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# Credit Default Swaps and Sovereign Debt Markets

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**Abstract:** This study investigates the link between price discovery dynamics in sovereign credit default swaps (CDS) and bond markets and degree of financial integration of emerging markets. Using CDS and sovereign bond spreads, the price discovery mechanism was tested using a vector error correction model. Financial integration is measured using news-based methods. We find that sovereign CDS and bond markets are cointegrated. In 57 percent of times, the CDS market leads in price discovery by adjusting before bonds to new information regarding credit risk. In 29 percent of times, bond markets are sources of price discovery. We also find a strong positive correlation of 0.84 between degree of financial integration and bond market information share. The evidence suggests that changes in sovereign credit risk and bond yields are significantly influenced by common external (global) factors while country specific factors play an insignificant role.

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# Credit Default Swaps and Sovereign Debt Markets

## I. Introduction

A credit default swap (CDS) is a contract that provides insurance against a default by a particular company or sovereign entity. The borrower company is known as the reference entity, and a default by the company is known as a credit event. The buyer (usually the bondholder) of the insurance (CDS) makes periodic payments (premium) to the seller and in return obtains the right to sell a bond issued by the reference entity for its face value if a credit event occurs (Hull, Predescu and White, 2004). The rate of payments made per year by the buyer is known as the CDS spread. If the CDS spread for a 5-year contract with a principal of $100 million is 400 basis points, the buyer pays $400,000 per year and obtains the right to sell bonds, issued by the reference entity, to the CDS seller, at $100 million face value in the event of a default by reference entity. The credit default swap market has grown rapidly since the International Swaps and Derivatives Association (ISDA) produced its first version of a standardized contract in 1998.

According to the ISDA, the global notional outstanding volume of credit derivatives transactions was $31.2 trillion in 2009, up from $631.5 billion in 2001. The academic literature by Duffie (1999) and Hull and White (2000) suggests that, in the absence of market friction, the arbitrage forces CDS spreads to be approximately equal to the underlying bond spreads (bond yield less risk free rate), since the CDS spread is equal to the risk premium paid to make the bond riskless. Therefore, the CDS and bond spreads are positively correlated. Both spreads should provide more efficient allocation and pricing of credit risk.

Blanco Brennan and Marsh (2005) examine the relationships between CDS premiums and bond yield spreads for emerging market sovereign borrowers and find that these two measures of credit risk deviate considerably in the short run due to factors such as liquidity and contract specifications, but a stable long-term equilibrium relationship between CDS and bond spread exists for most countries. They also find that CDS premiums tend to move more than one-for-one with bond yield spreads and CDS premiums often lead the bond market in price discovery. These findings contradict evidence by Ammer and Cai (2007) that bond spreads leads CDS in price discovery. Chan-Lau and Kim (2004) do not find any equilibrium price relationship among the sovereign bond, CDS and the equity markets. None of these studies attempts to link efficiency of pricing credit risk to financial integration.

In relation to financial integration, Adam, Jappelli, Menichini, Padula and Morgan (2002), Adjaouté and Danthine (2003), Codogno, Favero and Missale (2003), Kim, Lucey and Wu (2004), Baele, Ferrando, Hördahl, Krylova and Monnet (2004) and Barr and Priestley (2004) investigate the question of how strongly bond yields are determined by world versus local factors. The authors argue that the world bond market is not integrated, as world factors have only a 70 percent influence on the development of domestic returns. Codogno et al (2003) and Longstaff, Pan, Pedersen, Lasse and Singleton (2007) find that movements in yields on the government bonds are driven primarily by changes in international risk (common external) factors, particularly the U.S. stock and high-yield bond markets, time-varying global risk premia and capital flows. Powell and Martinez (2008) find that a small number of global factors can explain the variation in CDS spreads in 20 emerging markets. Galindo, Izquierdo and Rojas-Suárez (2010) argue that while financial integration is a channel through which adverse financial shocks lead to credit contractions and increases in interest rates, it also helps credit markets to deepen and the cost of finance to decline in the absence of adverse external financial shocks. As the cost of capital (domestic bonds and equity yields) fall, the CDS spreads are also bound to fall in response to lower credit risk associated with lower bond yields.

This brings into fore the question as to whether emerging economies should pursue financial integration in the hope that exposure to and competition from global markets and institutions will strengthen domestic financial markets and institutions. In the realm of above arguments, it is unclear whether financial integration increases market efficiency in pricing and allocation of risk. This study hypothesizes that (i) price discovery takes place mainly in the CDS market in emerging markets and (ii) emerging markets that are more integrated with global financial markets are more efficient in CDS spreads and bond price discovery process.

These hypotheses can be substantiated by the following arguments. First, the CDS market is more flexible and less capital-intensive since only the CDS premium have to be paid. Second, CDS traders can easily go long and short in credit risk while shortening bonds is more difficult. Third, bond spreads in the secondary market depend on the available number and specifics of the outstanding bonds. However, the CDS market is more standardized (in terms of tenor, notional, currency etc.) and less dependent on primary bond market issuances. We can make a counter-argument that CDS has lower liquidity than the bond market, granted limited and opaque information in trading of CDS securities.

Several considerations have motivated this study in investigating financial integration and price discovery in sovereign CDS and bond markets. First, the seven emerging markets under study (Argentina, Brazil, China, Colombia, Mexico, Philippines and South Africa) are the leading names in sovereign bond markets in terms of trading volume and liquidity. We explore the link between financial integration and pricing efficiency in these markets. Second, previous studies have focused on financial integration with respect to money market, stock markets, foreign exchange markets, and corporate bond markets. No study has attempted to link financial integration to efficient pricing of credit risk.

We are concerned with not only whether the pricing of sovereign CDS and bond securities fully reflects all the available information but also whether global or domestic factors exert more influence on pricing of credit risk. This finding will assist investors and portfolio managers in evaluating which information (global or domestic) is more relevant to pricing of securities.

We aim to contribute to the existing literature in two main ways. First, we attempt to link credit risk pricing efficiency to degree of global financial integration of emerging markets. Second, we used a new benchmark in relating individual emerging markets to global factors. Instead of using the conventional U.S government bonds as benchmarks, we use an emerging market global bond index consisting of 31 globally spread and most active emerging markets.

Briefly, our results are as follows. In six of seven sovereigns, CDS and bond spreads are cointegrated; hence, a long-run equilibrium relationship exists between CDS and bond markets. In 57 percent of times, the CDS market leads in price discovery by adjusting before bond markets to new information regarding credit risk. In 29 percent of times, bond markets are sources of price discovery. We also find a strong positive correlation of 0.84 between degree of financial integration and bond market information share. The evidence suggests that changes in sovereign credit risk and bond yields are significantly influenced by common external (global) factors while country specific factors play an insignificant role. This is consistent with previous literature and empirical findings by Diaz and Gemmill (2006), Grandes (2007), González and Yeyati, (2008), Psalida and Sun (2009) and Longstaff, Mithal and Neis (2004).

The rest of the paper is organized as follows: Section II reviews the literature. Section III details the data and empirical methodologies employed in price discovery and measuring financial integration. Section IV discusses the empirical results while section V concludes.

## II. Literature Review

Research in CDS and bond markets can be broadly categorized into two bodies: corporate bonds and sovereign bonds. Studies on corporate bonds yield have their origin from the structural models pioneered by Black and Scholes (1973) and Merton (1974). In later years, alternative models, reduced form models have been developed by Jarrow, Lando and Yu (1995). Structural models define credit risk as the outcome of relentless deterioration of a firm's asset with underlying assumption that a firm defaults on its obligations if the value of its asset value falls below a specified threshold. Research by Alexander, Edwards, and Ferri (2000), Longstaff et al (2004) and Powell and Martinez (2008) finds that yield curve, stock price, stock price volatility and financial leverage are the most statistically significant factors in determining a firm's credit risk. Reduced form models consider default time as a random stopping time with stochastic arrival intensity. Previous literatures conclude that taxation, default and liquidity components are the important factors in determining default risk. In an attempt to reconcile structural and reduced form models, Driessen (2005) pools all the significant factors from both models into a single linear regression. However, no great breakthrough is documented.

A number of papers have addressed the information discovery relationship between CDS and bond markets. In corporate bond markets, Houweling and Vorst (2005) and Hull et al (2004) find that there is no price equilibrium between corporate CDS rate and bond yield. However, Zhu (2006) finds the price discrepancy between corporate CDS rate and yield spread only exists in short run and price equilibrium is observed in long run. Norden and Weber (2004) and Zhu (2006) find that both stock and CDS markets lead the corporate bond market, which supports the hypothesis that information seems to flow first into stock and credit derivatives markets and then into corporate bond markets. Amato and Remolona (2003) suggest non-diversifiable and idiosyncratic risks account for three quarters and for one quarter of the default risk of BBB/BAA-rated corporate bonds respectively. Empirical evidence by Driessen (2005) and Berndt, Douglas, Duffie,Ferguson and Schranz (2005) estimates an average bond risk premium of 189 basis points after accounting for tax and liquidity effects.

In the studies about the credit risk in sovereign bonds, Min (1998) uses factors in structural models to explain credit risk, and Duffie,and Liu (2001) use reduced form models. Both studies fail to find the main force driving the changes in credit risk in sovereign bonds. Ammer and Cai (2007) find that bond spreads lead CDS premiums for emerging market sovereigns more often than has been found for investment-grade corporate credits, consistent with the Cheapest-to-deliver (CTD) option. The CTD option constrains CDS liquidity for riskier borrowers. Furthermore, the CDS market is less likely to lead for sovereigns that have issued more bonds, suggesting that the relative liquidity of the two markets is a key determinant of where price discovery occurs. Blanco and Marsh (2005) finds that most price discovery occurs in the credit default swap market. Longstaff et al (2007) argues that by using sovereign CDS data, investors can “factor out” the component of sovereign bond returns due to changes in interest rates and focus instead on the returns due exclusively to sovereign credit risk. Furthermore, the sovereign CDS market is often more liquid than the corresponding sovereign bond market, resulting in more accurate estimates of credit spreads.

Remolona, Scatigna and Wu (2007) argue that sovereign spreads can be decomposed into two components: the expected loss from default and the risk premium. The risk premium compensates investors for the fact that the realized loss from default may exceed the expected loss. Such a default risk is asymmetric because the possible losses from default are large relative to the possible gains from an absence of default. Jarrow et al (2005) claim that a zero default risk premium in a world of risk-averse investors is only possible if defaults on different bonds are independent and investors are able to diversify away any idiosyncratic risks by holding a sufficiently large portfolio of bonds. Empirical results pertaining to presence of sovereign risk premium in a spread and its size are mixed.

*Financial integration and efficient pricing of securities*

Financial integration has been analyzed in key segments of the financial system. In foreign exchange market, Aguilar and Hördahl (1998) and Castrén and Mazzotta (2005) try to evaluate eligibility for the introduction of the euro by means of correlation analysis of national currencies against the U.S. dollar (USD) and alternative benchmarks. Komarkova and Komárek (2007) and Tai (2007) examine the foreign exchange market integration for selected new European Union (EU) member states using standard rolling correlation analysis, the concept of beta-convergence and sigma-convergence. Money market integration studies have largely focused on the EU countries. Studies by Baele et al (2004) and Adam et al (2002) investigate the speed and degree of financial integration using the concept of beta and sigma convergence. They find that the money market was strongly integrated before the introduction of euro.

Cornelius (1993) has examined market efficiency in five emerging markets on the basis of causal relationships between stock prices and changes in the money supply. He shows that changes in the money supply Granger cause (Granger, 1986) stock prices in India, Korea, Malaysia, and Mexico, implying that markets in these emerging economies have an element of informational efficiency. Yuhn (1997) investigates whether stock prices reflect the efficient discounting of new information on market fundamentals in the five highly integrated industrialized markets (the United States, Canada, Japan, the United Kingdom, and Germany) over two decades. He finds that U.S and Canadian stock markets have informational efficiency.

According to Espinoza and Kwon (2009) and Chai and Rhee (2005), the benefits of financial integration have traditionally been divided into three categories. First, financial liberalization is thought to promote efficiency in the allocation of capital through financial development. Capital flow to countries with the highest rates of return allows inter-temporal consumption smoothing, increased competition and improved pricing efficiency in financial system. Second, risk-diversification may improve, and the reduced risk profile of profits and consumption should improve welfare. Third, a reduction in government regulations enhances transparency, and shifts in international markets' assessment of an economy may act as a disciplinary device. However, Lewis (1997) argues that financial integration leads to synchronization of business cycles, minimization of risk-diversification benefits, increased risk of contagion among countries that share some fundamentals, increased volatility including episodes of so-called "sudden stops" due to external shocks and closure of access to international bond markets. Kose, Eswar, Prasad and Terrones (2003) also argue that there is some evidence that a certain threshold of domestic market developments and institutions has to be reached--and most emerging economies are well below that level--before the vulnerability to external shocks can be decisively reduced. Blommestein and Santiso (2007) support this argument by suggesting that successful participation by emerging markets in this uncertain and more complex global financial landscape requires a well-functioning domestic, local currency bond market.

## III. Data and Empirical Methodology

### *Sources of Data*[1]

The data used for price discovery are weekly sovereign CDS spreads and emerging market bond index (EMBI) spreads for each sovereign entity. EMBI is traditionally a market-capitalization

[1] We collected CDS data from Thomson Reuters, Datastream, when Dr. Jung-Suk Yu worked for Samsung Economic Research Institute in Korea.

weighted index. The index includes USD denominated Brady Bonds, Eurobonds, traded loans, and local market debt instruments issued by sovereign and quasi-sovereign entities for debt denominated in USD, with a minimum current face value outstanding of US$500 million. EMBI spreads are frequently used in International Monetary Fund, National Bureau of Economic Research, credit trade papers and similar studies. The data is from JP Morgan Chase for five year sovereign CDS contracts. The weekly data spans January 2004 to October 2009. This results in 305 observations for each of the seven emerging sovereign entities (Argentina, Brazil, China, Colombia, Mexico, Philippines and South Africa), except the Philippines, which has 302 weekly observations. The seven sovereigns constitute more than 45 percent of the emerging market global bond index weight. Moreover, Brazil, Philippines, Mexico and South Africa have the highest bond trading frequency which provides high liquidity.

*Empirical methodology*

The main objective of this paper is to examine the long-term co-movement (equilibrium price relationship) and short-term dynamic linkages between sovereign bond spreads and the CDS premium, price discovery dynamics between the two spreads and the influence of the degree of financial integration in each sovereign. To this end, the time series techniques, including cointegration test, Granger causality test, vector error correction model (VECM) and information-based integration measure method are used.

The existence of equilibrium price relationships or cointegrating equations is a two-step approach involving (i) testing whether the CDS and bond yield spreads (BYS) are characterized by a unit root (non-stationary) and (ii) testing for cointegration or long-term relationship using Johansen (1988, 1991) approach. At a formal level, the unit root tests use Augmented Dickey-

Fuller (ADF) method by Dickey and Fuller (1979) and Phillips-Perron (PP) method by Phillips and Perron (1988). The results are presented in Table 2.

*Long-term co-movement between CDS and bond spreads*

After confirming that CDS and bond spreads are non-stationary, we test for the long-term equilibrium price relationship between the two series. When variables are non-stationary, the classical ordinary least squares technique becomes inefficient since the assumption of stationarity is violated. Theoretically, this problem could be resolved by differencing a non-stationary series until it becomes stationary but differencing causes long-term information loss. Cointegration modeling mitigates this problem by avoiding differencing of the each series. The existence of cointegration between the CDS and bond spreads imply that there is no arbitrage opportunity between the two markets in the long run as predicted by the theory.

We use the Johansen (1988, 1991) approach to test for cointegration. This approach gives not only the number of cointegrating vectors but also provides consistent estimates of the entire cointegrating matrix. Moreover, this approach allows us to test restrictions using the likelihood ratio statistic, which has a known distribution and is a function of just one parameter.

The cointegration rank test is performed on a vector auto regression (VAR) of order *p* using the following initial cointegration equation:

$$\mathbf{Y}_t = \mathbf{A_0} + \mathbf{A_1}\mathbf{Y_{t-1}} + \cdots + \mathbf{A_p}\mathbf{Y_{t-p}} + \boldsymbol{\varepsilon}_\mathbf{t} \tag{1}$$

where $\mathbf{Y} = 2\times 1$ vector of CDS spreads and bond spreads, $\mathbf{A}_0$, $\mathbf{A}_i$, and $\boldsymbol{\varepsilon}_t$ are $2\times 1$ vector of intercept, coefficient estimate and stochastic/random error term respectively. The cointegration test equation takes the following form:

$$\boldsymbol{\Delta}\mathbf{Y}_t = \boldsymbol{\Pi}\mathbf{Y_{t-1}} + \sum_{i=1}^{p-1}\boldsymbol{\Gamma}_i\boldsymbol{\Delta}\mathbf{Y}_{t-1} + \mathbf{e_t} \tag{2}$$

where $\mathbf{\Pi} = \sum_{t=1}^{p} \mathbf{A}_i - \mathbf{I}$ and $\mathbf{\Pi}_i = -\sum_{j-t+1}^{p} \mathbf{A}_i$ and $\mathbf{I}$ is a $2 \times 1$ vector of identity matrix. The determinant of matrix $\mathbf{\Pi}$ should be zero (rows are linearly dependent) since the term $\mathbf{\Pi Y_{t-1}}$ has to be stationary for cointegration to hold. If the two markets are cointegrated, coefficient matrix $\mathbf{\Pi}$ has a rank of one and there exists $2 \times 1$ vectors α and β such that $\mathbf{\Pi} = \alpha\beta^T$ where $\alpha$ is a vector of speed of adjustment coefficients and $\beta$ is the cointegrating vector. The null and alternative hypothesis would thus be as follows:

$H_0$: The coefficient matrix $\mathbf{\Pi}$ has a full rank of 2 (the two spreads are not cointegrated).

$H_a$: The coefficient matrix $\mathbf{\Pi}$ has a full rank of 1 (the two spreads are cointegrated).

If the null hypothesis is rejected, then the two price series are cointegrated, a confirmation that there exists equilibrium price relationship between CDS and bond markets. The cointegrating rank, *r*, can be tested with two statistics, trace and maximal eigenvalue. The Monte Carlo experiments reported in Cheung and Lai (1993) suggest that the trace test shows more robustness to both skewness and excess kurtosis in the residuals than the maximal eigen value test.

*Short term interaction between CDS and bond spreads and adjustment to information*

Lehmann (2002) defines price discovery as efficient and timely incorporation of the information implicit in investor trading into market prices. When closely related assets trade in different markets, it is important to investigate which of the assets contributes most to the price discovery process. A Granger causality test is used to investigate the dynamic relationship between the CDS and bond markets. The test is utilized to provide insightful trace of the direction of the linkage. The Granger causality does not provide conclusive evidence on economic causality, but is able to appraise whether there is a consistent pattern of shifts in one series preceding the other. The results therefore provide grounds for further investigation of the causal mechanisms.

Given two series of CDS and bond yield spreads, CDS Granger causes BYS if past values of CDS contain useful information beyond that is contained in past values of BYS to explain the current value of BYS. This can be done using the following equation:

$$\Delta y_t = \alpha + \sum_{j=1}^{p} \beta_j y_{t-j} + \sum_{j=1}^{p} \varphi_{j-1} x_{t-j} \qquad (3)$$

where $\alpha$ is a constant, $p$ is the number of lags, $\Delta$ is the first difference operator, $\beta_j$ and $\varphi_j$ are coefficients of lagged vales of $y$ and $x$ series respectively. If there is Granger causality from $x$ to $y$, then some of the $\varphi_j$ coefficients should be non-zero, a tentative implication is that price discovery may be occurring in market $x$ since some past (lagged) values of $x$ can partly explain current values of $y$. If all $\varphi_j$ coefficients are zeros, $x$ does not Granger cause $y$, hence we can make a tentative conclusion that no price discovery occurs in market $x$. Therefore the Granger causality test can be performed by testing the hypothesis: $H_0 : \varphi_1 = \varphi_2 = \cdots = \varphi_p = 0$ which can be readily implemented using the standard *F*-tests. A rejection of the hypothesis test implies that $x$ Granger causes $y$. If $y$ also Granger causes $x$, there is feedback effect or bidirectional causality. Theoretically, there should be bidirectional causality, implying that price discovery occurs in both markets since the two markets trade closely related assets.

*Price discovery dynamics using the vector error correction model*

Before using the vector error-correction model (VECM), we need to set the appropriate lag length, p, to ensure the error terms in the VECM are Gaussian (the residuals do not exhibit autocorrelation and non-normality). The optimal lag length of individual series or variable is determined using the residual analysis of an unrestricted VAR model. The Akaike Information Criterion (AIC), the Schwarz Bayesian information criterion (SBIC), Final prediction error (FPE) and Hannan-Quinn information criterion (HQIC) are applied in the an unrestricted VAR. Blanco et al (2005), Zhu (2006) and Norden and Weber (2004) use both AIC and SBIC measures. Chan-Lau and Kim (2004) and Ammer & Cai (2007) favor SBIC measure. Lutkepohl (1993) and Hayashi (2000) discusses the four selection criteria and provide evidence that SBIC and HQIC provides consistent estimates of the true lag order, whereas AIC and FPE will overestimate the true lag order with a positive probability. In this study, SBIC and HQIC are used as lag selection criterion.

The VECM framework explains the dynamic lead-lag relationship between CDS and bond markets. The cointegration equation relating CDS market to bond market takes the following form.

$$CDS_t = \gamma_0 + \beta_i BYS_t + \nu_t \tag{6}$$

A no-arbitrage scenario exists if $\gamma_0 = 0$ and $\beta_i = 1$. The coefficient, $\beta_i$ indicates the long run equilibrium relationship between sovereign CDS spreads and sovereign bond spreads. The error term, $\nu_t$ should be stationary, $I(0)$. In VECM, we lag both the dependent and independent variables to derive the lagged error correction model (ECM).

$$\text{Lagged ECM} = \nu_{t-1} = CDS_{t-1} - \gamma_0 - \beta_i BYS_{t-1} \tag{7}$$

The VECM then takes the following form.

$$\Delta CDS_t = \gamma_{10} + \lambda_1 \ \text{ECM}, \nu_{t-1} + \sum_{j=1}^{p} A_{1j} \Delta CDS_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta BYS_{t-j} + \varepsilon_{1t} \tag{8}$$

$$\Delta BYS_t = \gamma_{20} + \lambda_2 \ \text{ECM}, \nu_{t-1} + \sum_{j=1}^{p} A_{2j} \Delta CDS_{t-j} + \sum_{j=1}^{p} \delta_{2j} \Delta BYS_{t-j} + \varepsilon_{2t} \tag{9}$$

The lambdas, $\lambda_1$ and $\lambda_2$ are the error correction or speed of adjustment coefficients. The comparison of magnitude and signs of these coefficients convey an idea of the relative efficiency of the CDS and bond markets in price discovery. If $\lambda_1$ is statistically significant and negative, then CDS spreads adjust to close the pricing gap, and bond spreads do not significantly adjust. This implies that bond spreads are leading CDS spreads in price discovery. The CDS is inefficient since the price reacts to publicly available information. If $\lambda_2$ for the bond market is statistically significant and positive, then, bond market adjusts to incorporate new public information in pricing of sovereign risk. The CDS is the venue for price discovery. If $\lambda_1$ and $\lambda_2$ are significant with correct signs, the relative magnitude of the two coefficients reveals that price discovery happens in both markets. Using $\lambda_1$ and $\lambda_2$ Hasbrouck (1995) developed a measure of information share (I.S) to identify the proportion of price discovery which each security contributes. I.S thus indicates the relative importance of the CDS and bond markets in price discovery, I.S= $\frac{\lambda_i}{\lambda_i - \lambda_j}$ or $\frac{\lambda_i}{\lambda_j - \lambda_i}$ depending on the sign of $\lambda_1$ and $\lambda_2$.

Erdem, Vasconcellos and Bae (2008) depart from these authors and argue that there are five different cases that a positive gap can be closed and for a negative gap, they add five scenarios: (i) an increase in CDS spread and a larger increase in bond spread, (ii) a decrease in CDS spread and a smaller decrease in bond spread, (iii) a decrease in CDS spread and an increase in bond spread, or (iv) a decrease in CDS spread and no change in bond spread (v) no change in CDS spread but an increase in bond spread. They propose the use of the difference of speed of adjustment coefficients, $\lambda_2 - \lambda_1$ to check whether one of the five scenarios above exists. If $\lambda_2 - \lambda_1$ is positive, error correction mechanism should occur. To this end, if the error at previous time period is positive, the measure $\lambda_2 - \lambda_1$ should be negative for the gap to close in any of the five scenarios. Conversely, if the error is negative, $\lambda_2 - \lambda_1$ should be positive for the gap to close. In sum, regardless of the sign of the error at time $t-1$, the $\lambda_2 - \lambda_1$ measure should be positive for the error correction mechanism to truly work properly. The results of this methodology are included in Table 5.

*Financial integration measures*

Baele et al (2004) propose to quantify financial integration using three main dimensions, namely (i) price-based, (ii) news-based and (iii) quantity-based measures. The price-based measures are a direct check of the law of one price (LOOP) which is a variant of purchasing power parity. Hazem (2005) states that LOOP is premised on the idea that when transaction costs and taxes are ignored, identical securities should carry the same price across all stock markets where such securities are traded. According to Oxelheim (2001), if two stock markets are integrated, then identical securities should be priced identically within both markets. Financial integration implies that securities in all markets are exposed to the same risk factors and the risk premia on each factor are the same in all markets. These measures are broadly classified into beta and sigma convergence indicators, originally developed by Barro and Sala-i-martin (1991). The news-based measures make it possible to identify existing market imperfections such as frictions and barriers. Babecky, Frait,Komárek and Komárková (2009) argue that news-based measures are designed to distinguish information effects from other frictions or barriers. In a financially integrated area, portfolios should be well diversified, and the degree of systematic risk should be identical across assets in different countries. Therefore, the arrival of new economic information of a common or global nature should dominate in impacting on prices. Local news will have significant influence on prices if the markets are not integrated. Stated differently, all news is global if markets are efficient and integrated. Following Baele et al (2004), the degree of integration of shocks can be estimated using the following regression.

$$\Delta R_{i,t} = \alpha_{i,t} + \gamma_{i,t} \Delta Rb_t + \varepsilon_{i,t} \qquad (10)$$

In Equation (10), $R_{i,t}$ represent the return on specific assets (bonds, stocks, currencies and interbank rate among others) in country $i$ at time $t$, $b$ is the benchmark portfolio or asset return (U.S. bonds or emerging market composite bond index) at time $t$, $\alpha$ is country $i$ constant at time $t$. The constant converges to zero. $\varepsilon_{i,t}$ is country $i$ shock or white noise disturbance at time $t$ and $\Delta$ is the difference operator.

Lags are excluded from the equation since news spreads much quicker and are adjusted for in price much faster relative to the data frequency. Coefficient $\gamma$ indicates the extent to which an asset of a selected country responds to news in the same way as the benchmark asset, assuming that the benchmark asset responds to global news only. The higher $\gamma$ is (in absolute terms), the higher the degree of financial integration irrespective of countries risk level measured by betas and sigmas.

Other measures of financial integration are the quantity-based measures which quantify the effects of mainly legal and other non-price frictions and barriers from both the supply and demand sides of the investment decision-taking process. Rolling correlations can also be computed as measure of financial integration among markets. For the purpose of this study, we shall utilize the news-based measures of financial integration. Rolling correlations will be computed to show the extent to which domestic bonds yields commove with global bond index (the benchmark) factors. Although sovereign bonds are denominated in USD, investors in sovereign bonds are spread across the global financial markets (not U.S. only). Therefore, we use the emerging market global bond index as the benchmark, as opposed to U.S. government bonds. The U.S. 5 year Treasury bond is still used as a benchmark to check robustness of our results.

## IV. Empirical Results

*Descriptive statistics*

Descriptive statistics in Table 1 show that Argentina had the highest volatility of CDS spread as measured by standard deviation (1057 basis points), while China had the lowest CDS spread volatility (51.64 basis points) over the sample period. In all cases, the mean is greater than median, an indicator of positively skewed distribution. The Jarque-Berra statistics and corresponding *P*-values shows the each series has non-normal distribution.

*Unit root testing*

The CDS spreads and bond spreads for all sovereigns exhibit unit root characteristic either at 1 percent or 5 percent significance levels. The SBIC was used for optimal lag selection. The PP test used the Bartlett Kernel spectral estimation method and Newey-West bandwidth method to control for higher order correlation of error terms. The (BYS show a strong non-stationarity trends relative to CDS spreads. Brazil, Mexico and Colombia CDS spreads are very weakly non-stationary.

*Cointegration tests*

Cointegration tests were based on Johansen and Juselius (1991) model of cointegration. Table 3 results indicate that CDS and bond markets are cointegrated in 6/7 sovereigns indicating existence of long run equilibrium relationship between CDS and bond spreads. The credit default swap and bond yield spreads for South Africa do not exhibit long run equilibrium, and BYS for using the unrestricted Vector autoregressive model in equations (iii) and (iv), SBIC and HQIC methods (defined in the table), were used to select the optimal number of lags for the ECM.

Under both lag selection methods, all sovereigns are cointegrated except South Africa. Consistent with the argument by Lutkepohl (1993) and Hayashi (2000), SIC and HQ yield similar cointegration results for three sovereigns. The cointegration results confirm that both markets price the credit risk in the long run. This confirms theoretical underpinnings that the two prices are of the same risk, and in the long run, market forces will eventually remove the arbitrage opportunity between the two markets

*Granger causality short-term dynamic interactions*

Having established the long-term relationship between CDS and bond spreads, the next step is to examine the short-term dynamic linkages between the two spreads. Specifically, we tentatively assess which spread or market (CDS or bond) is more efficient in reflecting changes in the credit risk of underlying sovereign. In other words, we evaluate how efficiently each market fully integrates new information regarding changes in the credit risk. While Granger causality tests indicate a close short term dynamic connection between the two markets, there is no clear evidence that this connection goes in a certain direction. We conduct Granger causality tests with one to six lagged weeks. Table 4 provides summary results.

In 4 out of 7 sovereigns (Argentina, China, Mexico, and South Africa), CDS spreads Granger cause bond spreads in all the six lags. In fact, there is bidirectional causality in South Africa (at five and six lags), Mexico and China. In Brazil and Philippines, the bond spreads Granger cause CDS spreads. The strength of this causality increases with the number of lags. In Colombia, neither of the two spreads Granger cause each other, implying absence of connection between the CDS and bond markets. The two markets are thus segmented. Granger causality tests suggest a close dynamic connection and interaction between the two markets in 6 out of 7 sovereigns. We can also tentatively conclude that sovereign CDS market is more efficient in integrating new information regarding changes in the credit risk. A weakness of causality tests is that they indicate a close dynamic connection between the two markets, but there is no clear evidence that this connection goes in a certain direction.

*Price discovery measures using VECM and information share*

The price discovery and pricing error correction depends on both the significance and magnitude of $\lambda_1$ and $\lambda_2$ coefficients. The two coefficients are the hallmark indicators of speed of adjustment and which market (CDS or bond) moves to adjust for price discrepancies. If $\lambda_1$ *is* significantly negative, the bond market moves to correct the price discrepancies. CDS plays the dominant role in price discovery. If $\lambda_2$ is significantly positive, the CDS market moves to correct the price discrepancies by adjusting to new information. The bond market plays the leading role in price discovery. If both $\lambda_1$ and $\lambda_2$ are significant with correct signs, then neither of the markets dominates in price discovery.

This is the explicit results for China, Mexico and South Africa. Both $\lambda_1$ and $\lambda_2$ are significant (using *t*-statistic) with negative and positive signs. Therefore, both CDS and sovereign bonds adjust to new information and neither dominates in price discovery. This evidence is collaborated by Granger causality where China, Mexico and South Africa have bidirectional causality. The information share of CDS and bond markets for China is almost equally split. The higher information share for CDS in case of Mexico reflects the stronger Granger causality of CDS on bond spreads. The higher CDS information share for South Africa clearly reflects the slower adjustment to new information as indicated by bond spreads Granger causality at five and six lags from Table 4. The *t*-statistic for Argentina the size and sign of $\lambda_2$ shows that CDS plays the leading role in price discovery. From Table 4, Granger causality suggests similar evidence, as CDS Granger causes bond spreads for all lags. Error correction results for Brazil and Philippines $\lambda_2$ is significant (at 5 percent and 10 percent respectively), hence CDS adjusts to new information and bond market leads in price discovery. The bond information share is more than 90 percent for both sovereigns. This is consistent with Granger causality tests where bond spreads Granger cause CDS spreads for both sovereigns.

As expected, Colombia, where neither CDS spreads nor bond spreads Granger cause each other, presents unique results. Both $\lambda_1$ and $\lambda_2$ are positive but $\lambda_1$ is trivial while $\lambda_2$ is significant at 10 percent. This could be interpreted that one market tracks the other market without providing any pricing information. In this case, the CDS spreads do all the adjustments to new information. In fact, the trivial size of insignificant $\lambda_1$ for Colombia suggests that the activities in bond markets provide little information that has no practical or economic impact in price discovery dynamics.

It is not unusual for bond spreads to lead CDS spreads in price discovery (CDS spreads do most of the adjustment to new information). Chan-Lau and Kim (2004) note that the bond market may dominate price discovery where banks are both the investors and the insurance (CDS) buyers. Additionally, CDS positions are more buy-and-hold natured since banks do not trade in CDS. In such cases, bond markets are more active, liquid and have high trading volume. Cases of CDS markets leading the bond market are not uncommon and could arise for three main reasons: First, informed traders operate in CDS markets and hence there are more market participants. Secondly, CDS accord the easiest way to trade credit risk, especially for shorting credit risk. Thirdly, bond market trades bond credit risk, while CDS market trades bond plus loan plus counterparty credit risk.

*Financial integration and price discovery relationship*

Tables 6 and 7 summarize the financial integration measures and how they relate to pricing efficiency in CDS and sovereign bond markets. We start by computing the rolling correlations between the sovereign bond yields and emerging market global bond index returns to assess how the two vary over time. Table 6 shows that there is very high correlation between the composite global bond index and sovereign bonds yields issued by the emerging markets. This is an indicator that sovereign bonds prices are largely influenced by global factors rather than local factors. This correlation seems to dissipate from 2007, 2008 and 2009 (weeks 157-305) especially for Argentina and China. This could be partly explained by the global financial crisis of 2007-2008, which affected different countries differently. It could also indicate that China and Argentina are less integrated with global markets than other five sovereigns.

*Financial integration and price discovery*

The rolling correlation results in Table 6 indicate that South Africa, Brazil, Mexico, Colombia and Philippines bond yields maintain high correlation with EMBI over time. This is not surprising, since even though we are using bond yields to compute correlations, such yields are significantly correlated to CDS spreads. Therefore, irrespective of which spread leads in price discovery, a high correlation is expected. Argentina and China correlations are deteriorating over time. This is fathomable for China which is still opening up its market to global investors.

A possible explanation for deteriorating correlation for Argentina could be the record default on $95 billion international bond in 2001 that led to breakdown in sovereign bonds trading in international market. As of August 2010, Argentina was still restructuring $12.9 billion portion of debt and facing a class action from individuals and corporate bondholders. These events and subsequent threats from potential international bondholders due to ongoing default legal tussles could have contributed to reduced trading of sovereign bonds and diminished integration of the country's financial markets with global financial markets.

However, the information share of 0.90 for Argentina's CDS market indicates the increased activity in CDS market as investors buy insurance to hedge against another possible default by Argentina. The high uncertainty surrounding Argentina bonds means higher fluctuations in bond yields and spreads. The bond market thus becomes an unreliable source of information for pricing of credit risk. The CDS spreads becomes the only source of information and leads the bond market in price discovery. An alternative explanation is that the high information share may contain little or no information if CDS buyers are the same as bond holders who buy and hold CDS contracts without trading them.

Results from Table 7 show that all financial integration coefficients are statistically significant as expected. The constant, which represents country-specific factors influencing the pricing of CDS and sovereign bonds, is insignificant. Using U.S. 5 year Treasury (government) bonds to proxy for global benchmark, the results remain qualitatively the same.

The relationship between financial integration measure (FIM) and price discovery reveals an interesting trend. The sovereigns in which bond spreads lead in price discovery (specifically Brazil and Philippines, which have FIM coefficients of 1.63 and 1.31 respectively) have the highest financial integration measures. In Argentina and China, where CDS plays a dominant role in price discovery (using information share) and CDS Granger causes bond spreads, financial integration measures are a paltry 0.35 and 0.23 respectively. Mexico and South Africa, which have bidirectional causality and moderately high CDS information shares (64 percent and 67 percent respectively) also record moderate degree of financial integration (0.88 and 0.60 respectively). We document a high positive correlation of 0.74 between financial integration measures and bond information share. When we preclude Colombia, correlation increases from 0.74 to 0.84. These results seem to provide important pieces of evidence. First, there is a positive relationship between price discovery dynamics in sovereign bond and CDS markets on one hand and financial integration on the other. Second, the bond and CDS spreads are influenced by common (global factors) rather that country specific factors. This is consistent with previous literature and empirical findings by Diaz and Gemmill **(**2006), Grandes (2007), González and Yeyati, (2008), Psalida and Sun (2009) and Longstaff et al (2004) that sovereign credit risk in both developed and emerging market is influenced primarily by common external (global factors) rather than local economic factors.

**V. Conclusion**

This study investigates if there is a link between financial integration and pricing discovery dynamics in sovereign CDS and bonds markets. The CDS and bond spreads are characterized by unit root. For each sovereign, the CDS and bond spreads are cointegrated; hence, long run equilibrium price relationship between CDS and bond markets exists. Granger causality tests show that there is a link between sovereign CDS and bond markets in six out of seven sovereigns. Three sovereigns (China, Mexico and South Africa) had bidirectional causality indicating a link and pricing information feedback between CDS and bond markets. All sovereigns except Brazil have a positive error correction factor which implies that CDS prices adjust to new information to maintain equilibrium relationship between CDS and bond prices. In Brazil and Philippines, CDS adjusts to new information hence bond market leads in price discovery. In Mexico, China, and South Africa, none of the markets generally dominate in price discovery although information share indicates a slight dominance by CDS market. In Argentina, CDS markets leads in price discovery as bond market adjusts to new information. This is partly explained by the fact that CDS are primarily used by hedgers and their information in unlikely to be significant to influence price discovery.

There is a strong positive relationship between price discovery and degree of financial integration. Sovereigns in which bond markets lead in price discovery are more integrated with world economies. Financial integration of emerging markets enhances pricing of sovereign credit risk due to influence of global factors on credit risk as opposed domestic factors. We suggest further research to investigate if degree of financial integration of a given country influences price discovery in corporate CDS and bonds. Moreover, using higher frequency data, research could be carried out to investigate the role of liquidity in pricing of sovereign CDS and bonds

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**TABLE 1. Descriptive Statistics of Sovereign Bond Spreads and Credit Default Swap (CDS) Spreads**

| Security | Mean | Median | Std. Dev. | Skewness | Kurtosis | JB | *P*-value | Obs |
|---|---|---|---|---|---|---|---|---|
| AGB | -277.049 | -293.727 | 83.768 | 0.382 | 2.060 | 18.656 | 0.000 | 305 |
| AGC | 722.959 | 320.900 | 1056.973 | 2.089 | 6.294 | 359.713 | 0.000 | 305 |
| BRB | 184.648 | 102.091 | 163.519 | 0.696 | 2.034 | 36.478 | 0.000 | 305 |
| BRC | 248.181 | 178.700 | 171.350 | 1.324 | 4.463 | 116.307 | 0.000 | 305 |
| CHB | -88.700 | -119.327 | 114.927 | 0.641 | 2.293 | 27.265 | 0.000 | 305 |
| CHC | 49.813 | 29.400 | 51.640 | 2.292 | 7.790 | 558.605 | 0.000 | 305 |
| COB | -92.183 | -137.884 | 117.059 | 0.713 | 2.158 | 34.872 | 0.000 | 305 |
| COC | 242.606 | 192.800 | 131.013 | 0.816 | 2.653 | 35.354 | 0.000 | 305 |
| MXB | -19.237 | -57.096 | 114.577 | 0.653 | 2.169 | 30.440 | 0.000 | 305 |
| MXC | 118.148 | 88.500 | 90.560 | 1.961 | 6.546 | 355.382 | 0.000 | 305 |
| PHB | -1.651 | -65.629 | 131.381 | 0.837 | 2.251 | 42.299 | 0.000 | 302 |
| PHC | 287.824 | 239.200 | 132.892 | 0.384 | 1.837 | 24.432 | 0.000 | 302 |
| SAB | -15.387 | -47.745 | 112.706 | 0.669 | 2.287 | 29.229 | 0.000 | 305 |
| SAC | 120.873 | 70.000 | 108.979 | 1.870 | 6.060 | 296.802 | 0.000 | 305 |

Note: AGB and AGC are Argentina bond spreads and CDS spreads respectively. BRB and BRC are Brazil bond spreads and CDS spreads respectively. CHB and CHC are China bond spreads and CDS spreads respectively. COB and COC are Colombia bond spreads and CDS spreads respectively. MXB and MXC are Mexico bond spreads and CDS spreads respectively. PHB and PHC are Philippines bond spreads and CDS spreads respectively and SAB and SAC are South Africa bond spreads and CDS spreads respectively. JB is Jarque-Bera statistic to test for normality of data distribution. Obs is number of weekly observations. All sovereigns have 305 weekly observations except Philippines which has 302 observations. Observations span January 2004 to October 2009. The bond spreads are equal to bond yields minus 5-year risk free rate of U.S. Treasury securities.

**TABLE 2. Unit Root Testing**

| Country | ADF unit root test | | PP unit root test | |
|---|---|---|---|---|
| | Unit root $I(1)$? | *p* value | Unit root $I(1)$? | *p* value |
| Argentina: CDS | Yes | 0.093** | Yes | 0.21** |
| BYS | Yes | 0.15** | Yes | 0.53** |
| Brazil: CDS | Yes | 0.016* | Yes | 0.016* |
| BYS | Yes | 0.57** | Yes | 0.74** |
| China: CDS | Yes | 0.077** | Yes | 0.062** |
| BYS | Yes | 0.50** | Yes | 0.84** |
| Colombia: CDS | Yes | 0.025* | Yes | 0.025* |
| BYS | Yes | 0.69** | Yes | 0.84** |
| Mexico: CDS | Yes | 0.042* | Yes | 0.042* |
| BYS | Yes | 0.43** | Yes | 0.89** |
| Philippines: CDS | Yes | 0.075** | Yes | 0.029* |
| BYS | Yes | 0.69** | Yes | 0.66** |
| South Africa: CDS | Yes | 0.086** | Yes | 0.07** |
| BYS | Yes | 0.52** | Yes | 0.93** |

Note: This table summarizes the unit root tests (non-stationarity of series data). CDS is the credit default swap while BYS is the bond yield spread. ADF is the Augmented Dick Fuller test while PP is the Philips-Perron test. * and ** show 1 percent and 5 percent significance level. We test the hypothesis that there is unit root. In all cases, we fail to reject the null hypothesis.

**TABLE 3. Cointegration Tests and Lag Selection**

| Country | Trace statistic | *P*-value | Cointegrated | SIC | HQIC |
|---|---|---|---|---|---|
| Argentina | 3.61 | 0.057 | Yes | 1 | 3 |
| Brazil | 3.88 | 0.76 | Yes | 2 | 3 |
| China | 0.65 | 0.42 | Yes | 11 | 3 |
| Colombia | 4.61 | 0.65 | Yes | 2 | 2 |
| Mexico | 0.58 | 0.45 | Yes | 2 | 3 |
| Philippines | 5.10 | 0.58 | Yes | 3 | 4 |
| S. Africa | 16.34 | 0.095 | Yes | 1 | 6 |

Note: SBIC is Swartz Bayesian information criterion. HQIC is Hannan-Quin information criterion. All P values show that we fail to reject null for six out of seven sovereigns.

**TABLE 4. Granger Causality of Sovereign Bond Spreads and Credit Default Swap (CDS) Spreads**

| Null Hypothesis: | Lag 1 | Lags 2 | Lags 3 | Lags 4 | Lags 5 | Lags 6 |
|---|---|---|---|---|---|---|
| | *P*-value | *P*-value | *P*-value | *P*-value | *P*-value | *P*-value |
| AGC does not Granger Cause AGB | 0.01660** | 0.02300** | 0.01040** | 0.01390** | 0.00750* | 0.00493* |
| AGB does not Granger Cause AGC | 0.64090 | 0.99660 | 0.88910 | 0.55770 | 0.63780 | 0.62480 |
| | | | | | | |
| BRC does not Granger Cause BRB | 0.50084 | 0.53509 | 0.4265 | 0.55002 | 0.58978 | 0.37199 |
| BRB does not Granger Cause BRC | 0.50453 | 0.02322** | 0.00782* | 0.01433** | 0.00964* | 0.00859* |
| | | | | | | |
| CHC does not Granger Cause CHB | 0.01497** | 0.0607** | 0.01097** | 9.80E-05* | 0.00019* | 0.00045* |
| CHB does not Granger Cause CHC | 0.10906 | 0.33804 | 0.39732 | 0.06029*** | 0.08557*** | 0.00345* |
| | | | | | | |
| COC does not Granger Cause COB | 0.90098 | 0.47741 | 0.61373 | 0.14736 | 0.20324 | 0.21693 |
| COB does not Granger Cause COC | 0.69321 | 0.21027 | 0.28545 | 0.34725 | 0.25662 | 0.1257 |
| | | | | | | |
| MXC does not Granger Cause MXB | 0.00844* | 0.00374* | 0.00407* | 0.00146* | 0.0021* | 0.00499* |
| MXB does not Granger Cause MXC | 0.06676*** | 0.01582** | 0.02107** | 0.01932** | 0.00112* | 0.000035* |
| | | | | | | |
| PHC does not Granger Cause PHB | 0.8793 | 0.94429 | 0.45688 | 0.20818 | 0.23944 | 0.34502 |
| PHB does not Granger Cause PHC | 0.8084 | 0.71447 | 0.11639 | 0.04024** | 0.05596*** | 0.03167** |
| | | | | | | |
| SAC does not Granger Cause SAB | 0.0055* | 0.00628* | 0.00699* | 0.0174** | 0.03244** | 0.04626** |
| SAB does not Granger Cause SAC | 0.2375 | 0.41769 | 0.73084 | 0.12258 | 0.09953*** | 0.000018* |

Note: AGB and AGC are Argentina bond spreads and CDS spreads respectively. BRB and BRC are Brazil bond spreads and CDS spreads respectively.CHB and CHC are China bond spreads and CDS spreads respectively. COB and COC are Colombia bond spreads and CDS spreads respectively. MXB and MXC are Mexico bond spreads and CDS spreads respectively. PHB and PHC are Philippines bond spreads and CDS spreads respectively and SAB and SAC are South Africa bond spreads and CDS spreads respectively. *, ** and *** means significant (reject null) at 1 percent, 5 percent and 10 percent respectively.

**TABLE 5. Vector Error Correction and Information Share**

| Country | Bond ( $\lambda_1$ ) | CDS ( $\lambda_2$ ) | Bond I.S | CDS I.S | EC size = $\lambda_2 - \lambda_1$ |
|---|---|---|---|---|---|
| Argentina | -0.020199** | 0.189421 | 0.0964 | 0.9036 | 0.20962 |
| | [-2.41106] | [ 1.79775] | | | |
| Brazil | 6.86E-05 | -0.001355** | 0.952 | 0.0480 | -1.420E-03 |
| | [ 0.38253] | [-2.30696] | | | |
| China | -0.018456** | 0.019395** | 0.4876 | 0.5124 | 0.037851 |
| | [-2.07829] | [ 2.40298] | | | |
| Colombia | 1.87E-06 | 0.00855** | -0.0002 | 1.0002 | 8.55E-03 |
| | [ 0.00114] | [ 2.09593] | | | |
| Mexico | -0.017768** | 0.031825** | 0.3583 | 0.6417 | 4.96E-02 |
| | [-2.22858] | [ 2.31847] | | | |
| Philippines | -0.000114 | 0.001386 | 0.9240 | 0.0760 | 0.0015 |
| | [-0.32463] | [ 1.82916]*** | | | |
| South Africa | -0.021302** | 0.044399** | 0.3242 | 0.6758 | 0.06570 |
| | [-2.25426] | [ 2.77404] | | | |

Note: The long run beta parameter is computed according to equation (5) and (6). $\lambda_1$ and $\lambda_2$ are error correction coefficients for CDS and bond markets respectively. $\lambda_2 - \lambda_1$ indicates the amount of error correction required to maintain long run equilibrium. It ignores the statistical significance of alphas. IS is information share. ** and *** represent statistical significance at 5 percent and 10 percent respectively $t \geq \pm 1.96$ and $t \geq \pm 1.65$ . [ ] shows *t*-statistics while EC stands for error correction.

**TABLE 6. 3-Year (156 weeks) Rolling Correlations between the Bond Yields and Global Bond Index**

| Weeks<br>Country | 1-156 | 53-209 | 105-260 | 157-305 |
|---|---|---|---|---|
| Argentina | 0.882 | 0.884 | 0.507 | 0.470 |
| Brazil | 0.995 | 0.996 | 0.883 | 0.772 |
| China | 0.946 | 0.930 | 0.629 | 0.387 |
| Colombia | 0.987 | 0.994 | 0.927 | 0.878 |
| Mexico | 0.986 | 0.978 | 0.941 | 0.893 |
| Philippines | 0.771 | 0.993 | 0.927 | 0.852 |
| South Africa | 0.963 | 0.956 | 0.982 | 0.858 |

Note: The correlation is between sovereign bond return and global bond index returns. Rolling correlations for each of the 7 sovereigns are computed using first 3 years (156 weeks) rolling window. In subsequent 3-year correlation, the first year series (52 weeks) is dropped and one more year (52 weeks) added.

**TABLE 7. Relationship between Financial Integration and Pricing Efficiency**

| Country | Argentina | Brazil | China | Colombia | Mexico | Philippines | S. Africa |
|---|---|---|---|---|---|---|---|
| FIM | 0.35 | 1.63 | 0.23 | 0.76 | 0.88 | 1.31 | 0.60 |
| *P*-values | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Constant | -0.08 | 0.19 | 0.19 | 0.07 | -0.04 | 0.85 | 0.12 |
| *P*-values | 0.57 | 0.36 | 0.14 | 0.51 | 0.73 | 0.55 | 0.45 |
| Bond I.S | 0.096 | 0.952 | 0.488 | 0.00 | 0.358 | 0.924 | 0.324 |
| CDS I.S | 0.904 | 0.048 | 0.512 | 1.00 | 0.642 | 0.076 | 0.676 |

Note: This table relates news-based measures of financial integration to sovereign CDS and bonds pricing dynamics. FIM is financial integration measure. I.S is information measure calculated from Table 5. The constant refers to country-specific factor which should ideally converge to zero. The *P*-values are used to indicate statistical significance.