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Country Insurance Using Financial Instruments

Yuanyan Sophia Zhang, Marcos Chamon, and Luca Antonio Ricci

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Prepared by Yuanyan Sophia Zhang, Marcos Chamon, and Luca Antonio Ricci[1]

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Abstract

The availability of financial instruments related to indices that track global financial conditions and risk appetite can potentially offer countries alternative options to insure against external shocks. This paper shows that while these instruments can explain much of the in-sample variation in borrowing spreads, this fails to materialize in hedging strategies that work well out-of-sample during tranquil times. However, positions on instruments such as those tracking the US High Yield Spread, the VIX, and especially other emerging market CDS spreads can substantially offset adverse movements in own spreads during times of systemic crises. Moreover, high risk countries seem to gain more, as their underlying weaknesses makes them more vulnerable to external shocks. Overall, the limited value in tranquil times, coupled with political economy arguments and innovation costs could justify the limited interest for this type of hedging in practice

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Author's E-Mail Address: yzhang@imf.org; mchamon@imf.org; lricci@imf.org

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I. INTRODUCTION

As emerging market economies become more economically and financially integrated into the global economy, they also become more vulnerable to exogenous shocks, such as sudden stops, global liquidity crunches, and terms of trade movements. Such shocks may trigger sudden tightening of external financing constraints, thus exposing countries to volatility of access to external capital and possible financial crises, which could impose large welfare costs on these economies. The recent global crisis has shown that even advanced economies are not immune to such financing constraints.

The problem is well recognized, but there is less consensus on the solution to adequately manage such risks. The main tools at the country's disposal are the choice of its liability composition (e.g. short-term versus long-term debt, local versus foreign currency debt) and the accumulation of international reserves. The latter has increasingly become an important additional source of self-insurance: even excluding China, numerous emerging markets have accumulated sizable amounts of reserves, both before and after the global financial crisis. One, largely unexploited tool is hedging through financial instruments, such as derivatives related to global financing (even available commodity options are not widely used).

In the recent years, an increasing number of such financial instruments have been emerging, offering opportunities for countries to insure against their external liability risks using "nontraditional" approaches, in spite of some operational costs and political challenges. It is easy to conceive that markets for additional financial instruments could develop. GDP-indexed bonds or contingent credit lines could help countries absorb or prevent crisis**.** Options and other derivatives related to indicators of global financial conditions could in principle offer protection to countries sensitive to global risks. For example, Caballero and Panageas (2008) suggest that emerging markets could use options on advanced economies' market volatility indices (such as VIX), to the extent sudden stops or balance of payment crisis are correlated with such indices. More generally, a broader set of financial instruments could be considered. For example, put options on large advanced economies' stock market indices (such as the S&P 500) could offer protection against risk. Interest rates of the U.S. and other advanced economies are also correlated with financing conditions for emerging markets (either when rates drop sharply, indicating distress in the advanced world, or when they rise quickly, drying liquidity from emerging markets). Spreads on US high-yield corporate bonds tend to be correlated with the spreads faced by emerging markets. Finally, one could even consider strategies where a country hedges by taking positions on the spreads of other countries.

With respect to adverse terms of trade shocks, commodity derivatives could help offset their negative effects on the economy. For example, an exporter can hedge against a decline in the commodity price via put options. If the country is prepared to pay the option premium it can retain the potential benefit from an increase in price. Alternatively it can finance the put options by selling call options limiting the upside potential from higher commodity prices (a "collar" strategy). For oil, and perhaps some other major commodities, the derivatives markets—especially when combining both the organized exchange and the over-the-counter markets—are likely to be deep enough to accommodate the hedging that most countries might potentially desire, even a few years ahead[2].

There is a large literature relating variations in emerging markets' credit flows to changes in global conditions. In a classic paper, Calvo, Leiderman and Reinhart (1993) show that capital flows to Latin America were influenced by the U.S. cycle and international interest rates. But the evidence of US interest rate influence on EMBI spreads is more mixed.[3] Gonzalez-Rozada and Levy-Yeyati (2008) find that a large fraction of the variability of emerging market bond spreads is explained by the VIX and the U.S. high yield corporate spread (HYS). Longstaff, Pan, Pedersen, and Singleton (2010) apply a Principal Component Approach (PCA) on CDS spreads of 23 EM countries. They find that the first principal component accounts for more than 47% of the total variations while the first three principal components account for more than 65%. Maier and Vasishtha (2008) suggest that the first and second principal components of a group of emerging markets' EMBI spreads are driven by global risk indicators such as the S&P500, the VIX, the US yield curve, and oil prices. Ozatay, Ozmen and Sahinbeyoglu (2009) regress the daily changes of EMBI spreads on a vector of foreign and domestic variables, using panel cointegration and an error correction approach. They find that VIX and US high-yield spreads, measuring global liquidity conditions and risk appetite, appear to have comparable impact on the EMBI spreads as the domestic fundamentals (e.g. fiscal position).

In this paper we explore whether this correlation between country spreads and global financial conditions can be used to construct an effective hedging strategy. More precisely, we analyze and quantify the extent to which positions on a set of financial instruments that correlate with the global financial conditions can help lower the volatility in emerging market spreads, and the probability of negative tail events (spikes in spreads). Among the instruments considered are indices for the VIX, the S&P 500, US high yield spreads, US term spreads, and commodity prices. The hedging strategies considered focus on minimizing the variance and different Lower Partial Moments

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[2] For example, in the case of oil, buying options covering tens of billions of U.S. dollars of nominal value is not likely to move the market.

[3] For example, Dailami et al. (2005) find that the impact of US interest rates (particularly long term rates) and high-yield spreads increases with the level of indebtedness of the borrowing country and also depends on contagion effects. Kamisky and Schmukler (1999) find that changes in US short-term interest rates increase country spreads and the impact is more severe in countries with lower credit ratings. However, Kamin and Von Kleist (1999) and Eichengreen and Mody (2000) find that the effect of US interest rates on newly-issued bond spreads are either statistically insignificant or negative.

(LPM) of the hedged spreads. Among the lower partial moments considered are the probability of a tail realization (2 standard deviations from mean), and the mean and variance of (hedged) spreads at that tail. Our results suggest a strong in-sample performance, which is consistent with the literature reviewed above. However, the out-of-sample performance is much poorer. During tranquil times these strategies yield limited gains, if any (and often times the hedging actually adds risk to the spreads). However, these tend to pay-off during spikes in global risk aversion (e.g. late 2008/early 2009), Thus, these strategies seem to be more useful for protection against tail events than for smoothing ongoing volatility of spreads. These results may help explain the limited interest for pursuing this type of strategy in practice, to the extent governments may be unwilling or find it hard to convince the electorate to use budgetary resources to buy protection against events they will not be blamed for.

The remainder of this paper is organized as follows. Section II describes the data. In section III, we identify the risk factors underlying countries' borrowing cost using the principal component and panel regression approach. Section IV describes the methodology for the different hedging strategies considered. Section V calculates the hedge ratios and presents the results. Section VI concludes.

II. Data and Hedging Strategies

We use EMBI and emerging markets' CDS spreads to measure countries' cost of borrowing. Conceptually, CDS spreads are a better measure since they are more standardized and liquid (EMBI spreads are based on an average of globally traded bonds, whose duration varies across countries). However, data on CDS spreads only starts in the early 2000s for most countries. Hence, we splice changes in EMBI spreads with those in CDS spreads starting from the date when the latter become available. Henceforth, country spreads used in our analysis refer to such EMBI-CDS spliced series. EMBI Global Index Stripped Spreads (GISS), available for 21 countries[4], are obtained from JP Morgan, and the 5-year CDS spread quotes are from Bloomberg.

We use the following indices to capture the global liquidity risks: VIX index, changes in the SPX index, US high yield corporate bond spreads (HYS), and US 10 year government bond spreads. These indices are described more in detail below. We also construct an index of emerging market spreads by averaging the EMBI spreads of all the sample countries excluding the country for which it is being used as a hedger. Such an index is relevant for the strategy that takes long positions in other emerging market CDX indices. We refer to this index as EMBICDX. Note that instruments such as VIX and HYS

[4] Argentina, Brazil, Bulgaria, Chile, China, Colombia, Ecuador, Korea, Hungary, Lebanon, Malaysia, Mexico, Panama, Peru, Philippines, Poland, Russia, South Africa, Thailand, Turkey, Venezuela. EMBI Global Index Stripped Spreads are constructed by averaging spreads on globally issued bonds that are dominated in USD and meet certain liquidity requirements.

capture mainly the global risks, while EMBICDX relates more directly to EM-specific risks.

The VIX index measures the volatility on the S&P 500 index implied by near the money options. There is not a spot market for this index. Trading is based on futures, which started trading in 2005 and settle on a monthly basis. The actual implementation of the hedging strategy would be based on the futures of the index, for example, buying a September contract in August, rolling into an October contract in September, and so on. Data on futures is available through the CBOE, and S&P has launched a total return index for such rolling strategy. Since the limited sample of futures data prevents us from meaningfully accounting for the costs of this strategy, we will assume that the country can take a derivative position on an index which pays a monthly return and is sold at a price that implies an expected return equal to the risk-free rate. This is clearly an unrealistic assumption, but will help us construct an upper-bound for the hedging demand (since we are assuming actuarially fair pricing for insurance that in practice tends to have significant costs given its systemic nature and lack of natural counterparties). The correlation between changes in the VIX index and the returns on the rolling future strategy is 0.69. The average bid ask spread for VIX futures is on average 27 basis points (which could add up to a substantial cost with monthly roll-over).

U.S. High Yield (HY) Bond Spreads are obtained from Bloomberg and calculated on the basis of the respective IBOXX CDX indices (constructed from the 125 most liquid corporate bond CDS). One can trade the US High yield CDX index whose return mimics the US high yield bond spreads. The main index for credit derivatives is the Dow Jones CDX index, which also offers region- and sector-specific sub-indices, including the US HY CDX. There is an active over-the-counter (OTC) market for these indices, which uses instruments such as total return swaps, credit default swaps, credit options, and credit-linked notes to trade the credit index. The actual returns on the US HY CDX index are different from the changes of the underlying spreads, because of nonlinearities in the formula for the former. However, since the US HY CDX index became tradable only from the beginning of 2004, and was highly correlated with the actual changes in the high yield spread (the correlation between monthly changes in the HY spread and returns on the HY CDX index is 0.67 in our sample) we will use the latter to test the hedging performance. The bid-ask spread for CDX index is on average 17 basis points. We abstract from this transaction cost in our analysis, therefore our results can be thought of as an upper-bound on how much hedging would be purchased.

The US term spread is measured by the spread between the 10 year government bond rate and the 3 month T-bill rate. The actual hedging strategy can simply be replicated by a standard swap and the return can be tracked by the FTSE interest rate swap index.

The Dow Jones Emerging market CDX index is readily available for trade, but in the strategy we consider, each country would exclude its own contribution to the index used for hedging. Hence, as discussed above, our EMBICDX hedger for a given country is calculated based on the average change in CDS spreads (EMBI spread if a CDS spread is not available) of all the countries in our sample excluding the country itself. This mimics the strategy of taking long positions in other emerging market countries' CDX indices. Major commodity exporters and importers may consider hedging for commodity shocks. We consider three major commodities: oil, gold, and copper. The hedging strategy considered is based on constantly rolling-over 1 month futures, with the returns measured by the S&P GSCI total return indices for the corresponding commodities.

Of course, other strategies could be considered. For example, we choose not to analyze option-based strategies, as we wanted the hedging positions to have a zero net cost (options would normally entail a cost or greater risk for the country). More importantly, the bid/ask spreads associated with options are often large, and the hedging strategies would become very costly (for example, bid-ask spreads for at-the-money VIX options are on the order of 5-10 percent). We do not consider hedging based on shorting SPX, as such strategy would be prohibitively expensive in expectation, and is also a poor hedger of asymmetric risks (which could be hedged with puts, but that would become even more expensive).

III. Preliminary Test

A. Principal Component Analysis

Unit root tests suggest that EMBI spreads, as well as returns on hedgers are not stationary (as expected). We take monthly differences of all the spreads, and log differences of the level variables, including VIX, SPX and oil prices. The first principal component on the monthly changes of the country spreads for 26 EMs explains about the 48 percent of the total variation. The first three principal components account for about 64 percent of the total variation, which is consistent in magnitude with the results of Longstaff et al (2008). Table 1 reports the results of a regression of these principal components on the returns of different hedging instruments. The first four columns reports univariate regression coefficients for the first four factors and only the first factor correlates with hedgers. We focus on the first factor. As one expects, liquidity risks in the global stock market and corporate bond market implied by the VIX and high yield spread movements are positively correlated, while stock market returns and the U.S. government bond yield are negatively correlated with spreads. Negative signs for oil prices reflect the fact that higher oil prices are considered as negative shocks to most EMs which are mostly oil importers. The movements in our hedgers tend to be highly correlated with each other. The last column reports the results from a multivariate regression of the common factor on these series. Only the stock returns, HY spread, and U.S. yield remain significant, while the effect of oil seems to be captured by movements in these three financial indicators.

Table 1. Principle Component Analysis

	Univariate Regression				Multivariate
	F1	F2	F3	F4	F1
VIXreturn	0.0011***	0.0002**	-0.0001	0.0000	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
SPXreturn	-0.0049***	-0.0004	-0.0000	0.0000	-0.0028***
	(0.0004)	(0.0003)	(0.0002)	(0.0001)	(0.0008)
HYSreturn	0 .0264***	-0.0019	0.0385	0.0016	0.0185***
	(0.0021)	(0.0014)	(0.0005)	(0.0010)	(0.0038)
FED10Yreturn	-0.0244**	-0.0025	-0.0031	-0.0024	0.0163*
	(0.0099)	(0.0044)	(0.0036)	(0.0033)	(0.0087)
OILreturn	-0.0008***	0.0003***	-0.0001	-0.0000	-0.0002
	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Total Observations	128	128	128	128	128
Adjusted R-squared					0.7169

Notes: The comovement of the preads of 21 emerging market economies can be mostly explained by the first three principal components (64%). We use the monthly data that cover the sample period from 1993M1 to 2009M6. VIXreturn: monthly return on VIX index; SPXreturn: monthly return on SP500 index; HYSreturn: monthly change of US HY bond spread; FED10Yreturn: monthly change of US 10 year bond spread; OILreturn: monthly return of oil. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively, in two-tail tests. Standard deviations of coefficients are in the paranthesis.

B. Panel Regression Analysis

Table 2 presents a panel regression for the country spreads using the hedgers as explanatory variables. In addition to the global variables from the last section, we also introduce an average of EM spreads (excluding the own country) as one of the country-specific hedging strategies (EMBICDX).

Columns 1-5 of Table II report univariate regressions results with the expected sign for all variables. In multivariate regressions, EMBICDX remains highly significant after controlling for all the other variables that capture the global risk factors (column 6). That is, other country spreads remain informative even after we control for a host of global risk factors that affect EM spreads. Column 7 introduces changes in commodity prices interacted with an export dummy to allow for different effects on importers and exporters. The results suggest a limited explanatory power for commodity prices (with the coefficients either not being statistically significant, or having the "opposite" sign). This result is consistent with Becker et al (2007), which show that while terms of trade shocks are important for developing countries, but they are less so for emerging markets.

In columns 8 and 9 we interact the hedgers with a dummy for whether the country is "high" or "low" risk (average spread in our sample above or below 500bp).[5] As expected, the spreads in riskier countries tends to be more sensitive to changes in global risk conditions.

Appendix Table I is analogous to Table II but uses the log change in country spreads as the dependent variable (as opposed to the level change). The results are similar, and tend to be more statistically significant.

IV. Hedging Approach

Let $\Delta spread_t$ denote the change in country spreads. Suppose that a country takes a position θ on a hedging instrument with return r_t, such that the change to its cost of borrowing becomes $\Delta spread_t + \theta r_t$, where we assume, for simplicity, that $E_{t-1} r_t = 0$.[6]

We consider two objective functions: variance minimization, and lower partial moment (LPM) attenuation. Under variance minimization the country solves the following problem:

$$\theta_{\text{var}} = \arg\min VAR[\Delta spread_t + \theta_{\text{var}} r_t] \tag{1}$$

The optimal hedging can be obtained by estimating the regression below using OLS, so that $\theta_{\text{var}} = -\beta$:

$$\Delta spread_t = \alpha + \beta r_t + \varepsilon_t \tag{2}$$

Using the LPM approach, the country seeks to minimize the expected value of an increasing function of tail realizations for its hedged spread. It solves:

$$\begin{aligned} \theta_{LPM} &= \arg\min L\left(c, n, m_f\right) \\ &= \arg\min \int_c^{\infty} m_f{}^n dF\left(m_f\right) \\ where \quad & m_f = \Delta spread_t + \theta_{LPM} r_t - c \end{aligned} \tag{3}$$

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[5] The "high" average spread countries are: Argentina, Brazil, Bulgaria, Ecuador, Russia, Turkey, and Venezuela. The "low" average spread countries are: Chile, China, Colombia, Hungary, Korea, Lebanon, Malaysia, Mexico, Panama, Peru, South Africa, and Thailand.

[6] This assumption greatly simplifies our problem. If the hedging position was costly (as opposed to self-financed), then a more complicated setting would be required to determine how much the country would demand for that hedging. But in this setting, we only have to worry about how it co-moves with the spread.

Where d_f is a probability density function for the return on the hedged spread, c is a threshold which is set at the country-specific mean plus two standard deviations, and n is a parameter that makes the loss function more costly on tail events. We will consider alternative values for this parameter: n=0, 1, or 2. When we set $n=0$, the objective function amounts to minimizing the tail probability (probability that change in hedged spreads is beyond country-specific threshold c). When we set n=1, the objective function minimizes the mean of the tail. Finally, for n=2, the objective function minimizes the variance of the tail. Note that the higher n, the more the objective function will be driven by extreme realizations (which can also raise over-fitting concerns).[7] The country could choose n on the basis of its degree of risk aversion. A higher risk-aversion at tail events would justify larger values for n.

The distribution function F is estimated non-parametrically using the data over the whole sample. The benefit of nonparametric estimation is that no specific functional form needs to be assumed. Given the fat tail and negative skewness of the distribution, the nonparametric approach gives more flexibility in distribution estimation. Minimizing $L\left(c,n,m_f\right)$ is equivalent to minimizing $E\left[\max\left(0,m_f-c\right)^n\right]$. Thus the optimal hedge ratio θ_{LPM} satisfies the following first order condition:

$$-nE\left\{\left[\max\left(0,\Delta spread_t+\theta_{LPM}*r_t-c\right)\right]\right\} \tag{4}$$

It can be shown that the second order condition is always satisfied when $n\geq 2$. Equation (3) indicates that θ_{LPM} is a function of c and n, but, as shown by Lien and Tse (2001), the effects of n and c on θ_{LPM} is not determined. In the ideal situation when the joint distribution of r_t and $\Delta spread_t$ is known, we can apply numerical methods to find the optimal hedge ratio. However, empirically, the true distribution of r_t and $\Delta spread_t$ is unknown and must be estimated. Following Lien and Tse (2000), we estimate the distribution of the portfolio return m_f for any given θ. Specifically, for a given θ, we construct the data series for m_f from the data of r_t and $\Delta spread_t$ and then apply the nonparametric methods to estimate the distribution of m_f. The details are as follows. Let $g(.)$ be a smooth probability density function. Suppose we have a random sample of N observations of m_f: $m_1, m_2, \ldots, m_N$, calculated for a given θ. Using the kernel method, the probability density of m_f, denoted by f_y is estimated using

$$f(y)=\frac{1}{Nh}\sum g\left(\left(y-m_i\right)h\right) \tag{5}$$

[7] Note that if we were to set c=-∞, the LPM and the variance minimization problems would be the same.

where h is the bandwidth. Silverman (1986) suggested that the choice of the kernel function has minimal effects on the density estimates; hence we choose $g(.)$ to be standard normal:

$$g(z) = (2\pi)^{1/2} \exp\left(-\frac{z^2}{2}\right) \tag{6}$$

and LPM is estimated using

$$L(c,n,m_f) = \int_c^{\infty} (y-c)^n \left(\frac{1}{Nh}\right) \sum g((m_i - y)h)dy \tag{7}$$

After a change of variable from y to $z = \left(\frac{m_i - y}{h}\right)$, we have

$$L(c,n,m_f) = \frac{1}{N} \int_{\frac{m_i - c}{h}}^{\infty} (m_i + hz - c)^n \sum g(z)dz \tag{8}$$

The bandwidth is critical in estimating the probability density. We calculate the theoretically optimal bandwidths for selected values of θ. And following Lien &Tse (2001), the optimal bandwidth is then taken as the average of the sample.
To sum up, for a given hedge ratio θ, we construct data series of the portfolio returns m_i, i=1, 2,..., N. We then apply the kernel method and optimal bandwidth to calculate the estimated LPM using equation (7). Lastly, we use grid search to find the optimal hedge ratio that produces the smallest estimated LPM. In the multi-hedger case, we extend to $r = \sum \theta_i r_i$.

Table 2. Cross Country Panel Regression

Dep Var: Chg(Spread)	Expected Sign	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8		Model 9	
									High Risk (Spd>500bp)	Low Risk (Spd<500bp)	High Risk (Spd>500bp)	Low Risk (Spd<500bp)
Chg(logVIX)	(+)	0.0349***					0.0045*	0.0260*	0.0057*	0.0014	0.0175***	0.0100***
		(0.0047)					(0.0024)	(0.0115)	(0.0025)	(0.0013)	(0.0055)	(0.0016)
Chg(logSPX)	(-)		-0.1455***				-0.0222*	-0.1784**	-0.0403	-0.0083	-0.1514***	-0.0356***
			(0.0213)				(0.0118)	(0.0684)	(0.0311)	(0.0063)	(0.0226)	(0.0078)
Chg(HYS)	(+)			0.7328***			0.1213	0.1260	0.3012	0.0099	0.8362**	0.1460***
				(0.1254)			(0.1327)	(0.1912)	(0.3270)	(0.0400)	(0.3522)	(0.0335)
Chg(EMBICDX)	(+)				0.8241***		0.7019***	0.7041***	1.4455***	0.3378***		
					(0.1324)		(0.1227)	(0.2645)	(0.2068)	(0.0316)		
Chg(FED10Y)	(-)					-0.6307***	0.1322	-1.2794**	0.4323	-0.0265	0.6648	0.0447
						(0.2095)	(0.3225)	(0.3727)	(0.8418)	(0.0690)	(0.8229)	(0.0656)
Chg(logOIL)	(+)							-0.0172*	-0.0026		-0.0003	
								(0.0086)	(0.0040)		(0.0037)	
EXP*Chg(logOIL)	(-)							0.0218	0.0150		-0.0126	
								(0.0274)	(0.0210)		(0.0189)	
EXP*Chg(logGOLD)	(-)							-0.0328	-0.0134		-0.0332*	
								(0.0322)	(0.024)		(0.019)	
EXP*Chg(logCOPPER)	(-)							0.0234**	0.0124**		0.0135***	
								(0.0086)	(0.0027)		(0.0024)	
R-Squared		0.0247	0.0749	0.0654	0.1502	0.0347	0.1564	0.1570	0.2350		0.1427	
# of Obs		3944	3944	3944	3944	3944	3944	3944	3944		3944	
P values of T tests between groups on correponding coefficients											VIX: P-value=0.2088	
											SPX: Pvalue=0.0001	
									EMBICDX: P-value=0.0000		HYS: P-value=0.0674	

Notes: Model 1-5 examine the pairwise correlations between the monthly LEVEL changes of EMBI spreads and monthly returns of various financial instruments. Series of EMBICDX are calculated as the average EMBI spreads of all the countries excluding the own country. FED10Y is the spread between US 10 year government bond and US 3 month T-bill. VIX, SPX, HYS, OIL, GOLD and COPPER, keep track of the movement of the VIX index, SP500 index, US high yield spread, Oil, gold and copper price movements respectively. Countries with average spread higher than 500bps are considered high risk group, while the rest are in the low risk group. Model 8 introduce dummies for both high risk and low risk groups. And the coefficients are group specific. For example, 1 bp change of EMBICDX corresponds to 1.4455 bps change of country spread for the high risk group, and 0.3378 bps change for the low risk group (after controlling for the impact from other variables). T tests in P values suggest whether the cofficients are significantly different between groups. Oil exporters are Russia, Venezuela, Mexico and Nigeria. South Africa is the gold exporter and Chile the copper exporter. *, **, and *** denote significance at the 10 percent, 5 percent and 1 percent levels, respectively, in two-tail tests. Standard deviations of coeffcients are in the parentheses

V. Results

The PCA and panel regressions in Tables I and II suggest the three most promising instruments are EMBICDX, VIX, and HYS which have reasonable liquidity and market depth. The tables show that commodity prices do not seem to be relevant in explaining the variations on EMBI spreads very well, implying that they would not constitute good hedging instruments for financial shocks. Hence, they will not be discussed in the remainder of the paper.

A. In-sample Performances from Static Hedging

Before moving on to dynamic portfolio hedging (multiple hedgers), we start with static hedging, and examine the key features of hedge ratios and the hedging performances. Positive correlation between hedge ratios and EMBI spreads suggest that high risk countries need to take larger position in hedging instruments than low risk countries to reduce volatility and tail risk of spread increases. Moreover, tail risk minimization requires more hedging effort, particularly from the high risk countries (Figure I-III).

Figure I. VIX Hedge Ratios (VAR & LPM) VERSUS MEAN EMBI Level

(Variance Minimization versus Tail Risk Minimization)

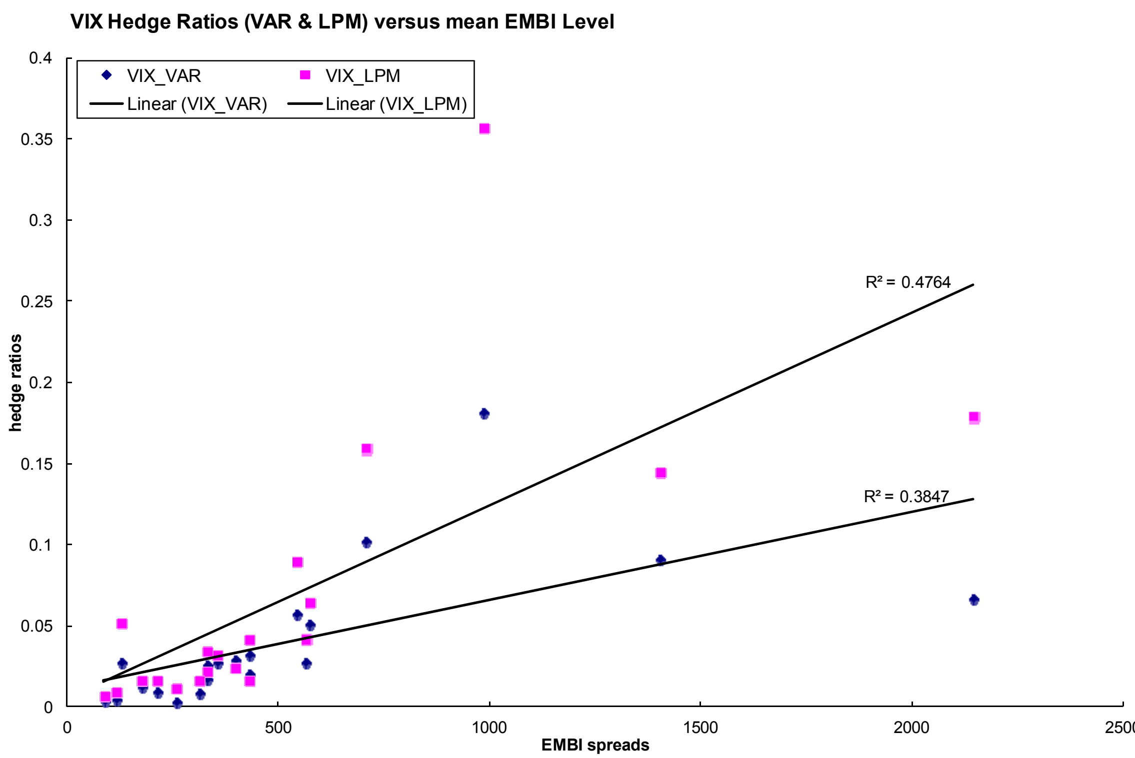


Figure II. HYS Hedge Ratios (VAR & LPM) versus mean EMBI Level

(Variance Minimization versus Tail Risk Minimization)

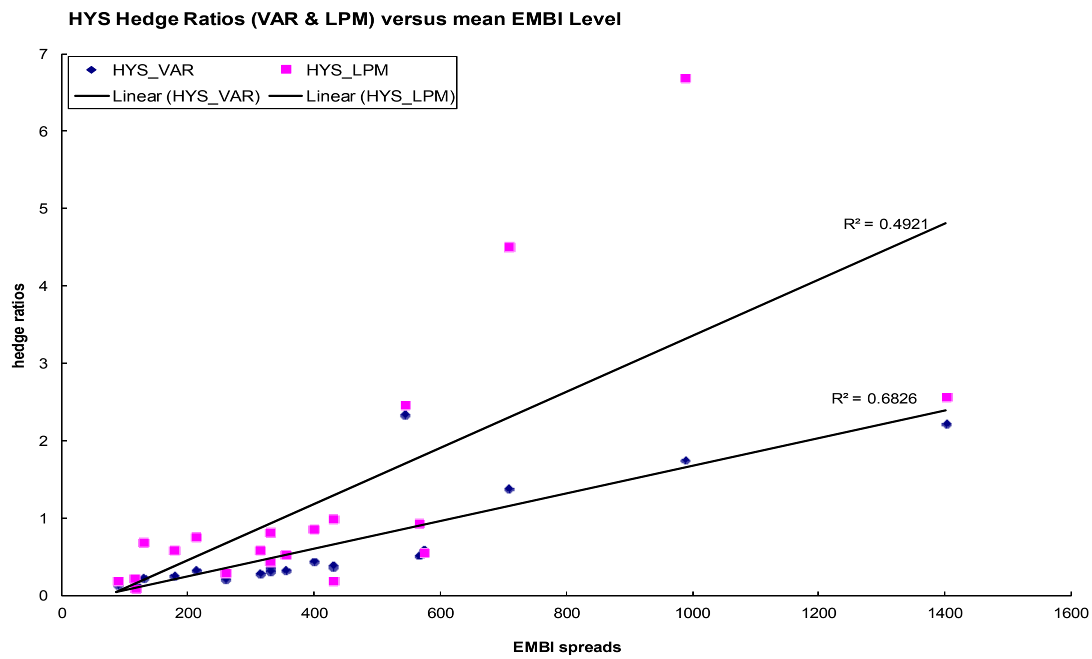
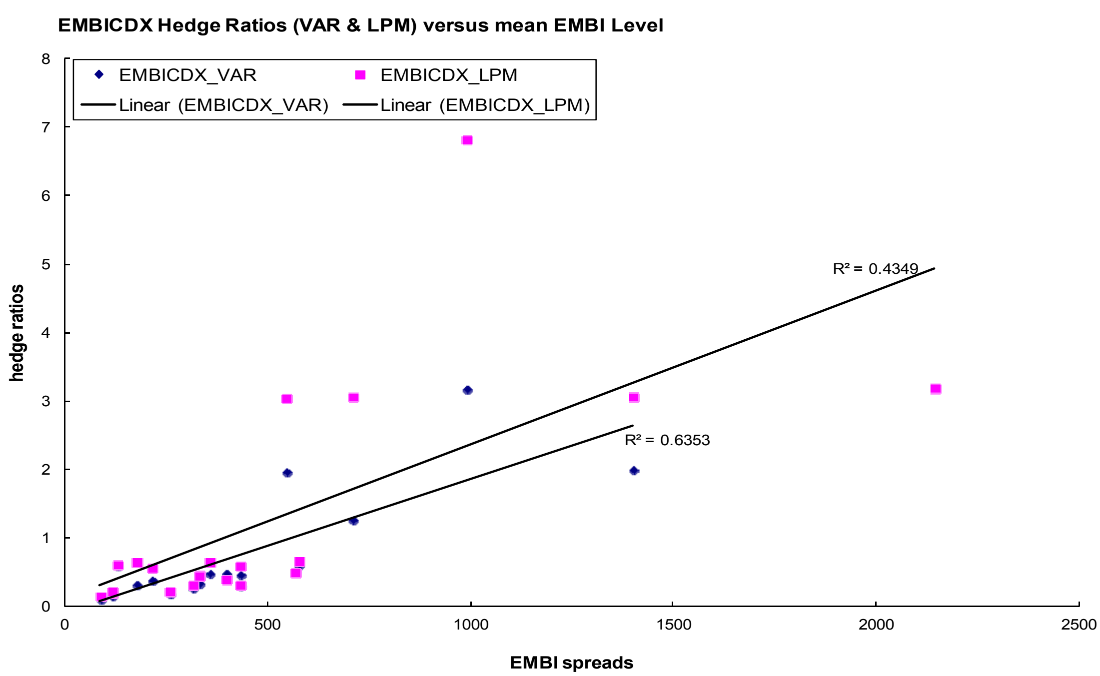


Figure III. EMBICDX Hedge Ratios (VAR & LPM) Versus Mean EMBI Level

(Variance Minimization versus Tail Risk Minimization)



B. Hedging Performance

Table 3 reports the in-sample performance of the different hedging instruments under the variance minimization approach. For ease of illustration, we report the standard deviation of the hedged portfolio and its percentage reduction under the different hedging strategies. On average, the EMBICDX tends to be the best hedger (reducing the standard deviation by 26 percentage points on average), followed by HYS (reducing the standard deviation by 20 percentage points on average). But there is large variation in the relative performance across countries (including two instances where VIX is the top performer). We also consider a two hedger strategy based on the EMBICDX and the HYS. As expected, this multi-hedging improves the performance (reducing the standard deviation by 31 percentage points on average). The reduction in standard deviation tends to be larger for the lower risk countries (e.g. those with average spread in the sample below 500bp).

Table 4 turns to the LPM approach. We set n=0, so the objective is to minimize the tail probability. EMBICDX and HYS continue to be our best individual hedgers, reducing the tail probability, on average by about 4 percentage points (5 percentage points when both instruments are used), which corresponds to about 40 percent reduction in the tail probability (47 percent when both instruments are used). The hedging performance remains comparable across high and low risk countries (although still better for the latter). Table 5 sets n=1, so the objective function is tail mean minimization (where the tail mean is the probability-weighted EMBI spread changes above the tail threshold, which is set as two standard deviations). Again, EMBICDX and HYS remain the best hedgers (although HYS now performs slightly better), and combined they can reduce the tail mean by, on average, 56 percent of its unhedged value. Extreme tail events are given more weight when n=2, the probability of which is reduced most significantly when EMBICDX is used as a hedger.”

Table 3. Standard Deviation Performance Using Variance Minimization Approach

Country	Unhedged	SD Reduction (%)					
		VIX	HYS	EMBI_CDX	HYS+EMBI_CDX	MeanEMBI	AveRating
Argentina	1072.14	1%	0.04	2%	4%	2144.11	5.24
Brazil	440.47	17%	0.12	18%	19%	706.72	7.14
Bulgaria	134.83	13%	0.19	32%	34%	563.86	8.05
Chile	38.21	29%	0.53	44%	60%	114.67	13.29
China	25.87	9%	0.36	33%	44%	86.72	15.03
Colombia	125.50	25%	0.15	22%	25%	352.73	9.69
Ecuador	572.49	10%	0.20	14%	21%	1400.52	3.85
Hungary	44.20	6%	0.25	13%	26%	113.04	13.18
Korea	96.04	6%	0.07	31%	32%	174.77	14.00
Lebanon	124.19	10%	0.12	5%	12%	429.39	6.01
Malaysia	105.78	3%	0.11	20%	20%	210.89	13.72
Mexico	97.51	25%	0.17	49%	49%	327.47	10.70
Panama	67.76	31%	0.28	21%	31%	327.70	10.00
Peru	120.78	20%	0.17	36%	36%	395.91	7.89
Philippines	125.63	26%	0.12	36%	37%	428.82	9.30
Poland	52.65	1%	0.18	18%	22%	256.02	13.33
Russia	873.79	15%	0.05	36%	45%	985.89	9.11
SouthAfrica	67.43	6%	0.18	31%	32%	311.42	11.82
Thailand	142.50	20%	0.05	33%	34%	126.43	11.43
Turkey	201.85	22%	0.10	22%	22%	573.52	7.70
Venezuela	438.73	5%	0.40	22%	41%	542.94	6.75
<500	88.15	16%	0.20	28%	33%	261.14	11.39
>500	533.47	12%	0.15	21%	27%	988.22	6.83
Average	236.59	14%	0.18	26%	31%	503.50	9.87

Notes: Under variance minimization approach, this table exhibits the standard deviation of the unhedged quarterly changes of EMBI spreads of each individual country (column 1); and the effectiveness of hedging using VIX, HYS and EMBI_CDX, measured by the percentage reduction of standard deviations (Column 2-5). The sample starts from 1993 Q1 to 2009 Q2, but the starting date varies across countries.

Table 4. Tail Probability Performance Using Tail Probability Minimization Approach (C=1SD, N=0, Quarterly)

Country		Tail Prob Reduction (Level)					
	Unhedged	VIX	HYS	EMBI_CDX	HYS+EMBI_CDX	MeanEMBI	AveRating
Argentina	0.06	0.00	0.01	0.00	0.02	2,144.11	5.24
Brazil	0.06	0.02	0.02	0.02	0.02	706.72	7.14
Bulgaria	0.09	0.01	0.05	0.07	0.07	563.86	8.05
Chile	0.10	0.04	0.08	0.04	0.08	114.67	13.29
China	0.09	0.00	0.03	0.04	0.04	86.72	15.03
Colombia	0.15	0.05	0.05	0.06	0.06	352.73	9.69
Ecuador	0.12	0.01	0.04	0.05	0.05	1,400.52	3.85
Hungary	0.06	0.00	0.01	0.00	0.01	113.04	13.18
Korea	0.07	0.01	0.02	0.04	0.04	174.77	14.00
Lebanon	0.13	0.02	0.04	0.00	0.04	429.39	6.01
Malaysia	0.07	0.01	0.03	0.03	0.03	210.89	13.72
Mexico	0.14	0.06	0.08	0.12	0.12	327.47	10.70
Panama	0.16	0.06	0.09	0.10	0.10	327.70	10.00
Peru	0.13	0.00	0.04	0.06	0.07	395.91	7.89
Philippines	0.11	0.02	0.05	0.04	0.05	428.82	9.30
Poland	0.07	0.01	0.02	0.03	0.03	256.02	13.33
Russia	0.04	0.02	0.01	0.02	0.02	985.89	9.11
South Africa	0.11	0.00	0.03	0.02	0.04	311.42	11.82
Thailand	0.06	0.03	0.03	0.02	0.03	126.43	11.43
Turkey	0.16	0.04	0.07	0.08	0.09	573.52	7.70
Venezuela	0.05	0.02	0.00	0.01	0.01	542.94	6.75
Average Level Reduction in Tail Probability by Risk Group							
<500		0.02	0.04	0.04	0.05	261.14	11.39
>500		0.02	0.03	0.04	0.04	988.22	6.83
Average		0.02	0.04	0.04	0.05	503.50	9.87
Average Percentage Reduction in Tail Probability by Risk Group							
<500		20%	39%	40%	49%	261.14	11.39
>500		23%	30%	38%	43%	988.22	6.83
Average		21%	36%	39%	47%	503.50	9.87

Notes: Under tail probability minimization approach, this table exhibits the tail probability of the unhedged quarterly changes of EMBI spreads of each individual country (Column 1). It also shows the effectiveness of hedging measured by the reduction of tail probability using VIX, HYS and EMBI_CDX (Column 2-5). Tail probability is defined as the probability that the qurarterly spread changes exceed the 2 standard deviation thresholds that are different across countries. The sample starts from 1993 Q1 to 2009 Q2, but the starting date varies among countries.

Table 5. Tail Mean Performance Using Tail Mean Minimization Approach(C=1SD, N=1, Quarterly)

Country	Unhedged	Tail Mean Reduction (Level)				MeanEMBI	AveRating
		VIX	HYS	EMBI_CDX	HYS+EMBI_CDX		
Argentina	1.83	0.04	0.49	0.00	0.52	2144.11	5.24
Brazil	0.78	0.24	0.29	0.35	0.32	706.72	7.14
Bulgaria	0.24	0.04	0.13	0.16	0.21	563.86	8.05
Chile	0.08	0.03	0.06	0.06	0.06	114.67	13.29
China	0.05	0.01	0.03	0.02	0.04	86.72	15.03
Colombia	0.35	0.14	0.11	0.15	0.15	352.73	9.69
Ecuador	1.42	0.19	0.73	0.69	0.76	1400.52	3.85
Hungary	0.09	-	0.03	0.02	0.03	113.04	13.18
Korea	0.18	0.02	0.04	0.05	0.09	174.77	14.00
Lebanon	0.29	0.07	0.09	0.09	0.09	429.39	6.01
Malaysia	0.17	0.02	0.06	0.03	0.08	210.89	13.72
Mexico	0.24	0.10	0.12	0.18	0.20	327.47	10.70
Panama	0.21	0.11	0.12	0.12	0.14	327.70	10.00
Peru	0.28	0.04	0.12	0.09	0.18	395.91	7.89
Philippines	0.25	0.07	0.10	0.10	0.13	428.82	9.30
Poland	0.08	0.01	0.05	0.02	0.06	256.02	13.33
Russia	1.27	0.37	0.24	0.51	0.66	985.89	9.11
South Africa	0.17	0.00	0.07	0.04	0.08	311.42	11.82
Thailand	0.20	0.10	0.06	0.10	0.13	126.43	11.43
Turkey	0.57	0.20	0.22	0.36	0.30	573.52	7.70
Venezuela	0.70	0.18	0.36	0.14	0.37	542.94	6.75
Average Level Reduction in Tail Mean by Risk Group							
<500		0.05	0.08	0.07	0.11	261.14	11.39
>500		0.18	0.35	0.31	0.45	988.22	6.83
Average		0.09	0.17	0.15	0.22	503.50	9.87
Average Percentage Reduction in Tail Mean by Risk Group							
<500		24%	43%	39%	58%	261.14	11.39
>500		22%	39%	42%	52%	988.22	6.83
Average		24%	41%	40%	56%	503.50	9.87

Notes: Under tail mean minimization approach, this table exhibits the tail mean of the unhedged quarterly changes of EMBI spreads of each individual country (Column 1). It also shows the effectiveness of hedging using VIX, HYS and EMBI_CDX measured by the reduction of tail mean(Column 2-5) . Tail mean is defined as the probability weighted above-threshold EMBI spread changes. The sample starts from 1993 Q1 to 2009 Q2, but the starting date varies among countries.

C. Out -of-Sample Performances: Dynamic Hedging

The in-sample performance of the hedging strategies is encouraging. But that may be a poor indicator of how such strategies would actually perform out-of-sample, which is what matters in practice.

Table 6 compares the in-sample and out-of-sample performance of the HYS and EMBICDX hedgers when the objective is variance minimization. Our out-of-sample estimates are constructed by initially using a sample that starts from the first available observation up to 2002Q4 to estimate the hedge ratio for 2003Q1. We then add one

Table 6. Standard Deviation Minimization: In-sample versus Out-of-sample Performances

	Monthly				Quarterly					
Country	In-the-Sample		Out-of-Sample		In-the-Sample		Out-of-Sample			
	HYS	EMBI_CDX	HYS	EMBI_CDX	HYS	EMBI_CDX	HYS	EMBI_CDX	MeanEMBI	AveRating
Argentina	7%	4%	-1%	-11%	4%	2%	10%	12%	2,144.11	5.24
Brazil	7%	14%	2%	2%	12%	18%	24%	23%	706.72	7.14
Bulgaria	6%	29%	-17%	14%	19%	32%	-109%	43%	563.86	8.05
Chile	25%	18%	-28%	-24%	53%	44%	-43%	29%	114.67	13.29
China	8%	23%	-28%	18%	36%	33%	-44%	27%	86.72	15.03
Colombia	11%	20%	-4%	-47%	15%	22%	-8%	-28%	352.73	9.69
Ecuador	9%	15%	-2%	-9%	20%	14%	-3%	24%	1,400.52	3.85
Hungary	27%	12%	-19%	16%	25%	13%	-25%	11%	113.04	13.18
Korea	8%	8%	-16%	7%	7%	31%	-27%	13%	174.77	14.00
Lebanon	7%	4%	-2%	8%	12%	5%	-6%	16%	429.39	6.01
Malaysia	8%	15%	-29%	4%	11%	20%	-40%	-34%	210.89	13.72
Mexico	11%	41%	-14%	-1%	17%	49%	-80%	36%	327.47	10.70
Panama	14%	33%	-13%	10%	28%	21%	-20%	36%	327.70	10.00
Peru	9%	28%	-6%	2%	17%	36%	-8%	25%	395.91	7.89
Philippines	11%	33%	-10%	3%	12%	36%	-28%	-9%	428.82	9.30
Poland	9%	23%	-23%	13%	18%	18%	-86%	15%	256.02	13.33
Russia	3%	17%	-9%	-30%	5%	36%	-153%	-116%	985.89	9.11
SouthAfrica	15%	25%	-16%	9%	18%	31%	-24%	37%	311.42	11.82
Thailand	4%	23%	-28%	8%	5%	33%	-37%	26%	126.43	11.43
Turkey	9%	18%	1%	-27%	10%	22%	-1%	2%	573.52	7.70
Venezuela	9%	28%	-2%	20%	40%	22%	-4%	-1%	542.94	6.75
Av. Spread <50	12%	22%	-17%	2%	20%	28%	-39%	2%	261.14	11.39
Av. Spread >50	7%	18%	-4%	-6%	15%	21%	-30%	24%	988.22	6.83
Average	10%	20%	-12%	-1%	18%	26%	-36%	9%	503.50	9.87

Notes: In the out-of-sample exercise, the first sample for estimation starts from the first date the data was available to 2002Q4. The estimated hedge ratio will be used to compute the hedging performance for 2003Q1. This one quarter ahead rolling strategy continues until the 2009Q3 (the end of the entire sample.) As a robustness check, we conduct the same exercise at monthly frequency. the objective is to minimize variance. And the table presents the percentage reduction of standard deviations in the corresponding sample period.

quarter of data at a time, using that sample to estimate the hedge ratio for the following quarter (e.g. use data up to 2003Q1 to estimate the hedge ratio for 2003Q2). For ease of illustration we report both the in-sample and out-of-sample results side by side. As expected, there is a substantial deterioration in the performance. Using the HYS as a hedger actually tends to increase the variance of spreads. The EMBICDX continues to reduce the variance, but much less so than in-sample (on average, just by 9 percent). There is substantial variation across countries, including cases where the hedging adds a significant amount of volatility to the spreads. As a robustness check, we also report the results from a monthly estimation (both in-sample, and rolling out-of-sample). Again, the out-of-sample performance is much weaker (on average making spreads more volatile). Table 7 reports the results for the tail probability. Again, the out-of-sample performance is worse than the in-sample, and there are instances where the hedging strategy actually increases the tail probability. This is true both at a quarterly and at a monthly frequency. Turning to the tail mean (Table 8), the out-of-sample performance actually points to an improvement, but concentrated on higher risk countries, whose tail events are more extreme (much larger spread changes)

Overall, these results suggest that the ability of the hedging strategies to explain much of the variation in sample fails to materialize into a strategy that would work well out-of-sample.

D. Properly Accounting for Tranquil and Crisis Times

One possible reason for a weak out-of-sample performance is that the global financial environment changes over time. More specifically, there were many crises in EMs from the beginning of our sample until 2002, followed by a relatively tranquil period of time until the global financial crisis. It is quite likely that hedge ratios computed in a sample involving mostly volatile times will prove inadequate when extrapolated to tranquil times. But these same hedge ratios could become relevant again in times of crises.

To test this hypothesis, we first estimate hedge ratios using data up to 2004Q4 (which includes most of the major EM crises episodes). We then compute the hedging performance of these hedge ratios in the tranquil period of 2005Q1-2007Q1 with the performance using those same hedge ratios in 2007Q2—2009Q2, a period marked by the global financial crisis. Table 9 reports the results from this estimation when the EMBICDX is used as a hedger and Table 10 when HYS is used.

The results from Tables 9 and 10 confirm our hypothesis that hedging mainly pays-off in times of crises. The hedging strategies based on data up to 2004Q4 would leave volatility largely unchanged in the tranquil times of 2005Q1-2007Q1. The EMBICDX hedging actually slightly increases volatility for low-risk countries, but reduces for high-risk ones,

Table 7. Tail Probability Minimization: In-sample versus Out-of-sample Performance

Country	Quarterly				Monthly					
	In-Sample		Out-of-Sample		In-Sample		Out-of-Sample			
	HYS	EMBI_CDX	HYS	EMBI_CDX	HYS	EMBI_CDX	HYS	EMBI_CDX	MeanEMBI	AveRating
Argentina	0.01	0.00	0.00	0.02	0.02	0.01	-0.03	-0.03	2,144.11	5.24
Brazil	0.02	0.02	0.03	0.04	0.01	0.02	0.00	0.00	706.72	7.14
Bulgaria	0.05	0.07	0.04	0.01	0.02	0.02	0.01	0.00	563.86	8.05
Chile	0.08	0.04	0.03	-0.03	0.06	0.02	0.03	0.00	114.67	13.29
China	0.03	0.04	0.04	-0.01	0.02	0.01	0.02	0.03	86.72	15.03
Colombia	0.05	0.06	0.00	0.02	0.03	0.02	0.03	0.03	352.73	9.69
Ecuador	0.04	0.05	0.01	0.03	0.01	0.01	-0.04	-0.01	1,400.52	3.85
Hungary	0.01	0.00	-0.02	0.00	0.01	0.00	0.03	-0.01	113.04	13.18
Korea	0.02	0.04	-0.04	0.01	0.01	0.01	0.00	-0.02	174.77	14.00
Lebanon	0.04	0.00	0.00	0.05	0.01	0.01	-0.02	-0.01	429.39	6.01
Malaysia	0.03	0.03	0.04	0.00	0.02	0.02	0.02	0.00	210.89	13.72
Mexico	0.08	0.12	0.04	0.03	0.02	0.07	0.00	0.00	327.47	10.70
Panama	0.09	0.10	0.05	0.02	0.04	0.05	0.04	0.00	327.70	10.00
Peru	0.04	0.06	-0.01	0.03	0.03	0.06	0.01	0.00	395.91	7.89
Philippines	0.05	0.04	-0.06	-0.06	0.04	0.02	0.00	-0.02	428.82	9.30
Poland	0.02	0.03	0.01	-0.04	0.00	0.00	0.00	0.00	256.02	13.33
Russia	0.01	0.02	0.00	0.00	0.01	0.01	0.00	0.00	985.89	9.11
South Africa	0.03	0.02	0.04	0.02	0.01	0.00	0.01	-0.01	311.42	11.82
Thailand	0.03	0.02	0.04	0.00	0.00	0.00	0.00	0.00	126.43	11.43
Turkey	0.07	0.08	0.02	-0.01	0.02	0.03	-0.01	0.02	573.52	7.70
Venezuela	0.00	0.01	0.01	-0.03	0.01	0.01	-0.02	0.01	542.94	6.75
Average Level Reduction in Tail Probability by Risk Group										
Av. Spread <500	0.04	0.04	0.01	0.01	0.02	0.02	0.00	0.00	261.14	11.39
Av. Spread >500	0.03	0.04	0.02	0.01	0.01	0.02	-0.01	0.00	988.22	6.83
Average	0.04	0.04	0.01	0.01	0.02	0.02	0.00	0.00	503.50	9.87
Average Percentage Reduction in Tail Probability by Risk Group										
Av. Spread <500	39%	40%	14%	-8%	25%	22%	21%	-6%	261.14	11.39
Av. Spread >500	30%	38%	38%	23%	25%	26%	-18%	-6%	988.22	6.83
Average	36%	39%	22%	2%	25%	23%	8%	-6%	503.50	9.87

Notes: In the out-of-sample exercise, the first sample for estimation starts from the first date the data was available to 2002Q4. The estimated hedge ratio will be used to compute the hedging performance for 2003Q1. This one-quarter-ahead rolling strategy continues until the 2009Q3 (the end of the entire sample.) As a robustness check, we conduct the same exercise at monthly frequency. The objective is to minimize tail probability (n=0). The table presents the percentage reduction of tail probability in levels as well as in percentages (by groups) in the corresponding sample period.

Table 8: Tail Mean Minimization: In-sample versus Out-of-sample Performance

Country	Monthly				Quarterly					
	In-the-Sample		Out-of-Sample		In-the-Sample		Out-of-Sample			
	HYS	EMBI_CDX	HYS	EMBI_CDX	HYS	EMBI_CDX	HYS	EMBI_CDX	MeanEMBI	AveRating
Argentina	0.19	0.14	0.49	0.50	0.49	0.00	1.14	1.12	2144.11	5.24
Brazil	0.04	0.11	0.10	0.11	0.29	0.35	0.58	0.57	706.72	7.14
Bulgaria	0.04	0.05	0.02	0.00	0.13	0.16	0.11	0.09	563.86	8.05
Chile	0.02	0.01	-0.01	-0.04	0.06	0.06	0.04	-0.03	114.67	13.29
China	0.01	0.01	-0.02	-0.02	0.03	0.02	0.02	-0.02	86.72	15.03
Colombia	0.04	0.04	0.04	0.03	0.11	0.15	0.03	0.09	352.73	9.69
Ecuador	0.11	0.17	0.42	0.43	0.73	0.69	1.09	1.07	1400.52	3.85
Hungary	0.02	0.00	0.00	-0.03	0.03	0.02	0.03	0.05	113.04	13.18
Korea	0.02	0.03	-0.01	-0.01	0.04	0.05	-0.02	0.03	174.77	14.00
Lebanon	0.02	0.01	0.02	0.02	0.09	0.09	0.14	0.17	429.39	6.01
Malaysia	0.02	0.02	0.01	-0.01	0.06	0.03	0.05	0.01	210.89	13.72
Mexico	0.03	0.08	0.01	0.00	0.12	0.18	0.06	0.06	327.47	10.70
Panama	0.04	0.06	0.02	-0.02	0.12	0.12	0.08	0.05	327.70	10.00
Peru	0.05	0.09	0.01	0.01	0.12	0.09	0.10	0.13	395.91	7.89
Philippines	0.05	0.05	-0.01	-0.01	0.10	0.10	-0.05	-0.05	428.82	9.30
Poland	0.01	0.01	-0.02	-0.03	0.05	0.02	0.04	-0.03	256.02	13.33
Russia	0.09	0.10	0.03	0.02	0.24	0.51	0.00	-0.03	985.89	9.11
SouthAfrica	0.02	0.02	-0.01	-0.03	0.07	0.04	0.08	0.07	311.42	11.82
Thailand	0.00	0.02	0.00	0.00	0.06	0.10	0.06	0.03	126.43	11.43
Turkey	0.05	0.09	0.06	0.09	0.22	0.36	0.22	0.20	573.52	7.70
Venezuela	0.07	0.10	0.29	0.29	0.36	0.14	0.87	0.89	542.94	6.75
Average Level Reduction in Tail Mean by Risk Group										
Av. Spread <!	0.02	0.03	0.00	-0.01	0.08	0.07	0.05	0.04	261.14	11.39
Av. Spread >!	0.08	0.11	0.20	0.20	0.35	0.31	0.57	0.56	988.22	6.83
Average	0.04	0.06	0.07	0.06	0.17	0.15	0.22	0.21	503.50	9.87
Average Percentage Reduction in Tail Mean by Risk Group										
Av. Spread <!	25%	33%	-1%	-42%	43%	39%	40%	21%	261.14	11.39
Av. Spread >!	19%	27%	40%	14%	39%	42%	79%	55%	988.22	6.83
Average	22%	30%	19%	-14%	41%	40%	60%	38%	503.50	9.87

Notes: In the out-of-sample exercise, the first sample for estimation starts from the first date the data was available to 2002Q4. The estimated hedge ratio will be used to compute the hedging performance for 2003Q1. This one-quarter ahead rolling strategy continues until the 2009Q3 (the end of the entire sample.) As a robustness check, we conduct the same exercise at monthly frequency. the objective is to minimize tail mean. And the table presents the percentage reduction of tail mean in levels as well as in percentages (by groups) in the corresponding sample period.

Table 9. Comparison of Dynamic Hedging Performances Using EMBICDX during Regular versus Crisis Period

Country		LPM			LPM Reduction (%)				
	Unhedged	Multi	HYS	EMBI_CDX	Multi	HYS	EMBI_CDX	MeanEMBI	AveRating
Argentina	23.73	19.99	19.99	22.41	16%	16%	6%	2144.11	5.24
Brazil	5.23	0.76	1.04	1.11	86%	80%	79%	706.72	7.14
Bulgaria	0.31	0.00	0.05	0.00	100%	84%	100%	563.86	8.05
Chile	0.04	0.00	0.00	0.00	96%	92%	92%	114.67	13.29
China	0.02	0.00	0.00	0.00	99%	96%	96%	86.72	15.03
Colombia	0.30	0.07	0.14	0.12	77%	55%	62%	352.73	9.69
Ecuador	8.82	0.88	0.89	2.52	90%	90%	71%	1400.52	3.85
Hungary	0.08	0.01	0.01	0.03	86%	86%	68%	113.04	13.18
Korea	0.29	0.02	0.24	0.02	94%	18%	94%	174.77	14.00
Lebanon	0.20	0.15	0.15	0.16	28%	28%	20%	429.39	6.01
Malaysia	0.26	0.01	0.07	0.01	96%	74%	96%	210.89	13.72
Mexico	0.23	0.01	0.07	0.01	97%	67%	97%	327.47	10.70
Panama	0.09	0.02	0.02	0.02	81%	75%	81%	327.70	10.00
Peru	0.22	0.01	0.04	0.01	97%	83%	97%	395.91	7.89
Philippines	0.36	0.01	0.11	0.01	96%	69%	96%	428.82	9.30
Poland	0.05	0.00	0.00	0.00	98%	94%	94%	256.02	13.33
Russia	33.85	0.40	15.86	0.40	99%	53%	99%	985.89	9.11
SouthAfrica	0.13	0.01	0.03	0.01	94%	76%	94%	311.42	11.82
Thailand	0.55	0.01	0.34	0.01	99%	38%	99%	126.43	11.43
Turkey	0.56	0.32	0.43	0.32	42%	23%	42%	573.52	7.70
Venezuela	7.70	0.20	0.20	1.39	97%	97%	82%	542.94	6.75
<500	0.20	0.02	0.09	0.03	88%	68%	85%	261.14	11.39
>500	11.46	3.22	5.49	4.02	76%	63%	68%	988.22	6.83
Average	3.95	1.09	1.89	1.36	84%	66%	79%	503.50	9.87

Notes: The table compares performances of multihedging strategy with single-hedging strategies in terms of reductions in LPM. And multiheding strategy form a portfolio that combines HYS and EMBI_CDX with the weight being determined through LPM loss function minimization. The sample starts from 1993 Q1 to 2009 Q2, but the starting date varies among countries.

Table 10. Comparison of Dynamic Hedging Performances Using HYS under Regular versus Crisis Period

Country		Tail Prob			Tail Prob Reduc (%)			Tail Prob Reduc (Level)				
	Unhedged	Multi	HYS	EMBI_CDX	Multi	HYS	EMBI_CDX	Multi	HYS	EMBI_CDX	MeanEMBI	AveRating
Argentina	0.06	0.05	0.05	0.06	26%	19%	1%	0.02	0.01	0.00	2144.11	5.24
Brazil	0.06	0.04	0.04	0.04	34%	34%	34%	0.02	0.02	0.02	706.72	7.14
Bulgaria	0.09	0.02	0.05	0.02	76%	50%	76%	0.07	0.05	0.07	563.86	8.05
Chile	0.10	0.02	0.02	0.07	76%	76%	36%	0.08	0.08	0.04	114.67	13.29
China	0.09	0.04	0.06	0.04	48%	30%	49%	0.04	0.03	0.04	86.72	15.03
Colombia	0.15	0.09	0.10	0.09	41%	31%	39%	0.06	0.05	0.06	352.73	9.69
Ecuador	0.12	0.07	0.08	0.07	41%	36%	42%	0.05	0.04	0.05	1400.52	3.85
Hungary	0.06	0.05	0.05	0.06	22%	23%	0%	0.01	0.01	0.00	113.04	13.18
Korea	0.07	0.03	0.06	0.04	54%	22%	52%	0.04	0.02	0.04	174.77	14.00
Lebanon	0.13	0.09	0.09	0.12	30%	28%	4%	0.04	0.04	0.00	429.39	6.01
Malaysia	0.07	0.04	0.04	0.04	39%	39%	39%	0.03	0.03	0.03	210.89	13.72
Mexico	0.14	0.02	0.06	0.02	86%	59%	86%	0.12	0.08	0.12	327.47	10.70
Panama	0.16	0.06	0.07	0.06	63%	54%	64%	0.10	0.09	0.10	327.70	10.00
Peru	0.13	0.06	0.09	0.07	51%	27%	45%	0.07	0.04	0.06	395.91	7.89
Philippines	0.11	0.06	0.06	0.07	48%	48%	37%	0.05	0.05	0.04	428.82	9.30
Poland	0.07	0.04	0.05	0.04	45%	32%	46%	0.03	0.02	0.03	256.02	13.33
Russia	0.04	0.03	0.03	0.03	36%	26%	35%	0.02	0.01	0.02	985.89	9.11
South Africa	0.11	0.08	0.08	0.09	33%	29%	21%	0.04	0.03	0.02	311.42	11.82
Thailand	0.06	0.03	0.03	0.04	46%	44%	38%	0.03	0.03	0.02	126.43	11.43
Turkey	0.16	0.06	0.09	0.08	59%	46%	52%	0.09	0.07	0.08	573.52	7.70
Venezuela	0.05	0.03	0.05	0.03	26%	1%	27%	0.01	0.00	0.01	542.94	6.75
<500	0.10	0.05	0.06	0.06	49%	39%	40%	0.05	0.04	0.04	261.14	11.39
>500	0.08	0.04	0.05	0.05	43%	30%	38%	0.04	0.03	0.04	988.22	6.83
Average	0.10	0.05	0.06	0.06	47%	36%	39%	0.05	0.04	0.04	503.50	9.87

Notes: The table compares performances of multihedging strategy with single-hedging strategies in terms of reductions in the probability that the spread changes exceed the threshold. And multiheding strategy form a portfolio that combines HYS and EMBI_CDX with the weight being determined through tail probability loss function minimization. The sample starts from 1993 Q1 to 2009 Q2, but the starting date varies among countries. Tail prob reduc (level) refers to the level change of tail probabilities. For example, in Brail, multihedging strategy reduces the probability that spread changes exceed the 2SD threshold is reduced from 6 to 2 percentage points. And this is a 26% reduction of the tail probability which is shown in the column called "Tail Prob Reduc (%)"

while HYS slightly reduces it for both. EMBICDX increases the tail risk for both groups of countries, while HYS increases it for low-risk while reducing for high-risk countries. Overall, during tranquil times these gains (when present) tend to be modest and would almost certainly be outweighed by transaction costs (if they were to be incorporated in our results).

But these very same hedge ratios that yield modest (if any) improvements in tranquil times would have led to a dramatic reduction in volatility and tail risk during the 2007Q2-2009Q2 crisis period, particularly for high spread countries. EMBICDX and HYS hedging would have reduced the standard deviation by roughly 80 and 75 percent on average, much higher than our in-sample values. The reductions in tail risk are also dramatic. While the reduction in tail probability is comparable to our in-sample results, the reduction in tail mean is reduced by about 90 percent for both hedgers. The reduction is larger for the higher risk countries. Since these countries tend to have higher hedge ratios, their strategies would have had higher returns during the crisis (shorting either the HYS or the EMBICDX paid off significantly). Overall, during crisis times, either EMBICDX or HYS hedging would have virtually eliminated tail risk in 2007Q2-2009Q2 for most high spread countries in our sample.

In a nutshell, these results suggest that hedging is of limited use during tranquil times (and likely counterproductive, especially if we take into account transaction costs). But during times of crisis, it can pay-off big time.[8] So, on average whether or not hedging will prove worthwhile depends on how frequent these global crises are, and on the expected costs during these crises.

VI. Conclusions

This paper has analyzed how different financial instruments would have been useful in hedging shocks to country borrowing spreads. We find that strategies based on U.S. high-yield spreads and strategies based on positions on other emerging market spreads are somewhat promising. Generally, these instruments can explain much of the in-sample movements in spreads—as shown in previous studies. They tend to perform poorer out-of-sample, unless large crisis are looming.

Indeed, the key result of this paper is that hedging on the basis of correlations derived during crisis sample periods can be very helpful for hedging against future crisis, as it can

[8] It is worth noting that the events in the 2007Q2-2009Q2 sample may have been particularly suitable for these strategies to pay-off, given the violent and unexpected price swings in the aftermath of the global financial crisis.

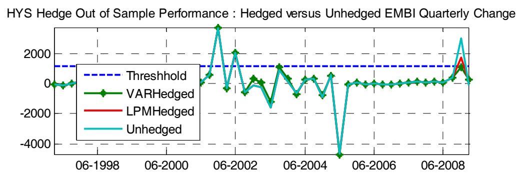
reduce volatility of tail risk to a very large extent (up to 90 percent). Interestingly, the same hedging would be ineffective or even counter-productive during tranquil times.

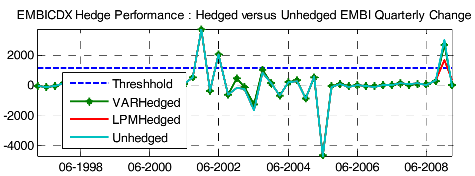
Another interesting result of the paper is that hedging is particularly useful for high-risk countries. Much of the risk in these countries tends to be associated with "home-grown" problems—such an unsustainable macroeconomic policies—and idiosyncratic behavior, which cannot be hedged by global financial instruments. However, to the extent that these countries are more sensitive to changes in external financing conditions, they can potentially benefit more from the hedging strategies considered.

On balance, the results suggest some cautious "experimentation" with the strategies considered could potentially complement the policy toolkit with which countries seek to insure themselves against global shocks. However, the uneven pay-off over the cycle can help explain why countries do not hedge. Even if events like the recent crisis heighten concerns about systemic risk to the point where governments consider buying protection against tail events, that choice is likely to be postponed as immediately after large events, people do not expect additional large crisis. As times goes by, tranquil times may reduce people sensitivity to risk of global crises, and it become difficult for governments to convince the electorate to use scarce budgetary resources to buy protection against tail events. Transaction costs, innovation costs, implementation challenges, and other political obstacles can also prevent these instruments from being widely used.

APPENDIX

Argentina





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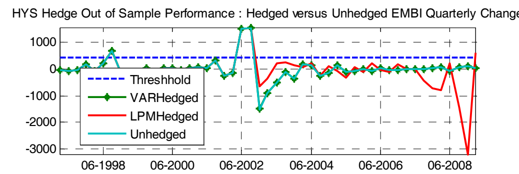

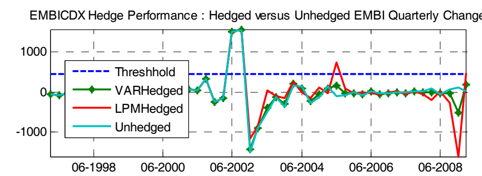

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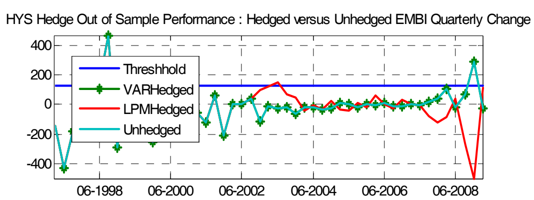

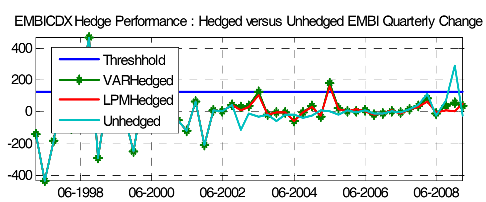

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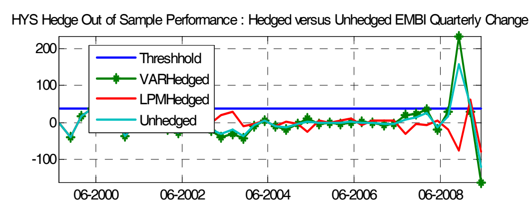
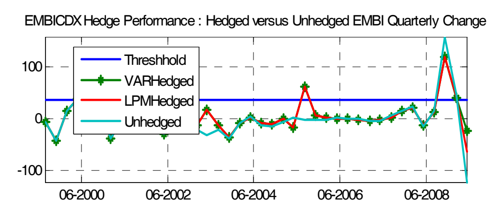
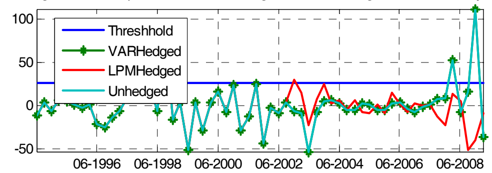


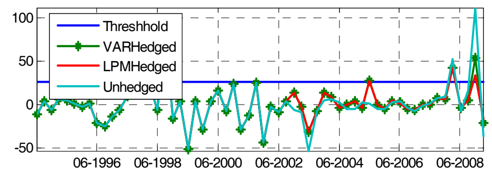


China

HYS Hedge Out of Sample Performance : Hedged versus Unhedged EMBI Quarterly Change



EMBICDX Hedge Performance : Hedged versus Unhedged EMBI Quarterly Change



Colombia

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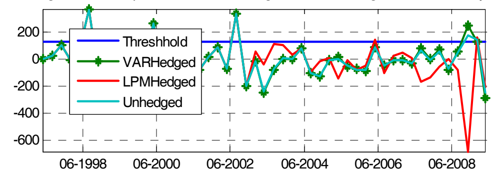

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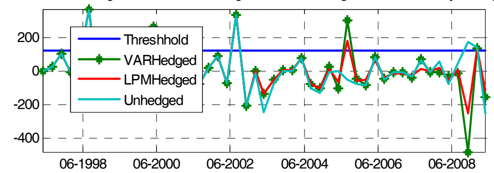

Ecuador

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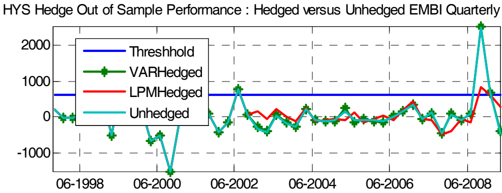

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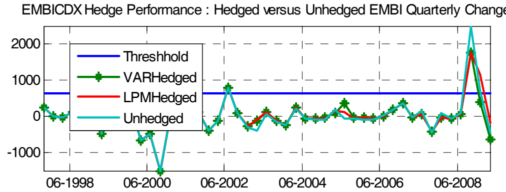
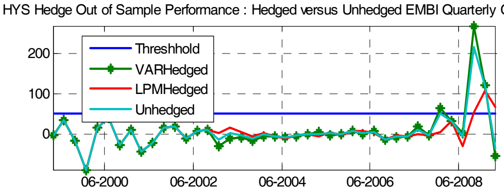
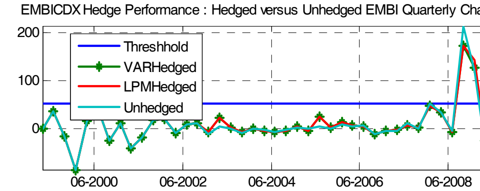


Hungary

HYS Hedge Out of Sample Performance : Hedged versus Unhedged EMBI Quarterly Change



EMBICDX Hedge Performance : Hedged versus Unhedged EMBI Quarterly Change



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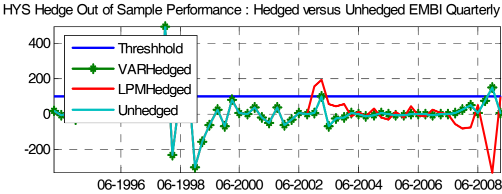
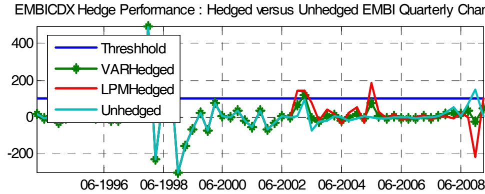
HYS Hedge Out of Sample Performance : Hedged versus Unhedged EMBI Quarterly Change

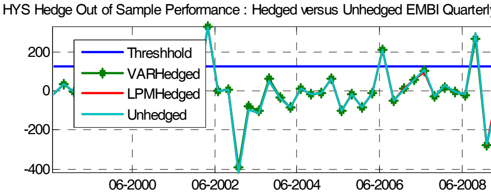


EMBICDX Hedge Performance : Hedged versus Unhedged EMBI Quarterly Change

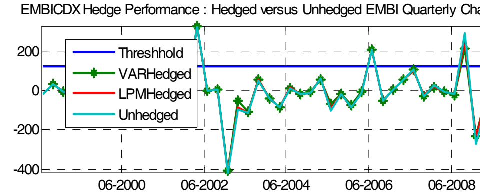


Lebanon

HYS Hedge Out of Sample Performance : Hedged versus Unhedged EMBI Quarterly Change



EMBICDX Hedge Performance : Hedged versus Unhedged EMBI Quarterly Change



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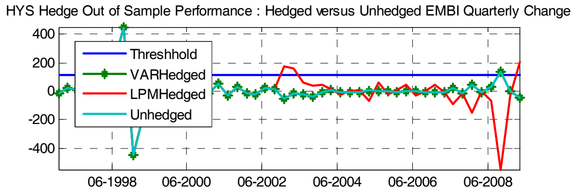

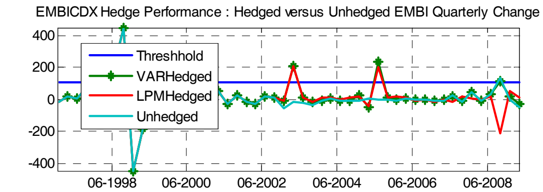

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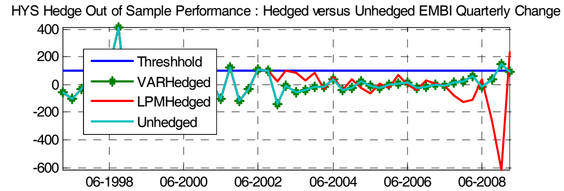

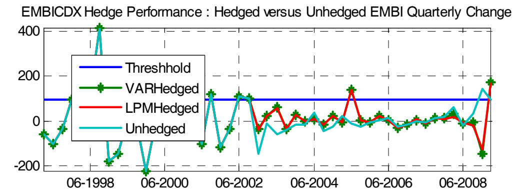

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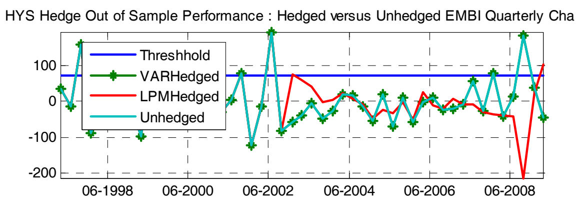

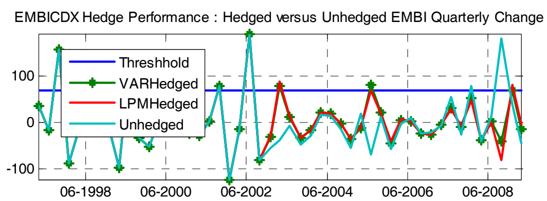

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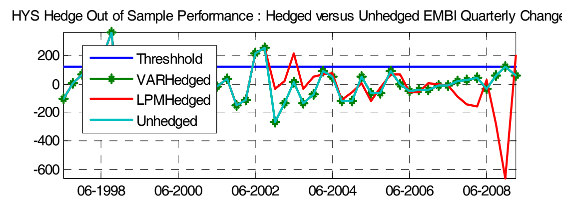

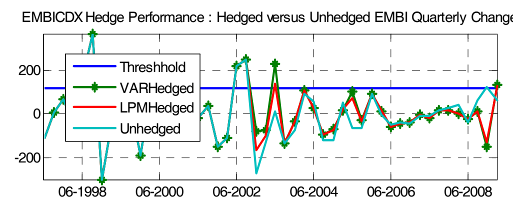

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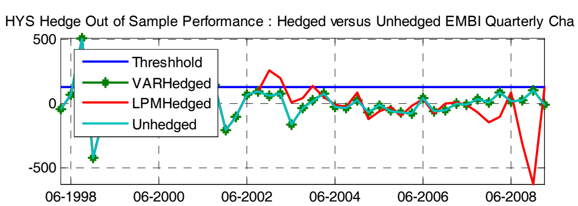

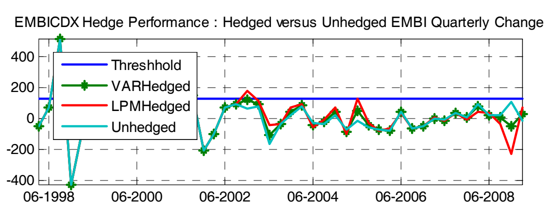

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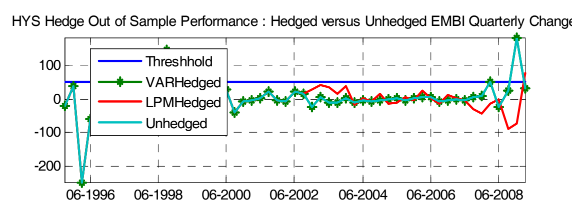

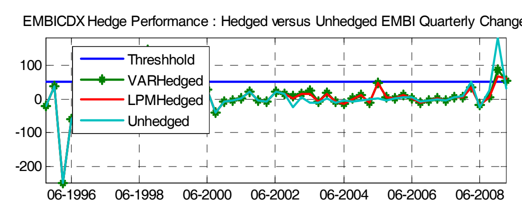

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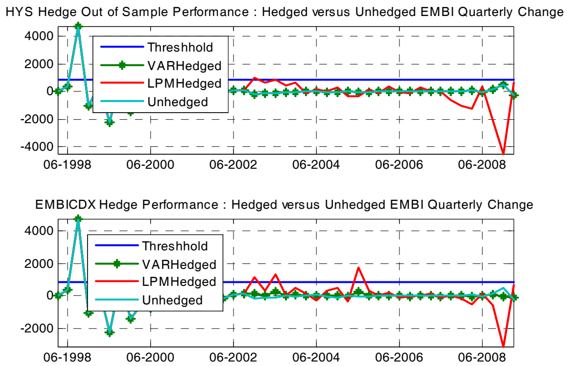

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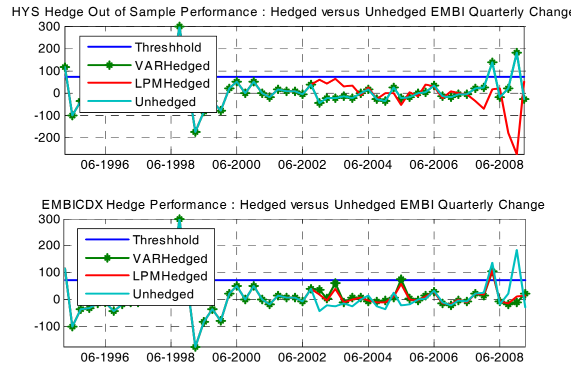

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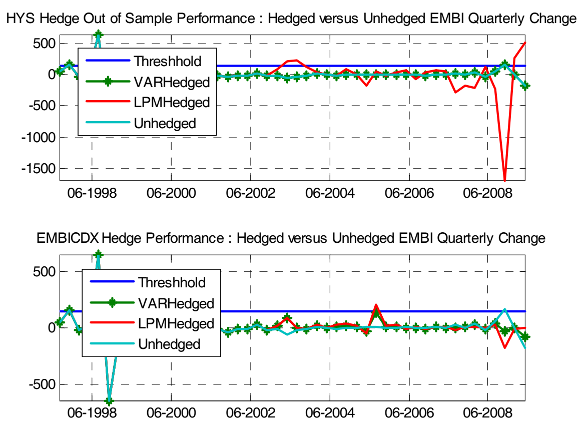

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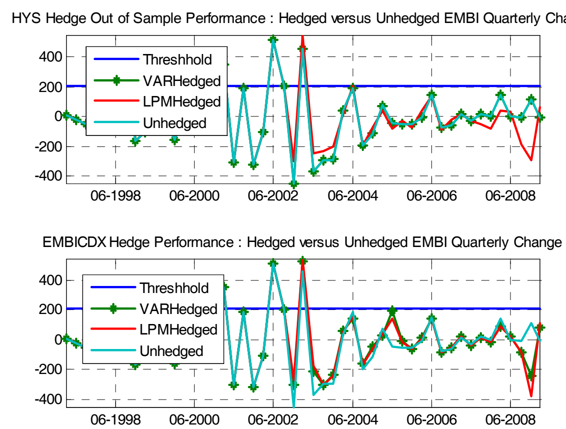

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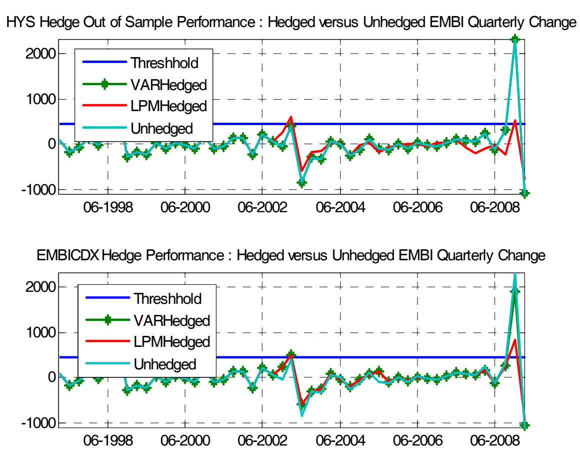

Appendix Table I

Dep Var: Chg(log(Spread))	Expected Sign	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8		Model 9	
									High Risk (Spd>500bp)	Low Risk (Spd<500bp)	High Risk (Spd>500bp)	Low Risk (Spd<500bp)
Chg(logVIX)	(+)	0.5808***					0.1177**	0.1164**	0.0942**	0.1314***	0.2478***	0.2350***
		(0.0339)					(0.0280)	(0.0274)	(0.0452)	(0.0355)	(0.0391)	(0.0387)
Chg(logSPX)	(-)	-2.1219***					-0.1467	-0.1464	-0.3357**	-0.0430	-0.9576***	-0.4611***
			(0.1287)				(0.0981)	(0.0972)	(0.1258)	(0.1285)	(0.0707)	(0.1434)
Chg(log(HYS))	(+)			1.1269***			0.4120***	0.4098***	0.4806***	0.2994***	0.8630***	0.8535***
				(0.0576)			(0.0605)	(0.0606)	(0.0867)	(0.0753)	(0.1065)	(0.0681)
Chg(log(EMBICDX))	(+)				0.7996***		0.5750***	0.6149***	0.7409***	0.4796***		
					(0.0486)		(0.0510)	(0.0513)	(0.0935)	(0.0432)		
Chg(FED10Y)	(-)					-0.5101***	0.1476**	0.1399**	0.0952	0.1696***	0.2597***	0.2697***
						(0.0484)	(0.0508)	(0.0507)	(0.0974)	(0.0570)	(0.0531)	(0.0925)
Chg(logOIL)	(+)							-0.7670	-0.0523		-0.0934	
								(0.4972)	(0.1034)		(0.1691)	
EXP*Chg(logOIL)	(-)							0.0404	-0.0114		0.0479	
								(0.0911)	(0.0775)		(0.1542)	
EXP*Chg(logGOLD)	(-)							-0.1847*	-0.2284*		-0.2392*	
								(0.0609)	(0.1026)		(0.1114)	
EXP*Chg(logCOPPER)	(-)							-0.0105	-0.0353		0.0039	
								(0.0468)	(0.0924)		(0.0857)	
R-Squared		0.1333	0.1327	0.1645	0.2537	0.0872	0.2739	0.2793	0.2996		0.1824	
# of Obs		3944	3944	3944	3944	3944	3944	3944	3944		3944	
P values of T tests between groups on corresponding coefficients									VIX: P-value=0.5483		VIX: P-value=0.8202	
									SPX: Pvalue=0.1346		SPX: Pvalue=0.0042	
									HYS: P-value=0.1267		HYS: P-value=0.9404	
									EMBICDX: P-value=0.0177		FED10y: P-value=0.9255	

Notes: Model 1-5 examine the pairwise correlations between the monthly PERCENTAGE changes of EMBI spreads and monthly returns of various financial instruments. Series of EMBICDX are calculated as the average EMBI spreads of all the countries excluding the own country. FED10Y is the spread between US 10 year government bond and US 3 month T-bill. VIX, SPX, HYS, OIL, GOLD and COPPER, keep track of the movement of the VIX index, SP500 index, US high yield spread, Oil, gold and copper price movements respectively. Countries with average spread higher than 500bp are considered high risk group, while the rest are in the low risk group. Model 8 introduce dummies for both high risk and low risk groups. And the coefficients are group specific. For example, 1 percentage change of EMBICDX corresponds to 0.7410 percentage change of country spread for the high risk group, and 0.4794 percentage change for the low risk group (after controlling for the impact from other variables). T tests in P values suggest whether the coefficients are significantly different between groups. Oil exporters are Russia, Venezuela, Mexico and Nigeria. South Africa is the gold exporter and Chile the copper exporter. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively, in two-tail tests. Standard deviations of the coefficients are in the parentheses

Appendix Table II: LPM Performance Using LPM Minimization Approach
(C=1SD, N=2, Quarterly)

Country		LPM Reduction (%)					
	Unhedged	VIX	HYS	EMBI_CDX	HYS+EMBI_CDX	MeanEMBI	AveRating
Argentina	23.73	0%	16%	6%	16%	2,144.11	5.24
Brazil	5.23	74%	80%	79%	86%	706.72	7.14
Bulgaria	0.31	63%	84%	100%	100%	563.86	8.05
Chile	0.04	90%	92%	92%	96%	114.67	13.29
China	0.02	27%	96%	96%	99%	86.72	15.03
Colombia	0.30	75%	55%	62%	77%	352.73	9.69
Ecuador	8.82	66%	90%	71%	90%	1,400.52	3.85
Hungary	0.08	50%	86%	68%	86%	113.04	13.18
Korea	0.29	9%	18%	94%	94%	174.77	14.00
Lebanon	0.20	40%	28%	20%	28%	429.39	6.01
Malaysia	0.26	11%	74%	96%	96%	210.89	13.72
Mexico	0.23	81%	67%	97%	97%	327.47	10.70
Panama	0.09	82%	75%	81%	81%	327.70	10.00
Peru	0.22	73%	83%	97%	97%	395.91	7.89
Philippines	0.36	81%	69%	96%	96%	428.82	9.30
Poland	0.05	31%	94%	94%	98%	256.02	13.33
Russia	33.85	79%	53%	99%	99%	985.89	9.11
SouthAfrica	0.13	48%	76%	94%	94%	311.42	11.82
Thailand	0.55	88%	38%	99%	99%	126.43	11.43
Turkey	0.56	60%	23%	42%	42%	573.52	7.70
Venezuela	7.70	7%	97%	82%	97%	542.94	6.75
<500	0.20	56%	68%	85%	88%	261.14	11.39
>500	11.46	50%	63%	68%	76%	988.22	6.83
Average	3.95	54%	66%	79%	84%	503.50	9.87

Notes: Under LPM approach, this table exhibits the LPM (which put heavy weights on the tail events) of the unhedged quarterly changes of EMBI spreads of each individual country; and of the hedged spread changes using VIX, HYS and EMBI_CDX. It also shows the effectiveness of hedging measured by the reduction of LPM. The sample starts from 1993 Q1 to 2009 Q2, but the starting date varies among countries.

Appendix Table III: Dynamic Hedge Ratios

	HYS Hedge Ratios							EMBICDX Hedge Ratios						
	2003	2004	2005	2006	2007	2008	2009	2003	2004	2005	2006	2007	2008	2009
Argentina	-3.75	-3.46	-3.75	-4.03	-5.02	5.30	3.04	-1.06	-0.64	-1.77	-1.91	-1.91	5.44	5.02
Brazil	5.02	4.60	4.88	4.45	4.74	6.29	2.05	2.90	3.04	4.03	3.89	4.03	4.17	1.77
Bulgaria	1.20	0.92	0.21	0.49	0.49	0.49	0.64	0.64	0.64	0.07	0.21	0.21	0.35	0.35
Chile	0.35	0.21	0.21	0.21	0.21	0.21	0.07	0.21	0.07	0.21	0.07	0.07	0.07	0.21
China	0.21	0.21	0.21	0.21	0.21	0.07	0.21	0.07	0.07	0.07	0.07	0.07	0.07	0.21
Colombia	1.34	1.63	1.20	1.34	1.34	0.78	0.07	0.49	0.49	0.78	0.78	0.78	0.78	0.49
Ecuador	2.05	2.33	3.04	2.76	1.91	2.19	2.62	1.34	1.20	0.64	1.34	1.34	1.63	3.32
Hungary	0.07	0.07	0.07	0.07	0.07	0.21	0.35	0.07	-0.07	0.07	0.07	0.07	0.07	0.21
Korea	0.92	0.64	0.78	0.64	0.35	-0.07	0.07	0.78	0.78	0.64	0.64	0.21	-0.07	0.21
Lebanon	-0.07	-0.07	-0.07	-0.35	0.78	1.06	1.63	0.07	-0.07	-0.07	0.49	0.35	0.64	0.64
Malaysia	0.92	0.64	0.21	0.35	0.35	0.35	0.35	0.78	0.64	-0.07	0.21	0.21	0.21	0.21
Mexico	1.06	0.92	0.49	0.35	0.35	0.35	0.35	0.64	0.64	0.35	0.35	0.35	0.21	0.21
Panama	0.49	0.49	0.49	0.49	0.49	0.49	0.35	0.49	0.35	0.35	0.35	0.35	0.35	0.21
Peru	1.34	1.06	0.92	1.06	0.64	0.92	0.35	0.64	0.64	0.64	0.64	0.64	0.64	0.35
Philippines	1.20	0.35	0.35	0.21	0.07	-0.07	0.21	0.64	0.35	0.07	0.07	0.07	-0.49	0.07
Poland	0.35	0.35	0.21	0.35	0.07	0.07	0.21	0.21	0.21	0.21	0.21	-0.07	0.07	0.21
Russia	6.72	0.64	2.62	2.90	3.61	4.03	5.16	6.86	0.78	2.62	2.33	2.76	2.90	2.90
SouthAfrica	0.64	0.49	0.49	0.64	0.21	0.21	0.35	0.35	0.35	0.35	0.35	0.21	0.21	0.35
Thailand	1.91	1.48	0.49	0.49	0.64	0.64	0.35	0.64	0.64	0.49	0.21	0.21	0.35	0.35
Turkey	0.92	0.78	0.92	0.92	0.92	0.49	-0.07	1.06	0.64	0.78	0.49	0.92	0.78	-0.07
Venezuela	1.77	1.48	-0.35	-0.21	-0.49	-0.07	2.62	1.34	0.92	-0.07	-0.07	-0.21	-0.21	3.46
Av. Spread <500	0.77	0.61	0.43	0.43	0.41	0.37	0.35	0.43	0.36	0.29	0.32	0.25	0.22	0.28
Av. Spread >500	1.99	1.04	1.08	1.04	0.88	2.68	2.29	1.87	0.94	0.90	0.90	1.02	2.15	2.39
Average	1.18	0.75	0.65	0.64	0.57	1.14	1.00	0.91	0.56	0.49	0.52	0.51	0.87	0.99

Notes: Dynamic hedge ratios are re-estimated every year which mimic the annual roll over hedging strategy. The 2003 hedge ratio is calculated based on the sample period from when the data was available to 2002Q4. 2004 hedge ratio is based on the sample up to 2003Q4, etc. We check the hedge ratios for both HYS and EMBICDX. Positive Hedge ratios indicate long positions in the corresponding hedgers.

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