0.18	0.34	-1.29
Residual	0.42	0.50	0.36	0.09	0.93	2.55	-1.10		1.12	0.69	-1.55	-0.40	0.13	0.74
Correction of misalignment	0.42	0.50	0.08	0.00	0.00	0.00	-1.10		0.36	0.00	-1.45	0.00	0.13	0.37
Increase of misalignment	0.00	0.00	0.28	0.09	0.93	2.55	0.00		0.76	0.69	-0.10	-0.40	0.00	0.37
	Malaysia							Mexico						
Actual	-1.46	0.76	2.40	-2.74	0.21	0.39	-0.60	-2.66	0.82	2.63	-3.01	0.00	0.59	-0.42
Model	-1.34	0.34	2.41	-2.78	0.13	0.24	-0.62	-1.52	0.38	3.43	-3.72	0.21	0.48	-1.07
Fundamentals	-0.66	0.14	0.11	-0.21	0.03	0.08	-0.04	-0.64	0.10	0.30	-0.03	0.07	0.23	-0.16
Global factors	-0.67	0.21	2.29	-2.57	0.09	0.16	-0.58	-0.89	0.28	3.13	-3.69	0.14	0.25	-0.91
Residual	-0.12	0.42	-0.01	0.04	0.08	0.15	0.01	-1.14	0.43	-0.79	0.71	-0.21	0.11	0.64
Correction of misalignment	0.00	0.29	-0.01	0.00	0.00	0.00	0.00	-0.80	0.34	-0.09	0.70	-0.01	0.11	0.10
Increase of misalignment	-0.12	0.13	0.00	0.04	0.08	0.15	0.01	-0.34	0.09	-0.70	0.01	-0.20	0.00	0.55
	Pakistan							Peru						
Actual		5.91	12.53	-16.57	3.89	2.53	-1.13	-5.30	0.66	3.28	-3.80	0.27	0.17	-0.49
Model		1.16	6.66	-8.48	0.25	0.95	-1.71	-0.63	0.32	3.20	-3.66	-0.02	0.18	-0.66
Fundamentals		0.44	-0.67	-0.78	-0.02	0.48	0.10	0.13	0.03	0.16	-0.22	-0.14	0.00	-0.01
Global factors		0.72	7.34	-7.69	0.27	0.47	-1.81	-0.76	0.29	3.04	-3.43	0.12	0.18	-0.65
Residual		4.75	5.87	-8.09	3.64	1.58	0.59	-4.67	0.34	0.09	-0.14	0.30	-0.01	0.18
Correction of misalignment		0.86	0.00	-8.09	0.00	0.00	0.00	-4.39	0.28	0.00	-0.14	0.00	-0.01	0.00
Increase of misalignment		3.89	5.87	0.00	3.64	1.58	0.59	-0.28	0.06	0.09	0.00	0.30	0.00	0.18
	Philippines							Poland						
Actual	-4.65	0.94	3.03	-3.77	-0.21	0.56	-0.78	-1.59	0.69	1.78	-1.97	0.65	0.61	-1.11
Model	-1.33	0.15	3.01	-3.44	0.03	0.18	-0.57	-0.35	0.00	2.02	-2.23	0.09	0.09	-0.41
Fundamentals	-0.50	-0.11	0.33	-0.44	-0.07	0.02	0.00	0.16	-0.18	0.19	-0.10	0.01	-0.03	0.05
Global factors	-0.83	0.25	2.68	-3.00	0.10	0.16	-0.57	-0.51	0.18	1.83	-2.13	0.08	0.13	-0.45
Residual	-3.32	0.79	0.02	-0.33	-0.24	0.39	-0.21	-1.23	0.69	-0.25	0.26	0.57	0.52	-0.70
Correction of misalignment	-3.32	0.00	0.00	-0.33	-0.24	0.00	-0.21	-0.76	0.47	-0.22	0.03	0.00	0.00	-0.70
Increase of misalignment	0.00	0.79	0.02	0.00	0.00	0.39	0.00	-0.47	0.22	-0.03	0.23	0.57	0.52	0.00
	Russia							Turkey						
Actual	-9.69	1.00	6.45	-6.95	0.61	0.88	-1.18	-5.43	1.11	2.87	-3.86	0.12	1.14	-1.25
Model	-2.47	0.29	4.09	-4.70	0.29	0.69	-1.06	-1.55	0.75	6.77	-7.40	0.43	0.41	-1.73
Fundamentals	-1.23	-0.06	0.32	-0.49	0.13	0.41	0.05	-0.24	0.27	1.08	-0.79	0.19	0.01	-0.38
Global factors	-1.25	0.36	3.77	-4.21	0.15	0.28	-1.11	-1.31	0.48	5.69	-6.62	0.24	0.40	-1.35
Residual	-7.21	0.70	2.36	-2.25	0.32	0.19	-0.12	-3.87	0.37	-3.90	3.54	-0.31	0.73	0.48
Correction of misalignment	-6.31	0.70	0.20	-2.16	0.08	0.00	-0.12	-3.30	0.37	0.00	3.54	0.00	0.73	0.14
Increase of misalignment	-0.90	0.00	2.16	-0.08	0.24	0.19	0.00	-0.58	0.00	-3.90	0.00	-0.31	0.00	0.34
	Ukraine							Venezuela						
Actual	-17.15	3.73	20.31	-21.15	0.28	4.35	-3.67	-5.52	3.46	11.07	-9.37	2.67	0.26	-3.74
Model	-2.57	-0.09	8.16	-8.22	0.48	0.49	-1.69	-0.36	1.19	12.93	-15.10	-0.40	2.78	-2.87
Fundamentals	-0.83	-0.61	2.26	-0.81	0.21	0.04	-0.08	2.25	0.05	0.82	-1.76	-0.82	2.02	0.39
Global factors	-1.74	0.51	5.90	-7.41	0.27	0.45	-1.62	-2.61	1.14	12.11	-13.35	0.43	0.76	-3.27
Residual	-14.58	3.83	12.15	-12.93	-0.19	3.86	-1.97	-5.16	2.28	-1.86	5.73	3.07	-2.52	-0.87
Correction of misalignment	-13.20	1.37	0.00	-12.93	-0.19	0.00	-1.97	-2.22	2.28	0.00	2.52	0.00	-2.52	-0.87
Increase of misalignment	-1.37	2.45	12.15	0.00	0.00	3.86	0.00	-2.94	0.00	-1.86	3.21	3.07	0.00	0.00

[24] Based on specification 1 in **Table 2-7**

Figure A 2.1. Fixed Effects Estimation[25]: Actual and Fitted EMBIG Spreads
(percentage point)



[25] Based on specification 2 in **Table 2-3**

(Concluded)

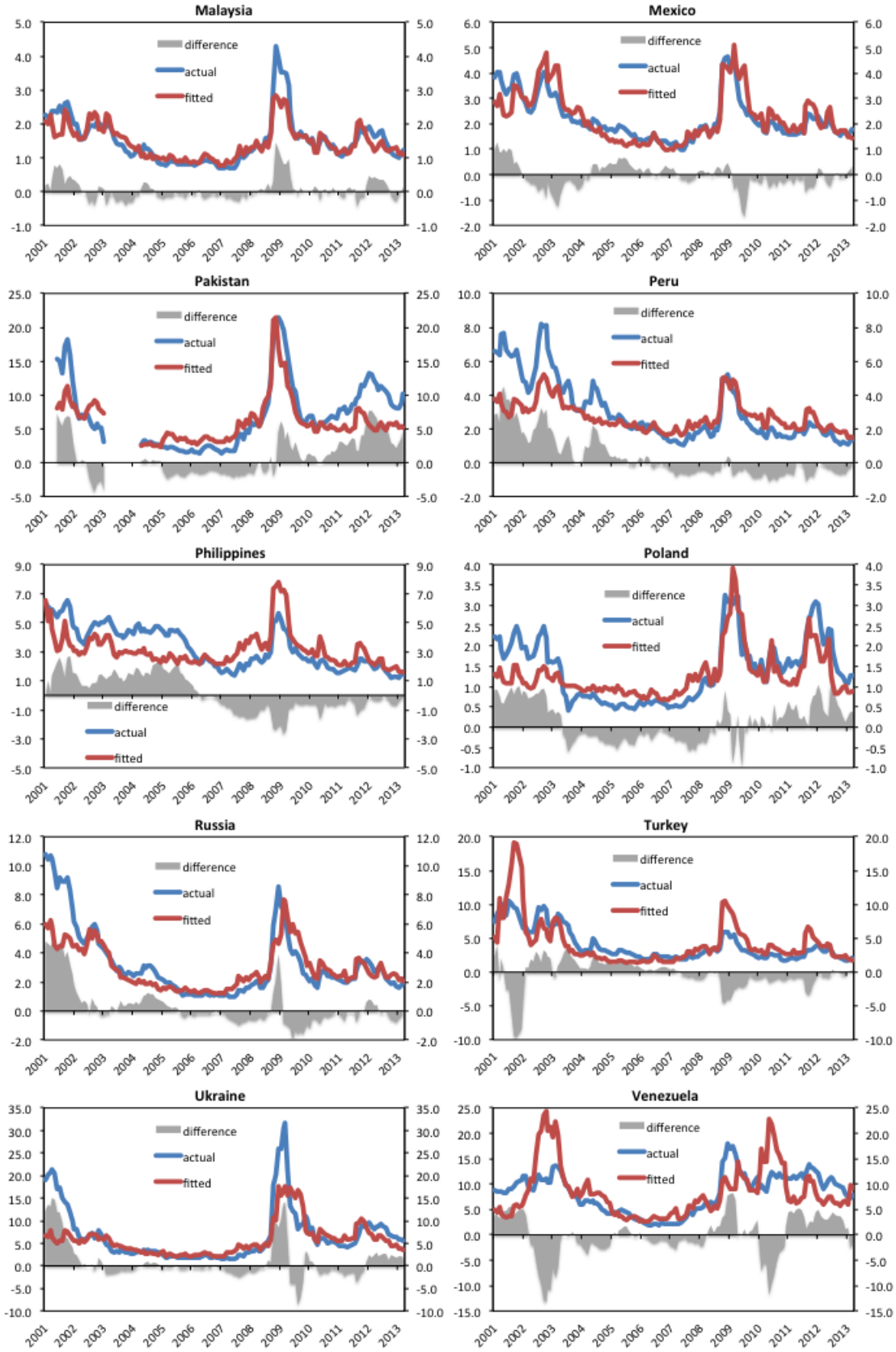
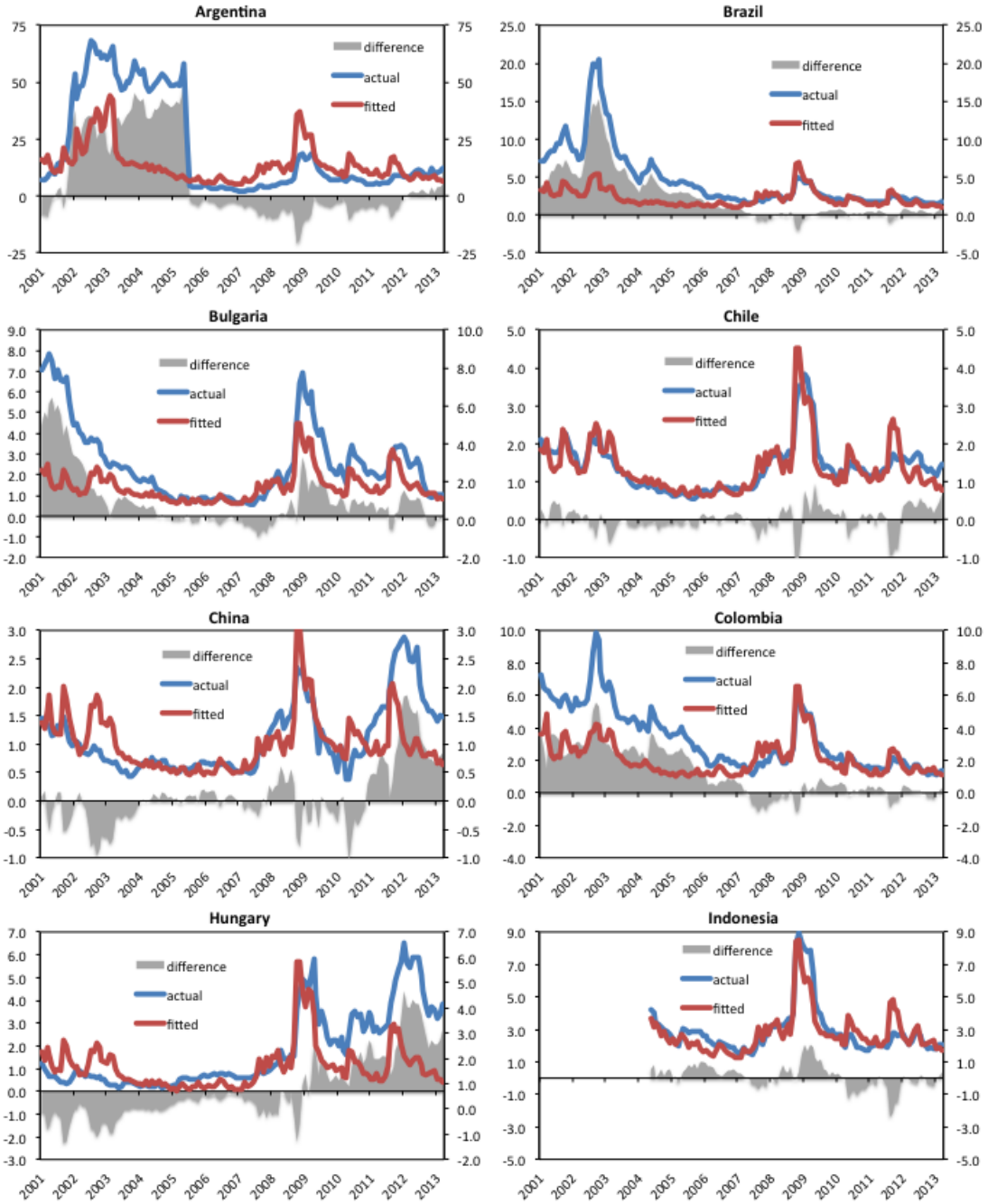

Malaysia
Mexico
Pakistan
Peru
Philippines
Poland
Russia
Turkey
Ukraine
Venezuela
difference
actual
fitted

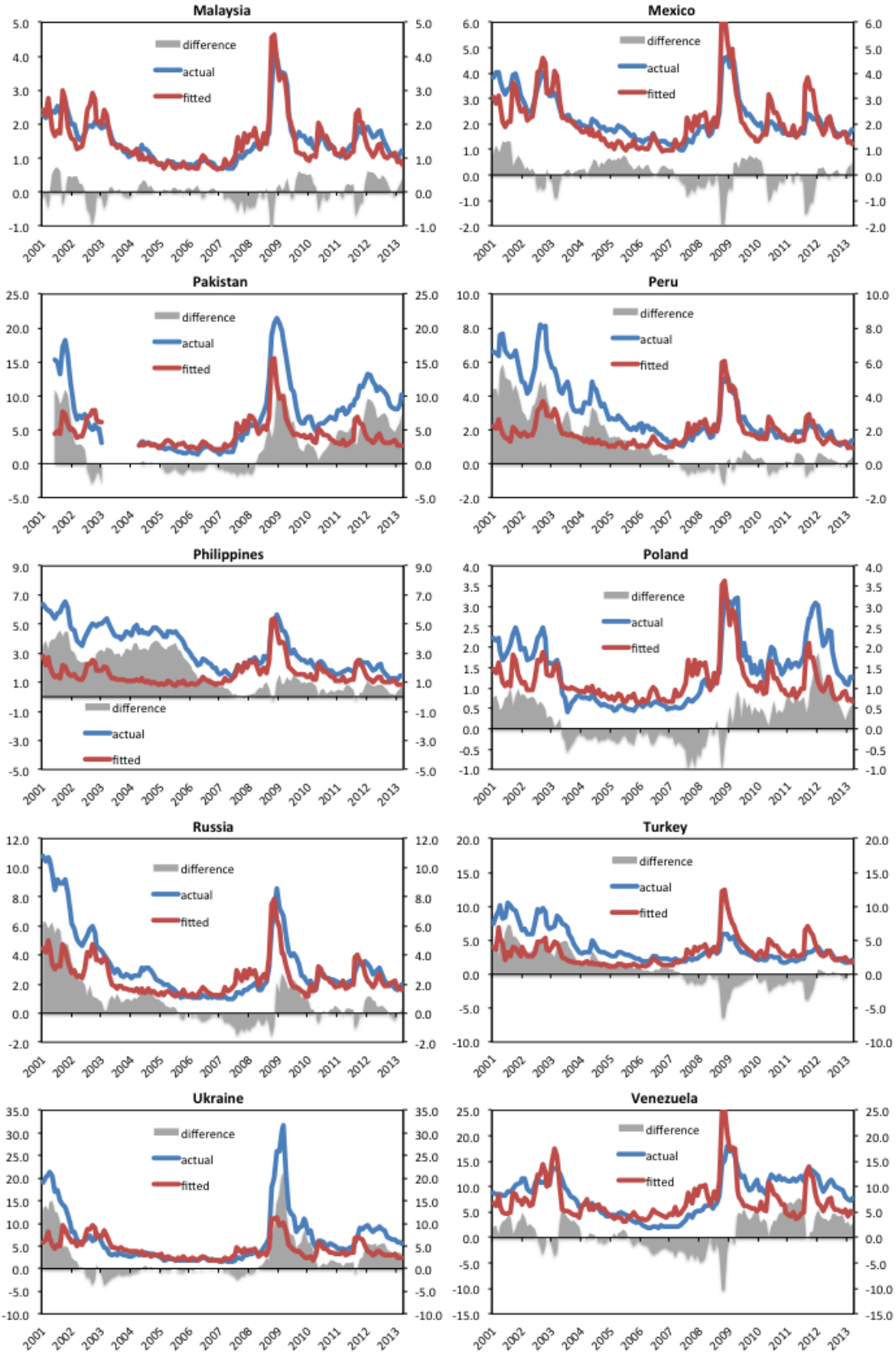
Figure A 2.2. Pooled Mean Group Estimation[26]: Actual and Fitted EMBIG Spreads

(percentage point)



[26] Based on the long-term coefficients of specification 1 in **Table 2-7**

(Concluded)


Malaysia
Mexico
Pakistan
Peru
Philippines
Poland
Russia
Turkey
Ukraine
Venezuela
difference
actual
fitted

3. Emerging Market Sovereign Bond Spreads and Shifts in Global Market Sentiment[27]

3.1. Introduction

Since the onset of the global financial crisis in 2007, financial markets have gone through several shifts between periods characterized by low and high risk aversion. A distinction between 'risk on' and 'risk off' periods is essential for the understanding of the behavior of emerging market sovereign spreads since the relationship between spreads, country-specific fundamentals and global factors could differ across these periods.

The identification of market sentiment regimes and the understanding of possible differences in the behavior of sovereign bond markets across regimes are important for both markets and policymakers. First, several papers showed that regime shifts affect optimal asset allocation and risk management decisions. For example, a large number of studies found evidence of increasing correlation between financial assets in bear markets and high-volatility periods that reduces the gain from diversification that is based on unconditional correlations, while others showed that the composition of the optimal portfolio changes if asset allocation decisions consider regime shifts. Second, it is important for policymakers to understand the possible consequences on financial assets of a shift in global market sentiment. The prevalence of favorable market conditions should not prevent them from focusing on reducing vulnerabilities, as weak fundamentals, which may be "overlooked" by investors during tranquil times, can amplify the negative effects on their economies of an adverse shift in global sentiment. As *El Erian and Spence* [2012] note, it is important for policymakers to have an appropriate design and use of both ex ante and ex post circuit breakers that could "prevent the evolution of structures that amplify feedback loops and break the serial contamination of expectations, the real economy, and market linkages, thereby interrupting the often disruptive dynamic that leads to a sequence of bad equilibriums".

In this chapter, following the identification of low-, medium- and high-volatility regimes, we investigate the behavior of emerging market sovereign bond spreads from three different angles. First, we analyze whether the cross-country correlation of spreads

[27] The chapter was published in Emerging Markets Review (see *Csontó* [2014]).

increases during high-volatility periods. Second, we regress spreads on the interactions of the regime probabilities with several country-specific and global variables with the aim of understanding whether the relationship between spreads and their determinants is different across regimes. Finally, we assess the impact of the strength of country-specific fundamentals on the exposure of spreads to adverse shifts in global market sentiment.

The remaining part of the chapter is organized as follows. Section 3.2 reviews the literature on the behavior of emerging market sovereign bond spreads. Section 3.3 and 3.4 describe the data and the estimation methodologies, respectively. Section 3.5 contains the estimation results. Section 3.6 analyzes the forecasting performance of the model, while Section 3.7 draws the policy implications. Section 3.8 concludes.

3.2. Related Literature

There is a wide stand of literature that analyzes whether the relationship between emerging market sovereign spreads and country-specific fundamentals/global factors changes over time and/or as a function of global conditions. The studies apply several techniques to split their samples.

González-Rozada and Levy-Yeyati [2005] use the Wald test to analyze whether there is a break in the impact on emerging market sovereign spreads of the high yield spread that serves as a proxy for risk aversion. They find that the break date of their sample period of 1993-2005 is September 1999 with the coefficient of the high yield spread being slightly higher for the earlier period at comparable significance level. *Comelli* [2012] splits the sample into two sub-periods called global abundant liquidity between January 2003 and July 2007 and global financial crisis between August 2007 and December 2011. He shows that while country-specific variables are significant determinants of spreads during both periods, the role of global factors changes: the coefficient of VIX increases substantially during the global financial crisis, while short-term U.S. Treasury yields become significantly negative during the global abundant liquidity period, suggesting the role of demand and supply conditions. He also finds that the long-term U.S. yield has become insignificant after 2003 suggesting that the focus of investors focus switched to country-specific factors.

The studies that analyze the impact on the behavior of spreads of global environment typically either split the sample into periods of low and high global risk

aversion or include the interaction of fundamentals with dummies of high global risk perception. Furthermore, they also differ in the technique used to distinguish between low- and high-volatility periods. *Levy-Yeyati and Williams* [2010] define distressed periods as the ones during which the ratio of government securities to total assets under management in money market funds is above the sample median. The rationale is that the flight-to-quality phenomenon leads to an increase of this ratio during high-volatility periods. They use the interaction of the distress period dummy with several global factors and find that the coefficient of the U.S. Federal funds rate turns from negative to positive, the impact of the high-yield spread and the steepness of the U.S. Treasury yield curve increases, while the effect of VIX index decreases during periods of high global risk aversion. *Baldacci et al.* [2008] classify periods as high-volatility ones if VIX index exceeds 25. By introducing the interaction of the high volatility dummy variable with the political risk indicator and fiscal balance into their panel regression, they show that the impact of fiscal indicators increases during high-volatility periods while that of political risk does not change significantly. *Dumicic and Ridzak* [2011] find that macroeconomic indicators and global factors drive spreads in the CEE countries during all periods, while sovereign risk and external solvency indicators become significant only in crisis times. For the latter, they introduce the interaction of the explanatory variables with a dummy that equals 1 if the DAX volatility index exceeds the sum of its historical mean and standard deviation. Applying panel threshold estimation, *Jaramillo and Weber* [2012] find that fiscal variables determine spreads in periods of high risk aversion, while macro variables become important determinants of spreads during low risk-aversion periods. Instead of an arbitrary choice, the authors apply a method that determines the threshold level of VIX endogenously based on maximum likelihood estimation. The *IMF* [2013] uses the interaction of the explanatory variables with the probability that VIX is in the high-volatility state where the probability stems from the estimation of a Markov-switching ARCH model on VIX. The estimation results show that there is a different set of country-specific variables that are significant determinants of sovereign credit default swap spreads during the high-volatility state: while the debt-to-GDP ratio, real GDP growth, market microstructure indicators and equity return are the main drivers during tranquil periods, the reserves-to-GDP ratio, banking ROA and equity volatility are found to be significant during periods of distress. Similarly, the impact of global factors also differs across regimes: VIX index has a significantly positive coefficient only during periods of distress, while

global equity return and funding costs are significant in both regimes, albeit with opposite signs.

3.3. Data

We have an unbalanced panel dataset of monthly observations between January 2004 and December 2012 for 17 emerging markets[28]. As the measure of sovereign risk, we calculated monthly averages of daily Emerging Market Bond Index Global (EMBIG) sovereign spreads downloaded from J.P. Morgan's research and market data website (MorganMarkets). The EMBIG spread is a market-capitalization-weighted average of spreads on US$-denominated Brady bonds, Eurobonds and traded loans issued by sovereign and quasi-sovereign entities.

We use the following country-specific fundamentals and global factors as explanatory variables:

3. Country-specific fundamentals:
    - *Consensus Economics (CE) Forecasts:* We use mean forecasts for real GDP growth, inflation and current account balance. As monthly forecasts are available for the actual and the following year, following *Nickel et al.* [2009] we calculated 12-month ahead forecasts in order to have the same projection horizon every month.[29] Since the survey was conducted only in every two months for Central and Eastern European countries before May 2007 and for Latin American countries before April 2001, linear interpolation was used to fill in the missing data in these periods.

[28] Asia: China, Indonesia, Malaysia, Pakistan, Philippines; Central and Eastern Europe: Bulgaria, Hungary, Poland, Russia, Turkey, Ukraine; Latin America: Brazil, Chile, Colombia, Mexico, Peru, Venezuela.

[29] *Nickel et al.* [2009] calculated 12-month ahead forecasts as follows: $f_{12m} = \frac{f_{current} \cdot m + \cdot f_{next}(12-m)}{12}$ where f_{12m}, $f_{current}$, f_{next} and m denote forecasts for the 12-month ahead period, the current year and the next year, and the number of remaining months in the current year, respectively.

- *Real GDP growth (percent):* As higher growth outlook is assumed to improve public debt sustainability, it is expected to have a negative relationship with spreads.
- *Inflation (percent):* It is expected to be positively related to spreads as domestic investors need compensation for inflation. Furthermore, higher inflation may also reflect a higher degree of economic uncertainty.
- *Current account balance (percent of GDP):* As higher current account balance improves the ability of the country to repay its external debt, it is expected to be associated with lower spreads. Since CE forecasts for current account balance are expressed in US$ terms, we normalized them with nominal GDP downloaded from the IMF's World Economic Outlook (WEO) database.

- *Actual data:*
  - *Public debt (percent of GDP):* As another fiscal indicator, it is expected to be positively related to spreads, reflecting that countries with higher debt are assumed to be riskier. Annual data from the WEO database was linearly interpolated.
  - *External debt (percent of GDP):* Higher external debt is expected to be associated with higher spreads. Quarterly data downloaded from the World Bank's database was linearly interpolated.
  - *Reserves (percent of GDP):* Serving as a liquidity indicator, higher reserves are expected to lead to lower spreads. Monthly data was downloaded from the IMF IFS database.

4. Global factors:
   - *Global risk aversion:* The Chicago Board Options Exchange Volatility Index (VIX), which measures the implied volatility of S&P index options, is used as a proxy for investors' risk appetite. VIX is expected to be positively associated with spreads. The source of data is Bloomberg.
   - *Global liquidity conditions:*

- *U.S. Federal funds rate:* It is used as a proxy for global liquidity conditions. As lower Fed funds rate is assumed to be associated with higher liquidity, it is expected to have a positive relationship with spreads. Data was downloaded from the website of Federal Reserve.
- *10-year U.S. Treasury yield:* As a proxy for global liquidity conditions, it is expected to have a positive relationship with emerging market sovereign spreads during tranquil times. However, during periods of distress the 'flight to quality' phenomenon can lead to decreasing U.S. Treasury yields and increasing emerging market spreads, thereby resulting in a negative relationship with spreads. The source of data is Bloomberg.

Table 3-1 shows descriptive statistics of the variables, while Table 3-2 contains their correlation matrix. The latter reveals that EMBIG spreads are positively correlated with inflation, public debt, external debt and global risk aversion and they are negatively related to growth, current account balance and international reserves in line with our prior assumptions. In contrast with our expectations, they have a negative relationship with the U.S. Federal funds rate and 10-year U.S. Treasury yield, with the latter possibly reflecting the dominance of the 'flight to quality' phenomenon. The latter is also supported by the negative correlation between long-term U.S. yields and VIX.

Table 3-1. Descriptive Statistics

Variable	Mean	Standard deviation	Min	Max
EMBI Global spread (percentage point)	2.93	2.99	0.14	31.58
Consensus Economics Forecasts				
Real GDP growth (percent, y/y)	4.45	2.18	-6.32	10.85
CPI (percent, y/y)	6.44	5.75	0.43	36.75
Current account balance (percent of GDP)	-0.03	5.23	-20.91	15.18
Actual Fundamentals				
Public debt (percent of GDP)	39.10	18.84	3.89	81.84
Gross external debt (percent of GDP)	42.76	32.47	4.48	196.76
International reserves (percent of GDP)	19.47	12.47	1.77	57.85
Global Factors				
VIX Index	20.81	9.93	10.82	62.64
U.S. Federal funds rate (percent)	1.87	1.97	0.07	5.28
10-year U.S. Treasury yield (percent)	3.62	0.99	1.50	5.10

Source: J.P. Morgan, IMF WEO, IFS, World Bank, Bloomberg, Fed, authors' calculations

Table 3-2. Pairwise Correlations

	embig	growth	cpi	ca	pubdebt	extdebt	reserves	vix	us_ffr	us10y
embig	1.0000									
growth	-0.4425	1.0000								
	(0.0000)									
cpi	0.6428	-0.1835	1.0000							
	(0.0000)	(0.0000)								
ca	-0.0559	0.2693	0.1657	1.0000						
	(0.0168)	(0.0000)	(0.0000)							
pubdebt	0.1024	-0.2603	-0.0613	-0.0782	1.0000					
	(0.0000)	(0.0000)	(0.0086)	(0.0008)						
extdebt	0.0819	-0.4228	-0.0741	-0.3356	0.2854	1.0000				
	(0.0005)	(0.0000)	(0.0017)	(0.0000)	(0.0000)					
reserves	-0.2509	0.2571	-0.2828	0.3609	-0.1894	0.2696	1.0000			
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
vix	0.4234	-0.3255	0.0820	-0.1279	-0.0844	0.0538	0.0519	1.0000		
	(0.0000)	(0.0000)	(0.0004)	(0.0000)	(0.0003)	(0.0225)	(0.0262)			
us_ffr	-0.3236	0.3561	-0.0573	0.0594	-0.0252	-0.1026	-0.0684	-0.4571	1.0000	
	(0.0000)	(0.0000)	(0.0141)	(0.0109)	(0.2813)	(0.0000)	(0.0034)	(0.0000)		
us10y	-0.2825	0.2894	-0.0230	0.0697	0.0192	-0.0888	-0.0839	-0.3910	0.7773	1.0000
	(0.0000)	(0.0000)	(0.3249)	(0.0028)	(0.4107)	(0.0002)	(0.0003)	(0.0000)	(0.0000)	

Note: p-values are in parenthesis.

3.4. Model

We apply a two-step procedure to analyze the behavior of emerging market sovereign spreads across different regimes of global market sentiment. In the first step, we use a Markov-switching framework to identify three regimes of global environment. Specifically, following *González-Hermosillo and Hesse* [2009], we run a Markov-

switching ARCH model on VIX that estimates the probability of VIX being in the low-, medium- and high-volatility regime in each period. In the second step, we run a panel regression of spreads that allows coefficients to differ across regimes: we introduce the interaction of regime probabilities with the country-specific and global explanatory variables in order to understand how the relationship between spreads and their determinants differs across regimes.

3.4.1. Identification of Regimes

Instead of an arbitrary selection of the thresholds of VIX, we follow *González-Hermosillo and Hesse* [2009] and *IMF* [2013] and estimate a Markov-switching ARCH model developed by *Hamilton and Susmel* [1994] on the first differences of VIX with the aim of identifying regimes characterized by low, medium and high volatility in financial markets. The mean equation describes an $AR(1)$ process with parameters being fixed among regimes:

Equation 3.1

$$y_t = \alpha + \beta y_{t-1} + \varepsilon_t$$

where y_t denotes a vector of observed variables, while ε_t follows a k-state and qth order Markov-switching ARCH process (SWARCH(k, q)):

Equation 3.2

$$\varepsilon_t = \sqrt{g_{s_t}}\nu_t \sqrt{\left(\alpha_0 + \sum_{i=1}^{q} \alpha_i \frac{\varepsilon_{t-i}^2}{g_{s_{t-i}}} + \zeta d_{t-1} \frac{\varepsilon_{t-1}^2}{g_{s_{t-1}}}\right)}$$

where $s_t = 1,2,\dots,k$ is an unobserved random variable with k being the number of states, ν_t is an i.i.d. process with zero mean and unit variance, while the last term in parenthesis accounts for asymmetry with d_{t-1} being a dummy variable that is equal to 1 if $\varepsilon_{t-1} \Big/ \sqrt{g_{s_{t-1}}} \leq 0$. The parameters differ across regimes due to the presence of the factor g_{s_t} that is normalized at unity for the first state: $g_1 = 1$ and $g_j \geq 1$ for $j = 1,2,\dots,k$ (i.e. the first regime is the low-volatility one). The variable s_t shows which regime the process is in at date t and is described by a Markov chain:

Equation 3.3

$$p_{ij} = p(s_t = j | s_{t-1} = i, s_{t-2} = k, \dots, y_{t-1}, y_{t-2}) = p(s_t = j | s_{t-l} = i)$$

where p_{ij} denotes the transition probabilities.

We estimate a SWARCH(3,2) model for the first differences of VIX that identifies low-, medium- and high-volatility regime. The estimated regime probabilities are then used in the fixed effects estimation.

3.4.2. Fixed Effects Estimation

Our starting point is the following model in which spreads are the function of several country-specific and global variables:

Equation 3.4

$$embig_{it} = \gamma'_1 X_{it-l} + \gamma'_2 Z_t + \mu_i + \varepsilon_{it}$$

where $embig_{it}$, X_{it}, and Z_t denote EMBIG spread, and a $(k_1 \times 1)$ and a $(k_2 \times 1)$ vector of country-specific and global explanatory variables, respectively, while μ_i, γ_1 and γ_2 are the country fixed effect, and $(k_1 \times 1)$ and $(k_2 \times 1)$ vectors of coefficients, respectively.

Since we want to assess how the global environment affects the relationship between spreads and country-specific/global variables, we also estimate a modified version of Equation 3.4 that allows regression coefficients to differ across regimes. To do so, we replace the country-specific and global explanatory variables in Equation 3.4 with their interaction with the probabilities of being in regime s in period t stemming from the SWARCH model:

Equation 3.5

$$embig_{it} = \sum_{s=1}^{k_s} p_{st}\, \gamma'_{1s} X_{it-1} + \sum_{s=1}^{k_s} p_{st}\, \gamma'_{2s} Z_t + \mu_i + \varepsilon_{it}$$

where γ_{1s} and γ_{2s} denote $(k_1 \times 1)$ and $(k_2 \times 1)$ vectors of coefficients, respectively, under regime s, p_{st} is the probability that VIX is in regime s in period t, while $k_s = 3$ is the number of regimes.[30]

[30] The *IMF* [2013] also used the interaction of the probability that the VIX is in the high-volatility regime with several explanatory variables. In contrast with this, we introduced the interactions of the regime probabilities with each regressor, therefore the coefficient of each explanatory variable in any period can

(continued…)

Before estimating Equation 3.4 and Equation 3.5, we first test whether the variables are stationary. We run the Im-Pesarad-Shin and the Fisher-type augmented Dickey-Fuller test for the EMBIG spread and the explanatory variables from both equations, i.e. the unit root tests are applied for the interaction between the explanatory variables and regime probabilities in the case of Equation 3.5. Both tests reject the null hypothesis that all panels contain unit roots for the EMBIG spread and each country-specific explanatory variable including both fundamentals and their interaction with regime probabilities except for current account balance and international reserves. Although in the latter case the null hypothesis is not rejected for fundamentals as contained by Equation 3.4, their interaction with regime probabilities is found to be stationary. As regards global factors, VIX is found to be stationary, while the results are mixed for the U.S. Federal funds rate and the 10-year U.S. Treasury yield. When applying the cointegration test developed by *Westerlund* [2008], however, we find that there is no cointegrating relationship among these variables. As *Phillips and Moon* [2000] show, the pooled regression of two nonstationary variables that are not cointegrated is not spurious but yields consistent estimates of the long-run average regression coefficient as N and T become large. Therefore, we proceed with the fixed effects estimation[31].

3.5. Estimation Results[32]

3.5.1. Identification of Regimes

The first step of our analysis includes the splitting of the sample into periods characterized by a different degree of volatility in financial markets. Following *González-Hermosillo and Hesse* [2009], we estimate a SWARCH model on the first

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be calculated as the weighted average of the regime-specific coefficients with the weights being the regime probabilities in the given period.

[31] The Hausman test rejected the random effects model in each specification.

[32] The Markov-switching ARCH model and the fixed effects panel regression were estimated in RATS and Stata, respectively.

differences of VIX between 2004 and 2012 that yields three regimes characterized by low, medium and high volatility in markets (**Figure 3-1**)[33]:

- The *low-volatility regime* has the highest probability in four periods: (i) in the pre-crisis period (before August 2007) that was characterized by abundant liquidity conditions and low risk aversion in global financial markets; (ii) between the middle of 2009 and the spring of 2010 when global sentiment improved substantially as compared to the short period following the fall of Lehman, possibly due to initial successes of some countries in reducing their macroeconomic imbalances and vulnerabilities, and the commitment of developed countries to handle the crisis; (iii) between the middle of 2010 and 2011 when global risk aversion moderated likely due to that the IMF/EU program in Greece, Ireland and Portugal boosted market confidence at the beginning; (iv) in the spring of 2012 when global market sentiment improved again as the ECB launched the second three-year longer-term refinancing operation that was followed by further liquidity-enhancing measures by central banks in the developed world and decreasing worries about the Euro Area debt crisis related to the outcome of the Greek elections, Spain requesting an external financial aid, the ruling of the German constitutional court about the European Stability Mechanism or the announcement of the Outright Monetary Transactions (OMT) program by the ECB.
- The *medium-volatility regime* had the highest probability in the following periods: (i) between August 2007 and August 2008 when global risk aversion increased at the onset of the crisis but did not reach an exceptionally high level until the fall of Lehman; (ii) at the end of 2008 when there was a temporary improvement in market conditions following the Lehman-default; (iii) in the first half of 2009 when market conditions moderated gradually; (iv) in the short period in the middle of 2010 when concerns about the Euro Area increased with Greece requesting an IMF-EU program, following a relatively long period of

[33] For a comprehensive analysis of global market conditions, see *González-Hermosillo and Hesse* [2009] who estimated the probability of low-, medium- and high-volatility states using euro-U.S. dollar Forex swaps, VIX and 3-month TED spread.

favorable market sentiment; (v) between the fall of 2011 and the spring of 2012 when worries about the Euro Area increased again related to specific events such as the Greek debt restructuring and elections.

- The *high-volatility regime* had probability close to 1 in three short periods. Global risk aversion reached an exceptionally high degree after the collapse of Lehman at the end of 2008, at the beginning of the Greek IMF-EU program in the middle of 2010, and reflecting renewed worries about the Euro Area in the summer of 2011.

Figure 3-1. Probability of low-, medium- and high-volatility regimes

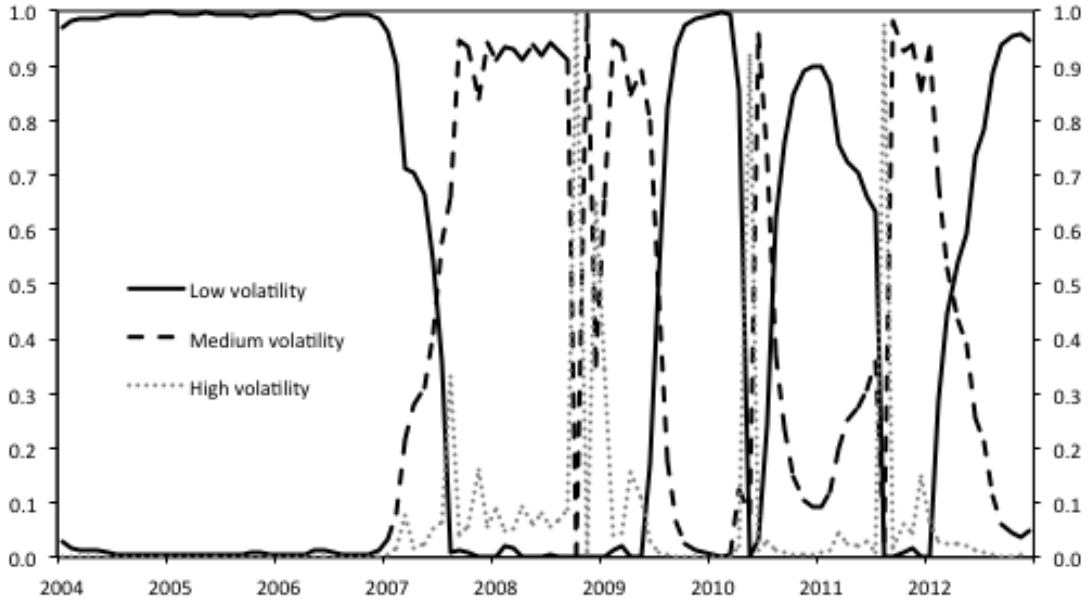


Table 3-3 shows the descriptive statistics of the variables in each regime. In line with our expectations, the high-volatility regime is associated with the highest average level of EMBIG spreads, the lowest growth rate and current account balance, and the highest inflation and gross external debt. As these country-specific indicators are CE forecasts with the exception of gross external debt, this possibly reflects that investors quickly revise their expectations downward when international sentiment deteriorates. CE forecasts also have higher standard deviation during higher-volatility periods that may reflect both larger differences in fundamentals across countries and more rapid revision of forecasts of analysts with the latter capturing increasing uncertainty. Similarly to EMBIG spreads, average VIX also increases in high-volatility regimes, while the U.S. Federal funds rate and the U.S. 10-year Treasury yield decline on

average when there is a switch from low- to middle- and from middle- to high-volatility regime, possibly reflecting the response of monetary policy to worsening global environment and the 'flight to quality' phenomenon. The table also reveals the lower variation of the U.S. Federal funds rate and the U.S. 10-year Treasury yield in high-volatility periods in terms of both standard deviation and the range of rates. Again, this could reflect that almost each high-volatility period is characterized by zero policy rate and the 'flight to quality' behavior of investors. Table 3-4 shows that the correlation between EMBIG spreads and VIX increases in medium- and high-volatility regimes, while the correlation with the U.S. Federal funds rate becomes insignificant in the high-volatility regime, possibly reflecting the low variation of the U.S. policy rate during these periods.

Table 3-3. Descriptive Statistics: Differences Across Regimes

Variable	Mean			Standard deviation			Min			Max		
	L	M	H	L	M	H	L	M	H	L	M	H
EMBI Global spread (percentage point)	2.44	3.78	5.36	2.14	3.88	5.09	0.14	0.60	0.37	12.22	31.58	25.81
Consensus Economics Forecasts												
Real GDP growth (percent, y/y)	4.62	4.11	3.86	1.90	2.68	2.24	-4.74	-6.32	-2.86	10.09	10.85	9.82
CPI (percent, y/y)	6.17	6.94	7.46	5.38	6.35	7.00	0.87	0.43	1.68	35.21	36.75	35.40
Current account balance (percent of GDP)	0.33	-0.74	-1.18	4.81	5.88	6.45	-14.00	-20.90	-20.91	13.94	15.18	14.78
Actual Fundamentals												
Public debt (percent of GDP)	40.45	36.21	36.80	18.71	18.76	19.35	4.44	3.89	4.75	81.84	81.48	81.52
Gross external debt (percent of GDP)	42.59	42.82	45.28	30.28	36.21	39.90	4.49	4.48	5.42	195.94	196.76	192.88
International reserves (percent of GDP)	19.10	20.20	20.45	12.13	13.21	12.57	1.77	1.97	2.26	57.85	56.22	46.94
Global Factors												
VIX Index	16.25	28.39	45.14	4.01	10.23	13.98	10.82	16.17	31.93	26.16	62.64	61.18
U.S. Federal funds rate (percent)	2.06	1.62	0.27	2.06	1.81	0.24	0.09	0.07	0.12	5.28	5.25	0.63
10-year U.S. Treasury yield (percent)	3.78	3.31	2.96	1.00	0.91	0.74	1.50	1.93	2.29	5.10	4.99	3.78

Note: L, M and H stand for low-, medium- and high-volatility regime, respectively. A period is classified as regime *s* if the probability of being in regime *s* is the highest in the given period.

Table 3-4. Pairwise Correlations: Differences Across Regimes

	embig	growth	cpi	ca	pubdebt	extdebt	reserves	vix	us_ffr	us10y
embig	1.00									
	1.00									
	1.00									
growth	-0.42 ***	1.00								
	-0.46 ***	1.00								
	-0.39 ***	1.00								
cpi	0.71 ***	-0.19 ***	1.00							
	0.61 ***	-0.15 ***	1.00							
	0.72 ***	-0.32 ***	1.00							
ca	0.07 **	0.29 ***	0.25 ***	1.00						
	-0.11 **	0.22 ***	0.07 *	1.00						
	-0.23 *	0.24 *	0.08	1.00						
pubdebt	0.21 ***	-0.29 ***	0.00	-0.12 ***	1.00					
	0.07 *	-0.27 ***	-0.15 ***	-0.05	1.00					
	-0.04	-0.19	-0.16	-0.01	1.00					
extdebt	0.09 ***	-0.45 ***	-0.07 **	-0.29 ***	0.29 ***	1.00				
	0.09 **	-0.40 ***	-0.08 *	-0.40 ***	0.29 ***	1.00				
	0.02	-0.40 ***	-0.12	-0.40 ***	0.30 **	1.00				
reserves	-0.31 ***	0.26 ***	-0.28 ***	0.39 ***	-0.19 ***	0.28 ***	1.00			
	-0.25 ***	0.26 ***	-0.29 ***	0.34 ***	-0.18 ***	0.26 ***	1.00			
	-0.30 **	0.35 ***	-0.33 ***	0.29 **	-0.15	0.27 **	1.00			
vix	0.29 ***	-0.39 ***	0.04	-0.06 **	-0.04	0.09 ***	0.09 ***	1.00		
	0.40 ***	-0.39 ***	0.04	-0.09 **	-0.01	0.06	0.00	1.00		
	0.38 ***	-0.17	0.13	-0.20 *	-0.11	0.02	-0.04	1.00		
us_ffr	-0.33 ***	0.31 ***	-0.05 *	0.05 *	-0.03	-0.11 ***	-0.08 ***	-0.74 ***	1.00	
	-0.34 ***	0.46 ***	-0.04	0.03	-0.06	-0.09 **	-0.03	-0.45 ***	1.00	
	0.13	0.11	0.09	-0.10	-0.06	0.03	-0.03	0.70 ***	1.00	
us10y	-0.26 ***	0.26 ***	-0.02	0.08 ***	0.02	-0.10 ***	-0.09 ***	-0.54 ***	0.76 ***	1.00
	-0.27 ***	0.32 ***	0.02	-0.01	-0.08 *	-0.08 *	-0.04	-0.27 ***	0.84 ***	1.00
	-0.01	0.14	0.05	-0.01	-0.03	0.04	-0.03	0.32 ***	0.84 ***	1.00

Note: The first, second and third rows show correlations during low-, medium- and high-volatility regimes, respectively. *, ** and *** indicate significance at the 10, 5 and 1 percent level, respectively.

We also analyze whether the average cross-country correlation of the first differences of EMBIG spreads differs across low-, medium- and high-volatility regimes, with the aim of understanding whether countries can decouple from other emerging markets during crisis times. Table 3-5 and **Figure 3-2** reveal several interesting phenomena. First, each cross-country correlation of spreads is positive in every regime. Second, average correlation increases in medium- and high-volatility regimes. Specifically, it rises from 0.46 in low-volatility periods to 0.64 and 0.89 in medium- and high-volatility regimes, respectively. These results indicate that emerging market bond spreads tend to move together in each period, albeit to a different extent across regimes characterized by low, medium and high volatility. Finally, there are some regional differences in the co-movement of spreads, with average correlation being the highest in Latin America in each regime.

Overall, the results show that cross-country correlations between spreads increase substantially during higher-volatility periods, possibly reflecting decreasing differentiation across countries by investors.[34] The results suggest that emerging market bond spreads are mainly driven by external factors during periods of distress, thus they can only partially decouple from their peer countries when global sentiment deteriorates. For policymakers, these findings indicate the importance of building buffers during tranquil times, as emerging markets could not fully decouple from their peers in periods of distress that could possibly result in unfavorable financing conditions in the case of an adverse shift in market sentiment. For investors, the main implication is that an unconditional asset allocation may not prove appropriate during high-volatility periods. As these periods are typically characterized by bear markets (**Figure 3-3**), gains from diversification decrease when this is the least desirable.

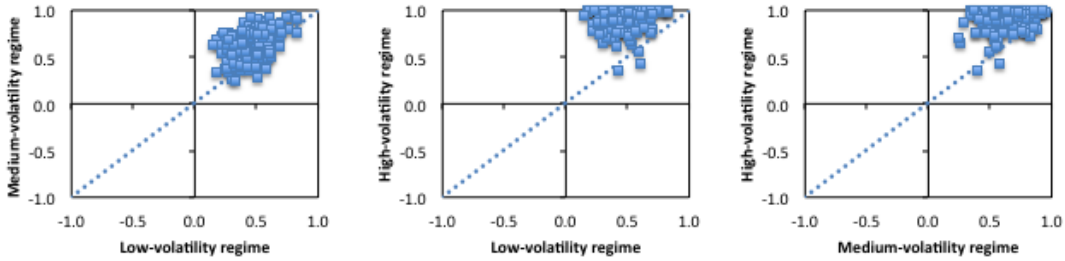
Table 3-5. Correlations between EMBIG spreads

	Mean	Min	Max
Low volatility	0.46	0.15	0.83
Asia	0.39	0.15	0.64
CEE	0.49	0.25	0.70
Latin Ameri	0.55	0.34	0.83
Medium volatil	0.64	0.24	0.95
Asia	0.66	0.51	0.83
CEE	0.57	0.24	0.88
Latin Ameri	0.71	0.43	0.95
High volatility	0.89	0.35	1.00
Asia	0.92	0.84	1.00
CEE	0.77	0.35	1.00
Latin Ameri	0.97	0.92	1.00

Note: The table shows cross-country correlations between EMBIG spreads during each regime and in each region.

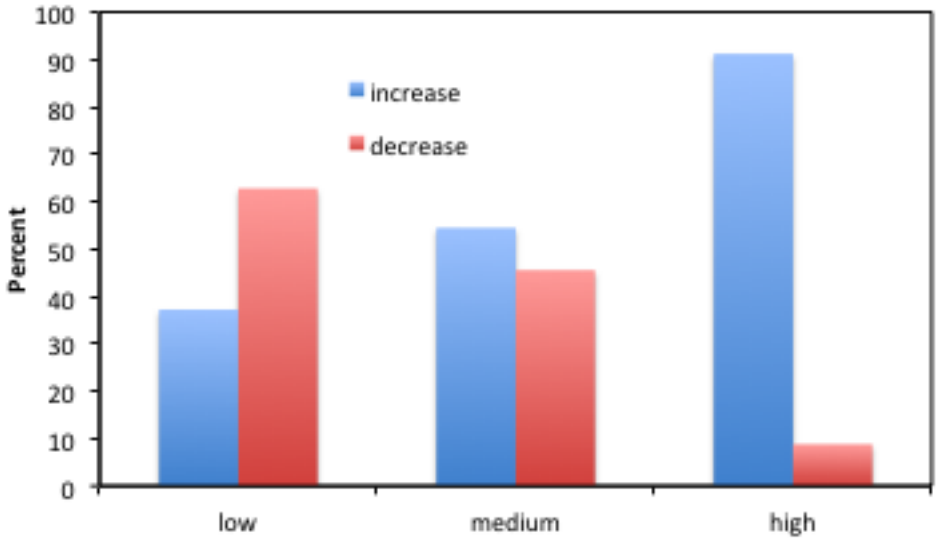
[34] The result that the cross-country correlation of financial markets increases in high-volatility periods is in line with the literature (for example, see *Edwards* [1998]). As the primary goal of our paper is to analyze the relationship between spreads, macroeconomic fundamentals and global market conditions, it does not aim at understanding whether the increasing cross-country correlation of spreads in certain periods reflects „monsoonal" or common shocks, spillovers through macroeconomic linkages or contagion (see *Masson* [1999]).

Figure 3-2. Correlations between EMBIG spreads in each regime



Note: The figure shows cross-country correlations of EMBIG spreads. Points above the 45-degree line shows correlations that are higher in the higher-volatility regime.

Figure 3-3. Monthly changes of EMBIG spreads during low-, medium- and high-volatility periods



3.5.2. Fixed Effects Estimation

The estimation of Equation 3.4 and Equation 3.5 shows that while country-specific fundamentals are important determinants of spreads in each regime and specification, albeit with different magnitude and significance across regimes, both the significance and sign of the coefficients of global factors increases during high-volatility periods as compared to the low- and the medium-volatility regime of the switching regression as well as the non-switching model (Table 3-6). In general, worse country-specific fundamentals, higher global risk aversion and lower long-term U.S. Treasury yields are associated with higher spreads, while the sign of the impact of the U.S. Federal funds rate differs across regimes.

Although country-specific fundamentals have an important role in explaining spreads in each regime, the significance and sign of their coefficients differ between the non-switching and switching specification as well as across regimes. As regards

forward-looking country-specific variables, real GDP growth and inflation are significant drivers of spreads in each regime of the switching model and in the non-switching regression as well, while current account is significant only in the high-volatility regime. Real GDP growth forecast has a negative coefficient, i.e. higher growth is associated with lower spreads as better growth outlook improves debt sustainability. Inflation expectations are positively related to spreads, possibly reflecting that domestic investors require compensation for higher inflation, while international investors consider countries with higher inflation riskier. The coefficients of both real GDP growth and inflation are the highest in the high-volatility regime possibly due to that investors pay more attention to changing expectations about fundamentals when global risk aversion is high. The current account forecast is significant with negative coefficient only during periods of distress, implying that countries could benefit from decreasing external imbalances during crisis times.

The role of actual country-specific fundamentals also shows some variation across regimes. Public debt has a significantly positive coefficient in the same magnitude in each regime and specification. We also checked whether fiscal balance is a significant driver of spreads. As it was not found to be significant either when it complemented public debt as an additional fiscal variable or when it replaced public debt in the regression, it was finally excluded from the model. External debt has a positive relationship with spreads in line with our prior expectations, albeit not significantly in the high volatility regime. International reserves have a significantly negative coefficient in the non-switching regression and in the low-volatility regime, suggesting that higher reserve coverage could lower spreads during tranquil times.

The significance of global factors differs across regimes as well as between the two specifications. The estimation results suggest that the importance of global factors in terms of their significance increases in the high-volatility regime. The VIX is positively associated with spreads in each column: increasing global risk aversion leads to higher spreads. However, its coefficient is not significant in the low-volatility regime. This possibly reflects that the variation of VIX is low (Table 3-3) and that the decisions of investors are rather driven by country-specific fundamentals during tranquil periods. In line with our prior expectation, the coefficient of VIX increases in the medium-volatility regime and is the highest during high-volatility periods, indicating the increase of the exposure of spreads to changes in global risk aversion in periods of distress. The U.S. Federal funds rate has a weakly significant negative coefficient and a strongly

significant positive impact on spreads in tranquil and crisis times, respectively, possibly reflecting that monetary easing leads to higher spreads through its impact on global growth and inflation outlook during tranquil periods, while it results in lower spreads through its effect on liquidity conditions during crisis periods. The 10-year U.S. Treasury yield has a significant negative coefficient in the medium- and high-volatility regimes. The negative relationship could reflect two phenomena. First, it could be related to demand and supply conditions in non-crisis periods: low U.S. interest rates create an attractive environment for emerging markets to increase bond issuance with the resulting excess supply of bonds leading to higher spreads (*Eichengreen and Mody* [1998]). Second, the negative sign could reflect the 'flight-to-quality' phenomenon in crisis periods, i.e. investors shift their demand from emerging market debt securities toward U.S. government securities when global risk aversion is high.

Table 3-6. Fixed Effects Estimation Results
(2004-2012, dependent variable: EMBIG spread)

	Non-switching	Switching		
		Low volatility	Medium volatility	High volatility
Consensus Economics Forecasts				
real gdp growth (-1)	-0.3957 ***	-0.4278 ***	-0.4602 ***	-0.5320 **
	(0.1030)	(0.0879)	(0.1169)	(0.2053)
cpi (-1)	0.3787 ***	0.2841 ***	0.4243 ***	0.5684 ***
	(0.0716)	(0.0506)	(0.0742)	(0.1250)
current account (-1)	-0.0769	-0.0188	-0.0730	-0.2096 ***
	(0.0488)	(0.0270)	(0.0534)	(0.0633)
Actual Fundamentals				
public debt (-1)	0.0470 ***	0.0430 ***	0.0520 ***	0.0471 **
	(0.0112)	(0.0116)	(0.0128)	(0.0184)
external debt (-1)	0.0222 ***	0.0192 ***	0.0154 *	0.0032
	(0.0057)	(0.0061)	(0.0088)	(0.0097)
reserves (-1)	-0.0605 ***	-0.0475 **	-0.0288	-0.0102
	(0.0145)	(0.0112)	(0.0197)	(0.0230)
Global Factors				
vix	0.0848 ***	0.0096	0.0847 ***	0.1062 ***
	(0.0060)	(0.0221)	(0.0116)	(0.0119)
us federal funds rate	0.1093	-0.1004 *	0.2644	0.8344 ***
	(0.0781)	(0.0541)	(0.1611)	(0.2217)
10y us treasury yield	-0.3794 **	-0.0032	-0.9047 ***	-1.4938 ***
	(0.1499)	(0.1024)	(0.2721)	(0.2683)
constant	0.0152	0.9618		
	(0.6379)	(0.6167)		
R-squared	0.5056		0.5615	
Number of observations	1,796		1,796	

Note: *, ** and *** indicate significance at the 10, 5 and 1 percent level, respectively. Driscoll-Kraay robust standard errors are in parenthesis. As the LM test developed by *Breusch and Pagan* [1980] suggests the presence of error cross-sectional dependence, we estimated the regressions with *Driscoll and Kraay* [1998] standard errors that are robust to heteroskedasticity, serial correlation and cross-sectional dependence. The non-switching column shows estimation results for Equation 3.4, while the switching columns contain the results for Equation 3.5.
Source: author's calculations

3.6. Forecasting Performance

Although the in-sample performance of the switching model is better than that of the non-switching regression, we also compare their out-of-sample forecasting performance using the Diebold-Mariano test[35].

[35] An important advantage of the test developed by *Diebold and Mariano* [1995] is that it does not require the forecast errors to be normally distributed. Under the null hypothesis of equal prediction accuracy of

(continued…)

Based on the estimation results of Equation 3.4 and Equation 3.5 between 2004 and 2011 (**Table A 3.3**), we compare the forecast accuracy of the non-switching and switching models for each country in 2012[36]. The results of the Diebold-Mariano test suggest that the overall out-of-sample forecast performance of the switching regression is slightly better than that of the non-switching specification. While the non-switching regression has better forecast accuracy in five countries with the difference being significant in only three of them, the switching model is more accurate in nine countries, albeit not significantly in four of them (**Table 3-7**)[37]. Specifically, the switching regression outperforms the non-switching model in Latin America and in more than half of Asian countries, while the forecast accuracy of the models is broadly similar in the CEE region with the switching regression having better forecast performance in Bulgaria, Hungary and Poland and the non-switching specification in Russia, Turkey and Ukraine. The latter could indicate that the heterogeneity of the CEE region with at least two groups according to the behavior of their sovereign bond spreads.

In general, the results of the test suggest that the switching regression has a slightly better forecast accuracy in 2012, implying that ignoring regime shifts in market sentiment and the different relationship between emerging market sovereign spreads and their determinants across regimes results in less accurate forecasts of spreads. The results could be attributed to the fact that the forecast accuracy of the models was compared in 2012 when market sentiment showed two distinct periods. The first half of 2012 was characterized by high global risk aversion thanks to increasing worries about the Euro Area debt crisis. In the second half of the year, market sentiment improved substantially reflecting the positive impact of liquidity-enhancing measures by major

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two models, the mean loss $\bar{d} = \sum_{i=1}^{n}[g(e_{1i}) - g(e_{2i})]/n$ equals zero where $g(e_{ji})$ shows the loss from the forecast error in period $i = 1, \dots, n$ by model $j = 1,2$. As $\bar{d}$ has a normal distribution according to the central limit theorem, one could estimate the variance of $\bar{d}$ and test the null hypothesis by comparing $\bar{d}/var(\bar{d})$ to a t-statistic with $n - 1$ degrees of freedom.

[36] Out of 17 countries we test the forecasting performance of the two models for 14 countries. We do not forecast spreads for China, Pakistan and Venezuela due to the absence of some explanatory variables in 2012.

[37] The calculations assume that regime probabilities are known for the forecast period of 2012.

central banks and positive developments about the Euro Area debt crisis such as the final outcome of the Greek elections, Spain requesting an external financial aid, the announcement of the Outright Monetary Transactions program by the European Central Bank and the ruling of the German constitutional court regarding the European Stability Mechanism. Intuitively, a model that allows the relationship of spreads with country-specific and global factors to differ across these periods is expected to outperform a model with constant coefficients of the determinants of spreads. As the above-described market-related events support the finding of the SWARCH model that there was a shift from the medium- to the low-volatility regime in the middle of 2012, the switching regression seems more accurate for explaining spreads as compared to the non-switching specification. As summarized above, this is confirmed formally by the results of the Diebold-Mariano test.

Table 3-7. Comparison of the Forecasting Performance of Switching and Non-switching Regression for 2012

	Better forecast accuracy	Diebold-Mariano test		Mean Squared Error		
		Test statistic	p-value	SW	NO SW	difference
Brazil	SW	-0.720	0.472	1.483	1.822	-0.339
Bulgaria	SW	-1.431	0.152	0.878	1.032	-0.154
Chile	SW	-5.647	0.000	0.117	0.589	-0.472
Colombia	SW	-3.635	0.000	0.146	0.455	-0.310
Hungary	SW	-2.525	0.012	4.709	7.031	-2.322
Indonesia	NO SW	2.409	0.016	0.689	0.458	0.231
Malaysia	SW	-1.220	0.223	0.071	0.298	-0.227
Mexico	SW	-1.185	0.236	0.017	0.051	-0.033
Peru	NO SW	1.296	0.195	0.055	0.026	0.028
Philippines	SW	-2.268	0.023	0.221	0.381	-0.160
Poland	SW	-2.119	0.034	0.215	0.581	-0.366
Russia	NO SW	2.316	0.021	0.691	0.286	0.405
Turkey	NO SW	0.537	0.591	0.289	0.210	0.080
Ukraine	NO SW	4.880	0.000	9.489	5.463	4.026

Note: The comparison of 2012 forecasting performance was based on estimation results for the period 2004-2011. SW and NO SW stand for switching and non-switching regression (three-regime and full sample estimations as contained by **Table 3-6**), respectively.
Source: author's calculations

3.7. Policy Implications

In order to assess the exposure of spreads to shifts in market sentiment, we compare regime-specific average fitted spreads. Average fitted spreads are calculated using average country-specific fundamentals on the whole sample, regime-specific

average global factors and regime-specific coefficients from **Table 3-6**.[38] As such, we apply the simplifying assumption that country-specific fundamentals are unaffected by shifts in global risk aversion. Although emerging markets are not expected to be able to fully decouple from global developments in reality, i.e. policymakers do not have a full control over the fundamentals of their countries, the assumption aims at demonstrating the impact on spreads of factors that are exogenous to policymakers such as global conditions and the regime-specific relationship between spreads and their determinants. The results show that spreads in countries with strong fundamentals change only slightly in the case of an adverse shift in market sentiment, whereas spreads in countries with weak fundamentals might increase substantially in the case of a shift from the low- to the medium- or high-volatility regime.

Table 3-8 shows that estimated spreads increase by around 120 and 220 basis points when there is a shift from low- to medium- and high-volatility regime, respectively, in a country with average fundamentals. The increase is driven by the combination of deteriorating global conditions and changing coefficients of the determinants of spreads at the time of the regime shift, i.e. in the case of an adverse shift in global market sentiment, spreads rise due to changing risk assessment of fundamentals by investors and worsening global factors both of which are developments that cannot be controlled by domestic policymakers. However, the same estimation performed on countries with strong and weak fundamentals reveals the importance of conducting sound macroeconomic policies that lead to improving fundamentals. While the increase in spreads rises to around 220 and 420 basis points when moving from low- to medium- and high-volatility regimes, respectively, in countries with weak fundamentals, fitted spreads are broadly the same across regimes in strong countries. The latter is due to that the impact on spreads of unfavorable global developments is offset by the increasing coefficients of some country-specific factors such as real GDP growth or current account balance, i.e. the favorable impact on spreads of strong fundamentals increases in periods of distress thereby neutralizing the increasing negative effect of global conditions.

[38] Fitted spreads are thus calculated as follows: $\widehat{embig}_s = \gamma'_{1s}\bar{X} + \gamma'_{2s}\overline{Z_s}$, where $\widehat{embig}_s$, $\bar{X}$ and $\overline{Z_s}$ stand for fitted average spread in regime s, average fundamentals on the whole sample and average global factors in regime s, respectively, while γ'_{1s} and γ'_{2s} are the estimated coefficients from **Table 3-6**.

Summing up, while countries with weak fundamentals could experience sharp increases in sovereign bond spreads when there is a shift from low- to medium- or high-volatility regimes, strong fundamentals make sovereign bond spreads less vulnerable to regime shifts in global market sentiment. This is the result of the higher coefficient of some country-specific factors in high-volatility regimes offsetting the effect on spreads of the combination of deteriorating global conditions and changing relationship of spreads with global conditions. This possibly suggests that while country-specific fundamentals might be "overlooked" by investors in tranquil periods, markets appreciate strong fundamentals when global risk aversion is high as reflected in the changing coefficient and thus contribution of fundamentals to spreads.

Table 3-8. Fitted spreads of an "average country" in each regime[39]

	Fitted spreads			Difference between regimes		
	Low volatility	Medium volatility	High volatility	Medium-Low	High-Low	High-Medium
Average fundamentals	2.40	3.62	4.64	1.21	2.24	1.02
Weak fundamentals	7.10	9.29	11.28	2.19	4.19	2.00
Strong fundamentals	-2.29	-2.05	-2.00	0.24	0.28	0.04

Note: Strong/weak fundamentals are calculated as average fundamentals plus/minus one standard deviation on the whole sample (strong fundamentals are calculated as average growth, current account balance, fiscal balance and reserves plus one standard deviation, and average inflation, public debt and external debt minus one standard deviation).
Source: author's calculations

3.8. Conclusions

After the identification of low-, medium- and high-volatility regimes, we analyzed the behavior of spreads from three different angles. First, in line with the literature, we found that cross-country correlations of EMBIG spreads increase substantially during medium- and high-volatility periods as compared to the low-volatility regime. This possibly suggests that emerging market bond spreads are mainly driven by external factors during periods of distress, thus they can only partially decouple from their peer countries when global sentiment deteriorates.

[39] Negative values are due to the fact that spreads are calculated for a hypothetical country, using the estimated coefficients of determinants.

Second, using the interactions of the regime probabilities with several country-specific and global variables as the determinants of spreads, our panel estimations showed that the role of both country-specific fundamentals and global factors differs across low-, medium- and high-volatility regimes. We found that while country-specific fundamentals are important determinants of spreads in each regime, albeit at different significance level and with a different size of coefficient, the importance of global factors increases during high-volatility periods. We also showed that the switching regression slightly outperforms the non-switching model in terms of both the in-sample explanatory power and the out-of-sample forecast accuracy.

Finally, we found that sound macroeconomic policies and strong fundamentals reduce the exposure of spreads to adverse shifts in global risk aversion. Specifically, based on the panel estimation results we showed that while a shift from low- to medium- and high-volatility regimes results in the substantial increase of fitted spreads of countries with weak fundamentals, the increase is much less pronounced in countries with stronger fundamentals.

Appendix

Table A 3.1. Country-specific Descriptive Statistics

	EMBI Global spread			Real GDP growth			CPI			Current account bal.			Public debt			Fiscal balance			Gross external debt			International reserves		
	Mean	Std. Dev.	Freq.	Mean	Std. Dev.	Freq.	Mean	Std. Dev.	Freq.	Mean	Std. Dev.	Freq.	Mean	Std. Dev.	Freq.	Mean	Std. Dev.	Freq.	Mean	Std. Dev.	Freq.	Mean	Std. Dev.	Freq.
Brazil	2.81	1.28	108	3.75	0.97	108	4.99	0.73	108	-0.96	1.43	108	67.08	2.62	108	-2.88	0.66	108	20.15	6.54	108	11.28	3.49	108
Bulgaria	1.98	1.37	108	3.51	2.18	108	4.54	1.58	108	-9.04	5.56	108	22.58	9.34	108	0.70	2.33	108	88.54	17.53	108	31.79	3.09	108
Chile	1.31	0.68	108	4.69	1.19	108	3.18	0.76	108	-0.25	1.59	108	7.62	2.69	108	2.58	3.33	108	37.74	5.37	108	13.50	2.46	108
China	1.15	0.68	108	8.92	0.81	108	3.10	1.10	108	4.44	2.14	108	20.75	4.64	108	-1.29	0.90	108	10.51	1.65	96	40.40	6.20	108
Colombia	2.48	1.13	108	4.10	1.09	108	4.34	0.76	108	-2.12	0.68	108	36.55	3.72	108	-1.40	0.99	108	23.83	4.55	108	9.86	0.66	108
Hungary	2.14	1.80	108	1.85	2.01	108	4.34	1.11	108	-3.65	3.39	108	71.08	8.57	108	-4.65	3.31	108	132.18	41.30	108	24.83	9.49	108
Indonesia	2.90	1.52	104	5.56	0.68	108	6.69	1.61	108	1.01	0.76	108	36.67	11.13	108	-0.64	0.63	108	36.86	10.59	108	12.44	1.21	108
Malaysia	1.37	0.69	108	4.86	1.36	108	2.52	0.64	108	11.12	1.80	108	47.11	5.48	108	-3.85	0.94	108	36.36	4.83	108	47.84	4.90	108
Mexico	1.93	0.74	108	3.03	1.43	108	3.89	0.35	108	-1.31	0.44	108	41.80	2.23	108	-2.38	1.35	108	5.49	0.77	108	2.47	0.48	108
Pakistan	6.56	4.86	105	4.89	1.13	108	8.50	2.29	108	-3.24	2.93	108	61.70	3.60	108	-4.88	2.11	108	34.09	3.81	96	8.66	2.08	108
Peru	2.24	0.95	108	5.37	1.06	108	2.66	0.57	108	-0.94	1.45	108	30.87	7.89	108	0.64	1.56	108	31.21	6.68	108	22.80	4.81	108
Philippines	2.80	1.15	108	4.60	0.87	108	4.91	1.17	108	2.57	0.69	108	49.88	8.85	108	-1.42	1.09	108	44.04	14.98	108	20.91	5.23	108
Poland	1.31	0.81	108	3.91	1.35	108	2.78	0.60	108	-3.01	1.26	108	49.58	3.96	108	-4.85	1.66	108	55.84	10.37	108	16.01	2.88	108
Russia	2.42	1.42	108	4.83	2.01	108	8.85	1.70	108	4.47	2.09	108	12.83	5.53	108	2.86	4.49	108	33.24	2.84	108	27.18	5.42	108
Turkey	2.86	0.94	108	4.12	1.81	108	7.90	1.59	108	-5.01	1.83	108	46.37	8.09	108	-2.43	2.15	108	40.41	3.36	108	10.92	1.12	108
Ukraine	5.96	5.84	108	4.09	3.26	108	10.69	3.05	108	-1.41	3.84	108	26.29	9.68	108	-3.44	1.47	108	64.50	17.19	108	19.94	3.23	108
Venezuela	7.76	4.21	108	3.53	2.60	108	25.63	6.65	108	6.80	2.65	108	35.92	10.01	108	-4.79	6.29	108	25.45	8.39	96	10.13	6.37	108
Total	2.93	2.99	1,829	4.45	2.18	1,836	6.44	5.75	1,836	-0.03	5.23	1,836	39.10	18.84	1,836	-1.89	3.50	1,836	42.76	32.47	1,800	19.47	12.47	1,836

Source: J.P. Morgan, IMF WEO, IFS, World Bank, Bloomberg, Fed, author's calculations

Table A 3.2. Pairwise correlations between EMBIG spreads

	Brazil	Bulgaria	Chile	China	Colombia	Hungary	Indonesia	Malaysia	Mexico	Pakistan	Peru	Philippines	Poland	Russia	Turkey	Ukraine	Venezuela
Brazil	1.00																
	1.00																
	1.00																
Bulgaria	0.35 ***	1.00															
	0.57 ***	1.00															
	0.91 *	1.00															
Chile	0.33 ***	0.57 ***	1.00														
	0.43 **	0.42 **	1.00														
	0.99 ***	0.92 *	1.00														
China	0.21 *	0.59 ***	0.49 ***	1.00													
	0.73 ***	0.49 ***	0.52 ***	1.00													
	0.85	0.56	0.82	1.00													
Colombia	0.82 ***	0.41 ***	0.39 ***	0.29 **	1.00												
	0.91 ***	0.67 ***	0.52 ***	0.61 ***	1.00												
	0.99 ***	0.93 *	0.99 ***	0.82	1.00												
Hungary	0.17	0.62 ***	0.32 ***	0.60 ***	0.24 **	1.00											
	0.34 *	0.50 ***	0.53 ***	0.69 ***	0.37 **	1.00											
	0.99 ***	0.88	0.99 ***	0.87	0.99 ***	1.00											
Indonesia	0.55 ***	0.60 ***	0.48 ***	0.39 ***	0.56 ***	0.34 ***	1.00										
	0.77 ***	0.72 ***	0.62 ***	0.54 ***	0.87 ***	0.44 **	1.00										
	0.99 ***	0.91 *	0.99 ***	0.84	0.99 ***	0.99 ***	1.00										
Malaysia	0.49 ***	0.46 ***	0.62 ***	0.37 ***	0.49 ***	0.18	0.47 ***	1.00									
	0.51 ***	0.86 ***	0.69 ***	0.50 ***	0.64 ***	0.62 ***	0.75 ***	1.00									
	0.98 **	0.91 *	0.99 ***	0.83	0.99 ***	0.99 ***	0.99 ***	1.00									
Mexico	0.58 ***	0.46 ***	0.51 ***	0.39 ***	0.73 ***	0.36 ***	0.60 ***	0.55 ***	1.00								
	0.89 ***	0.72 ***	0.49 ***	0.58 ***	0.92 ***	0.36 **	0.92 ***	0.70 ***	1.00								
	0.99 ***	0.92 *	0.99 ***	0.83	0.99 ***	0.99 ***	0.99 ***	0.99 ***	1.00								
Pakistan	0.17	0.56 ***	0.31 ***	0.25 **	0.27 **	0.33 ***	0.40 ***	0.14	0.31 ***	1.00							
	0.68 ***	0.58 ***	0.65 ***	0.57 ***	0.75 ***	0.39 **	0.77 ***	0.63 ***	0.73 ***	1.00							
	0.98 **	0.88	0.97 **	0.84	0.97 **	0.95 **	0.97 **	0.94 *	0.97 **	1.00							
Peru	0.78 ***	0.42 ***	0.46 ***	0.36 ***	0.82 ***	0.27 **	0.45 ***	0.54 ***	0.68 ***	0.22 *	1.00						
	0.94 ***	0.61 ***	0.46 ***	0.73 ***	0.91 ***	0.33 **	0.77 ***	0.55 ***	0.85 ***	0.76 ***	1.00						
	0.98 **	0.92 *	0.97 **	0.79	0.97 **	0.95 **	0.97 **	0.94 *	0.97 **	0.99 ***	1.00						
Philippines	0.40 ***	0.48 ***	0.41 ***	0.46 ***	0.50 ***	0.32 ***	0.64 ***	0.41 ***	0.54 ***	0.30 **	0.44 ***	1.00					
	0.86 ***	0.62 ***	0.52 ***	0.68 ***	0.91 ***	0.39 **	0.82 ***	0.58 ***	0.81 ***	0.73 ***	0.92 ***	1.00					
	0.97 **	0.87	0.96 **	0.83	0.96 **	0.94 *	0.95 **	0.92 *	0.96 **	0.99 ***	0.99 ***	1.00					
Poland	0.26 **	0.68 ***	0.49 ***	0.69 ***	0.36 ***	0.68 ***	0.59 ***	0.49 ***	0.50 ***	0.30 **	0.41 ***	0.50 ***	1.00				
	0.45 **	0.73 ***	0.68 ***	0.60 ***	0.55 ***	0.81 ***	0.61 ***	0.81 ***	0.54 ***	0.51 ***	0.46 ***	0.52 ***	1.00				
	0.85	0.78	0.87	0.76	0.86	0.90 *	0.88	0.92 *	0.87	0.75	0.75	0.71	1.00				
Russia	0.51 ***	0.69 ***	0.47 ***	0.54 ***	0.61 ***	0.57 ***	0.44 ***	0.51 ***	0.62 ***	0.37 ***	0.61 ***	0.44 ***	0.59 ***	1.00			
	0.73 ***	0.87 ***	0.47 ***	0.56 ***	0.78 ***	0.38 **	0.82 ***	0.82 ***	0.85 ***	0.77 ***	0.78 ***	0.73 ***	0.58 ***	1.00			
	0.82	0.78	0.81	0.62	0.81	0.75	0.80	0.73	0.81	0.90 *	0.91 *	0.92 *	0.42	1.00			
Turkey	0.75 ***	0.48 ***	0.44 ***	0.35 ***	0.82 ***	0.25 **	0.64 ***	0.52 ***	0.68 ***	0.30 ***	0.70 ***	0.47 ***	0.42 ***	0.56 ***	1.00		
	0.79 ***	0.63 ***	0.35 **	0.59 ***	0.76 ***	0.37 **	0.79 ***	0.61 ***	0.86 ***	0.62 ***	0.76 ***	0.75 ***	0.48 ***	0.75 ***	1.00		
	0.99 ***	0.87	0.99 ***	0.89	0.98 **	0.99 ***	0.99 ***	0.99 ***	0.99 ***	0.96 **	0.96 **	0.95 **	0.88	0.77	1.00		
Ukraine	0.22 *	0.39 ***	0.49 ***	0.29 **	0.30 ***	0.33 ***	0.47 ***	0.51 ***	0.44 ***	0.41 ***	0.30 ***	0.36 ***	0.43 ***	0.37 ***	0.27 **	1.00	
	0.54 ***	0.53 ***	0.38 **	0.25	0.60 ***	0.24	0.79 ***	0.56 ***	0.77 ***	0.54 ***	0.43 **	0.41 **	0.39 **	0.63 ***	0.68 ***	1.00	
	0.78	0.70	0.76	0.64	0.76	0.71	0.75	0.67	0.76	0.88	0.87	0.90 *	0.35	0.99 ***	0.73	1.00	
Venezuela	0.37 ***	0.41 ***	0.42 ***	0.37 ***	0.38 ***	0.50 ***	0.44 ***	0.25 **	0.44 ***	0.39 ***	0.39 ***	0.37 ***	0.41 ***	0.51 ***	0.38 ***	0.60 ***	1.00
	0.68 ***	0.60 ***	0.59 ***	0.53 ***	0.63 ***	0.28	0.68 ***	0.62 ***	0.69 ***	0.66 ***	0.66 ***	0.63 ***	0.54 ***	0.73 ***	0.64 ***	0.53 ***	1.00
	0.92 *	0.90 *	0.91 *	0.69	0.92 *	0.87	0.91 *	0.86	0.91 *	0.96 **	0.97 **	0.97 **	0.61	0.97 **	0.88	0.94 *	1.00

Note: The first, second and third row show correlations during low-, medium- and high-volatility regimes, respectively.

Table A 3.3. Fixed Effects Estimation Results

(2004-2011, dependent variable: EMBIG spread)

	Non-switching	Switching		
		Low volatility	Medium volatility	High volatility
Consensus Economics Forecasts				
real gdp growth (-1)	-0.3859 ***	-0.4091 ***	-0.4614 ***	-0.4815 **
	(0.1051)	(0.0875)	(0.1291)	(0.2078)
cpi (-1)	0.3880 ***	0.3086 ***	0.4433 ***	0.5965 ***
	(0.0624)	(0.0464)	(0.0666)	(0.1157)
current account (-1)	-0.0991	-0.0237	-0.0807	-0.2063 ***
	(0.0628)	(0.0389)	(0.0608)	(0.0721)
Actual Fundamentals				
public debt (-1)	0.0486 ***	0.0406 ***	0.0499 ***	0.0453 **
	(0.0147)	(0.0149)	(0.0164)	(0.0217)
external debt (-1)	0.0198 ***	0.0169 **	0.0119	0.0059
	(0.0061)	(0.0067)	(0.0086)	(0.0105)
reserves (-1)	-0.0579 ***	-0.0398 ***	-0.0207	-0.0063
	(0.0137)	(0.0103)	(0.0191)	(0.0273)
Global Factors				
vix	0.0851 ***	0.0122	0.0918 ***	0.1052 ***
	(0.0054	(0.0222)	(0.0083)	(0.0103)
us federal funds rate	0.0971	-0.1329 ***	0.2538 *	0.7497 ***
	(0.0811)	(0.0489)	(0.1506)	(0.2156)
10y us treasury yield	-0.3233 *	0.1462	-0.7633 ***	-1.4015 ***
	(0.1650)	(0.1125)	(0.2515)	(0.2764)
constant	-0.2837	0.2049		
	(0.6607)	(0.7424)		
R-squared	0.5126		0.5876	
Number of observations	1,625		1,625	

Source: author's calculations

4. Correlations between emerging market spreads

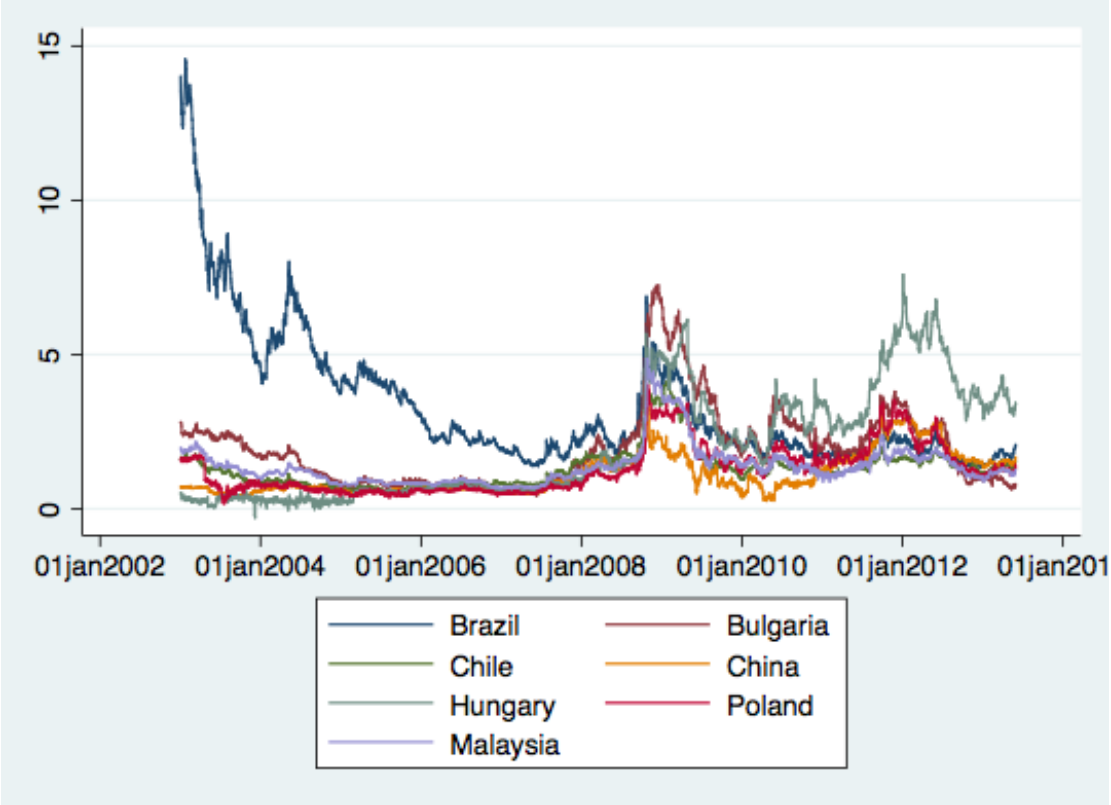
4.1. Introduction

Emerging markets have gone through several crisis episodes in the last two decades such as the Tequila crisis of 1994, the Asian crisis of 1997, the Russian default of 1998, Ecuador defaulting on its Brady bonds in 1999 or the Argentine default of 2001. Although these crisis events differed in terms of the main triggers, each of them was associated with increasing market volatility across emerging markets. For example, the global financial crisis that started in 2008 revealed that emerging market cannot fully decouple from either developed market developments or each other as reflected in the general increase in spreads across countries during turbulent periods (**Figure 4-1**). This – coupled with the increasing reliance of emerging market countries on external bond issuance in the last two decades – increased the interest of both policymakers and investors in understanding the nature of contagion across markets.

The better understanding of the nature of potential spillovers and contagion could help policymakers be better prepared for crisis events, by conducting sound macroeconomic policies that reduce the likelihood and/or size of contagion as well as by building up an appropriate size of buffers. For investors, the analysis of the nature of co-movements is important due to that although investing in a large number of countries could reduce the risk profile of a portfolio consisting of emerging market sovereign bonds given their moderate historical co-movements, cross-country correlations tend to be time-varying. Specifically, during periods of increased correlation, diversification benefits may be eroded, thereby leaving investors exposed to possible adverse shifts in global conditions.

In this chapter, we analyze the time-varying nature of the co-movement of spreads between Hungary and selected emerging market countries by estimating a Dynamic Conditional Correlation (DCC) GARCH model. The remaining part of the chapter is organized as follows. Section 4.2 reviews the literature on the co-movement of financial markets. Section 4.3 and 4.4 describe the data and the estimation methodologies, respectively. Section 4.5 contains the estimation results. Section 4.6 concludes.

Figure 4-1. EMBI Global spreads (percentage point)



Source: J.P. Morgan

4.2. Related Literature

The analysis of the increasing co-movement of financial markets during crisis periods has been the subject of a large number of studies. It has often been attributed to spillovers and contagion observed during several emerging market crisis episodes. One of the most popular methods to assess these phenomena has been the analysis of the timely evolution of cross-country correlations. However, an increase in cross-country co-movements may not indicate the presence of contagion, as it can also be the result of other factors. Specifically, *Masson* [1999] attributed exchange rate variation to three components: (i) 'monsoonal' or common shocks, (ii) spillovers occurring via trade and other macroeconomic linkages, (iii) residual: contagion (a jump between equilibria triggered by a crisis in another market). Similarly, *Baig and Goldfajn* [1999] argue that co-movements are driven by external shocks, spillovers and herd mentality, by testing for evidence of contagion between the financial

markets of five Asian countries in a VAR framework as well as by analyzing their unadjusted and adjusted correlation.

Excess co-movement was first used as a measure of contagion by *Pindyck and Rotemberg* [1990] who argued that co-movements of the prices of unrelated commodities could be due to common macroeconomic factors and contagion. The latter is attributed to investors' liquidity constraints as well as 'sunspots' or changes in market psychology. The authors also quantified the excess co-movement of stock prices as the correlation of residuals from the regression of listed companies' returns on common factors such as macroeconomic variables and a stock market index (*Pindyck and Rotemberg* [1993]).

Bekaert et al. [2005] also defines contagion as excess correlation. Furthermore, they decompose excess returns on national equity indices into global, regional and local components. They find no evidence of contagion during the Mexican crisis and economically meaningful increases in residual correlation during the Asian crisis. By comparing unadjusted and adjusted correlations of emerging market sovereign bond spreads, *Bunda et al.* [2010] analyzed the relative importance of pure contagion and common external shocks for co-movements during several emerging market crisis episodes. Similarly to the method applied by *Pindyck and Rotemberg* [1990, 1993], contagion is defined as excess co-movement, i.e. co-movement unexplained by either common shocks or spillovers through trade and other macroeconomic linkages. Specifically, the time-varying excess co-movement of spreads is calculated as the rolling correlation coefficient of residuals stemming from the regression of spreads on variables representing global risk aversion and liquidity conditions.

The use of correlation analysis for assessing contagion has also been criticized by several papers. *Forbes and Rigobon* [2001] show that tests for contagion would be biased in the presence of heteroskedasticity, endogeneity and omitted variables, as they tend to interpret interdependence as contagion. By distinguishing between an increase in cross-market co-movements without a change in the underlying transmission among these markets (interdependence) and a shift in cross-market linkages (contagion), they criticize the traditional definition of contagion that focuses only on the magnitude of cross-market relationships. Specifically, given that an increase in market volatility tend to lead to rising cross-market co-movements,

traditional tests overstate the magnitude of cross-market linkages.[40] However, the authors show that cross-market linkages do not change significantly during crisis episodes, suggesting that shocks are mostly transmitted through non-crisis-contingent channels including trade, policy coordination, 'country reevaluation' or random common shocks as opposed to crisis-contingent channels such as multiple equilibria based on investor psychology, endogenous liquidity shocks triggering portfolio reallocation or political economy considerations. In short, there is 'no contagion, only interdependence' during most crisis periods. By adjusting stock market correlations for a change in market volatility, *Forbes and Rigobon* [2002] show that there was no contagion during the U.S. stock market crash in 1987, the Mexican devaluation in 1994 and the Asian crisis in 1997. They conclude that the high level of co-movement during both crisis and non-crisis periods was rather the result of the high degree of interdependence of these markets. However, *Corsetti et al.* [2005] show that the effectiveness of the correction of correlation coefficients like the one proposed by *Forbes and Rigobon* [2002] is ambiguous in the presence of common shocks.

Some recent papers resorted to new estimation techniques, mostly the Dynamic Conditional Correlation multivariate Generalized Autoregressive Conditional Heteroskedasticity (DCC GARCH) model of *Engle* [2002]. *Frank et al.* [2008] estimated a DCC GARCH model that accounts for structural breaks with the aim of analyzing the transmission of liquidity shocks from U.S. conduits and structural investment vehicles to other credit and equity markets in the U.S. The authors found that implied correlations increased during the global financial crisis as a result of new channels of liquidity shock transmission such as the intensifying interaction between market and funding illiquidity and the rising importance of bank solvency. By analyzing the co-movement of some financial variables in advanced and emerging markets in a DCC GARCH framework, *Frank and Hesse* [2009] found that correlations between advanced and emerging countries increased sharply following the Chinese stock market correction in February 2007, in the summer of 2007, at the time of the Bear Sterns rescue and the collapse of Lehman, and they remained

[40] *Edwards* [1998] was among the first who investigated volatility spillovers. Specifically, by applying a GARCH framework, he found no evidence of volatility contagion from Mexico to Chile and significant volatility spillover from Mexico to Argentina during the 1990s.

elevated during the global financial crisis, thereby also suggesting that emerging market could not decouple from unfavourable developments in advanced economies. *Antonakakis* [2012] estimated a DCC GARCH model in order to analyze the dynamic co-movement of Euro Area sovereign bond yield spreads. He found an inverted U-shaped curve of cross-country spread correlations during the global financial crisis, thereby suggesting the presence of decoupling effects between core and periphery countries from 2009. *Piljak* [2013] found the presence of a substantial time-varying co-movement of emerging government bond markets and U.S. sovereign bonds by applying a DCC GARCH framework. He also showed that macroeconomic factors, especially domestic ones, play a major role in explaining these co-movements, while global factors have a less pronounced impact on co-movements.

4.3. Data

We have daily data for seven emerging market countries[41] during the period starting on January 1, 2003 and ending on May 31, 2013. As the measure of sovereign bond spreads, we obtained daily Emerging Market Bond Index Global (EMBIG) spreads from J.P. Morgan's research and market data website (MorganMarkets). The EMBIG spread is a market-capitalization-weighted average of spreads on US$-denominated Brady bonds, Eurobonds and traded loans issued by sovereign and quasi-sovereign entities.

We use the following global factors with the aim of controlling for the impact on EMBIG spreads and their cross-country correlation of common shocks:

- *Global risk aversion:* The Chicago Board Options Exchange Volatility Index (VIX), which measures the implied volatility of S&P index options, is used as a proxy for investors' risk appetite. Given that emerging market sovereign bonds are considered risky assets, an increase in global risk aversion is expected to lead to investors reallocating their funds to safer asset classes, thereby resulting in

[41] The list of countries include in our analysis is the following: Brazil, Bulgaria, Chile, China, Hungary, Malaysia and Poland. We estimated the model for a larger number of countries and kept only the significant results in this chapter.

increasing spreads across the emerging market bond universe and rising cross-country correlations of spreads. The source of data is Bloomberg.

- *Global liquidity conditions:* As a proxy for global liquidity conditions, the 5-year U.S. Treasury yield is expected to have a positive relationship with emerging market bond spreads during tranquil times. However, during periods of distress, the 'flight to quality' phenomenon can lead to decreasing U.S. Treasury yields and increasing emerging market spreads, thereby resulting in a negative relationship between the U.S. and emerging bond markets. Although the sign of the impact on EM sovereign bond spreads of U.S. Treasury yields is conditional on market conditions, global market conditions are expected to affect the cross-country correlation of emerging market spreads during both distressed and tranquil periods provided that emerging market countries are treated in the same way by investors. Data was downloaded from Bloomberg.
- *Reallocation between asset classes:* The S&P 500 Index is used as a proxy for the performance of equity markets. As such, it is used as a measure of investors' portfolio reallocations between equity and bond asset classes. Specifically, an increase in the S&P 500 Index is assumed to reflect the reallocation of funds from bonds to equity. As a result, it is expected to be associated with an increase in EM sovereign bond spreads. As long as investors do not differentiate among EM countries, global portfolio reallocations are expected to lead to increasing cross-country correlation of spreads. The source of data is Bloomberg.

Table 4-1 shows descriptive statistics of the variables, while **Table 4-2** contains their pairwise correlations. The latter shows that each cross-country correlation of spreads is positive, albeit in differing magnitude. There is also a positive relationship between spreads and VIX index, suggesting that an increase in global risk aversion leads to higher spreads. The negative co-movement of emerging market spreads with the 5-year U.S. Treasury yield and the S&P 500 Index may indicate portfolio reallocations by investors.

Table 4-1. Descriptive Statistics

	Obs	Mean	Std. Dev.	Min	Max
EMBIG spreads					
Brazil	2,602	3.3028	2.2111	1.3314	14.5707
Bulgaria	2,602	1.9605	1.2939	0.4213	7.2501
Chile	2,602	1.3027	0.6379	0.5151	4.1068
China	2,602	1.1101	0.6604	0.2577	3.3277
Hungary	2,602	2.0149	1.7858	-0.2944	7.5814
Poland	2,602	1.2714	0.7799	0.1660	4.0134
Malaysia	2,602	1.3738	0.6566	0.6479	4.8665
Common factors					
vix	2,602	20.6237	9.7032	9.89	80.86
us5y	2,602	2.7892	1.3323	0.5426	5.2310
sp500	2,602	1,218.29	189.7993	676.53	1,669.10

Source: author's calculations

Table 4-2. Pairwise Correlations

	embig_bra	embig_bul	embig_chil	embig_chin	embig_hun	embig_mal	embig_pol	vix	us5y	sp500
embig_bra	1.0000									
embig_bul	0.3932	1.0000								
	(0.0000)									
embig_chil	0.3561	0.2938	1.0000							
	(0.0000)	(0.0000)								
embig_chin	0.2110	0.3205	0.2838	1.0000						
	(0.0000)	(0.0000)	(0.0000)							
embig_hun	0.1581	0.3480	0.2248	0.2443	1.0000					
	(0.0000)	(0.0000)	(0.0000)	(0.0000)						
embig_mal	0.2915	0.3310	0.3735	0.5504	0.2038	1.0000				
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)					
embig_pol	0.2331	0.3387	0.2800	0.2908	0.4169	0.3022	1.0000			
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)				
vix	0.3993	0.2633	0.2382	0.1136	0.1343	0.2192	0.0915	1.0000		
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
us5y	-0.3796	-0.4898	-0.1622	-0.2048	-0.2812	-0.2911	-0.3232	-0.3572	1.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)		
sp500	-0.4218	-0.3090	-0.1963	-0.1486	-0.1767	-0.1861	-0.1696	-0.8225	0.4358	1.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	

Source: author's calculations

4.4. Model

In order to analyze the time-varying cross-country correlations of spreads, we estimate the DCC GARCH model of *Engle* [2002] that is a generalization of the *Bollerslev* [1990] constant conditional correlation (CCC) estimator.[42]

Let r_t denote an $n\ x\ 1$ vector of changes in spreads with zero mean and time-varying covariance as follows:

Equation 4.1

$$r_t | I_{t-1} \sim N(0, D_t R_t D_t) \ ,$$

where I_{t-1} denotes the set of information available at time $t-1$, $D_t = diag\{\sqrt{h_{it}}\}$ is a $(n\ x\ n)$ diagonal matrix containing the standard deviations stemming from the estimation of univariate GARCH models with the i^{th} element being $\sqrt{h_{it}}$, while R_t is the $(n\ x\ n)$ time-varying correlation matrix.

The model is estimated in two stages. First, univariate GARCH models are fitted for each spread in our sample. Second, the standardized residuals from the previous stage are used to estimate the parameters of the DCC. As Engle [2002] shows, the DCC model is formulated in the following specification:

Equation 4.2

$$D_t^2 = diag\{\omega_i\} + diag\{\kappa_i\} \circ r_{t-1} r_{t-1}' + diag\{\lambda_i\} \circ D_{t-1}^2 \ ,$$

$$\varepsilon_t = D_t^{-1} r_t \ ,$$

$$Q_t = S \circ (\iota' - A - B) + A \circ \varepsilon_{t-1} \varepsilon_{t-1}' + B \circ Q_{t-1} \ ,$$

$$R_t = diag\{Q_t\}^{-1} Q_t diag\{Q_t\}^{-1} \ ,$$

where Q_t is the time-varying covariance matrix, S is the unconditional correlation matrix of residuals ε_t, ι is a vector of ones, $\circ$ is the Hadamard product.

Due to the non-stationarity of our variables, we estimate the model on the first differences of spreads in order to calculate unadjusted correlations of spreads across countries. In order to estimate adjusted correlations, we also run the model on spreads adjusted for common external shocks.

[42] See *Caporin and McAleer* [2013] for the pitfalls associated with the DCC representation.

4.5. Estimation Results[43]

The estimation results reveal several interesting phenomena regarding the co-movement of the EMBIG spreads of Hungary and other emerging market countries (**Table 4-3**). First, the Hungarian EMBIG spread exhibits the strongest implied correlation with Polish spreads in both unadjusted and adjusted terms. Specifically, their average unadjusted and adjusted correlation amounts to 0.46 and 0.40, respectively. This finding is in line with our prior expectations given that Hungary and Poland belongs to the same geographical region and went through similar economic and political events, such as becoming a member country of the European Union, in the first half of our sample period. The small difference between the average adjusted and unadjusted implied correlations suggests the presence of contagion during most of our sample period; however, common shocks also seem to contribute to the strong co-movement of spreads.

Table 4-3. Descriptive Statistics of Adjusted and Unadjusted Time-varying Correlations of EMBIG Spreads Between Hungary and Other EM Countries

	Obs	Mean	Std. Dev.	Min	Max
Adjusted correlations of EMBIG spreads between Hungary and...					
-Brazil	2,602	0.0982	0.1523	-0.4547	0.5999
-Bulgaria	2,602	0.1618	0.0843	-0.1075	0.7442
-Chile	2,602	0.1356	0.0474	-0.1729	0.4282
-China	2,602	0.1834	0.1233	-0.1471	0.5904
-Poland	2,602	0.3957	0.1991	-0.1363	0.7732
-Malaysia	2,602	0.1756	0.1518	-0.1914	0.6015
Unadjusted correlations of EMBIG spreads between Hungary and...					
-Brazil	2,602	0.2329	0.1926	-0.2477	0.6950
-Bulgaria	2,602	0.3464	0.2257	-0.4416	0.8964
-Chile	2,602	0.2027	0.1621	-0.2289	0.6125
-China	2,602	0.2394	0.1409	-0.2852	0.6900
-Poland	2,602	0.4624	0.1817	-0.1276	0.7761
-Malaysia	2,602	0.2343	0.1554	-0.0876	0.6390

Note: Adjusted correlations are calculated as correlations between spreads after controlling for the impact of common shocks.
Source: author's calculations

[43] The estimation was done in Stata.

The EMBIG spread of Hungary is also strongly correlated with the Bulgarian spread, with average unadjusted correlation reaching 0.35, possibly reflecting moderate differentiation by investors among countries in the same region. However, given that adjusted correlations amount to only 0.16, the co-movement seems to be driven by common external shocks to a high extent. Implied correlations of spreads are somewhat lower between Hungary and Brazil, Chile, China and Malaysia, in line with our assumption about regional differentiation by investors.

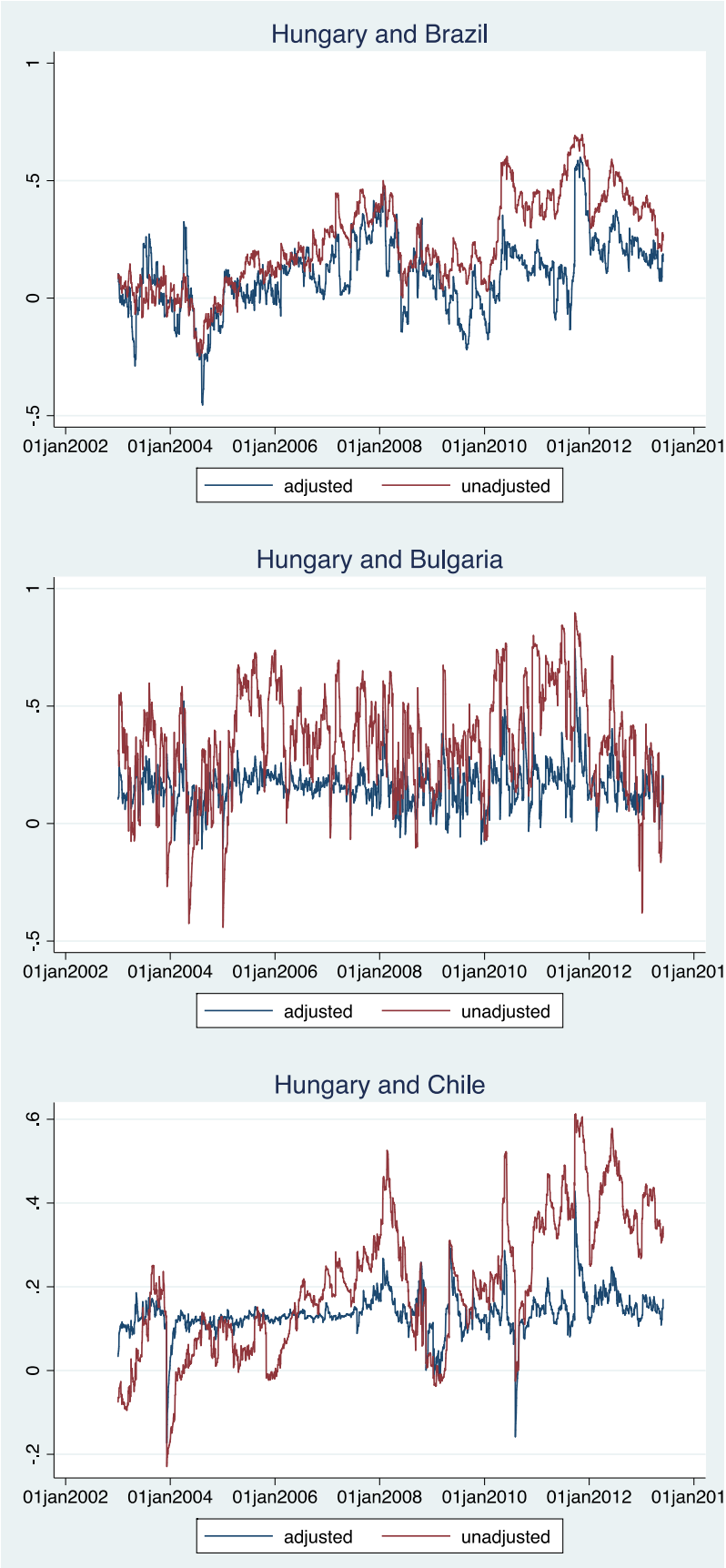
Second, based on the timely evolution of implied correlations we can distinguish between three periods (**Figure 4-2**):

- *Pre-crisis period (2002-2007):* Unadjusted implied correlations increased gradually throughout this period, except for the one with Bulgarian spreads that remained quite volatile in the range of 0-0.5. Correlations increased in a period characterized by a growing interest of international investors in emerging market debt (*Anderson et al.* [2010]) as well as moderate differentiation by investors across emerging market countries (*Arslanalp and Takahiro* [2014]). These developments are mostly attributed to sound macroeconomic policies and better public debt management conducted by emerging market countries in the aftermath of the Asian crisis of 1997 and Russian default of 1998 as well as potential diversification benefits associated with emerging market sovereign bonds for investors. Given that adjusted correlations remained close to unadjusted correlations during most of this period, both country-specific and global factors could have contributed to the increasing co-movement of spreads. However, the rise in adjusted correlations indicates the high importance of idiosyncratic factors.
- *Peak of the global financial crisis (2008-2009):* Unadjusted correlations decreased as compared to their pre-crisis level. This suggests increasing differentiation by investors between Hungary and our sample of emerging market countries at the onset of the global financial crisis. Specifically, Hungary was severely hit by the crisis and was among the first countries that had to resort to the European Commission (EC), the International Monetary Fund (IMF) and the World Bank (WB) following the default of Lehman in the fall of 2008. Given that other emerging

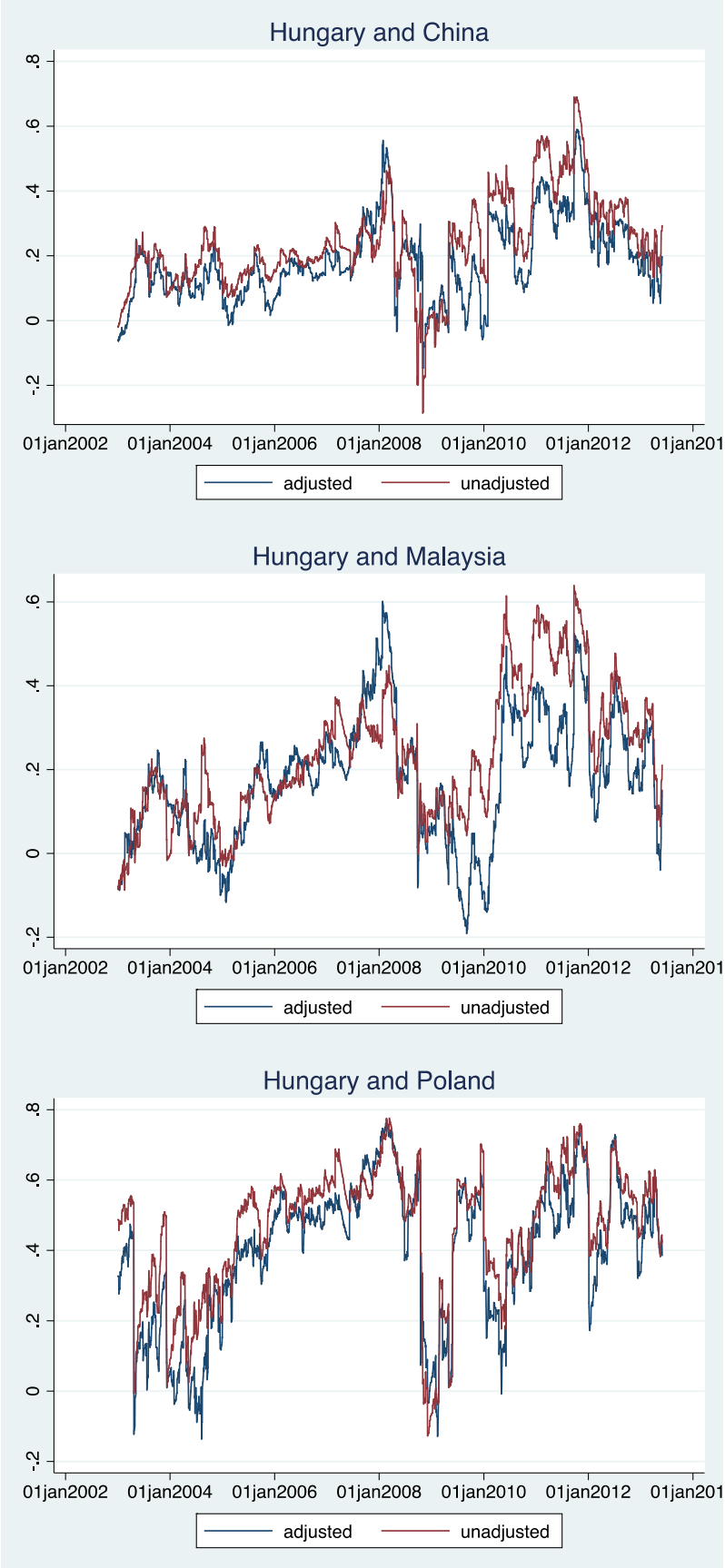
markets remained more resilient to global developments, there was a decoupling of Hungary from its peers to some extent. The decrease in adjusted correlations also suggests the important role of idiosyncratic shocks.

- *Global financial crisis (2010-2013):* Unadjusted correlations increased sharply in 2010-2011. This is in line with the finding of *Arslanalp and Takahiro* [2014] on decreasing differentiation among emerging markets by investors after the global financial crisis. This was attributed to the following factors: (i) liquidity-enhancing measures of central banks in advanced economies; (ii) search-for-yield phenomenon driven by low interest rates in advanced countries; (iii) improved economic growth outlook for emerging markets; (iv) public debt sustainability concerns in some advanced economies. Specifically, these global developments made investors overlook differences in the strength of fundamentals between emerging markets. The authors show that foreign investors increased their holdings of emerging market sovereign bonds by around half a trillion US$ in 2010-2012. As indicated above, this huge inflow of funds benefits emerging markets in general without much differentiation across them, thereby leading to rising co-movements of spreads. The increasing difference between unadjusted and adjusted correlations during this period suggests that the increasing co-movement of spreads between Hungary and other emerging markets was mostly driven by common external factors during this period.

Figure 4-2. Adjusted and unadjusted correlations of EMBIG spreads between Hungary and other EM countries



(Concluded)



Note: Adjusted correlations are calculated as correlations between spreads after controlling for the impact of common shocks.
Source: author's calculations

4.6. Conclusions

Using a multivariate GARCH framework, we were analyzing the time-variation of correlations between the EMBIG spreads of Hungary and selected emerging market countries from three regions. We showed that on average the Hungarian spread exhibits the strongest co-movement with its regional peers, Poland and Bulgaria, while implied correlations are much smaller with countries from Asia and Latin America. This suggests that there is some degree of regional differentiation by investors across countries.

We found three distinct periods regarding the co-movement of spreads between Hungary and other emerging markets. In the pre-crisis period, there was a gradual increase in implied correlations, suggesting decreasing differentiation by investors across countries. This is in line with the growing interest of investors in emerging market debt throughout this period, mostly driven by improving macroeconomic policies in these countries. During the global financial crisis, correlations decreased, indicating the different assessment of Hungary and other emerging countries by investors. Specifically, Hungary was severely hit by the market turmoil following the collapse of Lehman and had to resort to the EC/IMF/WB, while other emerging markets proved more resilient at this phase of the crisis. The analysis of correlations adjusted for the impact of common external shocks also suggests that the weakening of the co-movement of spreads was mostly driven by idiosyncratic shocks. In the aftermath of the global financial crisis, correlations increased substantially. Our analysis suggests that decreasing differentiation was the result of common external factors. In line with the literature, these factors could include the expansive monetary policy in advanced economies, the search-for-yield behavior of investors and the improving macroeconomic performance of emerging markets as compared to advanced countries.

The understanding of the timely evolution of the co-movement of spreads is of crucial importance for investors. As the cross-country correlation of spreads is affected by global market conditions, regional developments as well as possible contagion between countries, investors should take these factors into consideration when making investment decisions. Specifically, as decisions based on unconditional co-movements might not bring sufficient diversification benefits under certain

circumstances, they should rather consider time-varying relationships between financial markets.

5. Summary and results

Using several estimation methods, we analyzed the determinants of emerging market sovereign bond spreads and their cross-country co-movements in a number of countries from four different perspectives. First, we analyzed emerging market debt spreads with the aim to disentangle the effect of global and country-specific developments as well as showed that the importance of country-specific and global factors is conditional on the time horizon and the degree of volatility in financial markets. Specifically, we made the following conclusions:

- Our pooled mean group estimation showed that while both country-specific and global developments are important determinants of spreads in the long run, it is mostly the global factors that determine spreads in the short run. This finding is intuitive and consistent with the literature. First, the asset-pricing theory predicts that all relevant information shall be included in asset prices (or spreads) and hence both global factors and the strength of country-specific fundamentals should be reflected in the long-run, equilibrium, level of bond prices (spreads). Second, since country-specific fundamentals change slowly over time, it is the variation in global factors that should be more important in driving country spreads in the short run.
- Using the interactions of the regime probabilities stemming from the estimation of a Markov-switching ARCH model on VIX index with several country-specific and global variables as the determinants of spreads, our panel estimations also showed that the role of both country-specific fundamentals and global factors differs across regimes associated with a low, medium and high degree of volatility in financial markets. We found that while country-specific fundamentals are important determinants of spreads in each regime, albeit at different significance level and with a different size of coefficient, the importance of global factors increases during high-volatility periods. This implies that the sensitivity of emerging market spreads to exogenous developments increases during periods of distress. We also showed that the switching regression slightly outperforms the non-switching model.

Second, we investigated whether and how the strength of fundamentals is related to the sensitivity of spreads to global factors. In order to do so, we utilized three approaches:

- In the fixed effects panel estimation, we compared the sensitivity of spreads to global conditions across two groups of countries associated with weak and strong fundamentals and found that countries with weak fundamentals have a higher exposure to changes in global risk aversion.
- In the pooled mean group estimation, we analyzed whether country-specific short-term coefficients of global conditions are related to country-specific fundamentals. We found that countries with stronger fundamentals tend to have lower sensitivity to changes in global risk aversion. This finding is important from the policy-making perspective as it highlights the premium on good policies, suggesting that solid domestic fundamentals do provide some cushion against sudden shifts in the global market sentiment.
- In the regime-switching estimation, we found that sound macroeconomic policies and strong fundamentals reduce the sensitivity of spreads to adverse shifts in global risk aversion. Specifically, based on the panel estimation results we showed that while a shift from low- to medium- and high-volatility regimes results in the substantial increase of fitted spreads of countries with weak fundamentals, the increase is much less pronounced in countries with stronger fundamentals.

Third, we decomposed changes in emerging market sovereign spreads in seven periods over the last decade in order to understand whether they are driven by improving fundamentals and/or global factors, and what role the unexplained part of changes plays. To our knowledge, such a comprehensive analysis has not been performed in the existing literature. In addition to the breakdown of fitted changes in spreads into the contribution of fundamentals and global factors as common in the literature, we also decomposed changes in the residual into correction of initial misalignment and increase/decrease in misalignment in the given period.

In general, we found that in periods of severe market stress and general lack of public understanding of country-specific developments, such as during the intensive

phase of the Eurozone debt crisis, global factors tend to drive the changes in spreads and misalignment tends to increase in magnitude and its share in actual spreads increases. This finding is in line with our previous conclusions about the increasing role of global factors in driving spreads during periods of financial market stress. The understanding of the drivers of changes in spreads is of essential importance for both policymakers and investors. A decrease in spreads could be attributed to either an improvement in country-specific fundamentals, an improvement in global conditions, a decrease in the extent of undervaluation or an increase in overvaluation of debt. If policymakers interpret a decrease in spreads as a signal of improving country-specific fundamentals – however, it was actually driven by external factors or changing misalignment – they might ease monetary and/or fiscal policy as well as abandon to purse structural reforms. This could increase the country's vulnerability, thereby possibly resulting in a sharp increase in spreads in the case of deteriorating external environment. Similarly, the misinterpretation of a decrease in spreads could leave investors increasingly exposed to global developments. For example, we found that the spectacular performance of emerging market sovereign debt in 2012 was mainly driven by an improvement in global factors. This warrants caution for policymakers and investors who need to be aware of risks associated with the potential reversal of the improvement in global sentiment.

Finally, we also analyzed the cross-country co-movement of spreads using two methods:

- After the identification of low-, medium- and high-volatility regimes using the Markov-switching ARCH model, we analyzed the regime-specific cross-country correlation of spreads. In line with the literature, we found that cross-country correlations of EMBIG spreads increase substantially during medium- and high-volatility periods as compared to the low-volatility regime. This possibly suggests that emerging market bond spreads are mainly driven by external factors during periods of distress, thus they can only partially decouple from their peer countries when global sentiment deteriorates.
- Using a multivariate GARCH framework, we were also analyzing the timely variation of correlations between the EMBIG spreads of Hungary and selected emerging market countries from three regions. We showed

that on average the Hungarian spread exhibits the strongest co-movement with its regional peers, Poland and Bulgaria, while implied correlations are much smaller with countries from Asia and Latin America. This suggests that there is some degree of regional differentiation by investors across countries.

We also showed that correlations between Hungary and other emerging markets increased substantially in the aftermath of the global financial crisis. Our analysis suggests that this was primarily driven by common external factors. In line with the literature, these factors could include the expansive monetary policy in advanced economies, the search-for-yield behavior of investors and the improving macroeconomic performance of emerging markets as compared to advanced countries. In contrast with this, correlations dropped at the peak of the global financial crisis in 2008, possibly due to the fact that Hungary was among the first emerging countries severely hit by the market turmoil following the collapse of Lehman while other emerging markets proved more resilient during this period.

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