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## On International Integration of Emerging Sovereign Bond Markets

by Itai Agur, Melissa Chan, Mangal Goswami, and Sunil Sharma



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**Prepared by Itai Agur, Melissa Chan, Mangal Goswami, and Sunil Sharma***

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## Abstract

The paper investigates the international integration of EM sovereign dollar-denominated and local-currency bond markets. Factor analysis is used to examine movements in sovereign bond yields and common sources of yield variation. The results suggest that EM dollar-denominated sovereign debt markets are highly integrated; a single common factor that is highly correlated with US and EU interest rates explains about 80 percent of the total variability in yields. EM sovereign local currency bond markets are not as internationally integrated, and three common factors explain about 74 percent of the total variability. But a factor highly correlated with US and EU interest rates still explains 63 percent of the yield variation accounted for by common factors. That said, there is some diversity among EM countries in the importance of common factors in affecting sovereign debt yields.

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Authors' E-Mail Addresses: iagur@imf.org; melissashirong.chan@sc.com; mgoswami@imf.org; ssharma@imf.org

* Itai Agur and Sunil Sharma are staff members at IMF Headquarters in Washington, DC. Mangal Goswami is at the IMF's South Asian Regional Training and Technical Assistance Centre (SARTTAC) in New Delhi, India. Melissa Chan was at the IMF-Singapore Regional Training Institute (STI) when the paper was written. For discussions and comments, the authors would like to thank Ralph Chami, Stijn Claessens, Woon Gyu Choi, Tom Cosimano, Neil Ericsson, Gee Hee Hong, Laura Kodres, Signe Krogstrup, Vance Martin, Peter Montiel, Changyong Rhee, Manmohan Singh, and other IMF colleagues. The usual disclaimer applies.

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## I. INTRODUCTION

Sovereign debt in emerging markets (EMs) has grown remarkably since the global financial crisis. The total market capitalization of the EM sovereign debt universe reached over $7.3 trillion by the second half of 2016, surpassing even the size of the US high-yield market.[1] Despite episodes of increased volatility, EMs saw a large cumulative inflow of foreign money into their debt markets in the aftermath of the financial crisis. A large share of these inflows was invested in bonds denominated in local currencies, marking a significant break from the past when foreign investors were attracted to EM foreign exchange denominated debt (Figure 1). This has led to a significant and persistent rise in foreign investor participation – for example, see Figure 2 for the experience of several Asian countries.

The global financial crisis also sparked renewed interest in the measurement of financial cycles. The concept of a financial cycle in which private sector balance sheets expand and contract in tandem with real estate and financial asset prices, is due to Minsky (1992).[2] An important feature of a financial cycle is that it need not be linked to business cycle developments for extended periods, except in the aftermath of financial crises when financial and business cycles become tightly coupled (Borio, 2014). Recent efforts at measuring financial cycles highlight that such cycles are of considerably longer duration than business cycles (Drehmann, Borio and Tsatsaronis, 2012).

Transmission of US financial conditions to financially-open economies could produce a global financial cycle. Miranda-Agrippino and Rey (2015) document a global factor in risky asset prices, which is strongly influenced by financial conditions in the US. A common component to financial cycles in financially open economies could imply that US monetary policy significantly transmits across borders via credit flows, the leverage of financial intermediaries, and risk premia (Shin (2012), Rey (2013), Bruno and Shin (2015), Blanchard et al. (2016)). Since EM bonds are generally categorized as risky assets, EMs are particularly exposed to the vagaries of global risk sentiments.

Exchange rate flexibility does provide some insulation from global financial conditions. Obstfeld et al. (2017), analyzing 40 emerging market economies over the period 1986-2013, show that countries with fixed exchange rates are more likely to experience financial vulnerabilities—faster domestic credit and house price growth, and increases in bank leverage—than those with relatively more flexible regimes. IMF (2017a) examines how much influence countries have over domestic financial conditions in a globally integrated

[1] Authors' calculations based on BIS debt securities statistics (domestic and international) for 16 emerging market countries.

[2] See also Crockett (2001).

financial system, and concludes that while global financial circumstances are important, countries do have some ability to affect domestic conditions.

The effect of global financial conditions on the conduct of domestic monetary policy, especially in EMs, has been a point of contention in recent policy debates.[3] Gopinath (2017) summarizes the issue as follows: while the "trilemma" is weakened, it continues to have some bite—flexible exchange rates provide greater monetary policy independence but the benefits in an open economy may not be as large as previously thought.[4]

Moore et al. (2013) find that US monetary conditions, and quantitative easing had a significant influence on capital flows to EMs. Choi et al. (2017) show that an increase in global liquidity generated by policies in advanced economies, led to capital spilling over into EM economies, boosting stock prices and output, appreciating local currencies, adding to foreign exchange reserves, and lowering policy rates. Singh and Wang (2017) argue that central bank balance sheet adjustments and changes in advanced country policy rates may differ in their financial spillovers to EMs, and that a variety of control levers may be needed by EM policymakers to pursue country-specific monetary and financial objectives.

IMF (2017b) and Powell (2017) assess that EMs should be able to manage the risks of policy normalization in advanced countries. Arteta et al. (2015) while providing reasons to expect a smooth US interest rate tightening cycle, caution that such a baseline is fraught with risks that could lead to a large temporary decline in capital flows to emerging and frontier economies. The significant risks include: uncertainty about the strength of the US recovery, a sharp adjustment in historically low US term premia, fragile market liquidity, and rising vulnerabilities in some EMs. Nier et al. (2014) show that at low levels of global uncertainty (as measured by the Chicago Board Options Exchange Volatility Index (VIX)) gross capital flows are driven by fundamentals, but in periods of stress, except for interest rate differentials, fundamentals may lose their significance. Their results also suggest that the effect of global financial conditions on gross capital flows increases with the host country's level of financial development.[5]

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[3] See, for example, Powell (2013, 2017), Rajan (2013, 2014), Rey (2013, 2016), Basu, Eichengreen and Gupta (2014), Mohan and Kapur (2014), Bernanke (2015), Edwards (2015), Obstfeld (2015), Yellen (2015), Disyatat and Rungcharoenkitkul (2016), Fischer (2016), Filardo et al. (2016), Mishra and Rajan (2016), Ricci and Shi (2016), Fratzscher, LoDuca, and Straub (2017), and Ibrahim (2017).

[4] The trilemma refers to the proposition that countries can choose two of (i) stable exchange rates, (ii) monetary policy independence, and (iii) free capital mobility, but not all three.

[5] Cerrutti, Claessens, and Rose (2017) express skepticism about the importance of a "global financial cycle" in explaining the pattern of observed capital flows. They argue that sensitivities to global factors can vary over time and depend on the type of flows—portfolio, bank, foreign direct investment—and whether they are inward or outward bound.

Goldberg and Krogstrup (2017) examine the connection between safe-haven flows (largely) to advanced economies and the risk-on-risk-off flows (largely) to EMs, and show that realized international flows are an imprecise measure of pressures that arise during capital flow episodes. They provide a broader metric of capital flow pressures that takes account of capital flows as well as exchange rate and interest rate changes, and devise a new measure, called the global risk response index, to gauge the degree to which such pressures are driven by global financial risks. Their analysis suggests that the sensitivity of capital flows to global risk aversion, while exhibiting substantial variation across time and countries, has increased over the past few decades, and in particular, since the global financial crisis.[6]

The growth in size and increased interest in EM sovereign debt has raised several questions. First, has greater foreign participation in EM sovereign bonds created a more internationally integrated market? If so, are these bonds more sensitive to the vagaries of the global market place than before? Second, do EM local currency and dollar-denominated sovereign bonds respond similarly to global financial conditions? And how will EMs be affected by an eventual normalization of monetary policies in advanced economies?

In this paper, we shed light on these questions by studying the common factors driving EM sovereign yields for dollar-denominated debt and local currency bonds. Our results show that EM dollar-denominated bond markets are more internationally integrated, and are now more sensitive to global interest rates than before the crisis. Local currency sovereign bond markets, though less integrated, are still substantially affected by US and Euro Area interest rates. With rising foreign investment in local currency bond markets, the integration of these markets should also increase as they develop and become more open. Local currency bonds reduce currency mismatches on sovereign balance sheets, but in formulating debt issuance strategies EM policymakers will need to evaluate whether the insulation from global events that local currency bonds may provide is worth the generally higher rates on such instruments.

## II. The Development of EM Bond Markets: Improved Foreign Access

The growth of EM sovereign bond markets has been driven primarily by EM local currency debt.[7] Market capitalization is concentrated in Asia and Latin America, and Asia now accounts for over 30 percent of the share of the EM local currency bond market. China has become the fourth largest global bond market.

[6] See also Chari et al. (2017).

[7] EM local currency *private* bond markets have also grown rapidly, outpacing the growth of EM local currency sovereign debt (IMF, 2016).

With continued increase in foreign ownership of the asset class, the growth in EM bonds has been accompanied by increasing integration with global markets, particularly since the global financial crisis. In some countries, like Brazil, Indonesia, Malaysia, Poland, South Africa, and Thailand, foreign investors currently own more than 30 percent of the outstanding debt stock. Accommodative monetary policy in the advanced economies and investor search for yield in the aftermath of the crisis, has led to increased flows into EM financial markets. Also, there has been a discernible shift in capital flows from bank lending to portfolio flows, notably debt, and bond funds have gained popularity among international investors. It should be noted, however, that the rise in foreign ownership is much larger from the EM perspective (as a share of EM bonds outstanding) than from the foreign investor perspective, and EMs are still significantly underweighted in the portfolios of investors from advanced economies (Figure 3).

Aside from cyclical considerations, the increase in foreign ownership of EM bonds has also been driven by improved access to these markets, facilitated by the inclusion of EM debt in various key benchmark indices. The development of these markets has been driven primarily by improvements in the investability of EM debt. Investability is typically defined in terms of the following dimensions: (i) Market Access; (ii) Market Taxation; (iii) Market Efficiency and Regulation; (iv) Market Infrastructure and Investor Base; (v) Market Size and Instruments. Improvement in these features, along with macroeconomic and financial stability, has attracted domestic and foreign investors to EM bonds.

EM local currency debt markets have continued to evolve and mature in several ways, significantly improving their accessibility to outside investors (Goswami and Sharma (2011), Bae (2012)). Market liquidity has improved as witnessed by higher secondary market turnover ratios and narrower bid-ask spreads. For example, the Singapore securities exchange (SGX) has launched a bond trading platform that could be extended to Asian local currency bonds, thereby providing an Asian liquidity center. In addition, pricing data for bond markets is readily available through private vendors who centralize information in most countries.

The attractiveness of some EM local debt has been enhanced because of inclusion in global EM sovereign benchmarks. And international banks that have access to EM markets have replicated actively managed sovereign debt funds using ETFs. Such products have witnessed rapid growth and increased market liquidity.

Access to domestic money and derivatives markets in EMs has also expanded. These markets enable foreign investors to borrow in local currency, hedge exposures, and widen the strategies for taking positions. In many countries, foreign investors now have access to on-shore local interest rate derivatives, and foreign exchange spot, forward, and derivative markets. Withholding taxes and other barriers to entry have also been lowered.

EM financial market infrastructure has also seen significant improvements. Such infrastructure is often a prerequisite for foreign investor access. Improved efficiency in asset servicing is one such form of market infrastructure, and includes securities lending, clearing, and payment and settlement systems. The safety of custodian services has also become an important part of the infrastructure enhancements. For example, the Philippines has reformed the trading and settlement of local currency government securities.

The degree of EM capital account openness varies widely. Countries like Singapore and Hong Kong have full convertibility, and others like Korea, Mexico, Malaysia, Indonesia, Poland, and Turkey, are also relatively open and becoming more so. Some are still gradually opening up -- most notably, China and India. For example, Chinese authorities have liberalized the onshore interbank bond market for qualified offshore institutional investors. In July 2015, the People's Bank of China removed quotas in the interbank bond market for foreign central banks, sovereign wealth funds, and certain international institutions like the World Bank. In July 2017 China and Hong Kong SAR launched the Bond Connect Program, which will further facilitate foreign investor access to Chinese bonds via Hong Kong SAR. Indian authorities have been slowly increasing the cap on foreign institutional investments in the domestic government bond market.

The upsurge in EM bond market liquidity is not only the result of increased foreign investor participation, however. There has been a significant expansion of the domestic investor base, notably pension funds and insurance companies. Such financial institutions have witnessed rapid growth due to the rising incomes of the EM middle classes.

## III. Our Approach to International Integration of EM Bond Markets

The international integration of EM bond markets has attracted considerable attention in the academic literature. Sutherland (1996) describes financial market integration as a process whereby asset returns converge and become increasingly affected by similar factors. A cursory look at yields for both foreign and local currency sovereign bonds from 2002 to 2016 (Figures 4 and 5) strongly suggests that EMs have witnessed yield convergence since the global financial crisis.

The second and more important hallmark of financial market integration is a heightened responsiveness of yields to global factors. Existing research generally points to a dominance of local and country-specific factors in explaining EM sovereign yields. This is particularly so for local currency sovereign bonds. According to Peiris (2010), local factors rather than global factors have dominated after the late 1990s EM crises. Similarly, Bunda, Hamann and Lall (2010) found increasing importance of EM-specific developments in driving co-movements of EM sovereign spreads. Jaramillo and Weber (2013a,b) and Miyajima, Mohanty and Chan (2012) also provide evidence that domestic variables are the key drivers

of local currency bond spreads, although Jaramillo and Weber (2013a) find that this to be so only in times of elevated global risk aversion.

Various econometric methodologies have been employed to measure co-movement across financial assets and to study the sensitivity of spreads to different factors. Bunda, Hamann and Lall (2010) utilized simple and partial bilateral correlations, while Fender, Hayo and Neuenkirch (2011) and Ebeke and Lu (2015) used GARCH models to disentangle the roles of common and country-specific factors in influencing EM spreads. Panel fixed-effects models are amongst the most popular and have been used by Peiris (2010), Miyajima, Mohanty and Chan (2012), Jaramillo and Weber, (2013a) and Ebeke and Lu (2015).

This paper takes a different approach. First, it uses data on EM sovereign bond yields instead of that on credit spreads. The bulk of the existing empirical literature employs the latter. While country spreads are related to country risk levels, bond yields are influenced by a much greater variety of factors, including global monetary conditions (Turner, 2014). Credit spreads may well go up while overall bond yields are falling and vice versa. Considering our interest in common factors driving interest rates, it is more appropriate to use yields in the analysis.

Second, the use of high frequency financial data in our analysis is in contrast with the quarterly or annual data used in most papers. This allows us to capture changes in global financial conditions and investor sentiments daily, which is particularly important given our interest in yield covariance. Both local currency and dollar-denominated bonds are considered.

Third, the paper employs factor analysis to study the co-movements and common influences driving bond yields. We identify common underlying factors that explain the common variation among a group of countries and try to interpret these factors in an economically meaningful way. This methodology is widely used in the asset pricing literature and has been employed by McGuire and Schrijvers (2003, 2006) to study EM sovereign debt spreads. In addition, we examine different country groupings to examine the heterogeneity among EMs in different regions.

## IV. METHODOLOGY AND DATA

The paper uses factor analysis to examine the common sources of variation in EM bond yields. The technique allows us to partition the observed variation in EM yields for a group of countries into a systematic component that can be explained in terms of a few underlying (global) latent factors and a second component that is country-specific.[8]

[8] See, for example, Johnson and Wichern (2007).

In matrix notation, the linear factor model can be expressed as:

$$X = \mu + L.F + \varepsilon \tag{1}$$

where X is a p x 1 column vector of observed variables, μ the corresponding vector of means, F is a m x 1 vector of unobserved latent factors, and L the p x m matrix of coefficients called factor loadings. In our application, the variables in X are bond indices for a group of EM countries.

The orthogonal factor model with m common factors makes the following assumptions:

$$\begin{aligned} &E(F) = 0; Cov(F) = I_m \\ &E(\varepsilon) = 0; Cov(\varepsilon) = \Psi, \text{ where } \Psi \text{ is a diagonal matrix} \\ &\text{F and } \varepsilon \text{ are independent} \end{aligned} \tag{2}$$

The covariance structure implied by the model is given by

$$\begin{aligned} &\Sigma = Cov(X) = E[(X-\mu)(X-\mu)'] = L.L' + \Psi \\ &Var(X_i) = \sigma_{ii} = l_{i1}^2 + ..... + l_{im}^2 + \psi_i = h_i^2 + \psi_i, \text{ i=1,2,....p} \end{aligned} \tag{3}$$

where, the portion of the variance of the $X_i^{th}$ variable contributed by the m common factors is called the $i^{th}$ communality, $h_i^2$, and is equal to sum of squared factor loadings of variable $X_i$ on the m common factors. Hence, the total variance of each underlying data series is the sum of the communality $h_i^2$ and the "uniqueness" or specific component $\psi_i$.

In general, the higher the 'communality' component, the larger the proportion of variability explained by the common factors. Also, series that are highly correlated tend to require fewer common factors to explain a significant portion of their variability.

In selecting the common factors, we follow the Kaiser-Guttman rule where factors are added until eigenvalues fall below one. This is essentially a criterion on the amount of variation each additional factor explains, and is used to avoid the construction of too many common factors. The factor loadings are taken as a measure of the degree to which individual bond yields co-move with common factors.

Since factor analysis is a purely statistical approach, it does not offer any guidance as to what the latent common factors represent, making the economic interpretation of the factors an inherently subjective exercise. Therefore, correlations of greater than 0.7 between market

variables and common factors are used to provide economic meaning to the common factors. For this purpose, sixteen high-frequency financial market variables in the following categories are used:

1. US Dollar interest rates: US 3-month Treasury yield, US 2-year Treasury yield, US 10-year Treasury yield, J.P. Morgan US Treasury Index yield (composite index), Barclays US High Yield corporate bond yield (composite index);

2. Euro interest rates: 3-month Euribor, 2-year swap rate, and 10-year swap rate;

3. Equity indices: MSCI-Emerging Market index, S&P 500 index, NASDAQ index, FTSE-100 index, and DAX index;

4. Liquidity & Volatility indices: Libor-OIS spread, TED spread and the VIX index;

5. Commodity price indices: S&P 500 Goldman Sachs Commodity index (a composite index), WTI, Brent, Crude Palm Oil, Copper, Aluminum, Wheat and Soybeans.

The factor model is estimated using daily yields between January 2002 - December 2016 and covers both the pre- and post-crisis periods. The data consist of yield-to-maturity data from country bond indices (GBI-EM Broad and EMBI Global/Diversified) constructed and maintained by J.P. Morgan.[9] The empirical exercise uses dollar-denominated yields of thirteen countries and local currency bond yields of fifteen countries. The former group includes Brazil, Chile, China, Colombia, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Turkey, and the latter has Brazil, Chile, China, Colombia, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Poland, Russia, South Africa, Thailand, and Turkey. Since balanced samples were required for factor analysis, a few countries where data was not available for a substantial part of the period covered had to be dropped to prevent a shortening of the sample period.

[9] The J.P. Morgan Government Bond Index – Emerging Markets (GBI-EM) Indices are benchmarks that track local currency bonds issued by EM governments. The EMBI Global/Diversified are broad EM US-dollar debt benchmarks that include US dollar-denominated Brady bonds, Eurobonds, and traded loans issued by sovereign and quasi-sovereign entities; only instruments denominated in US dollars are considered for inclusion. US dollar instruments where the coupon or redemption payment is linked to an exchange rate are not eligible for inclusion. See J.P. Morgan (2014, 2015).

## V. EMPIRICAL RESULTS

The empirical results of the factor analysis presented in Table 1 indicate that a single significant factor drives the common variation in yields on sovereign dollar-denominated debt for the thirteen EM countries in the sample. The single factor F1 explains 79.5 percent (10.33 ÷ 13) of the total variability (sum of diagonal elements of the correlation matrix) in sovereign debt yields.

The average uniqueness, that is the part of total variation in each sovereign's debt yield not explained by the common factors, is 0.2 (0.17 excluding China), implying that on average about 80 percent (83 percent excluding China) of the total variability in sovereign dollar-denominated debt yields is accounted for by the common factors. The differences in uniqueness or specificity is considerable: ranging from 0.06 for Mexico to 0.62 for China. This means that the common factor accounts for 94 percent of the variation in yields on Mexico's sovereign dollar-denominated debt but only about 38 percent of the variation in similar Chinese yields.

The above results are robust to a regional decomposition. We consider three sub-groups: an Asian group consisting of China, Indonesia, Malaysia, Philippines (sub-group 1); a Latin American cluster composed of Brazil, Chile, Colombia, Mexico, and Peru (sub-group 2); and a third set of countries comprised of Poland, Russia, South Africa, and Turkey (sub-group 3). The factor loadings obtained for each of the three sub-groups are depicted in Tables 2-4.

The results for the sub-groups show that the magnitudes of the loadings on the single factor are broadly like those obtained from the combined sample. However, there is some regional variation in the proportion of total variability explained by the common factor. For the Latin-American countries, common factors account for 86 percent of the total variability in sub-group 2, whereas it is 77 percent for sub-group 3, and 67 percent for the Asian countries in sub-group 1.

Having shown that a single common factor drives the levels of EM dollar-denominated bond yields, we explore the interpretation of this common factor. By construction, the "common factor" is an unobservable composite entity. We use simple correlations with international variables that EMs face, to identify potentially important economic influences on the EM debt yields. As mentioned in Section IV, we correlate the common factors with five sets of variables: US interest rates, Euro-area interest rates, regional and country equity indices, measures of liquidity and volatility, and commodity price indices.

Table 5 presents the correlation results. The single common factor has a high positive correlation (defined as above 0.7) with US and Euro-area interest rates. Not surprisingly, the common factor is highly correlated with the index for US Treasuries and the US Treasury 10-

year rate. The correlation with the US Treasury 2-year rate is close to 0.7, while the correlation for short-term 3-month rate is lower. Correlations with the Euro-area rates, including the 3-month, 2-year, and 10-year Euribor, are also significant.

These correlations suggest that the US and Euro-area interest rates are important drivers of the yields on EM sovereign bonds. The analysis performed on the sub-groups reveals that the correlations between the common factor and the US and Euro interest rates are broadly similar in the sub-groupings and the combined sample. Furthermore, the Latin American sub-group also exhibits a strong correlation with copper and soybean prices. That said, given the sub-group differences in the proportion of total variability explained by common factors, we see that the US and Euro area rates are more important in influencing the yields on sovereign dollar-denominated debt of the Latin-American countries compared to that for the other two sub-groups.

In contrast to sovereign dollar-denominated debt, the analysis of sovereign local currency debt reported in Table 6 shows that there are three common factors (F1, F2, F3) affecting yields. The variation accounted for by the common factors is 11.068, which is 74 percent (11.068 ÷ 15) of the total variability.

There are considerable differences in the "uniqueness measure" or the portion of the total variation in each sovereign yield that is not explained by the common factors. For example, Korea has a uniqueness measure of 0.07 and the three common factors explain 93 percent of the total variation in its sovereign local currency debt yield, whereas at the other extreme is South Africa with a uniqueness measure of 0.59 with only 41 percent of its yield variation explained by the common factors.[10] Korea, Mexico, Chile, Poland, Indonesia, and Colombia are countries with uniqueness measures of less than 0.2, and hence where the common factors have the strongest influence. Common factors are of less importance in India, Brazil, Turkey, Thailand and Hungary where the uniqueness measures lie between 0.2 and 0.3, and of least importance in South Africa, Russia, China, and Malaysia which have uniqueness measures greater than 0.3.

The first factor, which we call the international interest rate factor, accounts for about 63 percent of the variability accounted for by common factors. Nine countries have relatively large loadings (greater than 0.7) on factor 1: Indonesia, Korea and Thailand in Asia; Chile, Colombia, Mexico in Latin America, and Hungary, Poland, and Turkey in Eastern Europe. As shown in Table 7, the international factor is highly positively correlated with US and Euro-area yields, implying that US and European rates (and hence their monetary policies), have a strong influence on local currency debt yields in these nine countries. This suggests

[10] For ease of exposition, we sometimes use "common variation" or "common variance" to refer to the "yield variability accounted for by common factors."

that despite having flexible exchange rates as a buffer, the domestic monetary conditions (sovereign local currency yields) in these EMs are importantly influenced by US and Euro-area monetary policies. It is worth noting that as expected the international interest rates explain a larger proportion of the total variability in the yields on EM sovereign dollar-denominated debt (80 percent) than that in EM sovereign local currency debt (46 percent = 74 percent x 63 percent).

Factor 2 accounts for 24 percent of the variability explained by the common factors, and is negatively correlated with the S&P GSCI commodity index, and the price indices for copper and crude-oil (Brent). This factor, which we call the commodities factor, has relatively high positive loadings (greater than 0.5) from Brazil, Malaysia, Russia, and South Africa, and negative loadings (less than -0.5) from Chile. It means that high commodity prices are associated with low values for factor 2, which in turn implies low interest rates (relative to average rates for each country) in Brazil, Malaysia, Russia, and South Africa.

Factor 3 explains 13 percent of the variability due to common factors, and China and India are the only countries with loadings of about 0.7 on it. Table 7 shows that factor 3 is not highly correlated with any of the variables mentioned in Section IV. And since China and India are the only countries with high loadings on factor 3, it may be interpreted as an emerging China-India factor.

To examine the evolution of EM bond market integration and the effects of the global financial crisis, the factor analysis was carried out sequentially over the period 2004-2016. The results are presented in Figures 6 and 7, and in Tables 8 and 9. Figure 6 reveals that EM dollar-denominated debt had three factors explaining the “common variation” in the 2004-2008 period, and that by the year 2013, factor 1, the international interest rate factor, had become dominant and was the single factor accounting for the common variation. Table 8, splits the data into pre-crisis (2004-2008) and post-crisis (2009-2016) periods, and shows that the global financial crisis did not impede the growing influence of international interest rates on EM dollar-denominated debt and that in the post-crisis period factor 1 accounted for about 92 percent of the common variance. In addition to the greater international integration of emerging bond markets over the period considered, to some extent the dominance of factor 1 maybe a reflection of the global financial crisis as a systemic shock to the international economy.

The story for EM local currency debt is somewhat similar. Figure 7 shows that four or five factors explained the common variation during the period 2005-2015, but that only three factors were needed by the end of 2016. And importantly, the proportion of common variation explained by factor 1 (international dollar and euro interest rates) rose from 33 percent in 2009 to 63 percent in 2016. Table 9 shows that factor 1 (international interest

rates) and factor 2 (commodity prices) together accounted for 71 percent of the common variation in the pre-crisis period, and this rose to 84 percent in the post-crisis period.

## VI. CONCLUSION

EM bond markets have continued to develop and become a global asset class. Global investors have channeled funds through asset managers to increase exposure to EM bond markets for various reasons, some of which are structural (such as diversification benefits, improvements in sovereign credit quality), while others are more cyclical in nature. Easy borrowing conditions in global markets have been a key cyclical factor, encouraging foreign investors to increase their exposure to EM interest rate risk, currency risk, and liquidity risk (Sobrun and Turner, 2015). Thus, the movement of foreign investors into EM bond markets partly relates to global monetary conditions. During the years of ample capital inflows, EM domestic bond yields fell, credit growth was rapid, and EM currencies appreciated (BIS, 2014). However, common global shocks can lead to "risk-off" periods and heightened selling pressure on EM bonds when investors shed risk. Indeed, EM debt funds came under significant selling pressure following the May 2013 announcement of the Fed's QE tapering, as well as during the market turbulence episode in August 2015.

This paper uses factor analysis to investigate the co-movement of EM sovereign bond yields and international interest rates. It shows that EM dollar-denominated sovereign debt markets are quite integrated, and a single factor that is highly correlated with US and Euro-area interest rates explains over 80 percent of the total variation in EM yields. While EM local currency bond markets are less integrated than the dollar-denominated market, they are nonetheless considerably influenced by US and Euro-area interest rates. Three common factors account for almost three-quarters of the total variation in EM sovereign local currency yields, and the most important common factor that accounts for 63 percent of the common variability (and 46 percent of total variability) is highly correlated with US and Euro-area interest rates. This suggests that US and Euro-area monetary policies are an important influence on the rates at which EM sovereigns can borrow. And this importance is likely to increase as local currency EM bond markets develop and become more open to cross-border flows. Foreign investor participation has already risen extensively and is likely to continue.

An important implication is that as EM domestic bond markets integrate further internationally and as investors and issuers are better able to borrow, hedge, and arbitrage across countries and currencies, local currency markets are likely to become more liquid but with a heightened sensitivity to external events—shocks from larger markets like the US and Eurozone may be propagated more quickly and have wider global effects. Further, as bond markets develop and cross-border links become more important, issuance of sovereign and

corporate debt in local currencies will have benefits but may raise new challenges, with repercussions for EM debt levels, currency mismatches, and issues related to original sin.[11]

To mitigate the risk of increased volatility that typically goes hand in hand with integration, local currency markets could be supported by various measures. Firstly, a broadening and deepening of the investor base of domestic nonbanks such as insurance companies, pension funds, and investment funds could prove helpful. Such domestic institutional investors can enhance the liquidity of capital markets and step-in to partly offset pressures during episodes of capital outflows.

The fact that local currency issuance reduces currency mismatches might create an impression of stability that is only partly true: a flight out of local currency bonds can still create extensive balance of payments pressures. Thus, reserve adequacy measures should also incorporate stress scenarios of the rollover risk from foreign investor holdings of domestic currency bonds. Macro-prudential and capital flow management measures could be considered to deal with sovereign foreign exchange liquidity risk and to influence the composition of the inflows: (i) higher reserve requirements, either on short-term external liabilities or on liabilities to non-resident investors; (ii) minimum holding period for bonds, particularly for foreign investors in local currency bond markets; and (iii) taxes on foreign bond inflows.

[11] See, for example, Eichengreen and Hausmann (2005), Eichengreen, Hausmann, and Panizza (2007), and references therein.

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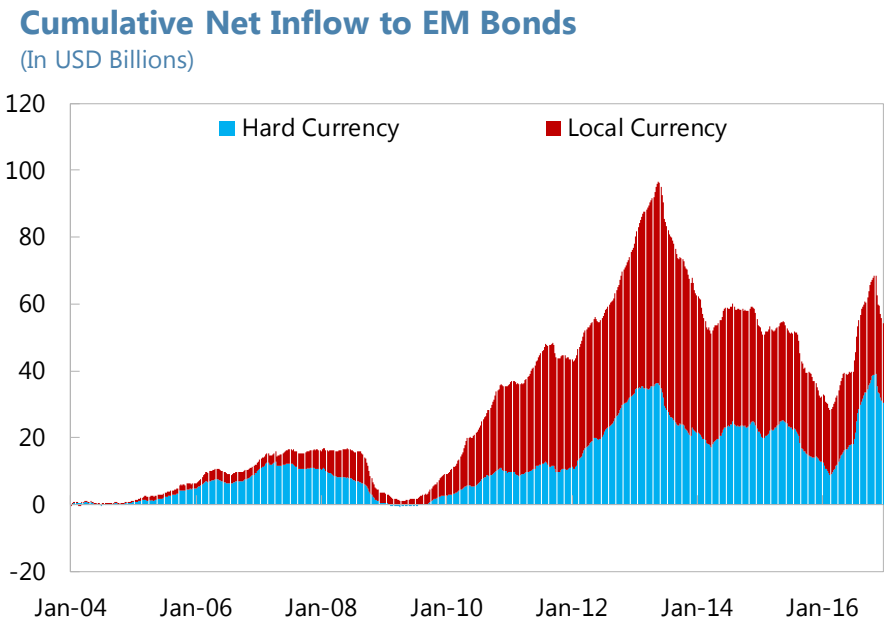
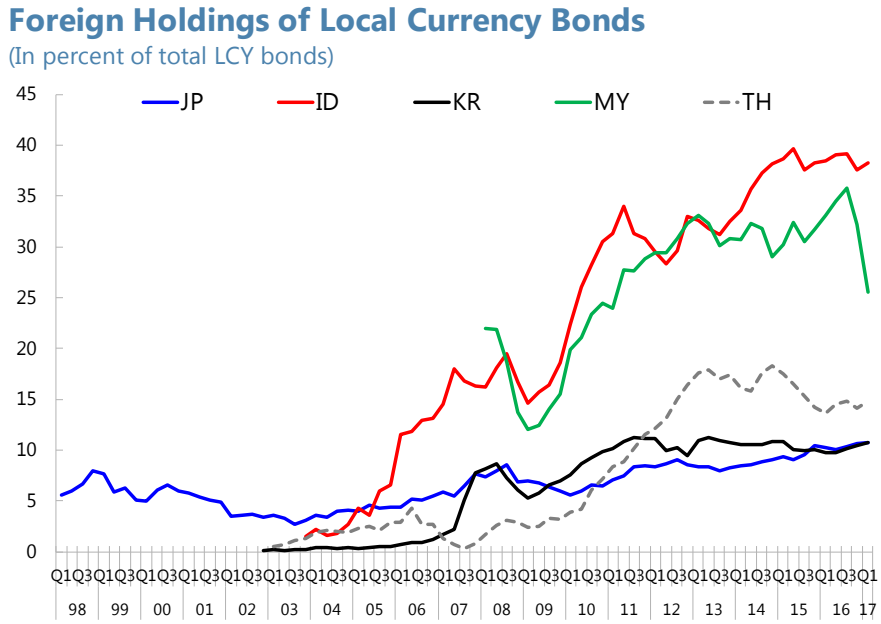
**Figure 1: Net inflows into emerging market bonds**



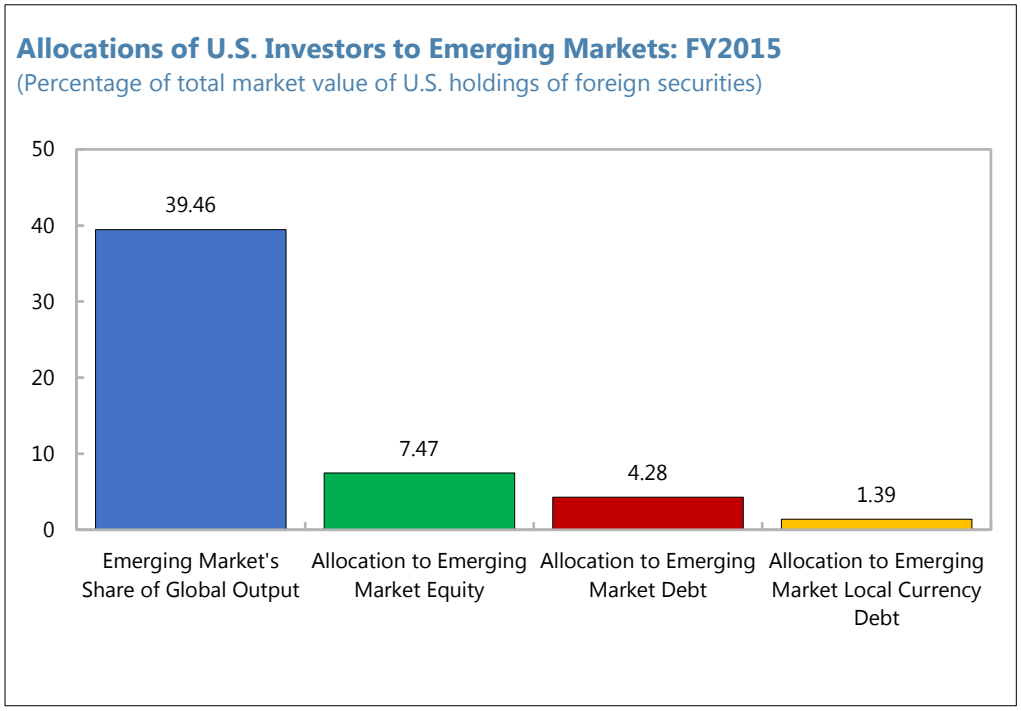

Source: EPFR Global.
Note: Hard currency denotes funds that invest 75 percent or more in debt denominated in the following currencies: US Dollar, Euro, British Pound, Swiss Franc, Japanese Yen, Canadian Dollar, Australian Dollar, and Swedish Krona.

**Figure 2: Foreign investor participation in EM local currency bond markets**



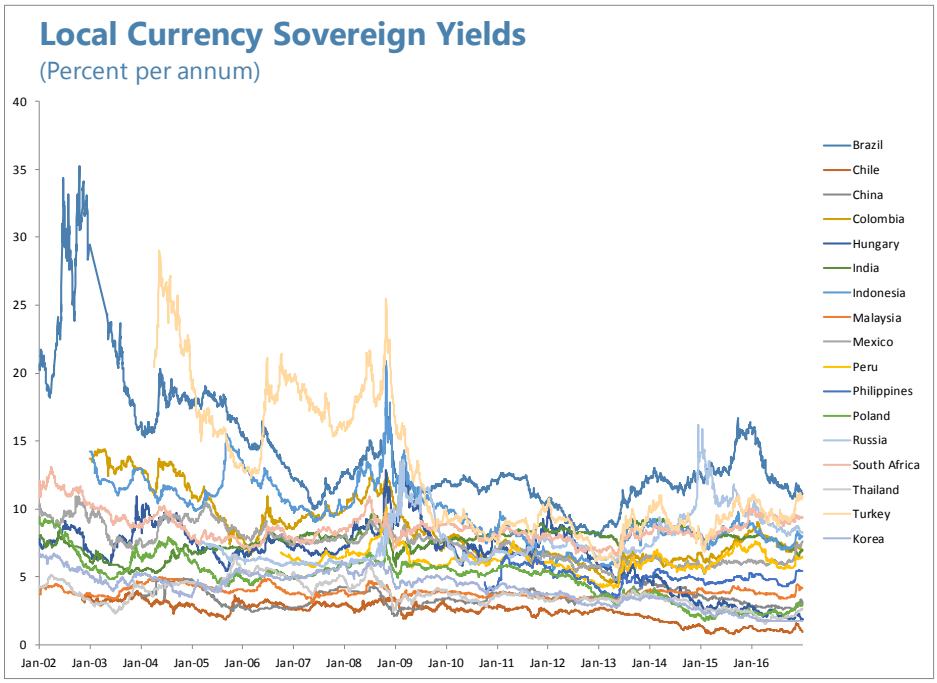

Source: Asia Bonds Online.
Note: ID = Indonesia; KR = South Korea; MY = Malaysia; TH = Thailand; JP = Japan (for comparison).

**Figure 3: Allocations of US investors to emerging markets**



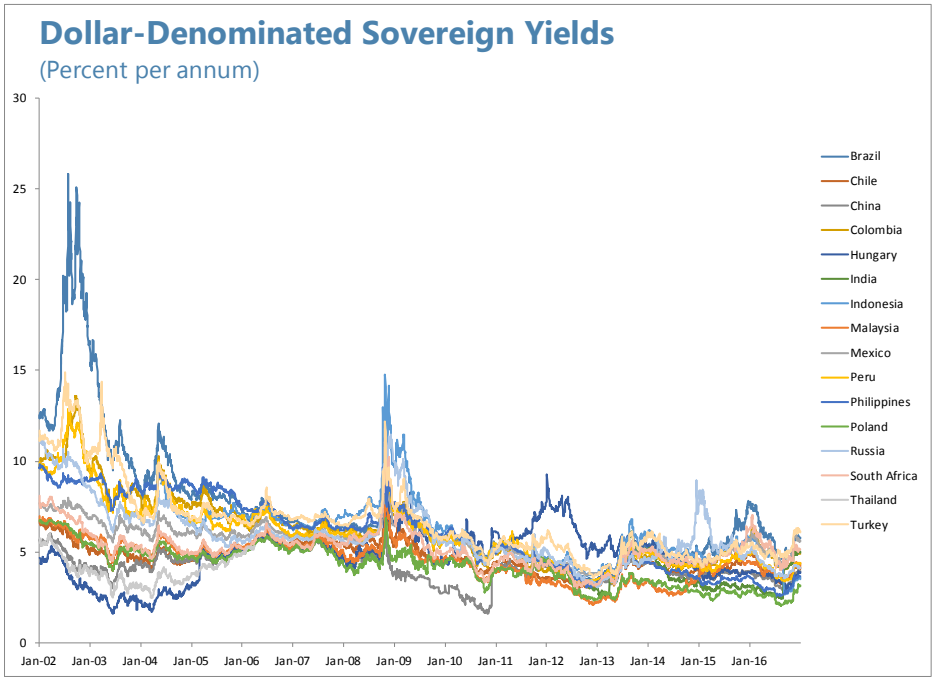

Source: 2015 US Treasury Report on US Portfolio Holdings and IMF World Economic Outlook 2016

**Figure 4: EM Local currency bond yields**




Source: JP Morgan data.

**Figure 5: EM Dollar-denominated bond yields**




Source: JP Morgan data.

**Figure 6: EM Dollar-denominated bond yields – Factor analysis**

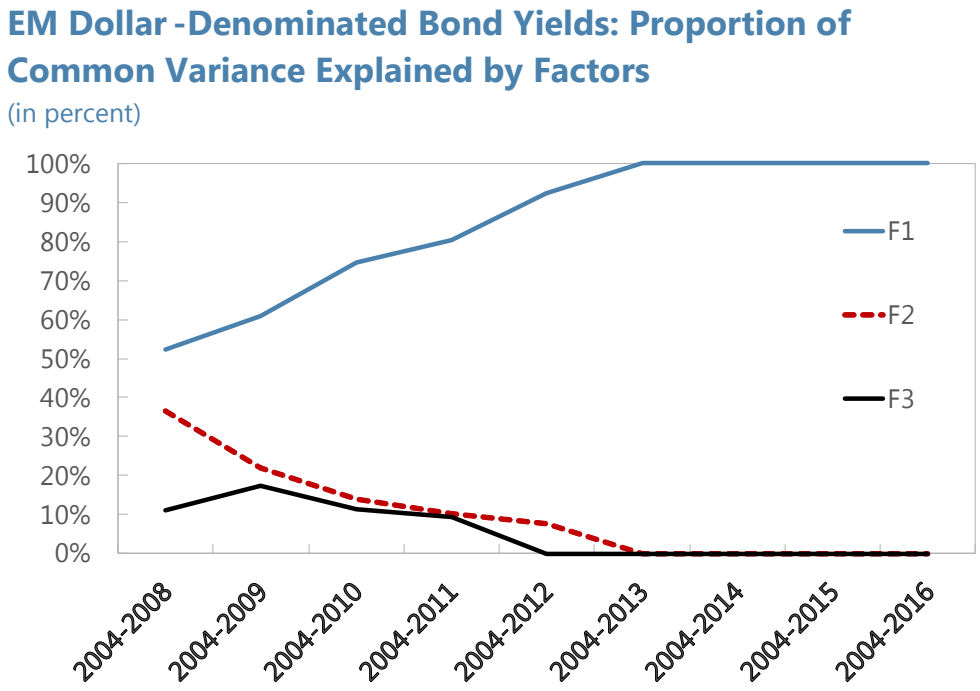



**Figure 7: EM Local currency bond yields – Factor analysis**

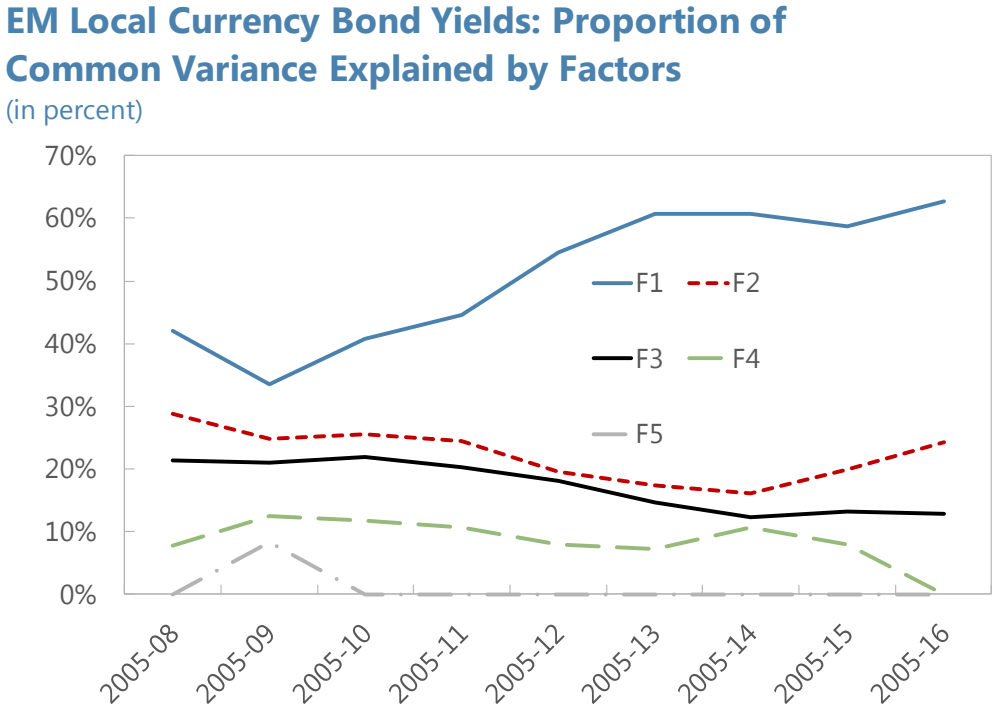


**Table 1: EM Sovereign Dollar-Denominated Currency Debt, 2004-2016**

Covariance Analysis: Ordinary Correlation
Balanced Sample: 3145 Observations between 5/28/2004 and 12/31/2016

| Country | Factor Loadings F1 | Communality | Uniqueness |
|---|---|---|---|
| CHINA | 0.619 | 0.384 | 0.616 |
| INDONESIA | 0.914 | 0.835 | 0.165 |
| MALAYSIA | 0.929 | 0.862 | 0.138 |
| PHILIPPINES | 0.902 | 0.814 | 0.186 |
| BRAZIL | 0.891 | 0.794 | 0.206 |
| CHILE | 0.903 | 0.815 | 0.185 |
| COLOMBIA | 0.962 | 0.925 | 0.075 |
| MEXICO | 0.969 | 0.940 | 0.060 |
| PERU | 0.965 | 0.932 | 0.068 |
| POLAND | 0.862 | 0.743 | 0.257 |
| RUSSIA | 0.797 | 0.634 | 0.366 |
| SOUTH AFRICA | 0.848 | 0.719 | 0.281 |
| TURKEY | 0.966 | 0.933 | 0.067 |

Variance accounted for by common factors: 10.332
Total Variance (sum of diagonal elements of correlation matrix): 13

**Table 2: EM Sovereign Dollar-Denominated Debt, 2004-2016: Sub-group 1**

Covariance Analysis: Ordinary Correlation
Balanced sample of 3145 observations between 5/28/2004 and 12/31/2016

| Country | Factor Loadings F1 | Communality | Uniqueness |
|---|---|---|---|
| CHINA | 0.619 | 0.383 | 0.617 |
| INDONESIA | 0.860 | 0.739 | 0.261 |
| MALAYSIA | 0.884 | 0.781 | 0.219 |
| PHILIPPINES | 0.880 | 0.774 | 0.226 |

Variance accounted for by common factors: 2.677
Total Variance: 4

**Table 3: EM Sovereign Dollar-Denominated Debt, 2002-2016: Sub-group 2**

Covariance Analysis: Ordinary Correlation
Balanced sample of 3747 observations between 1/2/2002 and 12/31/2016

| Country | Factor Loadings F1 | Communality | Uniqueness |
|---|---|---|---|
| BRAZIL | 0.888 | 0.788 | 0.212 |
| CHILE | 0.818 | 0.669 | 0.331 |
| COLOMBIA | 0.982 | 0.964 | 0.036 |
| MEXICO | 0.961 | 0.923 | 0.077 |
| PERU | 0.976 | 0.953 | 0.047 |

Variance accounted for by common factors: 4.30
Total Variance: 5

**Table 4: EM Sovereign Dollar-Denominated Debt, 2002-2016: Sub-group 3**

Covariance Analysis: Ordinary Correlation
Balanced sample of 3747 observations between 1/2/2002 and 12/31/2016

| Country | Factor Loadings F1 | Communality | Uniqueness |
|---|---|---|---|
| POLAND | 0.843 | 0.711 | 0.289 |
| RUSSIA | 0.913 | 0.833 | 0.167 |
| SOUTH_AFRICA | 0.831 | 0.69 | 0.310 |
| TURKEY | 0.910 | 0.829 | 0.171 |

Variance accounted for by common factors: 3.062
Total Variance: 4

**Table 5: Correlation between Common Factors and Other Variables - EM Sovereign Dollar-Denominated Debt**

| Variables | F1 | Sub-group 1 F1 | Sub-group 2 F1 | Sub-group 3 F1 |
|---|---|---|---|---|
| ***US Interest Rates*** | | | | |
| US Treasury | 0.81 (77.61) | 0.84 (86.50) | 0.80 (81.98) | 0.74 (66.98) |
| US Treasury 3-months | 0.59 (41.43) | 0.64 (47.02) | 0.41 (27.83) | 0.35 (22.84) |
| US Treasury 2-years | 0.69 (53.73) | 0.73 (60.74) | 0.55 (39.88) | 0.48 (33.58) |
| US Treasury 10-years | 0.81 (76.56) | 0.83 (83.86) | 0.77 (73.75) | 0.71 (61.75) |
| US High Yield Corporate | 0.23 (13.38) | 0.20 (11.24) | 0.30 (19.23) | 0.40 (27.09) |
| ***Euro Interest Rates*** | | | | |
| Euribor 3-months | 0.72 (58.24) | 0.76 (65.05) | 0.66 (53.31) | 0.66 (54.18) |
| Euribor 2-years | 0.75 (63.14) | 0.79 (71.78) | 0.70 (59.51) | 0.69 (58.65) |
| Euribor 10-years | 0.77 (68.42) | 0.81 (76.25) | 0.78 (76.42) | 0.76 (72.59) |
| ***Equity*** | | | | |
| MSCI Emerging Market Index | -0.59 (-40.50) | -0.57 (-38.57) | -0.79 (-78.93) | -0.75 (-69.59) |
| S&P 500 | -0.57 (-38.98) | -0.60 (-41.92) | -0.65 (-51.74) | -0.64 (-50.68) |
| NASDAQ | -0.65 (-47.92) | -0.69 (-53.02) | -0.70 (-59.44) | -0.68 (-56.82) |
| FTSE | -0.59 (-41.30) | -0.59 (-40.82) | -0.71 (-61.86) | -0.69 (-57.55) |
| DAX | -0.63 (-45.58) | -0.66 (-49.36) | -0.71 (-61.62) | -0.67 (-55.47) |
| ***Liquidity and Volatility*** | | | | |
| Libor-OIS | 0.37 (22.12) | 0.34 (20.39) | 0.12 (7.445) | 0.21 (13.36) |
| Ted Spread | 0.46 (29.33) | 0.46 (28.66) | 0.13 (8.05) | 0.19 (11.72) |
| VIX | 0.35 (20.67) | 0.31 (18.34) | 0.39 (25.73) | 0.48 (33.63) |

**Table 5 (Continued)**

| Variables | F1 | Sub-group 1 F1 | Sub-group 2 F1 | Sub-group 3 F1 |
|---|---|---|---|---|
| ***Commodity Prices*** | | | | |
| S&P GSCI Index | -0.41 | -0.37 | -0.68 | -0.63 |
| | (-24.95) | (-22.47) | (-56.65) | (-49.91) |
| WTI | -0.32 | -0.28 | -0.61 | -0.57 |
| | (-18.62) | (-16.61) | (-47.10) | (-41.98) |
| Brent | -0.45 | -0.42 | -0.68 | -0.62 |
| | (-28.09) | (-25.59) | (-56.28) | (-48.54) |
| Crude Palm Oil | -0.49 | -0.51 | -0.64 | -0.60 |
| | (-31.90) | (-33.14) | (-51.05) | (-45.39) |
| Copper | -0.45 | -0.43 | -0.72 | -0.68 |
| | (-28.16) | (-26.33) | (-63.16) | (-56.02) |
| Aluminum | 0.20 | 0.25 | -0.27 | -0.27 |
| | (11.63) | (14.51) | (-17.03) | (-17.26) |
| Soybean | -0.64 | -0.64 | -0.74 | -0.68 |
| | (-46.56) | (-47.02) | (-66.47) | (-56.72) |
| Wheat | -0.38 | -0.36 | -0.56 | -0.51 |
| | (-22.74) | (-21.66) | (-41.78) | (-36.18) |

**Table 6: EM Sovereign Local Currency Debt, 2005-2016**

Covariance Analysis: Ordinary Correlation
Balanced Sample: 2981 Observations between 2/1/2005 and 12/31/2016

| Country | Factor Loadings | | | Communality | Uniqueness |
|---|---|---|---|---|---|
| | F1 | F2 | F3 | | |
| CHINA | -0.102 | -0.279 | 0.688 | 0.561 | 0.439 |
| INDIA | -0.210 | -0.339 | 0.736 | 0.701 | 0.299 |
| INDONESIA | 0.831 | 0.374 | -0.098 | 0.840 | 0.160 |
| KOREA | 0.914 | -0.305 | 0.051 | 0.930 | 0.070 |
| MALAYSIA | 0.454 | 0.531 | 0.399 | 0.647 | 0.353 |
| THAILAND | 0.833 | -0.220 | 0.143 | 0.763 | 0.237 |
| BRAZIL | 0.503 | 0.681 | 0.065 | 0.721 | 0.279 |
| CHILE | 0.769 | -0.544 | -0.077 | 0.893 | 0.107 |
| COLOMBIA | 0.812 | 0.381 | 0.082 | 0.811 | 0.189 |
| MEXICO | 0.916 | 0.248 | -0.065 | 0.905 | 0.095 |
| HUNGARY | 0.733 | -0.458 | -0.200 | 0.787 | 0.213 |
| POLAND | 0.831 | -0.428 | -0.018 | 0.874 | 0.126 |
| RUSSIA | -0.432 | 0.504 | -0.168 | 0.469 | 0.531 |
| TURKEY | 0.836 | 0.248 | 0.037 | 0.761 | 0.239 |
| SOUTH_AFRICA | 0.100 | 0.511 | 0.367 | 0.406 | 0.594 |
| Proportion of common variance explained by factors | 0.627 | 0.243 | 0.129 | | |

Variance accounted for by common factors: 11.068
Total Variance: 15

**Table 7: Correlation between Common Factors and Other Variables**

| | EM Sovereign Local Currency Debt | | |
|---|---|---|---|
| Variables | F1 | F2 | F3 |
| ***US Interest Rates*** | | | |
| US Treasury | 0.84 | 0.12 | 0.04 |
| | (85.05) | (6.37) | (2.03) |
| US Treasury 3-months | 0.66 | 0.07 | -0.03 |
| | (48.06) | (3.64) | (-1.80) |
| US Treasury 2-years | 0.72 | 0.17 | -0.04 |
| | (56.82) | (9.18) | (-2.28) |
| US Treasury 10-years | 0.86 | 0.04 | 0.08 |
| | (92.26) | (1.92) | (4.19) |
| US High Yield Corporate | 0.16 | 0.05 | -0.38 |
| | (8.72) | (2.70) | (-22.44) |
| ***Euro Interest Rates*** | | | |
| Euribor 3-months | 0.87 | -0.10 | 0.13 |
| | (94.11) | (-5.41) | (7.31) |
| Euribor 2-years | 0.91 | -0.15 | 0.11 |
| | (118.28) | (-8.43) | (5.86) |
| Euribor 10-years | 0.93 | -0.28 | 0.04 |
| | (140.99) | (-15.81) | (2.23) |
| ***Equity*** | | | |
| MSCI Emerging Market Index | -0.29 | -0.55 | 0.51 |
| | (-16.80) | (-35.72) | (32.18) |
| S&P 500 | -0.72 | 0.42 | 0.33 |
| | (-56.11) | (25.43) | (19.06) |
| NASDAQ | -0.82 | 0.41 | 0.27 |
| | (-77.14) | (24.72) | (15.35) |
| FTSE | -0.56 | 0.05 | 0.43 |
| | (-36.78) | (2.65) | (26.35) |
| DAX | -0.76 | 0.32 | 0.34 |
| | (-63.14) | (18.13) | (19.85) |
| ***Liquidity and Volatility*** | | | |
| Libor-OIS | 0.35 | 0.09 | -0.10 |
| | (20.24) | (4.73) | (-5.27) |
| Ted Spread | 0.49 | 0.11 | 0.02 |
| | (30.66) | (6.27) | (0.95) |
| VIX | 0.29 | -0.02 | -0.24 |
| | (16.53) | (-1.19) | (-13.29) |

**Table 7 (Continued)**

| Variables | Sovereign Local Currency Debt F1 | F2 | F3 |
|---|---|---|---|
| ***Commodity Prices*** | | | |
| S&P GSCI Index | 0.01 | -0.69 | 0.53 |
| | (0.48) | (-52.59) | (34.33) |
| WTI | 0.09 | -0.64 | 0.56 |
| | (5.03) | (-45.76) | (37.31) |
| Brent | -0.06 | -0.71 | 0.51 |
| | (-3.13) | (-54.41) | (32.46) |
| Crude Palm Oil | -0.25 | -0.43 | 0.35 |
| | (-14.24) | (-25.97) | (20.59) |
| Copper | -0.07 | -0.72 | 0.47 |
| | (-3.96) | (-55.84) | (28.79) |
| Aluminum | 0.56 | -0.40 | 0.34 |
| | (36.63) | (-23.92) | (19.90) |
| Soybean | -0.43 | -0.53 | 0.31 |
| | (-25.78) | (-33.85) | (17.66) |
| Wheat | -0.08 | -0.58 | 0.35 |
| | (-4.36) | (-38.77) | (20.19) |

**Table 8: EM Sovereign Dollar-Denominated Debt, 2004-2016 - Proportion of Common Variance Explained by Factors**

| | Pre-crisis (5/28/2004-9/12/2008) | Post-crisis (9/15/2008-12/31/2016) | Full sample |
|---|---|---|---|
| F1 | 52.2% | 91.8% | 100.0% |
| F2 | 36.7% | 8.2% | |
| F3 | 11.1% | | |
| Common Variance | 11.791 | 11.033 | 10.332 |
| Total Variance | 13 | 13 | 13 |

**Table 9: EM Sovereign Local Currency Debt, 2005-2016 - Proportion of Common Variance Explained by Factors**

| | Pre-crisis (2/1/2005-9/12/2008) | Post-crisis (9/15/2008-12/31/2016) | Full sample |
|---|---|---|---|
| F1 | 42.0% | 48.2% | 62.7% |
| F2 | 28.7% | 36.2% | 24.3% |
| F3 | 21.4% | 15.6% | 12.9% |
| F4 | 7.8% | | |
| Common Variance | 12.644 | 12.245 | 11.068 |
| Total Variance | 15 | 15 | 15 |