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Abstract

This paper investigates empirically the integration of bond markets of emerging market economies into the global bond markets from 2003 to 2012. The paper employs factor analysis based on the Arbitrage Pricing Theory to extract global factors from a panel of 38 bond yields of advanced and emerging market economies. The results reveal that bond yields in advanced economies, which constitute the driving forces behind the global bond market, do not dominate in explaining the variation of emerging market bond yields. Instead, the dynamics in emerging market bond yields can also be attributed to movements in the equity markets in both advanced and emerging market economies as well as emerging market currencies. In addition, the degree of emerging market integration changes over time and across countries.

JEL Classification Numbers: F15, F36, G12, G15.

Keywords: Bond Yields, Financial Integration, Arbitrage Pricing Theory, Dynamic Factor Model, Rolling Regression.

*The views expressed in this paper are those of the author(s) and do not necessarily represent those of the South African Reserve Bank or South African Reserve Bank policy.

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1 Introduction

Capital flows to emerging markets have increased substantially since the global financial crisis (IMF, 2014). Figure 1 indicates the flows to the largest 10 emerging markets as well as a full sample of 30 emerging markets.[1] In 2011 and 2012 the volume of inflows was higher than before the crisis in 2007. While FDI is the most important source of inflows, bond flows have increased in importance, overtaking equity flows in 2010. In 2010 the bond inflows of 2010 were five times more than in 2006, and in 2012 they increased to eight times more than in 2006.

The emergence of emerging market bonds in the scene can be attributed to local and global factors. According to Peiris (2010) local factors, rather than global factors, became more important after the emerging market crises of the late 1990s, as these countries have increasingly exploited local bond markets as a source of finance. Ever since, domestic bond markets in emerging market countries have grown rapidly. Together with the domestic growth, foreign participation in these domestic bond markets has also grown.

Globally, interest in emerging market bonds has risen due to a search for portfolio diversification. The IMF (2014) attributes the renewed interest in emerging market financial assets to improved fundamental economic conditions as well as relatively low yields in financial assets of advanced economies. Local financial markets therefore grew and new assets, like local-currency-denominated sovereign debt, came to the fore. According to Burger, Warnock and Warnock (2011), emerging market local currency bonds offered attractive diversification benefits particularly to US investors during the crisis period. Returns depended primarily on the performance of the emerging market currencies relative to the US$ and returns were much higher and volatility lower compared to emerging market equities. Miyajima, Madhusudan and Chan (2012) comment on the diversification possibilities of emerging market bonds by stating that emerging market bonds should not appeal to international investors if their yields are driven by global factors. In order to be an effective alternative investment asset, emerging market bonds must be driven by local or domestic factors rather than global ones.

Against this background of increased international interest in emerging market bonds,

[1] Top 10 consists of: Brazil, India, China, Russian Federation, South Africa, Turkey, Mexico, Chile, Poland and Indonesia. The 30 countries also include: Bulgaria, Czech Republic, Hungary, Romania, Ukraine, Argentina, Colombia, Ecuador, Peru, Venezuela, Malaysia, Philippines, South Korea, Thailand, Egypt, Lebanon, Morocco, Nigeria, Saudi Arabia and the UAE.

and specifically local currency bonds, this paper seeks to identify, firstly, the driving forces behind global sovereign bond yields. Secondly, it distinguishes the drivers of bond yields in developed markets from those of emerging markets. Thirdly, it determines the extent to which emerging sovereign bond yields are integrated into the global bond market. Specifically, the paper establishes whether the variation in the emerging market bond yields can be explained mainly by global factors. Importantly, the study investigates the possibility of changing patterns of integration over time and across countries. The current paper is closely related to recent studies by the IMF (2014), Jaramillo and Weber (2013), Burger, et al. (2011), Miyajima, et al. (2012), and Ebeke and Lu (2014).

The empirical results point to vast differences between the driving forces behind developed and emerging market bond yields. Developed markets are impacted by yields in developed markets, stock market returns and the USD/YEN exchange rate. Emerging markets are driven by developed market yields, emerging market currencies and stock market returns. These drivers are dynamic in nature and change over time due to economic conditions. Regarding emerging market local currency bonds, we observe varying levels of integration over time. Poland and Hungary are the most integrated countries. In general, the variation in emerging market bond yields are better explained by common factors extracted from an emerging market sample compared to a global sample.

The rest of the article is organised as follows. Section 2 provides an overview of literature on the integration of emerging markets into the global bond market, as well as the determinants of bond yields. Section 3 describes the model used in the empirical section. The data and the empirical results are discussed in Section 4. Section 5 concludes the paper.

2 Literature Review

According to Bekaert and Harvey (2003), financial markets are integrated when assets with identical risk yield the same return regardless of their domicile. During the integration process, emerging market stocks, with diversification potential, are bought by foreign investors, leading to higher prices. At the same time, both local and international investors stop investing in inefficient sectors. Sutherland (1996) describes financial market integration as a process in which countries converge, and are faced by the same shocks. In addition, the hedging properties of their assets also converge.

Many studies use various versions of correlation coefficients to measure co-movement between financial assets. The literature is in agreement that correlations between the indices in levels are not appropriate. Either first differences or percentage returns are

employed. However, correlation coefficients serve as a first indication of co-movement. In addition, correlation accounts only for bivariate analysis between two variables. The analysis weakens when the number of variables increases.

Raj and Dhal (2008) provide a comprehensive summary of the use of cointegration analysis in determining the presence of financial market integration. The presence of a single long-run relationship between a group of markets indicates that these markets are treated as single-asset countries by investors and that specific shocks affect investor sentiment towards the region (or group) as a whole (Voronkova, 2004). While some authors report only on the outcomes of test statistics and the number of cointegrating vectors present, Voronkova (2004) stresses that the statistical significance of the error correction term strengthens evidence in favour of integration. Like most other vector autoregressive (VAR) analysis, cointegration analysis can accommodate only a limited number of variables with the risk of running out of degrees of freedom where the number of coefficients exceeds the number of observations.

Other studies involve more than one empirical technique. See, for example, Lucey and Voronkova (2006), who tested the integration of the Russian stock market employing the Johansen multivariate cointegration approach, the Gregory-Hansen residual based cointegration test and a DCC-GARCH model. Pukthuanthong and Roll (2009) argue that correlation across indices is a poor measure of integration, and that the explanatory power (R-square) of a multi-factor model provides a better indicator of integration. This study follows closely the latter approach, that is, factor analysis which contains a large panel of global bond yields for advanced economies (AEs) and emerging market economies (EMEs).

In their review of the literature on bond market integration, Lucey and Steeley (2006) highlight the limited research on (government) bond market integration, despite the perception of increased integration. Cappiello, Engle and Sheppard (2006) echo the sentiments of Lucey and Steeley in observing that conditional volatility has been widely studied for stock markets, but not for government bond returns.

The empirical literature on emerging markets indicates low levels of integration. Bunda, Hamann and Lall (2010) conclude that until the recent global financial crisis the bonds of 18 emerging market countries were driven only by external factors. Fender, Hayo and Neuenkirch (2012) investigate the bond returns of 12 emerging market countries using the principal component analysis. The first principal component from the sample explains 32% of the variation in yields before the recent global financial crisis and 69% of the variation after the crisis. These results are consistent with the findings of Bunda, Hamann, and Lall (2010), viz. that bond yields of EMEs become more integrated after the recent financial crisis. Thupayagale and Molalapata (2012) consider integration

among the bond markets of the US, Mexico, South Korea and South Africa. They find no long-term trend among the three emerging markets or with the US. South African bonds respond to US bonds but not to any of the other three emerging markets. There is also a downward trend in correlation between US and South African bonds. Piljak (2013) concludes that domestic macroeconomic factors of 10 emerging and four frontier market countries are more relevant than global factors in explaining co-movement with US bonds.

McGuire and Schrijvers (2006 and 2003) have done some of the earliest work in giving meaning to common factors driving bond markets. They consider the following economic variables as possible representatives of the global forces: equity returns, long- and short-term interest rates, market volatility (as measured by the implied volatility of the DAX), euro/dollar exchange rate and the oil price. Both factors show a negative correlation with equity returns. The first factor is negatively correlated with the oil price, while Factor 2 depicts a positive relationship. Both factors exhibit a positive relationship with market volatility. Although the economic factors identified in these two studies dealt with explaining the factors influencing bond spreads, it is assumed that the same factors will impact on bond yields.

Piljak (2013:36) investigates linkages between the US bond market and 10 emerging bond markets. She finds varying patterns (diversity among EMEs) – positive correlations with China, Mexico, Poland and South Africa, and negative correlations between Brazil and Russia. The co-movements of bond returns are best explained by domestic macroeconomic factors – in China and Mexico global factors are more important.

Recently, four studies focus on the determinants of emerging market local currency bond yields, namely, Jaramillo and Weber (2013), Miyajima, et al. (2012), Burger, et al. (2011), and Ebeke and Lu (2014). Jaramillo and Weber (2013), using monthly panel data, focus on the impact of macroeconomic variables on yields. They stress the importance of the fiscal position as domestic determinant together with inflation and production levels. In terms of international factors, a higher VIX index requires a higher emerging market bond yield, and in the case of a weak fiscal position, an increase VIX leads to a relative higher increase in the yield.

Miyajima, et al. (2012) also employ monthly panel data and find that domestic factors are more important in explaining emerging market bond yields than global factors. The impact of the global factors also changes over time. The VIX, for instance, does not have a consistent long-term impact. During 2000 – 2007 it has a significant impact, but from 2008 – 2011 the impact is halved and becomes statistically insignificant. The US 10-year yield starts off as being insignificant and later doubles in size and becomes significant. In their study of quarterly data Ebeke and Lu (2014) as well as Burger,

et al. (2011) stress the importance of exchange rates in local currency bond investment decisions. Foreigners expect a higher bond yield when emerging market currencies depreciate.

3 The Model

The model used in this study is based on the Capital Asset Pricing Model (CAPM) proposed by Sharpe (1964) and Lintner (1965). The standard CAPM states that excess returns on equity markets are driven by one factor. Ross (1976) extended the CAPM to a multi-factor model, also known as Arbitrage Pricing Theory (APT), where, in the absence of arbitrage, the systematic component of equity returns is explained by a linear function of more than one factor. The APT, however, is silent on the number of factors required to explain the variation in returns. Since no arbitrage profit is possible under equilibrium, the return of every asset is a linear combination of the expected return of the asset and the asset's response (or loadings) on the common factors (Roll and Ross, 1980). Mathematically we have

$$r_i = E(r_i) + \beta_{i1} f_1 + \beta_{i2} f_2 + \cdots + \beta_{ik} f_k + \varepsilon_i \tag{1}$$

where r_i is the returns of aset i, $E(r_i)$ is the the expected returns of asset i, f_k are common factors, β_{ik} measures the sensitivity of returns of asset i on common factor f_k, and ε_i is the noise term of asset i, indicating unsystematic risk or the idiosyncratic component (Roll and Ross, 1980).

Building on Ross's theory, Chamberlain (1983) and Chamberlain and Rothschild (1983) provide asymptotic conditions to empirically estimate the underlying factors of the APT through principal component analysis. With some restrictions, as the number of assets becomes large, the covariance matrix of asset returns has a finite number, k, of unbounded eigenvalues, which in turn allows for proper identification of a unique factor structure of k factors. The remaining eigenvalues, attributed to the idiosyncratic component, are bounded. With the law of large numbers the idiosyncratic components vanish.

The contribution of Chamberlain (1983) and Chamberlain and Rothschild (1983) is based on seminal work of Geweke (1977) and Sargent and Sims (1977). Recently, factor analysis has seen an increase in popularity mainly due to its ability to accommodate large a cross-section of time series without the risk of running out degree of freedom. Factor models summarise information from a large panel of time series into two unobserved and orthogonal components, namely, the common component, which is explained by few common latent factors, and the idiosyncratic component, which is specific to each series.

In factor analysis format, equation (1) becomes

$$r_{it} = \lambda_0 + \lambda_{i1} f_{1t} + \lambda_{i2} f_{2t} + \cdots + \lambda_{ik} f_k + \xi_{it} \tag{2}$$

or in vector format

$$R_t = \Lambda F_t + \Xi_t \tag{3}$$

where $R_t = (r_{1t},\, r_{2t},\, \ldots,\, r_{Nt})'$ is the $N \times 1$ vector of returns, $F_t = (f_{1t},\, f_{2t},\, \ldots,\, f_{kt})'$ is the $k \times 1$ vector of common factors, which is common to all returns, $\Lambda = (\lambda_1',\ \lambda_2',\ \ldots,\ \lambda_1')$ is the $N \times k$ matrix of factor loadings, and $\Xi_t = (\xi_{1t},\, \xi_{2t},\, \ldots,\, \xi_{Nt})'$ is the $N \times 1$ vector of idiosyncratic components. If R_t represents the global bond market, we can say that F_t is the vector of global factors, and Ξ_t contains factors specific to each bond market; hence, they are specific to each country.

4 Data and Empirical Results

4.1 Data

The empirical aspect of the present study concerns the yield on long-term government bonds. The specific measure is the Thompson Reuters-supplied nominal government benchmark bid yield (10 years), quoted in local currency, downloaded from Datastream. Data for 19 countries is available from 1995, mostly developed economies. In order to include more countries, especially emerging economies, in the empirical analysis, the starting date is extended to 2003.[2] Bond yields for the following countries are subsequently included: Australia, Austria, Belgium, Canada, China, Colombia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Ireland, Israel, Italy, Japan, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Russian Federation, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom and United States.

The original daily data is transformed into weekly averages. Working with weekly rather than daily data has a few advantages. It avoids the problem of unsynchronised international trading and eliminates the noise in daily data. The weekly average yields are not stationary and are differenced once before being employed in the empirical study. The study period thus runs from 8 April 2003 until 2 October 2012, resulting in 496 weekly data points for 38 countries.

Three different country samples are considered for the empirical analysis. The first group includes all 38 countries for which yield data is available, called *Global sample*,

[2]Data for Israel is available from April 2002, China June 2002, Colombia September 2002, Austria February 2002, Belgium February 2002 and the Russian Federation April 2003.

which represents 95.06% of all outstanding domestic securities issued by governments in December 2010 according to BIS (2011). Thus, we are confident that this sample is a good proxy of the global bond market. The second group, *Developed markets*, contains 25 developed markets.[3] It includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, United Kingdom and United States. The last group, *Emerging markets*, consists of the 13 emerging market countries, namely, China, Colombia, Czech Republic, Hungary, India, Malaysia, Mexico, Philippines, Poland, Russian Federation, South Africa, Taiwan and Thailand.

4.2 Empirical Results

The first step in factor analysis is to determine the number of factors that is present in the panel data set. The IC_{p1} criteria of Bai and Ng (2002, henceforth BN) suggest three factors for the *Global sample*, but are inconclusive for the *Developed markets* and *Emerging markets*. The eigenvalue criteria suggest three factors for both the *Global* and the *Developed* groups, as the third eigenvalue is less than the threshold of 5%, whereas they propose 10 factors for the *Emerging* group. In addition, the Alessi, Barigozzi and Capasso (2010, henceforth ABC) criteria, which improve on the BN, propose three factors for the Global and the Developed groups, while they are inconclusive for the Emerging group. In order to be consistent and for the sake of comparability, we propose three factors for all three groups.

The choice of three factors is in line with findings of previous studies, particularly if one considers the number of countries involved. Litterman and Scheinkman (1991) identified three factors that explain returns on US treasury notes. McGuire and Schrijvers (2003) identified one factor explaining changes in dollar-denominated daily bond spreads of 15 emerging markets during 1997-2003. McGuire and Schrijvers (2006) identified two factors explaining changes in euro-denominated daily sovereign bond spreads of 15 emerging markets during 2001-2004. Perignon, Smith and Villa (2007) state that most empirical studies found three principal components (common factors) to be sufficient in explaining bond yields and that the three-factor structure is stable over time.

Following the above discussion, three common factors are extracted from all three country groupings. Even though the test criteria for the emerging markets group are inconclusive, three factors are extracted in order to allow comparisons between findings for the three country groups.[4] Table 1 contains the cross-correlations of the nine ex-

[3] According to the FTSE classification.

[4] Refer to Figure 2 for individual figures of each.

tracted factors. As expected, the first factors from the global sample and the developed sample are highly correlated at 0.994. The difference between the first factor from the global sample and emerging markets is evident in the low correlation of only 0.522.

The similarities among the second factors are less than among the first factors. The correlations of -0.675, 0.306 and -0.126 underline the differences in the extracted factors. The third factors differ even more. From Table 1 it is evident that the underlying common factors in the emerging bonds market are vastly different from the underlying common factors in the developed bond markets.

4.3 Identifying common factors

The extracted common factors are the result of a purely statistical process, are void of economic meaning and are perceived as black boxes. This section attempts to identify economic variables that can explain movements in these latent factors through their correlations with economic variables. In so doing, we are opening the black boxes inherent to factor analysis, in line with Ludvigson and Ng (2009). In the process, some economic meaning and interpretation is added to the common factors. However, working with weekly data limits the choice of variables to those available on a daily or weekly frequency and excludes macroeconomic variables like the fiscal position, inflation and level of production, which are available on monthly frequency.

Following the work of McGuire and Schrijvers (2006 and 2003), Jaramillo and Weber (2013), Miyajima et al. (2012), and Ebeke and Lu (2014), this part of the empirical analysis includes proxies for macroeconomic variables regarding the oil price, government bond yields, stock market returns, short-term interest rates, volatility and exchange rates. Table 2 reports on correlations between the first common factor extracted from each of the three country groupings and these macroeconomic variables across the whole sample period.[5]

The oil price, represented by the percentage change in the Brent crude oil price, displays a positive and statistically significant correlation with the first factor from the global and developed sample, but not with the emerging markets one.

The correlations depicted in Table 2, which portray the relationship between common factors and returns on stock markets for the US (USequity), the UK (UKequity), Germany (Gerequity), and the combined returns of developed markets (DVequity) and emerging markets (EMequity), are consistent with the findings of McGuire and Schrijvers (2006). For the emerging market factor, there is a negative relationship with all the indicators of stock market returns. It implies that as the returns on stock markets

[5] Correlations with the respective second and third factors are available from the authors on request.

decrease, investors turn to emerging bond markets as they provide higher yields. In general, however, there is a positive relationship between stock market returns and the first factor from the global as well as the developed sample. A comparison of the size of the estimated correlations with the country groupings shows that the correlation with DVequity is higher with the developed factor and for the emerging markets factor it is higher with the EMequity. Regardless of the choice of common factor or the stock market indicator, there is overwhelming evidence of the impact of stock market returns on government bond bid yields.

We consider the percentage change in the 10-year government bid yield of the US (US10year), the UK (UK10year) and Germany (Ger10year) for long-term interest rates. The correlations of all three interest rate variables with all three first factors are positive and significant. As regards the size of the correlation coefficients, German rates have a stronger influence on the developed factor than the US rates, while US rates have the biggest impact on the emerging markets factor.[6] Nevertheless, it seems as if the first factor from all samples represents the 10-year bond yield of advanced economies, as the bond yields display the highest overall correlation coefficient.

In addition, we consider in the analysis four indicators of short-term interest rates. All four are in the format of change in the weekly average three-month interest rate for the respective countries, namely, emerging markets (EM3month), the Euro market countries (EUR3month), the UK (UK3month) and US (US3month). The relationships with all three factors are positive – indicating that investors expect a higher yield on long-term government bonds if the short-term interest rates increase. Importantly, the US short-term interest rate is not statistically significant for any of the factors.

Furthermore, we use the VIX index as a proxy of expected future stock market volatility or measure of investor fear.[7] Investors become more fearful with a rise in the VIX. The results in Table 2 exhibit a negative relationship between the VIX and the global and developed factor, but a positive relationship with the emerging markets factor. These correlations with the first factors underline an important aspect of investor behaviour. When expectations of stock market volatility increase, their long-term bid yield in general (globally and in terms of developed bond markets) decreases, but in dealing with emerging markets, their bid yield increases. Ederington and Golubeva (2011) observe that a high or rising VIX, indicative of stock market uncertainty in the US, prompts fund managers to move investments out of equity and into bonds. The higher demand for bonds increases bond prices – lowering bond yields. The negative correlation between VIX and the global and developed factors is explained by this sequence of

[6] This is in line with the Peiris (2010) finding.

[7] The VIX is the implied volatility of the S&P 500 stock index.

events linking a high VIX with lower developed market bond yields. On the other hand, Ebeke and Lu (2014) and Csonto and Ivaschenko (2013) estimated a positive relationship between the VIX and local currency bond yields of emerging markets. In the wake of stock market uncertainty, investors look to emerging markets as alternative investment destinations, but being risk averse, they would require a higher yield when investing in local debt securities.

Lastly, we consider the relationship between bond yields and exchange rates. When investors invest in local currency bonds, exchange rates have an important impact on their expected yield. To account for this effect, we include five exchange rates in the analysis, namely, the US dollar relative to the Euro (USD/EUR), the Japanese yen (USD/JPY), the Polish zloty (USD/PLN), the Mexican peso (USD/MXN) and the South African rand (USD/ZAR).[8] All five are quoted as USD per foreign currency – therefore a higher value for the exchange rate means that the USD is stronger and the foreign currency weaker. A negative correlation with the common factors therefore implies that a stronger USD (weaker foreign currency) would require a higher yield. The USD/Euro exchange rate does not drive the first common factor from the global or developed sample. The estimated correlation coefficient is small and not statistically significant. The yen, however, does influence these common factors – indicating that a stronger USD (weaker yen) would require a higher yield on global and developed bonds. Correlations with all the emerging market currencies are small, but positive and significant – implying that a weaker USD (stronger emerging market currencies) would require a higher yield on global and developed sovereign bonds.

Considering the common factor from the emerging market sample, all the correlations with the exchange rates are negative and statistically significant – and of the highest correlations reported in Table 2. It can therefore be concluded that exchange rates are indeed important drivers of local currency emerging market sovereign bond yields. A stronger USD, and thus weaker Euro, yen, zloty, peso or rand, would drive up emerging market bid yields.[9]

During different phases of the economic cycle and difficult economic conditions it is expected that different economic factors could drive the global bond market. The correlations reflected in Table 3 are calculated for the whole study period. However, these findings may be misleading because of the changing nature of relationships that

[8] These three emerging markets are representative of the regional distribution as well as of the largest sovereign bond markets included in the empirical analysis. Correlations with the currencies of Hungary, India, Philippines, Russia, Thailand and Taiwan rendered similar results and are available from the authors on request.

[9] This finding is consistent with the literature discussed in Section 2. When EME currencies depreciate, foreign investors expect a higher yield from EME local currency bonds.

are often observed in finance. We use rolling correlations calculated over a 24-week period to deal with these time-varying correlations. The reported rolling correlations are between the first factors extracted from the global and emerging markets samples and all the economic variables that display a correlation coefficient of 0.8 during any one of the 24-week periods. The developed market factors are excluded from further analysis due to the emerging market focus of this paper and because of their similarity with the global factors. The rolling correlations can shed light on the potential variability of the economic factors driving the global bond market as well as account for possible structural breaks/changes in the importance of these drivers over time. Graphical representations of the estimated rolling correlations can be found in Figure 3. In order to account for both positive and negative correlations, the absolute values of the correlation coefficients are reported in the graphs.

The first factor extracted from the global sample is the most influential – explaining 34% of the variation in global bond yields (see Table 1). The highest correlations recorded in Table 2 are with government bond yields of the US and Germany. The rolling correlations reflected in Panel 1 of Figure 3 confirm the dominance of these yields in explaining the variability of the first factor from the global sample. During the longest part of the sample, German yields dominate. For brief periods in 2009, 2010 and 2011 the US yield dominates – these periods of US yield dominance coincide with the financial crisis period emanating from the US. Towards the end of 2012 German yields regain their dominance. The only other variables that periodically qualify as important drivers are investor fear in 2003, due to reversal in the Fed interest rate policy, stock market returns of both developed and emerging markets, and the oil price in 2010. During 2009 and 2010 the oil price was significantly lower – in the presence of a global recession and particularly debt-related problems in Europe. Until 2007 exchange rates had no real impact on the first global common factor – this changed during the sub-prime crisis and Lehman Brothers collapse. During 2007 – 2008 and again in 2010 the USD/JPY is highly correlated with the first global factor. Even the emerging market currencies had an impact on global bond yields during 2010 – 2011.

While German and US bond yields show a clear link with the first factor extracted from the global sample, there is no single economic factor that dominates in explaining the first factor extracted from the emerging markets sample. In the beginning of the study period investor fears, German bond yields, US bond yields and short-term European interest rates (reflective of monetary policy changes in AEs) are the main contributors. Towards the end of the period, the stock market returns of developed and emerging markets come to the fore – see Panel 2 of Figure 3. The rolling correlations with the exchange rates reveal interesting results. During the start of the global financial

crisis, end 2007 and the best part of 2008, exchange rates practically lost all influence on emerging bond yields. The euro has an impact only during the Euro-debt crisis of 2009 – 2010. The emerging market currencies are more important drivers towards the end of the sample.

The impact of the global financial crisis as well as the subsequent Euro-zone crisis is evident from Figure 3. The US 10-year bond yield is a much more important driver of the global factors during the crisis periods, as are equity returns (both developed and emerging) and the VIX. In the same way, equity returns are increasingly important in explaining emerging common factors during and after the global financial crisis. The oil price, as a probable indicator of global economic activity, and short-term interest rates in the Euro-zone (probably due to the Euro crisis) prove to be influential in driving emerging bond yields towards the later stage of the sample period.

The analysis of time-varying correlation indicates that, except for the first global factor, which seems to be driven by the 10-year bond yield in AEs, the contribution of other variables changes over time, depending on factors such as the business cycle and financial crises. Against this backdrop, it is essential to assess the integration of EMEs bond markets into the global bond markets.

4.4 Integration of emerging bond markets

We first consider the analysis based on full sample and then we examine the possibility of variation in the integration overtime. We use the variance share of common component (VS), which determines the portion of variation in bond yields of EMEs explained by global factors, as a measure of integration. A value closer to one implies strong integration, whereas a value closer to zero indicates no integration. Table 3 reports on the results when the standardised change in the weekly bid yield of the 10-year government bonds of the 13 emerging markets is explained in a regression by the three common factors extracted from two of the three country groupings. We exclude the developed group in this analysis for two reasons. Firstly, the main focus of the paper is to analyse the integration of EMEs bond yields in the global bond yield market. Secondly, the factors extracted from the developed group are highly correlated with factors extracted from the entire sample. This implies that advanced economies are the main drivers of global bond markets, and the inclusion of the developed factors will be a mere replication of the analysis on global factors.

Table 3 ranks the VSs for the individual countries, from a sample of the global sample comprising 38 countries. Poland depicts a VS of 52.7% and Russia only 2.04%. Of the 13 emerging market countries the Polish bond market is the most integrated with the global bond markets and the Russian bond market the least integrated. The VSs of Hungary,

South Africa, Mexico and the Czech Republic are 43%, 42%, and 39%, respectively. Except for Poland, idiosyncratic factors are responsible for a larger variation in emerging market bond yields than global factors. Thus, EMEs' bond markets are less integrated into the global bond market.

The above analysis, however, is silent on the degree of integration among EMEs' bond markets. Considering the three common factors from the sub-group of emerging markets, Poland and Hungary are again in the top two positions, with 64.38 and 54.96% of the variation in bond yields explained by common emerging market factors. The Russian sovereign bond market is the least integrated of all 38 countries – even in terms of the emerging market common factors. Mexico, Czech Republic and South Africa are the countries with the smallest difference in VS from the two samples. This may indicate that there is not too much of a difference between the impact of global forces and emerging market forces on these three local bond markets.

The diversity within the emerging markets group becomes clear from Table 3 – and is further evident from regressions on the global common factors and regional comparisons in Table 4. The bond yields for each country are regressed on the three factors from the global sample and reported in Table 4. Since bond yields entered the analysis in standardised format, the actual size of the estimated coefficients can be compared. As a region, emerging Europe, with the exclusion of the Russian Federation, is the most integrated with global bond markets. Europe is followed by Latin America, and Asia is the least integrated region.

In general, Factor 1 displays small and statistically insignificant coefficients. Except for Taiwan, this common factor is not the main driver of emerging market bonds. Based on the discussion on the identification of economic factors driving the common factors, it seems that the global bond market is not the main determinant of dynamics in emerging market bond yields.

The second global factor is most important in explaining yield variation in Europe (excluding Russia) and South Africa, and least important for Asian countries. This again underlines the regional differences in the emerging market group. This second global factor was identified to be affected by a combination of global economic forces, in particular stock market returns in developed and emerging markets. South African and European bonds are thus regarded as an alternative investment option, particularly during periods of decreasing returns in equity markets.

Given the evidence of the time-varying nature of relationships based on rolling correlations, we expect to observe similar patterns in the integration process. It means that there might be instances where EMEs are more integrated with the global market, and other circumstances where they decouple from the global market. Figure 4 displays the

estimated VSs of 24-week rolling regressions for all 13 emerging market countries with the standardised change in bond yields as dependent variable and the three common factors from the global sample as explanatory variables. No general trend in emerging market integration is observable from Figure 4. As observed in the full-sample analysis, the European countries of Czech Republic, Hungary and Poland display the highest levels of integration with global markets. Czech integration has lowered significantly in 2009 and recovered since. Russian integration started at a very low level and has increased since 2010, but is still one of the least integrated markets. Colombia is the only country that ended the sample period at a lower level of integration from where it started. China and India reached their highest levels of integration in 2010 and 2009 respectively and have both dropped since then. Malaysia, Thailand and South Africa showed clear upward trends in integration during the last part of the sample period. These results are in line with the findings based on time-varying correlations.

5 Conclusion

Given that it uses a sample of 38 countries from the developed as well as emerging markets, this is one of the most comprehensive studies dealing with bond market integration. The results confirm that for the period April 2003 – October 2012 three common factors drive global nominal yields on 10-year government bonds, thus confirming the applicability of the APT to explaining changes in long-term bond yields. There is however a significant difference in the factors driving global bond markets and those driving emerging ones. This is evident from the low correlations between extracted factors as well as the economic factors driving these factors. Global markets are mostly driven by long-term interest rates in Germany, while emerging markets are influenced by rates in the US. Regardless of the sample, stock market returns affect bond yields.

Valuable insights are gained from analysis in rolling periods, rolling regressions as well as rolling correlations. The varying nature of integration, as well as the changing economic variables driving common factors, is exploited. Examples include the varying importance of long-term interest rates in Germany and the US, and periods where different factors momentarily emerge as important drivers – for instance, short-term European interest rates, international oil prices, investor fears and certain exchange rates during and after the global financial crisis.

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Table 1: Correlations Between Factors

	Factor 1	Factor 2	Factor 3
Global-Developed	0.994***	-0.675***	0.276***
Global-Emerging	0.522***	0.306***	0.270***
Developed-Emerging	0.435***	-0.126***	0.026

Note *, **, ***, indicate significant at 10%, 5%, and 1%, respectively

Table 2: Correlation Factor 1 and Economic Variables

	Global	Developed	Emerging
Oil Price	0.258***	0.261***	0.040
US10year	0.813***	0.818***	0.350***
UK10year	0.788***	0.803***	0.286***
Ger10year	0.827***	0.841***	0.298***
USequity	0.347***	0.381***	-0.184***
UKequity	0.327***	0.361***	-0.194***
Gerequity	0.426***	0.457***	-0.117***
DVequity	0.350***	0.386***	-0.214***
EMequity	0.312***	0.349***	-0.266***
EM3month	0.088*	0.076*	0.162***
EUR3month	0.151***	0.138***	0.160***
UK3month	0.119***	0.100**	0.189***
US3month	0.087*	0.085*	0.065
VIX	-0.184***	-0.207***	0.108**
USD/EUR	0.062	0.089**	-0.248***
USD/JPY	-0.392***	-0.394***	-0.167***
USD/PLN	0.130***	0.168***	-0.342***
USD/MXN	0.203***	0.237***	-0.276***
USD/ZAR	0.150***	0.184***	-0.304***

Note *, **, ***, indicate significant at 10%, 5%, and 1%, respectively

Table 3: Comparing variance share across two samples

Global			Emerging		
Country	Variance Share	Ranking	**Country**	Variance Share	Ranking
Poland	0.527	1	Poland	0.6438	1
Hungary	0.4264	2	Hungary	0.5496	2
South Africa	0.4208	3	Thailand	0.4936	3
Mexico	0.4006	4	Taiwan	0.493	4
Czech Republic	0.3864	5	South Africa	0.4774	5
Taiwan	0.2845	6	Malaysia	0.4741	6
Thailand	0.2835	7	Mexico	0.4396	7
Malaysia	0.2733	8	Czech Republic	0.4286	8
Philippines	0.1922	9	China	0.4174	9
Colombia	0.1268	10	India	0.3989	10
India	0.1095	11	Colombia	0.3153	11
China	0.0216	12	Philippines	0.2823	12
Russian Federation	0.0204	13	Russian Federation	0.0989	13

Table 4: Regressing yields on global factors

	Factor 1	Factor 2	Factor 3	Variance Share
Europe				
Czech Republic	0.137***	0.228***	0.022	0.386
Hungary	0.016*	0.381***	0.104***	0.426
Poland	0.087***	0.357***	0.185***	0.527
Russian Federation	-0.017	0.073***	-0.029	0.020
Latin America				
Colombia	0.042***	0.129***	0.160***	0.127
Mexico	0.060***	0.234***	0.299***	0.401
Asia				
China	0.013	0.039	0.082***	0.022
India	0.069***	0.017	0.143***	0.109
Malaysia	0.081***	0.135***	0.246***	0.273
Philippines	0.009	0.163***	0.227***	0.192
Taiwan	0.143***	0.048**	0.077***	0.285
Thailand	0.111***	0.140***	0.177***	0.283
Africa/ Middle East				
South Africa	0.076***	0.284***	0.233***	0.421

Note *, **, ***, indicate significant at 10%, 5%, and 1%, respectively

Figure 1: Portfolio flows to Emerging Markets

Source of data: Institute of International Finance, Inc[10]

[10]Capital inflows to 30 countries (CAPINFLOW30) and capital inflow to the 10 largest countries (CAPINFLOW10) take scale on the left-hand-side axis. The components of the 10 largest countries (debt inflow (DEBTIN10), equity inflow (EQUITYIN10), FDI inflow (FDIIN10)) take scale on the right-hand-side axis.

Fiure 2: Three Factors extracted from Three Groups

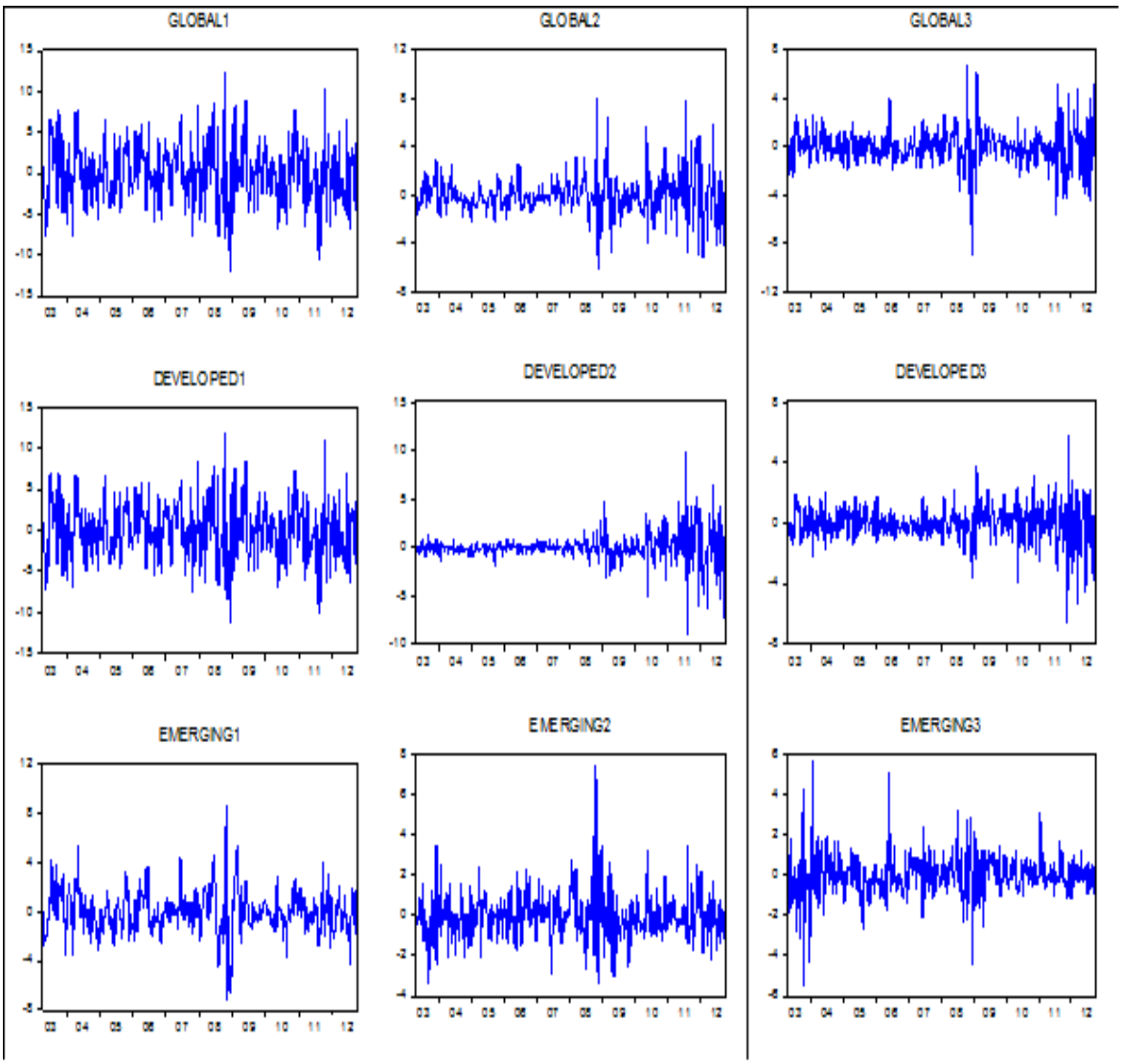

Figure 3: Rolling Correlations between Common Factors and Economic Variables

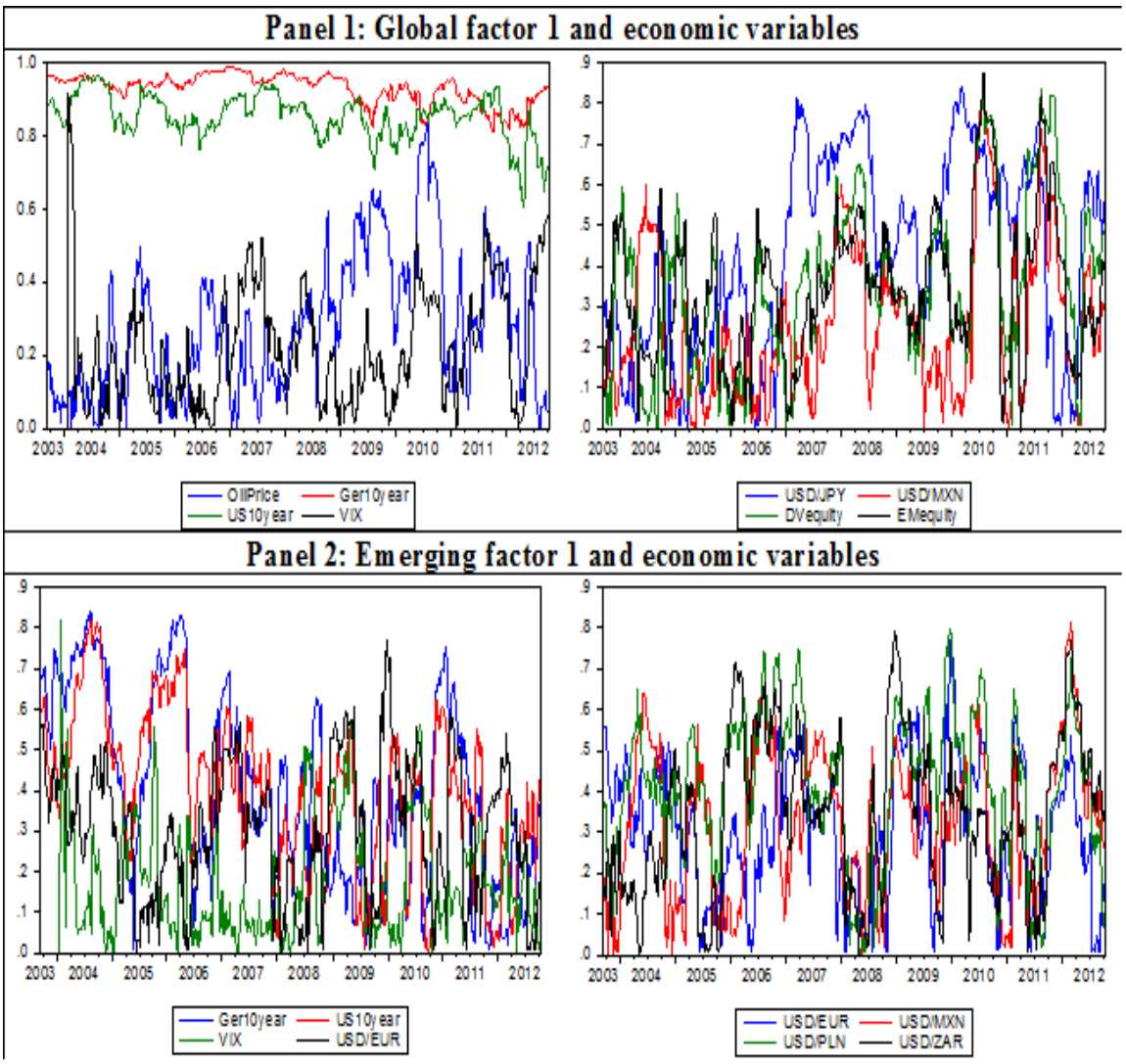

Figure 4: Variance Shares from 24-week Rolling Regressions