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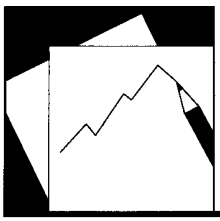

IMF Working Paper

Correlations in Emerging Market Bonds: The Role of Local and Global Factors

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IMF Working Paper

Asia and Pacific Department

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Prepared by Irina Bunda, A. Javier Hamann, and Subir Lall [1]

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Abstract

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This paper examines the comovement in emerging market bond returns and disentangles the influence of external and domestic factors. The conceptual framework, set in the context of asset allocation, allows us to describe the channels through which shocks originating in a particular emerging or mature market are transmitted across countries and markets. We show that using a simple measure of cross-country correlations together with the commonly used average correlation coefficient can be more informative during episodes of heightened market instability. Data for the period 1997–2008 are analyzed for evidence of true contagion and common external shocks.

JEL Classification Numbers: F42, G12, G15
Keywords: Emerging markets, bond markets, financial crises, comovement, contagion

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I. INTRODUCTION

Emerging markets (EMs) have been marked by several well-documented episodes of volatility spillovers and contagion. The Tequila crisis of 1994–95, the Asian crisis of 1997, the Russian default and the collapse of LTCM in 1998, the market reaction after the September 11 terrorist attacks, the run-up to the Argentine debt default in late 2001, the U.S. HY market selloff of 2002, or most recently the U.S. sub-prime market-related volatility of the summer of 2007, and the collapse of Lehman Brothers in mid-September 2008 are prominent examples of market events accompanied by the transmission of financial market instability across borders. Other than foreign direct investment, EM bonds have been the largest source of financing to EMs since the beginning of the 1990s. International bonds have, however, been a volatile source of financing, vulnerable to external shocks and abrupt shifts in market sentiment. Volatility in secondary markets has usually been associated with diminished appetite for primary market issuance (IMF, 2001) and often associated with capital outflows and foreign exchange market pressures.

The sharp spikes in volatility of EM bond prices and returns are often captured by increased cross-country market correlations in the now vast literature on contagion. In fact, correlation analysis represents one of the major strategies to measure the cross-country transmission of shocks.[2] However, in the wake of the Asian crisis, the inference of contagion drawn from increased cross-country correlation coefficients has been challenged by Ronn (1998), Forbes (2001), and Rigobon (2002). These authors show that the presence of simultaneity, omitted variables or heteroskedasticity in the data may cause correlation coefficients to be biased upward during periods of market turmoil; this may alter the interpretation of traditional correlation coefficients, leading to erroneously interpret market "interdependence" as contagion. Although under certain assumptions it is possible to adjust these coefficients to eliminate the bias, the effectiveness of the correction in the presence of common shocks has been questioned in subsequent studies (Corsetti, Pericoli, and Sbracia, 2005).

Other important studies have argued that the rise in the correlation coefficients is driven entirely by an increase in underlying volatility. This has led to the investigation of volatility spillovers across markets (King and Wadhwani, 1994; Chou et al, 1994; Lin, Engle and Ito, 1994; Edwards, 1998; and Park and Song, 1999). However, more recently, Yoon (2005) noted that contagion may be due to factors other than increased volatility and that the direction of the bias implicit in correlation coefficients depends strongly upon the underlying data-generating process.[3]

Aside from these technical shortcomings, another objection could be raised with respect to the use of correlation coefficients to gauge contagion, in terms of the role of "third factors," particularly global financial factors, in driving market comovements. Excess comovement, free from the influence of "third factors," was first quantified by Pindyck (1990) and Rotemberg (1993) and used as a measure of contagion in mature markets. After taking into account common fundamentals, they showed that there is a residual comovement across stocks from

[2] For early papers, see King and Wadhwani (1990) and Lee and Kim (1993), and subsequent work by Calvo and Reinhart (1996) and Frankel and Schmukler (1998).

[3] When returns follow, for instance, a stochastic unit root process, heteroskedasticity causes the correlation coefficients to be biased downward—Yoon (2005).

very different industries and idiosyncratic fundamentals. However, little is known with regard to EMs as far as the residual comovement is concerned. For instance, in the case of the exchange rate variation, Masson (1999) identifies three components, namely: "monsoonal" or common shocks simultaneously affecting all countries, spillovers occurring through trade and other macroeconomic linkages, and a residual, that is the component unexplained by the previous systematic relations and referred to as "contagion." Valdés (1997) uses secondary market debt prices as well as country credit ratings and shows that fundamentals are unable to explain the cross-country comovement of creditworthiness among Latin American countries. Baig and Goldfajn (1999) test for evidence of contagion across East Asian financial markets. In order to account for the residual comovement, they control for own country and cross border news and other fundamentals and show evidence of cross-border contagion in the currency and equity markets. Bekaert, Harvey, and Ng (2005) propose a two-factor model (U.S. equity market returns and a regional equity portfolio return) with time-varying betas and apply it to stock markets in Europe, Southeast Asia and Latin America during the Tequila and Asian crises of the 1990s. They find little evidence of additional contagion, defined as excess correlation of the idiosyncratic residuals in the case of the Mexican crisis, but a significant increase in residual correlation during the Asian crisis.

Regarding the interpretation of the excess comovement, the literature attributes this residual comovement either to multiple equilibria (sunspots) or to market behavior. Jeanne (1997) and Jeanne and Masson (2000) develop a Markov-switching model and apply it to the ERM crisis. In their view, discontinuities in the shock transmission process are associated with jumps between multiple equilibria in the currency market. As for the market-based interpretation of contagion—to which our paper is related—there are mainly three strands of the literature. According to one, contagion can be captured by shifts in market investors' perceptions and attitudes towards risk (Kumar and Persaud, 2001; Chakravorti and Lall, 2004). The second strand of the literature portrays contagion as the result of investors' herding behavior (Lakonishok, Shleifer, and Vishny, 1992; Christie and Huang, 1995; Kim and Wei, 2002; Choe, Kho, and Stulz, 1999). Finally, according to the third view, contagion is the result of "wake-up calls" by investors (Goldstein, 1998; Baig and Goldfajn, 1999; Kaminsky and Schmukler, 1999).

In this paper, we use a three-factor model of EM bond returns to address the question of whether increases in EM comovement usually associated with crisis episodes are attributable to common shocks or to "pure" contagion. Our analysis is based on the average correlations of each country's sovereign bond returns with the rest of the EMBI Global during 1997–2008, adjusted for the presence of common external factors (for our purposes, U.S. Treasury bonds, U.S. HY market returns and equity market returns). The correlation coefficients of residuals can thus be viewed as a measure of "excess comovement" or "true contagion" that is the part of the comovement unexplained by common external shocks. The alternative measure we propose in this paper better differentiates episodes of true contagion from reaction to common external factors. The remainder of the paper is organized as follows. Section 2 proposes a conceptual framework for the analysis of "pure" contagion in emerging bond markets based on aggregate correlations. In Section 3, we present the main methodological issues and describe the data. In Section 4, we provide an application of our framework to the episodes of market turmoil affecting EMs over the period 1997–2008. Section 5 concludes.

II. Country-Specific vs. Externally Driven Comovement in Emerging Markets

A. A Single-Factor Model of Individual Country Returns

Comovements in emerging bond markets are often proxied by the average correlation of bond returns.[4] But these average correlations may be driven by a wide range of factors, some of which are internal to the asset class or to the issuing country, while others are not. Thus, we can classify these factors in the following two categories:

- Common external factors originating in developed countries
- Other factors which could account for the residual comovement of EM returns. These factors can be linked to international investors' behavior, as investors shift between asset classes and markets according to their expectations and attitudes towards risk.

Formally, consider the standard single-factor model of individual country returns for two countries *i, j (i≠j)*:

$$R_i = \beta_i \cdot f + \varepsilon_i \qquad (1)$$

$$R_j = \beta_j \cdot f + \varepsilon_j \qquad (2)$$

where β_i, β_j represent the country-specific loadings; f denotes the common external factor and $\varepsilon_i, \varepsilon_j$ denote idiosyncratic country-specific factors.[5] Thus, in order to disentangle the roles of the common external and country-specific factors, we could use the following two indicators of market comovement:

- a simple correlation coefficient of country specific returns or:

$$\rho_{i,j} = \rho(R_i, R_j) \qquad (3)$$

- and a correlation coefficient of residuals, henceforth the adjusted correlation coefficient:

$$\hat{\rho}_{i,j} = \rho(\varepsilon_i, \varepsilon_j) = \frac{(\varepsilon_i' \cdot \varepsilon_j)}{(\varepsilon_i' \cdot \varepsilon_i)^{1/2} \cdot (\varepsilon_j' \cdot \varepsilon_j)^{1/2}} \qquad (4)$$

which is also the partial correlation coefficient of returns R_i and R_j, given f ; $\hat{\rho}$ could then be used as a measure of the comovement of bond returns after removing the influence of

[4] See, for example, IMF (2001) for an application.

[5] The analysis relies also on the assumption that the error terms are distributed normally. The empirical implications of this assumption are discussed in Section V.

common external shocks. A significant increase in this indicator during times of increased market volatility could then be viewed as evidence of "pure contagion" or excess comovement. Notice, however, that an increase in the correlation of the residuals would also lead to an increase in ρ. For $\hat{\rho}$ to increase while ρ remains constant, the initial increase in excess comovement would have to be offset by a simultaneous decline in correlations driven by the common factor. As a result, it is essential to focus on the joint behavior of ρ and $\hat{\rho}$. For example, periods characterized by (positive and) high values of ρ but (positive and) low values of $\hat{\rho}$ would imply that the two countries' returns are correlated in similar ways with the external common factor. On the other hand, when ρ is low and $\hat{\rho}$ is high, the "true" (or residual) comovement of EMs outweighs general trends in the global common factor. In the case in which EMs are oppositely linked to the common external factor, removing the impact of this common external factor will actually strengthen the linkages between emerging countries bond returns. If the two correlation coefficients are equal, market comovement is fully explained by developments in EMs and, thus $\beta_{i,j} = 0$.

B. Risk and Comovement: A Simple Conceptual Framework

Let's consider now how ρ and $\hat{\rho}$ would behave in the runup to a global or country-specific, negative event—Figure 1.[6] An increase in ρ, while $\hat{\rho}$ decreases or remains constant indicates that risks of a selloff in EM stem mainly from a shock occurring in mature markets. A concomitant rise in both correlations during tranquil times indicates that the risk of a generalized selloff could come from either front: global factors as well as a given event in another EM.[7] Finally, low or decreasing values of ρ and $\hat{\rho}$ may be an indication of market tiering (i.e., the presence of two or more groups of countries characterized by high within-group correlation but low inter-group correlations) with risks potentially coming from the highly volatile group of emerging countries (Bunda, Hamann, and Lall, 2005).

Figure 1: Evolution of ρ and $\hat{\rho}$ in a Pre-Crisis Period and Potential Sources Of Risk

ρ	$\hat{\rho}$	**Source of risk**
↑	≈;↓	Mature markets
≈;↓	↑	Emerging markets
↑	↑	Mature or emerging markets
≈;↓	≈;↓	Potentially, from a subgroup of emerging markets

[6] We assume here that the shock in question is anticipated with less than full certainty. Typical examples of such shocks could be a liquidity shock in a financial system or the unexpected release of poor economic data.

[7] As indicated above, "pure contagion" could also imply decreasing values of ρ while $\hat{\rho}$ is increasing in the run-up to a crisis, if global factors are pushing returns in opposite directions.

How could this framework be applied to provide an exante description of the shock propagation mechanisms and the behavior of global investors in the face of financial market instability? We follow the performance ρ and $\hat{\rho}$, together with EM spreads, before and after the occurrence of a particular discrete, adverse event. As in the model described in *(1)–(2)*, we focus on common external shocks affecting the EMs (the shock affects ε_i but not *f*) and on EM-specific shocks with potential spillover effects to other EMs (the shock affects *f* but not ε_i).

Generally, in the aftermath of the first event we would expect $\hat{\rho}$ to increase only to the extent that the shock to one EM is correlated to the idiosyncratic part of the return to bonds in the other EM (i.e., if it is capturing the true market comovement after controlling for the presence of global factors). But ρ would also rise as the simple correlation measure is affected by both global and country-specific factors. A widening of EM spreads would be consistent with a generalized selloff across EMs. Conversely, a decrease in $\hat{\rho}$ and ρ would suggest that investors are discriminating within the EM asset class according to their country risk perception. Regardless of the changes in average spreads in EMs, these would be increasing for some countries and declining for others, consistent with the notion of selective selloff.

In the aftermath of a negative event in mature markets, we would expect an increase in ρ driven by the common external factor and no change in $\hat{\rho}$; spreads would widen reflecting mainly a shift away from EM debt in general. A similar movement in ρ and $\hat{\rho}$, although with declining spreads, could also be observed following a positive global shock. The key message in this case would be that the main downside risk for EM debt going forward is a generalized selloff triggered by a global event, rather than contagion following a negative event in a specific EM.[8]

It is worth noting here that when formulating the model *(1)-(2),* we assume that developments in mature markets are always exogenous to EMs and that there is no feedback from EMs into advanced markets either contemporarily or with lags. It is, of course, entirely possible that big enough shocks in EMs may have a simultaneous or delayed impact on global conditions. As discussed later in the paper, our exogeneity assumption appears to have been violated in a few recent episodes.

C. Capturing the Impact of Global Factors

The performance of dollar-denominated EM bonds, such as those included in the EMBI Global, is closely tied to asset returns of mature markets, particularly U.S. assets.[9]

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[8] It may be worth noting that a decrease in $\hat{\rho}$, at any point, may indicate investors' shifts within the EM class or even market *tiering*, with two groups of EMs characterized by high within but low inter-groups correlations. We test for this possibility in Bunda, Hamann and Lall (2005) and find evidence of this "market tiering" during 2003-05.

[9] The EMBI Global index used in this study is benchmarked against the U.S. Treasury bonds.

Therefore, in our analysis, we focus on the three relevant benchmarks of U.S. asset markets as proxies for the common "external factor" in the model described by equations *(1)–(2)*.[10]

The first variable is the return on U.S. Treasury bonds (US-TB) for a maturity comparable with that of bonds included in the EMBI Global (i.e., five to seven years). The interest rates on treasury bonds are commonly assumed to be the risk-free rate and are accepted as a benchmark for the general level of interest rates prevailing in the U.S. economy. Studies on international capital movements show that EMs bond returns are significantly affected by variations in U.S. interest rates (Arora and Cerisola, 2001). Moreover, since the EMBI global comprises U.S. dollar denominated securities, the rate on US-TB is the best proxy for the underlying risk–free interest rate.

The sensitivity of bond returns to changes in US-TB returns is a good indicator of changes in market behavior and investors' risk aversion during crisis times. Generally, the yield on EM bonds is composed of the yield on the underlying US-TB and a default premium (spread) due to the existence of a country default probability. This probability may be close to zero whenever markets have confidence in the issuer's ability to pay off its debt. Conversely, when market participants put into question the government's ability (or willingness) to repay its outstanding debt on time, the yield on EM bonds will rise in order to compensate security holders for the increased risk. During market rallies, whenever EM prospects are encouraging, investors tend to switch away from low yielding risk-free TBs and buy EM debt securities that offer a higher return. The increase in the demand for high-yield EM bonds leads to a decline in spreads over treasury securities. This observed pattern may also be the consequence of reductions in risk-free interest rates, which may reduce the external debt service burden of an EM and/or improve the issuing country's macroeconomic fundamentals. Conversely, global investors may shift to TB in times of stress, whenever heightened risk perceptions or uncertain economic prospects become dominant. Such a reassessment would prompt investors to scale back their exposures to EM debt and lead to widening spreads. This "flight to safety and to quality" effect has often been a common pattern of crisis episodes.

The second variable is the return on the Standard and Poor 500 stock index (US-SPX), that is, the composite index of the U.S. stock market as a proxy for a mature market stock portfolio. Over the period of study, U.S. and European stock markets have evolved along similar lines. As a result, the use of a composite equity index reflecting the evolution of U.S., European and Japanese equity indexes is unlikely to provide additional information, and, in addition, may add noise due to exchange rate expectation effects.

Emerging bond sensitivities to changes in equity market returns may reflect global portfolio reallocations between bonds and equity. The investors' behavior towards stocks depends on the growth prospects of the home country of investors (higher rates of investment, productivity growth, etc). Therefore, investors would tend to prefer their own equities when earnings growth is high, but may nevertheless shift to the risk-free asset if risk aversion rises.

[10] We also exclude non-U.S. variables (such as European or composite indices) as proxies for common factors in order to avoid the additional complications related to exchange rate expectations Our findings are robust to the use of non-U.S. dollar indices; test results are available upon request.

The third variable is the performance of the U.S. High Yield corporate bonds (US-HY) and aims at capturing the global investors' behavior regarding these two competing debt assets. The selected index is characterized by an average rating comparable to the one of EMs (BB and B rated). Therefore, the two indexes (US-HY and EMBI Global) approximately reflect the same degree of creditworthiness, one reflecting domestic corporate bonds and the other external bonds.

The relationship between US-HY returns and EM debt returns is not straightforward. In the context of increased risk aversion, investors are likely to treat these two assets classes indiscriminately by selling them against risk-free assets. Troubles in the HY sector often reverberate through the EMs and, over the last decade, selloffs in the first market have triggered similar selloffs in the latter market. For instance, episodes of turbulence such as the one seen during the 2000 selloff could be associated with an increase in the overall risk of the portfolio. In this case, investors tend to reduce the exposure in similar securities in terms of risk (in particular, EM bonds). However, investors may also have a different attitude toward these two asset classes, according to their perception of sovereign and corporate default risk. If there are concerns about the ability of corporate (sovereign) issuers to service or to roll-over their debt in the HY (EM) bond markets, we expect global investors, in particular cross-over investors, to shift to the other market for a more attractive risk-return profile. For instance, doubts about the sequencing of lenders' reimbursement in the case of a sovereign debt crisis, and sometimes, higher market risk associated with EM bonds compared to corporate HY ones, could lead to a situation in which the former asset group may be viewed as more prone to a broad-based selloff.[11]

Together, the previous three factors will be used to capture the common influence of external developments, denoted by *f* in model equations *(1)–(2)*.

III. Methodological Issues And Data

We obtained daily data for 18 of the 33 EM countries initially included in the EMBI Global during the period starting on March 3, 1997 and ending on the October 31, 2008.[12] The selected countries (Argentina, Brazil, Bulgaria, Colombia, Croatia, Ecuador, Malaysia, Mexico, Morocco, Panama, Peru, Philippines, Poland, Russia, South Africa, South Korea, Turkey and Venezuela) accounted for 92 percent of the index in 1997 and for 88 percent in 2005—see Appendix. Data were obtained from Bloomberg.

Returns on all assets were computed on a daily or weekly (five day) basis according to the following relationship:[13]

$$R_{t/t-i} = \ln(I_t / I_{t-i}) \quad i = 1 \text{ or } 5 \qquad (5)$$

[11] As was the case, for example, during the Argentinean debt selloff of 2001–02.

[12] The J.P. Morgan Emerging Markets Bond Index Global (EMBI Global) tracks total returns for US-dollar denominated debt instruments issued by EMs sovereign and quasi-sovereign entities (Brady Bonds, Loans, Eurobonds, etc). Currently covers 189 instruments and 31 countries. For further methodological details see the Appendix.

[13] We obtained more significant results when using weekly returns, as they seem to be less affected by the autocorrelation of daily returns. In the remainder of the paper we show only the results obtained using weekly returns.

where

- I_t is the closing value of the index level on day *t*;
- R_t denotes the net rate of return between dates *t* and *t*-1 (or *t*-5); and
- *t* is the trading date. For U.S. and EM bonds, dates were based on the New York bond and holiday calendar and were harmonized with the dates of other variables.[14] For the three proxies of global indicators (TB, SPX, and HY indices), we use the daily closing prices provided by Bloomberg. Data for non-Asian countries were lagged by one day to adjust for the time difference between Asian and non-Asian markets.

Initially there were 2,936 trading dates for the EMBI Global, 2,968 for SPX and 3,048 for both the US-HY and US-TB indices. After harmonization, we obtained 2,930 common trading dates. Infrequent trade dates, during which US-SPX and/or the EMBI Global were not quoted, accounted for 4 percent of the 12-year sample.[15] As shown in the literature on thin trading, infrequently traded assets may bias estimations because prices recorded at a given time may actually reflect information relative to a transaction that had taken place before. As a result, thin trading is likely to induce autocorrelation of returns (Lo and MacKinlay, 1988; Miller, Muthuswamy, and Whaley, 1994) and lead to a downward bias in asset price correlations (Martens and Poon, 2001). In order to alleviate these problems we focus on weekly (five-day) returns.[16]

With the data just described, we proceeded to compute rolling correlation coefficients over 60-day windows. For a given country *i*, simple correlation coefficients between that country and the remaining ones ($\rho_{i,j}$, for $i \neq j$) were estimated and an average for country *i* was obtained as:

$$\rho_i = \sum_j \rho_{i,j} \qquad (6)$$

A similar approach was followed to compute the partial correlation coefficients $\hat{\rho}$, which are equivalent to simple correlation coefficients between the residuals ε_i and ε_j in:

$$\begin{aligned} R_{i,t} &= \beta_{i,0} + \beta_{i,1} \cdot R_{US-TB,t} + \beta_{i2} \cdot R_{US-SPX,t} + \beta_{i,3} \cdot R_{US-HY,t} + \varepsilon_{i,t} \\ R_{j,t} &= \beta_{j,0} + \beta_{j,1} \cdot R_{US-TB,t} + \beta_{j,2} \cdot R_{US-SPX,t} + \beta_{j,3} \cdot R_{US-HY,t} + \varepsilon_{j,t} \end{aligned} \qquad (1'\text{-}2')$$

As we have already mentioned in sub-section 2.1, the correlation coefficient of residuals becomes a measure of the comovement in bond returns after removing the influence of the three common external shocks.

[14] It is generally impossible to distinguish whether identical prices on consecutive days in a few cases reflect primary markets closure or infrequent trade of EMs bonds. In these cases we computed the inferred price between the last trading day and the opening day.

[15] The only interruption longer than one day took place in the aftermath of September 11, 2001, when markets were closed for four days.

[16] Weekly returns were also used by Cappiello, Engle and Sheppard (2006) to deal with the bias introduced by nonsynchronous trade in the correlation analysis of global equity and bond returns.

IV. MAIN RESULTS

We present first the evolution of an aggregate measure of the two indicators of market comovement and discuss the major emerging trends, namely the average of the rolling correlations across all 18 countries. We then analyze in detail the major episodes of market turmoil occurred in 1997–2008 using the framework described in Section 2.2.

A. Evolution of the Simple and Partial Cross-Country Average Correlations

Figure 2 below illustrates the evolution of aggregate correlations, simple and partial, as measures of the overall and excess comovement in EM bond markets.[17]

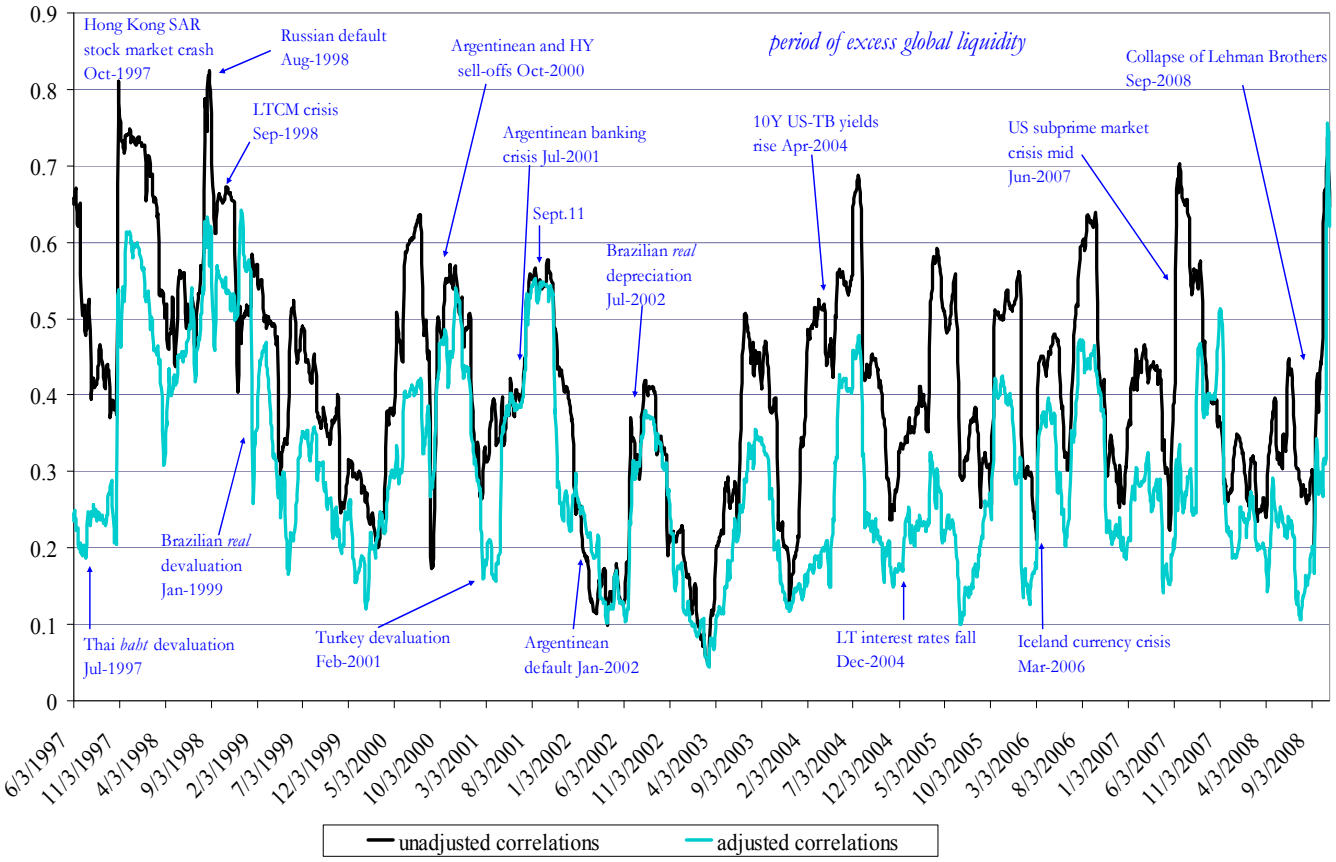
As a general feature, we note that the aggregate simple and partial rolling correlations are always positive, suggesting a tendency for individual country returns to move together. Annual average correlations are 0.56 in 1997, 0.59 in 1998, 0.41 in 1999, 0.43 in 2000, 0.42 in 2001, 0.24 in 2002, 0.27 in 2003, 0.45 in 2004, 0.43 in 2005, 0.41 in 2006, 0.43 in 2007 and 0.34 in 2008.

The large spikes in global average correlations in Figure 2 are usually associated with major episodes of financial markets turmoil and suggest a relatively low degree of investor discrimination during selloffs compared with more normal times. The main rises in correlations take place during the Hong Kong SAR stock market crash of October 1997, the Russian sovereign default in the summer of 1998, the selloff of Argentinean bonds and speculative corporate bonds in the U.S. HY market in 2000, and, more recently, during the summer 2007 and at the end of October 2008. These episodes highlight the importance of "crossover" investors, who tend to unwind their open positions in EMs during times of turmoil.

After 2000, the peaks in adjusted correlations associated to crisis episodes are considerably lower than the levels reached previously. At the same time, we can see a secular decline in the average values of $\hat{\rho}$ and ρ over most of the period, with a modest uptick seen only in the summer of 2007 in response to the liquidity events surrounding the U.S. sub-prime mortgage market. The decline is clearer in the case of $\hat{\rho}$. In fact, comovements in EM bond returns appear to be increasingly less specific to EMs and mainly driven by events taking place in mature markets, as showed by the widening gap between $\hat{\rho}$ and ρ since early 2003. This could be due to the general increase in liquidity and lower interest rates in global financial markets through early 2007, as well as the improved fundamentals in many EMs. The decline in correlations come to a halt during the fall of 2008 when the financial turmoil accelerated dramatically turning into a more acute crisis of confidence driven mainly by the failure of Lehman Brothers in mid-September 2008.

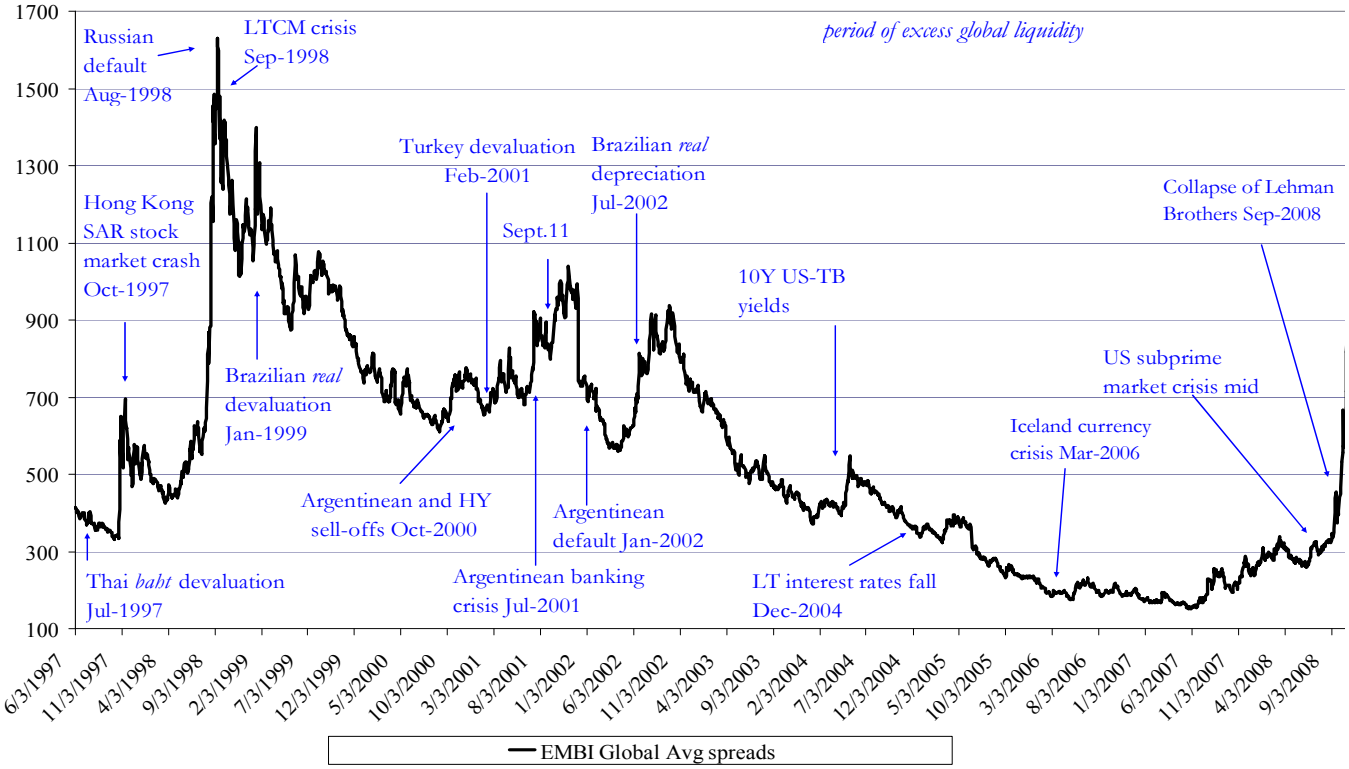
[17] Aggregate correlations were computed as the average of all 153 pairwise canonical correlations of the 18 countries within the sample over a 60-day rolling window.

Figure 2: Adjusted and Unadjusted Rolling Average Correlations



As mentioned in Section 2.2, an analysis of simple and partial correlations, together with sovereign spreads, can be useful in identifying the sources of comovement in bond returns. Figure 3 below shows the evolution of the EMBI Global average spread over the period under consideration. The all time high, of more than 1600 bps was reached during the Russian crisis and the LTCM collapse of 1998. The peaks of intermediate size are associated with systemic events taking place in mature or EMs: the Brazilian *real* devaluation of 1999 (spreads of around 1,100 bps), the Argentinean banking crisis of 2001, September 11, 2001 (spreads as high as 900 bps), and the Brazilian *real* depreciation of 2002 (spreads of around 800 bps). These trends seem to suggest better investor differentiation of the risks carried by EM bonds during this decade as compared with the 1990s. It is only during the fall of 2008 that the downward trend in spreads has been reversed, with spreads rising abruptly from 300 bps to around 900 bps from September to October 2008, as evidence of more indiscriminate selling among EMs.

Figure 3: EMBI Global Spreads



B. Application of the Conceptual Framework to the Period 1997–2008

We briefly analyze the evolution of $\hat{\rho}$ and ρ, as well as EM spread behavior, in connection with the key exogenous events that took place during the sample period.[18] Our aim is to identify the potential sources of risk and highlight the roles of global as well as country specific factors in explaining the comovements amongst EM returns.

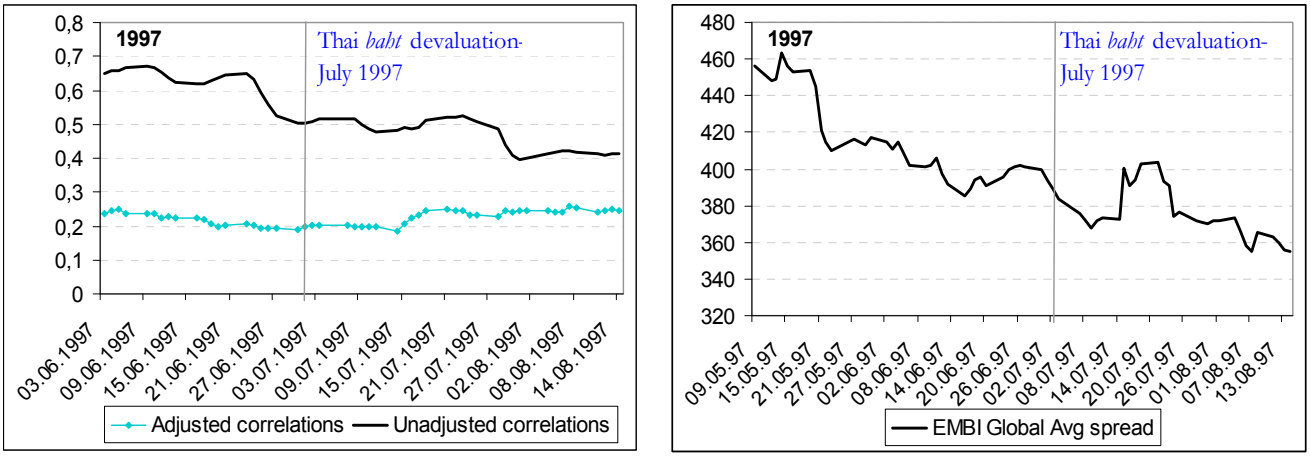
The Thai baht devaluation (July 2, 1997) seems to have had little impact on investors' attitudes towards EM bonds. From Figures 4a–b we can see $\hat{\rho}$, ρ and sovereign spreads decreased in the run-up to the crisis, suggesting this event was largely unanticipated by markets. This negative EM country–specific shock triggered a decrease in ρ but kept $\hat{\rho}$ at the same level, which indicates an absence of spillover effects to other EMs. Until October 1997, investors largely treated the Thai *baht* devaluation as an isolated event and did not anticipate a worsening of other countries' fundamentals.[19] The crisis was seen as a standard currency crisis whose origins were in the financial sector, and investors did not appear to anticipate that the currency crisis would affect

[18] Aggregate EM spreads were computed as a 60-day rolling average of EMBI Global spreads against the US-TB from 1998 through 2008. For 1997, EMBI+ spreads were used.

[19] Indeed, further to the Thai *baht* floating, contagion spread only to other Asian currency markets (devaluation of the Philippine *peso*, depreciation of the Singapore dollar in mid-July, free floating of the Indonesian *rupiah,* and speculative attack on the Hong Kong SAR dollar in August).

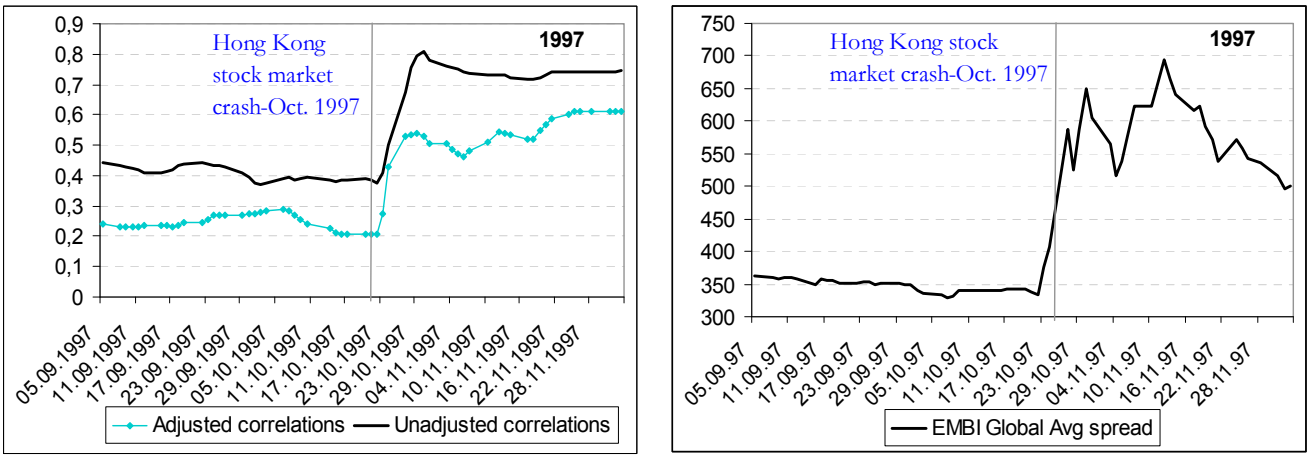
macroeconomic performance in Southeast Asia over the medium term. At the same time, favorable financial conditions at the international level (low interest rates) helped maintain the attractiveness of EM securities, viewed as highly profitable by global investors.

Figures 4a–b: The Thai Devaluation:
Evolution of Correlations and EM Spreads



The Hong Kong SAR stock market selloff (October 20–23, 1997) was a negative EM-country specific event that marked a reversal in the evolution of spreads and correlations. We note a change in investors' attitude towards risk some days before the crisis (by 100 bps, although spreads would rise by some 250 bps in the following three weeks—Figure 5b). Both correlation coefficients rose significantly after the crisis, with $\hat{\rho}$ more than doubling to a high of 0.6 a month later—Figure 5a. The increase in residual comovement in the aftermath of the stock market selloff points to contagion in EMs. The Hong Kong SAR event could thus be viewed as a clear example of significantly increased market comovement after controlling for the common external factors.

Figures 5a-b: Hong Kong SAR Market Crash:
Evolution of Correlations and EM Spreads

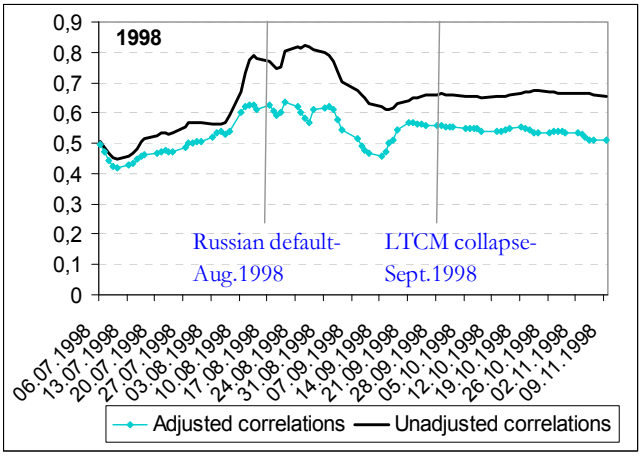


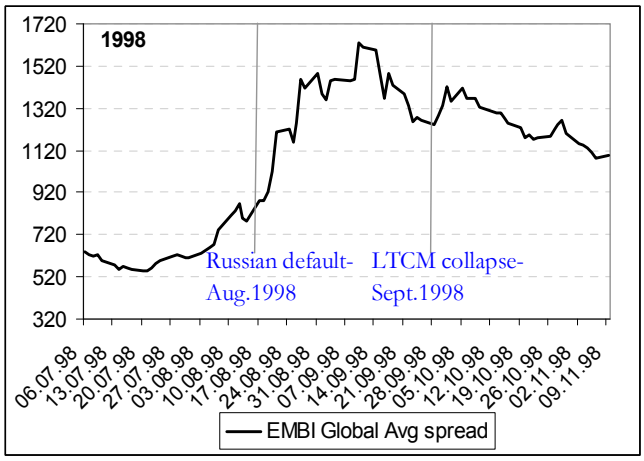
The surge in ρ with a peak of 0.8 at the end of October, together with wider spreads, shows that, starting with the Hong Kong SAR market crash, the Asian crisis became global. Indeed, Korea and Thailand's sovereign ratings were downgraded by S&P and the Dow Jones Industrial Average

declined by 554 points on October 27.[20] Equity markets in Brazil, Argentina and Mexico also saw their biggest single day losses at around that time.

The Russian default (August 17, 1998) and the LCTM crisis (September 27, 1998). The behavior of $\rho, \hat{\rho}$ and spreads in the run-up to the Russian default differs from those seen in the previous two episodes. Both correlation coefficients increased prior to the crisis and remained at high levels during the crisis—Figure 6a. A possible interpretation would be insufficient investor differentiation in the run-up to the crisis, followed by "herd behavior" during and after the crisis. High values of ρ and $\hat{\rho}$ prior to the Russian default point to risks to EM that could come either from mature markets (reflecting the global turbulent situation in the aftermath of the Asian crisis) or specific events taking place in Russia. The sovereign debt moratorium was a negative EM-specific shock and was followed by a significant rise in spreads and correlations. Spreads soared to an all-time high of around 1,600 bps in September 1998—Figure 6b—suggesting higher risk aversion towards the EM group as a whole.

Figures 6a-b: Russian Default and the Collapse of LTCM: Evolution of Correlations and EM Spreads





As in the case of the Hong Kong SAR stock market crash, this event originating in EMs had important spillover effects on both mature and EMs. Investors' "flight to quality and liquidity" in a context of increased uncertainty in financial markets led to indiscriminate selloffs of EM bonds. In September, the crisis affected stock markets of Latin America and exchange rates also came under pressure.[21] Banks, hedge funds, and other financial institutions in industrial countries started accumulating losses at this time. The situation worsened with the collapse of the U.S. Hedge Fund LTCM on September 27, 1998. Even if it were to be attributed to the liquidity dry up that followed

[20] This spillover into advanced markets, while strictly speaking a violation of our assumption of exogeneity of the global variables, is a rare event.

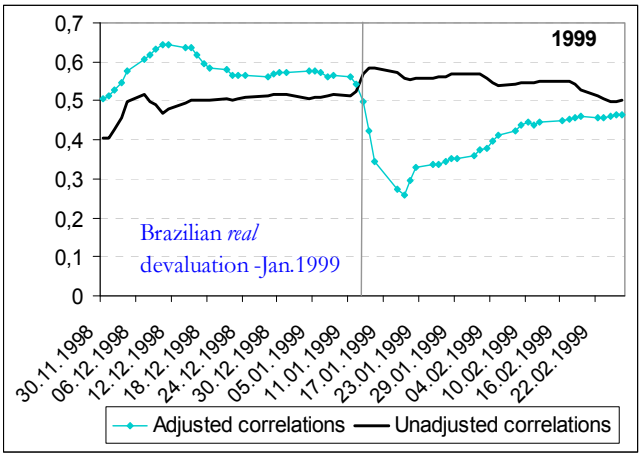
[21] Malaysia pegged its currency to the U.S. dollar and adopted capital controls; Colombia widened the exchange rate fluctuation band by 9 percent; interest rates in Brazil doubled, reaching 50 percent on September 10; short-term interest rates in Mexico peaked at 48 percent; the Chilean authorities proceeded to raise interest rate and allowed for more exchange rate flexibility; and whereas China tightened foreign exchange regulations.

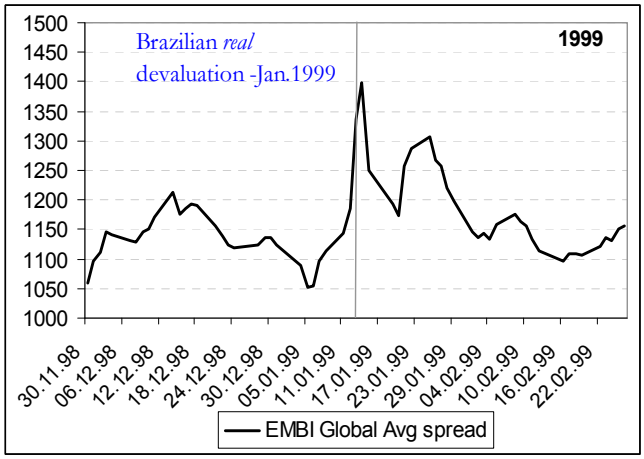
the Russian crisis, the LTCM collapse could explain the very high levels reached by spreads and simple correlation during the period.[22]

The Brazilian real devaluation (January 13, 1999) is characterized by an unusual configuration of correlations and spreads. Figure 7a shows that both correlations increased in the run-up to the devaluation, pointing to risks originating in EM and mature markets. However, $\hat{\rho}$ remained above ρ prior to devaluation. This indicates that the "true" comovement among EMs was strong but tended to be offset by the global factors. Indeed, the run-up to the Brazilian *real* devaluation was characterized by investors' loss of confidence (since the Russian crisis) on the sustainability of several EMs. On one hand, we have to bear in mind that the Brazilian crisis started towards the end of 1998 and that expectations about the abandonment of its tightly managed exchange rate arrangement and investors' exit from the EMs asset class occurred before the devaluation, as shown by the increase in $\hat{\rho}$. On the other hand, the confluence of shocks in mature markets, especially the interest rate cuts that followed the LTCM collapse may have dampened the impact of the crisis on the EM asset class.

In the aftermath of the Brazilian *real* devaluation, spreads and adjusted correlations ($\hat{\rho}$) decreased (see Figures 7a–b), pointing to a lack of spillover effects to the other EMs (i.e., investors discriminated between the crisis country and other EM assets). The increase in ρ, however, highlights the presence of another external event affecting the market comovement. One possible explanation is that events in Brazil further diminished global investors' risk appetite, which was already low in the aftermath of the Russian crisis.[23]

Figures 7a–b: Brazilian *real* Devaluation:
Evolution of Correlations and EM Spreads





From the end of the Brazilian currency crisis on, investors seem to have discriminated better between crisis-hit countries and the rest of the EM group. The upgrade of South Korea to BBB –

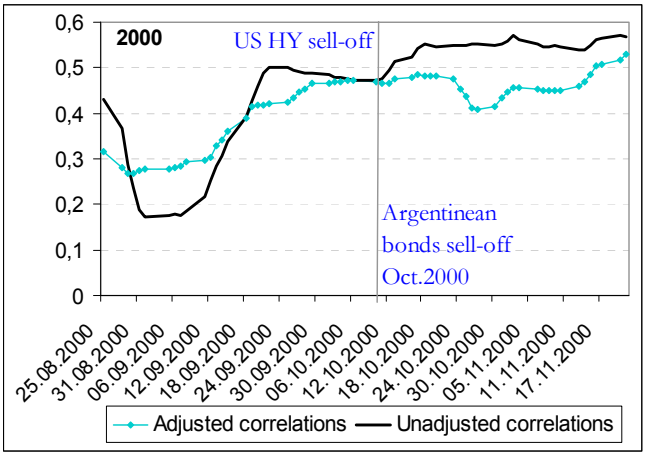
[22] It is worth noting that LTCM had previously announced (on September 2) annual losses of 52 percent. Nevertheless, news of the fund's increasing difficulties came to light well before this date.
[23] This would represent another instance in which the assumption of no feedback effect from EM to advanced countries does not hold.

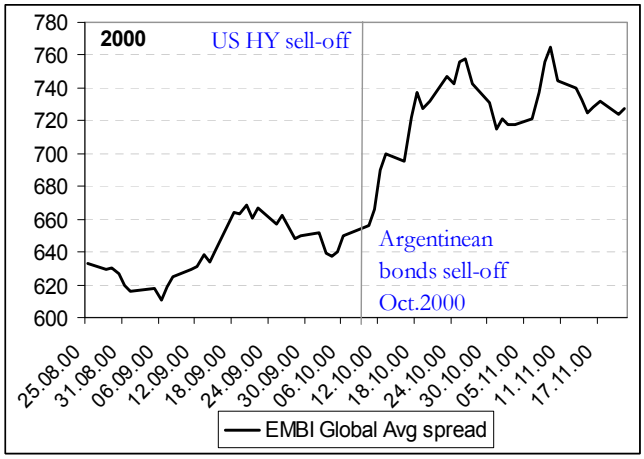
at end–January 2000 coincides with a stabilization trend in Asian financial markets. At the same time, high levels of ρ indicate a strong dependence of EM debt on global trends. Declining interest rates in major mature markets may have been the common shock that led to better investors' differentiation between potential borrowers (from Asia and Europe, for instance) once confidence had been re-established.

In the run-up to the ***Argentinean and U.S.–HY selloffs*** (October 2000)—and following a dip in both correlation coefficients—we notice a sharp increase in both $\hat{\rho}$ and ρ, which suggests that the risks of a broad-based selloff could have come either from EMs (e.g., fears about prospects for Argentina and Turkey) or from mature markets (e.g. global earnings slowdown, deterioration in U.S. credit markets, revision of expectations of U.S. monetary policy, poor performance of mature equity markets (Nasdaq), downgrading of the technology, media and telecommunications sector, etc).

The simultaneous occurrence of an adverse EM-country specific and a global shock triggered an increase in spreads and correlations in the aftermath of these events (see Figures 8a–b). This configuration indicates that global investors evaluated the default risk as being high. They tended to unload risky assets (risky corporate bonds or EM bonds) and moved up the credit quality spectrum toward safer assets (TB for instance).

Figures 8a–b: Evolution of Correlations and Spreads during the Argentinean and US-HY Selloff

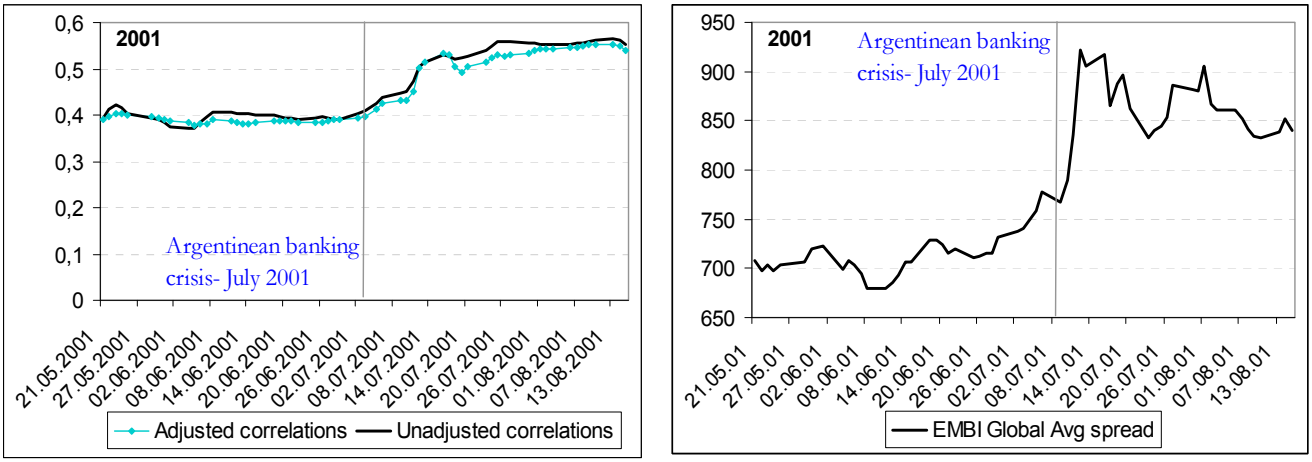




In the case of the ***Argentinean crisis*** of 2001, ρ and $\hat{\rho}$ moved hand in hand before, during and after the crisis. This suggests that global factors played no role in bond return correlations and, instead, that the risks to the EM class were seen as coming mainly from EM-specific events—mainly developments in the then highly correlated Argentinean and Brazilian debt markets. Actually, the favorable context of the monetary easing in the U.S., which should have benefited HY and EM bonds, had been overshadowed by credit concerns in particular EMs.

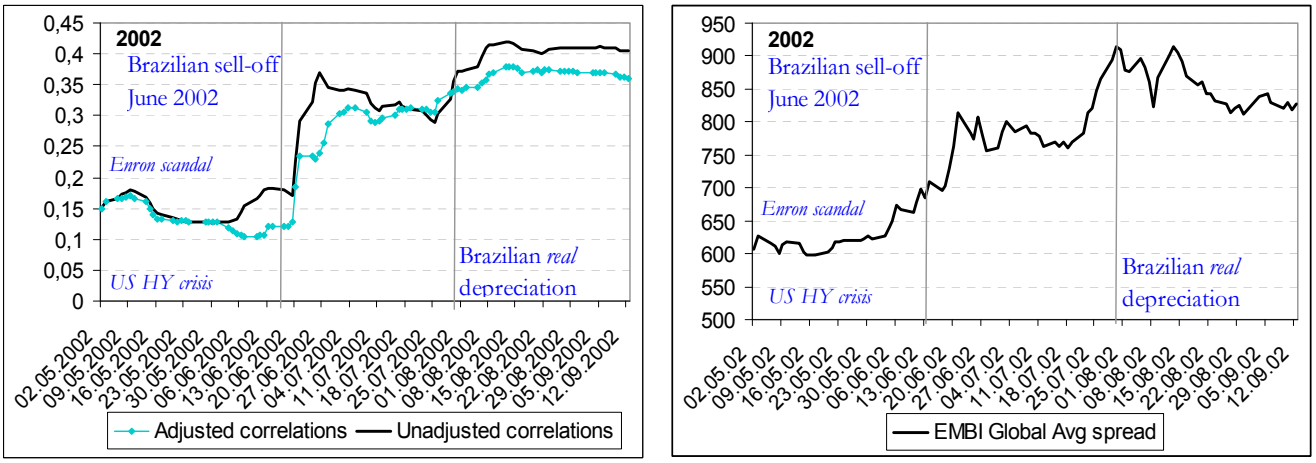
As Figure 9a shows, the Argentinean crisis is another case of increased market comovement in the post-crisis period. Following the onset of the banking crisis, fears about Argentina spread across EMs and generated a broad-based selloff, which is consistent with the simultaneous rise in $\hat{\rho}$ and EM spreads.

Figures 9a–b: Evolution of Correlations and Spreads during the Argentinean Banking Crisis



The ***Brazilian selloff*** (mid-June 2002) took place during a period of global turbulence in mature markets (***Enron scandal, US high-yield crisis***) and was preceded by spikes in both ρ and $\hat{\rho}$ (Figure 10a), reflecting concerns about both EMs (elections fears in Brazil and Turkey, concerns about Argentina's economic situation) and mature markets. The increase in both correlations since late May 2002 and EM spreads since late June 2002 (Figure 10b) indicates that global investors associated these events with higher overall risk of the portfolio. They tended to dump risky assets and move up in the credit quality spectrum towards TB. Similar trends are noticed one month later, in the aftermath of the ***Brazilian real depreciation*** (end of July 2002). Widening EM spreads coincide with the deterioration and increased volatility in global markets, whereas the rise in $\hat{\rho}$ indicates that factors specific to EMs may also have come to play a role.

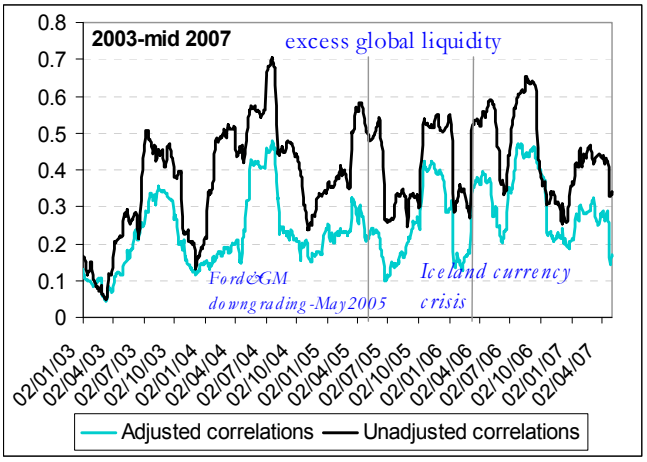
Figures 10a–b: HY Crisis, Brazilian Selloff and Devaluation: Evolution of Correlations and Spreads

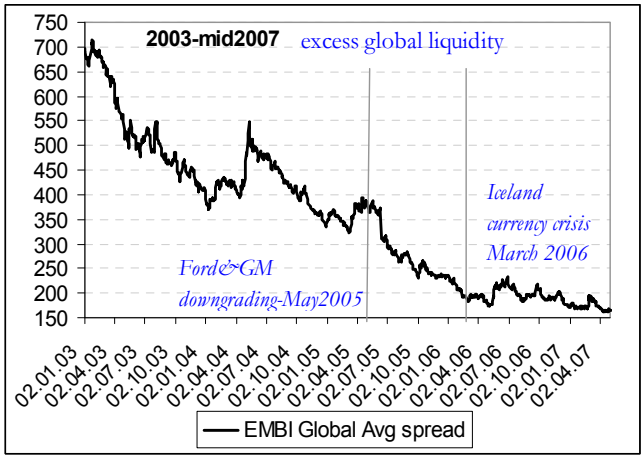


The period of what some have termed **"*excess global liquidity*"** in mature markets, starting roughly in 2003 and lasting until the summer of 2007, can be viewed in our model as a drop in the U.S. "safe" rate. This period is characterized by low spreads and low values for $\hat{\rho}$ (with the exception of the peaks in July 2003 in the aftermath of the Iraq war and the rise in oil prices or in July 2004, following the tightening of U.S. monetary policy) which indicates a lack of generalized EM

comovement and better investor discrimination (Figures 11a–b). This could be due to the upgrade of some emerging countries of the EMBI Global to investment grade (e.g., Mexico, Bulgaria, and Croatia) and to improved macroeconomic fundamentals. Sustained overall growth and strong exports enabled Asian and Latin American countries to record current account surpluses that have been used, in many cases, to repay external debt obligations and to build up foreign reserves. This period was also associated with a substantial improvement in the maturity structure and currency composition of public debt across many countries—see Chapter 3 of IMF (2006).

Figures 11a–b: Emerging Period of Excess Global Liquidity: Evolution of Correlations and Spreads

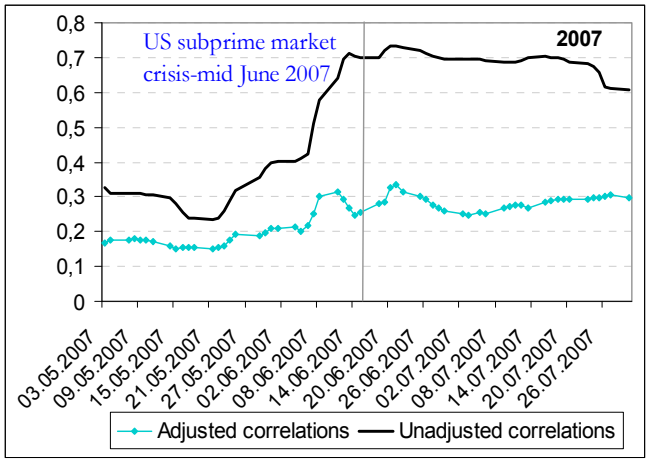


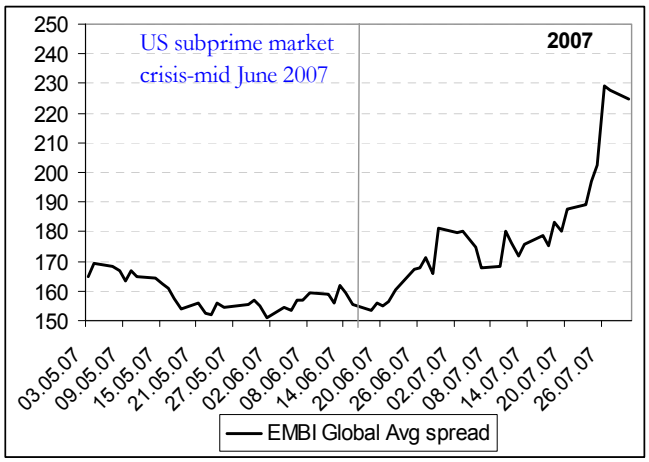


In the run-up to the ***U.S. sub-prime market crisis*** during the summer of 2007, we notice an increase in both correlations, much steeper for ρ than $\hat{\rho}$ (Figure 12a). As shown in Figure 12b, EM spreads rose significantly. These trends indicate that risks were coming mainly from mature markets, as confirmed by the widening gap between the two series following the events in June. Values of ρ reach the "crisis level" of 0.7 by the time the sub-prime fallout strikes mature markets in Europe and Japan. However, the values of $\hat{\rho}$ stay very low. The divergence in the values of ρ and $\hat{\rho}$ in the run-up to the crisis is in contrast with developments since the Hong Kong SAR stock market crises.

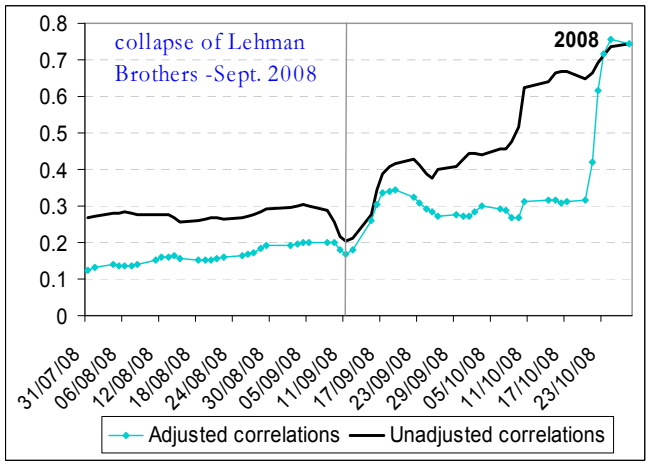
The events surrounding the ***collapse of Lehman Brothers in September 2008*** marked a turning point for EMs during the sub-prime related financial crisis. While both ρ than $\hat{\rho}$ were low in the preceding period despite the very virulent financial crisis in advanced economies, the second half of September marked a sharp rise in both correlations and spreads (see Figure 13a-b). The rise in ρ provides evidence of the role of the common external factor in affecting EM bond returns, especially as $\hat{\rho}$ did not rise as much. However, by late-October, $\hat{\rho}$ rose sharply suggesting, according to our framework, that investors' attitudes towards EM had become much less discriminating over time. Overall, the evidence indicates that the collapse of Lehman Brothers marked a turning point in the propagation of the financial crisis to EM bonds—see also Chapter 8 in IMF (2009).

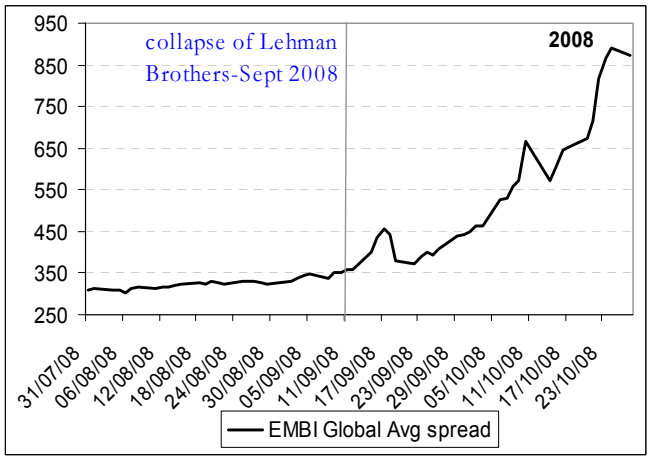
Figures 12a–b: U.S. Sub-Prime Market Crisis:
Evolution of Correlations and EM Spreads





Figures 13a–b: Collapse of Lehman Brothers:
Evolution of Correlations and EM Spreads





Of the events described in this section, three are characterized by increases in $\hat{\rho}$ to levels higher than 0.5 in the aftermath of the crisis: the Hong Kong SAR market crash of October 1997, the Russian crisis and LTCM collapse of 1998 and Argentinean banking crisis of 2001.[24] These cases represent the clearest examples of "pure contagion" in our sample, as the values of the correlation coefficients rise significantly denoting unusual levels of EM bond returns that are not correlated with external factors.

[24] The reference is to the average value of the correlations over the 30 working days following the relevant crisis. Two additional examples of "pure contagion" emerge if one lowers the threshold to 0.54: the Argentinean bond and US HY selloff of October 2000, and September 11, 2001.

V. CONCLUSION

In this paper we propose a simple conceptual framework for analyzing investors' attitudes towards risk in EMs. This framework, based on the evolution of EM spreads and aggregate correlations, allows us to identify the potential sources of risks to the EM class, distinguishing between external and country specific driven comovement.

Our analysis covers 18 out of the 33 EM countries included in the EMBI Global over the period March 1997 to the end of October 2008. In order to disentangle the roles of common external and idiosyncratic factors, we compute sample averages of bilateral correlations between EM's bond returns. Simple and partial correlations are calculated, in the latter case controlling for the impact of global factors: global liquidity (proxied by the yield of U.S. Treasury bills), and risk (proxied by HY corporate bonds and the Standard & Poor 500). The partial correlations are then treated as a measure of the excess-comovement of EM bond markets, or the comovement that is not explained by common external factors. Increases in this measure during episodes of financial market instability are interpreted as "pure contagion."

We find evidence of "pure contagion" in the cases of the Hong Kong SAR market crash of October 1997, the Russian crisis and the collapse of LTCM collapse in 1998, and the Argentinean crisis of 2001. We also find that partial correlations, as measure of "pure contagion," systematically decline from 1997 through early 2003. From then on they tend to fluctuate around a flat trend. At the same time, there is a widening gap between simple and partial correlations, which tends to suggest that, until the most recent financial crisis, the comovement of EM bond returns was driven to a lesser extent by specific EM developments and to a larger extent by external events. In other words, the period since 2003 can be characterized as exhibiting very low levels of "pure" contagion. The dramatic decline in EM spreads during this period can be attributed not only to global factors, but also to improving country fundamentals across the range of EM countries.

The extended period of low correlations appears to have ended in September 2008, coinciding with the financial turbulence associated with the collapse of Lehman Brothers. Both—first simple and subsequently partial—correlations rose sharply in the aftermath, indicating that the common global shock explained much of the rise in EM bond volatility initially, and that investors' discrimination across EMs diminished sharply in the period around late October 2008.

One final caveat is in order. The usefulness of the analysis based on average correlations depends on the assumption that the underlying distribution of bond returns is unimodal. If it is not, average correlations may mask the existence of clusters that exhibit, on average, low or no correlation between themselves but high correlations within the group. This phenomenon, usually referred to as "market tiering," may arise during certain periods and subsequently disappear. In a separate paper (Bunda, Hamann and Lall, 2005) we tested for the existence of market tiering during the period 1997–2005 and found some evidence of tiering but only for 2003–05: a high-variance group, which drove most of the comovement in the sample was made mainly of sub-investment grade bonds, whereas the low-variance group was composed of bonds rated as investment grade.

APPENDIX

Country	Index Weight March 1997	Index Weight October 2008 2/	Country	Index Weight March 1997	Index Weight October 2008 2/
Argentina	20.00%	0.86%	Panama	1.90%	2.28%
Brazil	19.20%	15.19%	Peru	1.30%	2.21%
Bulgaria	1.80%	0.52%	Philippines	2.90%	7.83%
Colombia	1.10%	3.37%	Poland	2.70%	1.37%
Croatia	0.60%	1/	Russia	6.30%	12.56%
Ecuador	1.30%	0.59%	South Africa	0.50%	1.09%
Malaysia	2.50%	2.88%	South Korea	7.50%	1/
Mexico	15.20%	13.56%	Turkey	0.90%	9.99%
Morocco	1.10%	1/	Venezuela	5.60%	6.73%
Latin America	***65.60%***	***54.15%***	***Europe, Middle East and Africa***	***13.90%***	***24.56%***
Asia	***12.9%***	***8.80%***			

1/ South Korea, Croatia, and Morocco bonds were dropped from the Index in May 2004, July 2004, and December 2006 respectively, while other countries not shown in the table (and not included in the analysis) have been added during the period.
2/ Regional weights in October 2008 include those of countries not listed in the table.

The EMBI global is a traditional, market capitalization-weighted index currently covering 31 EM countries. Included in the EMBI global are U.S. dollar denominated Brady Bonds, Eurobonds, traded loans and local market debt instruments issued by sovereign and quasi sovereign entities. It differs from its predecessor, the Emerging Markets Bond Index Plus (EMBI+) by the country selection criteria (the per capita income level as defined by the World Bank and the country debt restructuring history instead of selecting country solely on a sovereign credit rating basis). Precisely, EMBI Global includes countries classified as having low or middle per capita income by the World Bank or having restructured their external or local debt in the last 10 years or currently being in process of restructuring its external or local debt. By contrast, countries included in the EMBI+ must only be rated (BBB)/(Baa3) or lower by S&P and Moody`s. These two selection criteria allow the EMBI Global to include a number of higher rated countries that international investors have nevertheless considered part of the EM universe. The index considers for inclusion EMs issues denominated in U.S. dollars with a minimum current face outstanding of US$500 million and at least 2½ years to maturity at the time of the inclusion in the index. No additional liquidity tests are required as it is the case with the EMBI+.

The total return from one trading day to the next, on a single instrument included in the EMBI Global takes into account the bond price and the coupon payment (or/and amortization if applicable):

$$TR_t = \frac{ESV_{s(t)} + C_{v(t)} + AM_t}{ESV_{s(t-1)}} - 1$$

where $ESV_{s(t)}$ is the effective settlement value that is principally the bond price, $C_{v(t)}$ is the coupon payment to which a holder on trade date *t* is entitled on value date *v(t);* (i.e., the date used to compute the accrued interests and generally coincides, but not always, with the settlement date). The coupon payment is determined by the instrument structure, ex-coupon conventions and holiday calendar. AM_t is the bond amortization (if applicable), also determined by the instrument structure, ex-coupon

conventions and holiday calendar. The price of day ***i*** between the first day of market closure (denoted by ***k***) and the first day of market opening (denoted by ***n***, with $n>k$) is computed according to the relation:

$$R_i = R_{k-1} + \left(\frac{R_n - R_{k-1}}{n-k+1} \right) \cdot (i-k+1)$$

REFERENCES

Arora, Vivek and Martin Cerisola, 2001, "How Does U.S. Monetary Policy Influence Sovereign Spreads in Emerging Markets?" *Staff Papers*, International Monetary Fund, Vol. 48 (3), pp. 474–98.

Baig, Taimur and Ilan Goldfajn, 1999, "Financial Market Contagion in the Asian Crisis," *IMF Staff Papers*, International Monetary Fund, Vol. 45 (2), pp. 167–195.

Bekaert, Geert, Campbell R. Harvey, and Angela Ng, 2005, "Market Integration and Contagion," *Journal of Business*, Vol. 78 (1), pp. 39–69.

Bunda, Irina, A. Javier Hamann, and Subir Lall, 2005, "Comovements in Emerging Market Bond Returns: An Empirical Assessment," paper presented at the Emerging Markets Finance–The Journal of International Money and Finance Conference, Cass Business School, City of London, UK, May. Available via the Internet: http://www.cass.city.ac.uk/conferences/emg_finance/thursday_5th_may.html).

Calvo, Sara and Carmen M. Reinhart, 1996, "Capital Flows to Latin America: Is There Evidence of Contagion Effects?" in *Private Capital Flows to Emerging Markets after the Mexican Crisis*, ed. by Calvo, Goldstein, and Hochreiter (Washington: Institute for International Economics).

Cappiello, Lorenzo, Robert F. Engle, and Kevin Sheppard, 2006, Asymmetric Dynamics in the Correlations of Global Equity and Bond Returns," *Journal of Financial Econometrics*, Oxford University Press, Vol. 4 (4), pp. 537–572.

Chakravorti, Sujit and Subir Lall, 2004, "Managerial Incentives and Financial Contagion," IMF Working Paper 04/199, (Washington: International Monetary Fund).

Choe, Hyuk, Bong-Chan Kho and Rene M. Stulz, 1999, "Do Foreign Investors Destabilize Stock Markets? The Korean Experience in 1997," *Journal of Financial Economics,* Vol. 54, pp. 227–264.

Chou, Ray Yeu-Tien, Victor Ng and Lynn K. Pi, 1994, "Cointegration of International Stock Market Indices," IMF Working Paper 94/94, (Washington: International Monetary Fund).

Christie William and Roger Huang, 1995, "Following the Pied Pier: Do Individual Returns Herd around the Market?" *Financial Analysts Journal,* Vol. 51 (4), pp. 31–37

Corsetti, Giancarlo, Marcello Pericoli, and Massimo Sbracia, 2005, "Some Contagion, some Interdependence: More Pitfalls in Tests of Financial Contagion," *Journal of International Money and Finance,* Vol. 24 (8), pp. 1177–99.

Edwards, Sebastian, 1998, "Interest Rate Volatility, Contagion and Convergence: An Empirical Investigation of the Cases of Argentina, Chile and Mexico," *Journal of Applied Economics* Vol. 1 (1), pp. 55–86.

Forbes, Kristin and Roberto Rigobon, 2001, "Measuring Contagion: Conceptual and Empirical Issues in Financial Contagion," in *International Financial Contagion*, ed. by Claessens and Forbes (Boston,: Kluwer Academic Publishers).

_____, 2002, "No Contagion, only Interdependence: Measuring Stock Market Comovements," *The Journal of Finance*, Vol. LVII (October), pp. 2223–2261.

Frankel, Jeffrey and Sergio Schmukler, 1998, "Crisis, Contagion and Country Funds: Effects on East Asia and Latin America" in *Managing Capital Flows and Exchange Rates,* ed. by Glick (Cambridge, UK: Cambridge University Press).

Goldstein, Morris, 1998, *The Asian Financial Crisis: Causes, Cures, and Systematic Implications*, (Washington, Institute for International Economics–Policy Analysis in International Economics).

International Monetary Fund, 2009, *Global Financial Stability Report*, April 2009, (Washington).

_____, 2006, *Global Financial Stability Report*, April 2006, (Washington).

_____, 2001, *Emerging Market Financing*, (Washington).

Jeanne, Olivier, 1997, "Are Currency Crises Self-fulfilling? A Test," *Journal of International Economics,* Vol. 43, pp. 263–86.

Jeanne, Olivier and Paul R. Masson, 2000, "Currency Crises, Sunspots and Markov-Switching Regimes," *Journal of International Economics,* Vol. 50 (2), pp. 327–350.

Kaminsky, Graciela and Sergio Schmukler, 1999, "What Triggers the Market Jitters? A Chronicle of the Asian Crisis," *Journal of International Money and Finance,* Vol. 18, pp. 537–60.

Kim, Woochan and Shang-Jin Wei, 2002, "Foreign Portfolio Investors Before and During a Crisis," *Journal of International Economics*, Vol. 56, pp. 77–96.

King, Mervyn A. and Sushil Wadhwani, 1990, "Transmission of Volatility between Stock Markets," *Review of Financial Studies,* Vol. 3(1), pp. 5–33.

Kumar, Manmohan S. and Avinash Persaud, 2001, "Pure Contagion and Investors' Shifting Risk Appetite: Analytical Issues and Empirical Evidence," IMF Working Paper 01/134, (Washington: International Monetary Fund).

Lakonishok, Josef, Andrei Shleifer and Robert W. Vishny, 1992, "The Impact of Institutional Trading on Stock Prices," *Journal of Financial Economics*, Vol. 32, pp. 23–44.

Lee, Sang-Bin and Kwang-Jung Kim, 1993, "Does the October 1987 Crash Strengthen the Comovement among National Stock Markets?" *Review of Financial Economics*, Vol. 3 (1), pp. 89–102.

Lin, Wen-Ling, Robert F. Engle and Takatoshi Ito, 1994, "Do Bulls and Bears Move across Borders? International Transmission of Stock Returns and Volatility," *Review of Financial Studies*, Vol. 7, pp. 507–538.

Lo, Andrew W. and A. Craig MacKinlay, 1988, "Stock Market Prices do not Follow Random Walks: Evidence from a Simple Specification Test," *Review of Financial Studies*, Vol. 1 (1), pp. 44–66.

Martens, Martin and Ser-Huang Poon, 2001, "Return Synchronization and Daily Correlation Dynamics between International Stock Markets," *Journal of Banking and Finance*, Vol. 25, pp. 1805–27.

Masson, Paul R., 1999, "Contagion: Macroeconomic Models with Multiple Equilibria," *Journal of International Money and Finance*, Vol. 18 (4), pp. 587–602.

Miller, Merton, Jayaram Muthuswamy and Robert. E. Whaley, 1994, "Mean Reversion of Standard and Poor 500 Index Basis Changes: Arbitrage-induced or Statistical Illusion?" *Journal of Finance*, Vol. 49, pp. 479–513.

Park, Yung Chul and Chi-Young Song, 1999, "East Asian Financial Crisis: One Year After," *IDS Bulletin (Institute of Development Studies, University of Sussex, Brighton, U.K.),* Vol. 30 (1), pp. 93–103.

Pindyck, Robert S. and Julio J. Rotemberg, 1990, "The Excess Comovement of Commodity Prices," *The Economic Journal*, Vol. 100, pp. 1173–89.

_____,1993, "The Comovement of Stock Prices," *Quarterly Journal of Economics,* Vol. 108 (4), pp. 1073–1104.

Ronn, Ehud I., 1998, "On the Relationship between Expected Returns and Implied Volatility of Interest Rate Dependent Securities," *Journal of Portfolio Management*, 4, pp. 93–109.

Valdés, R., 1997, "Emerging Market Contagion: Evidence and Theory," Working Paper No. 007 (Santiago: Central Bank of Chile).

Yoon, Gawon, 2005, "Correlation Coefficients, Heteroskedasticity and Contagion of Financial Crises," *The Manchester School*, Vol. 73(1), pp. 92–100.