Essays on Emerging Market and Frontier Market Bonds

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Declaration

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I declare that the three papers included are co-authored with my PhD supervisors, Prof Kate Phylaktis and Prof Stephen Thomas. The research questions, data accumulation, analysis and exercise were completed by me alone, while my supervisors guided and edited this thesis.

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The first chapter of this thesis was presented as a research paper at the 2018 Infiniti conference in Poznan and has been published on SSRN[1], where it has been downloaded 111 times.

[1] https://www.ssrn.com/index.cfm

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Abstract

This thesis presents three research papers in the field of emerging market (EM) finance and provides an analysis of frontier market (FM) bond markets, covering both local currency bonds and sovereign Eurobonds. Using empirical analysis, these papers identify the factors that impact such bonds' prices/yields and whether an increase in liquid EM credit default swap (CDS) contracts can be a lead indicator for sovereign FM Eurobond yields.

The first paper investigates the impact of local and global macroeconomic factors on Eurobonds and local currency bonds issued in sub-Saharan Africa (SSA) at different points on the yield curve. The study used a unique proprietary dataset. The results show that a country's local monetary policy interest rate and its trade balance impact both local currency bond yields and Eurobonds; global risk aversion, as proxied by the Volatility Index, impacts only the Eurobonds, especially those issued by commodity-importing countries; and the explanatory power of most of our models is high.

The second paper analyses whether FM bonds are more affected by the International Monetary Fund's (IMF's) macroeconomic forecast changes than the more financially developed EM bond markets, given that there are greater challenges in terms of the availability and quality of macroeconomic data. The study utilised a daily bond return dataset, applying unbalanced panel regression within the context of an event study methodology. The IMF's macro forecast changes were found to have no significant effect on the FM sample, implying that the level of financial development of the individual country does not impact the results. This suggests that IMF forecast changes may well be embedded prior to the database release.

The final paper investigates whether benchmark EM sovereign CDS prices have a leading effect on FM sovereign Eurobond yields, using SSA Eurobonds as the sample FM and the following EM CDS: Brazil, China, Itraxx Asia (excluding Japan's CDS index), South Africa and Russia. By applying the Baba, Engel, Kraft and Kroner model, our analysis demonstrates that the volatility spillover from the relatively more liquid EM CDS price changes exerts a leading effect on FM Eurobond yields. In 39.1% of the cases, and when augmenting the pair model from a 2x2 to a 7x7 model to capture the potential spillover effect from a higher number of variables, we find that the signs and multiplier remain the same. In the sample, South Africa's and Turkey's CDS prices are the most consistent leading indicators for SSA Eurobond yields.

Abbreviations

Abbreviations of variables used in Chapter 1

Abbreviations of dependent variables and their equivalent abbreviation with the applied 1 quarter lag	**Dependent and independent variables**
mtb_3 / mtb_3lag	3-month T-bill
mtb_6 / mtb_6lag	6-month T-bill
mtb_12 / mtb_12lag	12-month T-bill
b_3 / b_3lag	3-year bond
b_5 / b_5lag	5-year bond
euro1 / euro1lag	Eurobond 1
euro2 / euro2lag	Eurobond 2
euro3 / euro3lag	Eurobond 3
mpr	Monetary policy rate
cpi	Consumer price index
qgdp	Quarterly real GDP
indpr	Industrial production
bot	Balance of trade
vix	Volatility Index
ust	10-year US Treasury yield

Abbreviations used in Chapter 2

AbnormRT	Abnormal return of Eurobond yield versus equivalent credit rating in the sample
yld	Change in yield
IMFspr_fall	Change in IMF macroeconomic composite for spring to autumn period for 1 forecast
IMFspr_spr	Change in IMF macroeconomic composite for spring to spring period for 1 forecast
IMFfall_fall	Change in IMF macroeconomic composite for autumn to autumn period for 1 forecast
AverageYLD	Average yield change for all frontier market bonds
FinDevelopDumy	Dummy variable where control countries' score is 0 and the FM score is 1
FinDevelopRank	Actual IMF financial development ranking
NexgemYLD	Change in yield for NEXGEM Index
UST	10-year US Treasury yield change
EMBI	Change in JPM EMBI index yield

Chapter 1. Introduction

1.1 Motivation for this Study and the Research Questions

The questions and subsequent studies addressed in this thesis originated from an investment professional's perspective. The author has been an emerging market (EM) and frontier market (FM) fixed income fund manager for more than 18 years. During that time, many market and macroeconomic observations were made that needed detailed analysis and an academic framework. For a fixed income or bond investor, it is important to understand how yield curves are impacted by macroeconomic announcements. EMs and FMs have been growing in importance. They have enjoyed phenomenal growth in not only sovereign Eurobond issuances but also their contribution to the global gross domestic product (GDP). EM countries, including FMs, witnessed their contribution to the world's GDP in purchasing power parity rise from 20.8% in 2000 to 38.8% in 2016 and 58.88% in 2023. In today's context, the EM forms part of many investment portfolios and benchmark global bond indices. Burger et al. (2012) identified a growing trend of foreign investors participating in EM domestic bond markets. Furthermore, the wider EM investment universe is far from homogenous, and from a practitioner's perspective, the FM is a sub-investment class that is separate from the financially more developed EM category. FM countries have their own dynamics in terms of bid/offer spreads, information availability and data availability, to name a few.

The FM subsegment of the EM universe tends to be the most under-researched, although compared to their EM peers, FM countries benefitted from disproportionally large portfolio flows between 2000 and 2014 relative to their GDP. FM countries saw a 0.6% increase in GDP, whereas EM countries experienced no change (Abidi et al., 2019). FM countries, as demonstrated by Svirydzenka (2016), scored lower on the International Monetary Fund (IMF) financial development index than, for example, Brazil, China, Russia, South Africa and Turkey. According to the IMF's 2013 country rankings on financial development, on the global level, South Africa ranked 28th, while the highest-ranking sub-Saharan Africa (SSA) country was Kenya, which ranked 115th out of the 183 countries in the sample (Svirydzenka, 2016).

One of the key challenges for FMs is that macroeconomic information is not as commoditised and easily accessible as it is for their more developed EM peers. This explains why some researchers have turned to alternative information providers to cover that gap. Senga et al. (2018) showed that macroeconomic data from the IMF have a substantial impact on SSA Eurobond yields. The researchers were able to find this by extrapolating the impact.

Considering the above, it is important for investors and policymakers to gain an understanding of how local macroeconomic information is embedded in bond yields and prices, if at all. Knowledge about the current state of an economy matters greatly, but one invests in the future, not in the past. Investors and policymakers therefore need to understand how FM bond markets react to changes in forecasts. And finally, given the wide bid/offer spreads and generally low liquidity in FM bond markets, it is important to know whether a more liquid EM is a good lead indicator for FM bond markets.

1.2 Main Research Questions

We will put each question into the relevant literature's context and explain the resulting contribution to related studies. Each research question will be developed and analysed within its own chapter. Following the information as presented, the main research questions addressed in this thesis are:

a) Chapter 2: What macroeconomic factors (MEFs) impact the yield curve in SSA?
b) Chapter 3: Do the International Monetary Fund's (IMF) macroeconomic forecast changes impact hard-currency sovereign FM Eurobond yields?
c) Chapter 4: Do 5-year EM sovereign credit default swap (CDS) price changes lead sovereign FM Eurobond yields?

To conduct the analysis on FM bond markets in this study, we focused on a subsegment of FM countries, consisting mainly, but not exclusively, of SSA countries, as they represent most designated FM countries. South Africa was therefore excluded from the FM SSA subsample, as it is a significantly more financially developed economy, as described above.

1.3 Empirical Framework Utilised in this Research

The literature concerning Chapter 2, regarding the relationship between the state of an economy and its respective term structure of interest rates, is vast, with most of the research concentrating on the US (e.g. Bekaert et al., 2010; Rudebusch and Wu, 2008; Evans and Marshall, 2007; Ang et al., 2006; Ang and Piazzesi, 2003; Fleming and Remolona, 1999; Taylor, 1993). However, this analysis draws from the strand of literature that uses various MEFs, also known as factor models, in their term structure models. These were first examined by Kozicki and Tinseley (2001), followed by Ang and Piazzesi (2003). The advantage of factor models is that they impose a no-arbitrage condition only and no other conditions on an economy in equilibrium (Ang and Piazzesi, 2003). The various studies using MEFs, such as inflation, as well as interest rates in a term structure model found that the approach improves the ability to explain low-frequency bond yield movements. Methodologically, we used a panel analysis approach similar to that applied by Jaramillo and Weber (2013), who focused on 26 EM countries but only included South Africa from the African continent. As Africa represents approximately half the FM countries in the world, FM nations were largely ignored in this study. Jaramillo and Weber (2013) found that fiscal variables impact 10-year local currency bond yields, conditional on global risk aversion. Using an unbalanced panel methodology to examine SSA bonds allowed us to analyse the behaviour of the local currency and the Eurobonds term structure of our group of African countries, which had not been covered in previous studies.

As FM sovereign bonds become more integrated into the wider EM benchmark bond indices (Abidi et al., 2019), one of the consequences is that they become more vulnerable to exogenous shocks from the global financial markets. The effects of these shocks increase due to weak policy buffers, insufficient financial resources and a lack of depth for FM own financial markets (Gündüz 2016). SSA, with the exclusion of South Africa, comprises a group of countries that are part of the FM categorisation and have not been extensively investigated, largely due to difficulty in gathering and accessing data. Nevertheless, in 2006–2016, the SSA region issued a total of 31 USD denominated sovereign Eurobonds at a total value of USD 25.6 billion, indicating that SSA should not be overlooked as an investment outlet. At the present time, most SSA Eurobond debt is included in the main EM bond indices, such as the benchmark JP Morgan Emerging Market Bond Index (JPM EMBI). In 2017, SSA Eurobonds accounted for 4.5% to the total JPM EMBI, and this increased to 6.7% in 2020[2].

That being said, FM sovereign and local market bonds still often lack the liquidity and the accessibility of quality macroeconomic data. Thus, it must be

[2] INDEX COMPOSITION (jpmorgan.com)

considered that there is a difference between the local bond market and the international Eurobond market for FM countries. In the former, many investors are local; in the latter, they are foreign and might not necessarily invest in a country's local sovereign debt markets, despite SSA offering some of the highest real interest rates in the wider EM universe. As a consequence, one expects a difference in investor behaviour and the analysis of local market data.

In the EM literature, the more traditional approach has been to analyse local currency debt markets separate from their respective countries' sovereign hard currency external debt. Our approach of analysing local currency and hard currency external debt simultaneously will allow investors to achieve a better risk and reward analysis of the bond yields, given the macroeconomic scenarios, thus encouraging investors to invest more in those markets. The lack of timely macroeconomic data is a feature of FM countries. As demonstrated by Choi and Hashimoto (2018), the better the data transparency, the more positive the impact on EM sovereign bond yields, lowering the spreads by up to 13% over the course of a year. Furthermore, local data are published with a delay, and it is well established that governments often succumb to pressures to produce budget balance forecasts that are too optimistic and that governments systematically underperform (Frankel, 2011).

One of the key factors enabling our analysis was our access to a unique macroeconomic dataset, allowing for the quarterly frequency for the period Q1 2006–Q2 2016 for our sample of African countries acting as a proxy for FM countries. Specifically, this dataset comprised the monetary policy rate, consumer price index, quarterly GDP, balance of trade and foreign exchange reserves, which were collected by Duet Asset Management. The overall analysis of the impact of macroeconomic data releases on Eurobond prices and local market bond yields followed Bekaert et al. (2010).

This study's contribution to the literature, through our use of the unique proprietary macroeconomic database, is a broadening of the understanding of the way FM bonds differ from EM bonds when macroeconomic information is released. The greater investors' and policymakers' understanding of the way MEFs impact the local yields and Eurobonds, the better various policies can be set and the more investment can flow into FM countries.

As highlighted, for FM countries, macroeconomic information is not as commoditised in terms of availability as for the more financially developed EM and developed market (DM) countries. This brings us to the next segment in this thesis. The IMF, in addition to making assistance programmes available to countries in distress, is a key data and information provider, especially in terms of macroeconomic information. As the information is regularly updated, free and easily available, it is a key source of information for EM and FM investors.

Therefore, in Chapter 3, we hypothesise that the IMF's macroeconomic announcements can have a substantial impact on FM sovereign lending markets, similar to the conclusion reached by Guzman and Heyman (2015). Previous research did not consider the effect of changes in IMF macroeconomic forecasts on FMs that do not negotiate with the IMF or have an IMF-funded programme. Even in the case of EMs, there has been minimal research on the impact of macroeconomic announcements on local capital markets (Andritzky et al., 2007). The findings of An et al. (2017) show that the World Economic Outlook (WEO) forecasts are more pessimistic than market consensus forecasts, although the analysis did not consider what the effect is on Eurobond prices in FMs. Most of the research on the effect of changes in macroeconomic forecasts or monetary policy on EM's asset classes focused on the US and its effect on EMs (Balcilar et al., 2017; Bowman et al., 2015; Hayo et al., 2012).

Our empirical analysis used an event study to isolate the influence of a forecast revision (Ederington et al., 2015; Gurkaynak and Wright, 2013) by the IMF and examine its impact on FM sovereign bond yields. To obtain our final equation for the panel regression, we first examin each of the components of the final equation used for the event study.

The aim was to calibrate the impact of changes in IMF macro forecasts on sovereign bond yields. The focus was on changes in the forecasts, as from a practitioner's point of view, the attention should be on the future state of the economy rather than on how much a previous forecast deviated from an actual state of the economy. This is especially important, as all data concerning the actual state of an economy are reported with various time delays.

The IMF's key macroeconomic forecasts are globally updated twice annually, in spring and autumn, on its WEO database. Through the application of unbalanced panel regression, this study's analysis considered the change in the forecast for the next calendar year from the IMF WEO database over a period of one year and a period of six months. Given that the IMF changes its forecasts within the WEO releases, and the magnitude of the forecast changes vary, it was important to identify whether these changes differed for different time frames, as this could alter the impact. The macroeconomic data used from the WEO were for the period 2000–2018. The macroeconomic indicators applied were the percentage of year-over-year GDP growth, denoted by (GDP); the annual percentage change in the consumer price index, represented by (CPI); and the current account balance to GDP, denoted by (CA). These three indicators were consistently available throughout the analysed period for all the countries in the subsample, as over the years, the IMF has increased the data available on the WEO.

The contribution to the existing literature by the study outlined in Chapter 3 is to gather knowledge about the impact of WEO database releases on FM Eurobond yields. This is not only relevant for academia but also for the various policy-making authorities, such as ministries of finance, and central banks.

Based on the analysis of the way macroeconomic announcements impact prices and bond yields for FM countries, using locally sourced data and forecast changes from the IMF's WEO, a natural question to ask from an investor's perspective is whether more liquid instruments could have a leading influence on FM bonds due to their faster incorporation of global events.

To answer this question, Chapter 4 of this thesis focuses on whether more liquid CDS contracts of the financially more developed EM countries have a leading effect on FM Eurobonds.

One well-documented element of CDS markets is that the contracts have a leading effect on the corporate bond market, implying that price discovery largely occurs in the CDS market rather than the market for corporate bonds (Blanco et al. 2005) due to liquidity issues. Like sovereign bonds, from a macroeconomic perspective, CDS contract prices move in response to changes in the country's economic indicators; hence, CDS contracts incorporate economic indicators (Sensoy et al., 2017).

According to Longstaff et al. (2011), one possible reason for CDS prices moving ahead of bond yields is that sovereign CDS markets are typically more liquid than the corresponding reference country's sovereign bond market, thus allowing for more specific price discovery or more accurate estimations of credit spreads and returns. This is particularly important when considering FMs, as the sovereign bond markets for FMs are typically significantly less liquid than those of the more developed EM markets (Delvaux et al. 2018).

Sovereign CDS spreads are not only driven by idiosyncratic country fundamentals but also by global factors (Bouri et al., 2017). Credit ratings are a key component of bond investment and portfolio construction. Analysts, investors and commentators use them to assess the creditworthiness of bond issuers rather than to ascertain the quality of bonds (Hull et al., 2004). In addition, as research by Norden and Weber (2009) shows, the co-movement between CDS prices and bond prices increases when the issuing company's credit rating lowers.

For our empirical study, we considered the 1-day price movement of EM sovereign 5-year CDS prices at 7:30 am GMT for Brazil, China, Russia, South Africa, Turkey and the Itraxx Asia, excluding Japan's index, as a global risk factor. We then compared those price movements with the (subsequent) 1-day yield movement of individual FM sovereign bonds, in this case represented by the SSA countries of Angola, Cameroon, Egypt, Ghana, Ivory Coast, Kenya, Nigeria and Senegal, at 8:30 am GMT[3].

As mentioned, FMs often have zero actively traded CDS or very little liquidity in their respective CDS market, thus making the nature of CDS price discovery difficult and sporadic, raising the question of whether larger EM benchmark CDS prices are correlated with FM Eurobonds. If there is a relationship between EM benchmark CDS

[3] The time difference is to account for the difference in trading hours, as CDS markets tend to be tradeable 24 hours during trading days, while SSA Eurobonds only trade during European trading times. This is represented in Figure 2.1, which shows the amalgamation of the sample sovereign Eurobond log yield returns versus the selected benchmark EM 5-year CDS log price returns. There is a clear correlation between the CDS price movements and the Eurobond yields.

prices and FM Eurobonds, are the sovereign CDS prices leading the FM Eurobond yields, as much research has shown to be the case for corporate Eurobonds (Blanco et al., 2005; Zhu, 2004)?

Given that sovereign CDS price movements have a leading effect on EM sovereign bonds, as per Ammer and Cai (2011), and that the liquidity of CDS markets is a key component of this relationship, we asked the following question: Could it be that the more liquid EM sovereign CDS prices (often referred to as benchmark EM CDS) lead the less liquid FM sovereign Eurobond yields? It has been shown that global factors affect both EM CDS prices (Longstaff et al., 2011; Blanco et al., 2005) and FM sovereign Eurobond yields and prices (Delvaux et al., 2018).

The contribution of the study outlined in Chapter 4 to the academic literature is that it fills the gap in our understanding of how the more liquid EM CDS lead the less liquid FM Eurobond yields. This is particularly important for market practitioners when constructing their investment portfolios and hedging their positions. For policymakers, this is important knowledge when considering these CDS contracts as indicators of global financial conditions.

1.4 Objectives and Contribution of the Thesis

As the EM fixed income asset class has grown, so has the FM subsegment. However, while the FM fixed income asset class has attracted large investments (Abidi et al., 2019), FMs differ from their EM peers in terms of financial development levels (Svirydzenka, 2016) and the depth and liquidity of financial markets. In addition to the challenge of data accessibility, FM countries often lack quality and timely macroeconomic data (Choi and Hashimoto, 2018). As a result, FMs have mostly remained under-researched.

Thus, the analysis in this thesis covers numerous elements that, thus far, have not been considered in detail in academic research. Given the challenges related to data accessibility and reliable issuance of macroeconomic data, it is compelling to further our understanding of those markets.

In summary, the contributions of this research to the existing literature can be broadly divided into three major categories. The main contribution is the broadening of our understanding of how the wider EM sovereign bond markets work. This is accomplished by furthering our comprehension of how FM bond markets differ through their trading, given their illiquidity and information integration into their respective yield curves due to the challenges of locally and internationally available data. In light of the growth in EM and FM bond markets, it is important to gain a better understanding of how the transmission of information differs. While academic studies covering FM countries have increased in recent years. research into FM bond markets remains at the fringes of bond market research. Given the uniqueness of our data, this research allows us to fill that gap in the existing academic literature. Furthermore, as there will eventually be more FM countries issuing Eurobonds, that market will continue to grow in importance. Thus, there is a need to further develop the literature on FM Eurobonds.

From an investor's perspective, provided by the author's background in the field, this thesis covers critical observations of FM bond markets' behaviours. At first glance, those behaviours may seem contradictory; yet, they have been accepted by investors in the field as part of the uniqueness of the FM universe. As a result, there is a need to frame a detailed understanding of the information transition mechanisms, from macroeconomic fundamentals to Eurobond prices and yields, and the impact on local currency yield curves. These findings are important, as an increase in investors' understanding of the drivers of these relatively illiquid FM bond markets will lead to an increase in fund flows into FM markets. This is significant because FM bond markets, commanding relatively higher yields, are often considered potential alpha generators when investment professionals are constructing their portfolios to beat their respective benchmark indices.

Finally, the analysis presented in this thesis will give policymakers a better understanding of the impact of the various data their respective institutions release and how such data affect the various FM governments' borrowing costs. The analysis covers not only local data that is released but also the impact from alternative data released by the IMF.

1.5 Structure of the Thesis

This thesis offers an empirical analysis of how emerging FM fixed income instruments react to various macroeconomic data releases and whether relatively more liquid financial instruments could be leading indicators for their performance. The main body of the thesis is divided into three chapters (Chapters 2, 3 and 4). Each of the chapters represents one research paper. Chapter 5 concludes the thesis; it presents the concluding remarks, based on the conclusions provided in the earlier chapters.

Chapter 2 investigates the impact of local and global MEFs on Eurobonds and local currency issued bonds in SSA, as a proxy for the wider FM, at certain points on their respective yield curves. Using a unique proprietary dataset collected from local authorities, central banks and independent international sources over the period 2001–2016, the study covers eight SSA countries as a subsample of FM countries and focuses on the following quarterly MEFs: monetary policy rates (mpr), inflation (cpi), GDP, gross foreign exchange reserves (fxres) and balance of trade (bot). The reason the analysis covers both cpi and mpr is that FM countries tend to have a significantly lower banking penetration rate than non-FM nations. As a result, they experience limited local borrowing activity by individuals or corporations, and they typically see significantly higher inflation band targeting (often 200 basis points or more around their target rate) and mpr rate movement by the central banks. The model the study employs follows the Bekaert (2010) analysis model, applying unbalanced panel regression and selecting the model of best fit through the Hausman specification test (1978).

The analysis additionally considers how certain commodity-importing countries (CIs), such as Kenya, might be affected differently than commodity-exporting countries (CEs), such as Nigeria, given that commodities can be a key USD revenue generator for CEs. The outcome demonstrates that the local mpr and the bot impact both local currency bond yields and Eurobonds; global risk aversion, as proxied by the Volatility Index (VIX), only impacts the Eurobonds and, to a greater extent, the CIs, as the model has a high explanatory power. Our main results can be summarised as follows. First, both the local treasury and bond yields, as well as the Eurobonds, are predominantly impacted by two factors – the local mpr and the bot – and the impact seems to be greatest at the short end for the local instruments and at the long end for the Eurobonds; the impact is contemporaneous for the former and stronger, with a lag, for the latter. Second, global risk aversion, proxied by the VIX, is only important for the Eurobonds, as expected, since investors in Eurobonds are mostly foreigners, and the impact increases with time. Third, when considering CEs versus CIs, the results show that for the former, the bot has a key impact on the local treasury and bond yields, while for the latter, it is the mpr, cpi and the amount of fxres that stand out as the main determinants. In the case of Eurobonds, global risk aversion impacts CIs more than CEs. This indicates that in contrast to the development indices, those indices being lower for CEs than for CIs, investors are less worried about a global risk-off scenario for cash flows in CEs, as the exports generate sufficient USD to service their foreign currency debt. Overall, the explanatory power is high for most models, confirming the results of earlier studies on the importance of MEFs. Finally, the results are robust to the exclusion of the *Communauté française d'Afrique* – French Community of Africa (CFA) – countries, Senegal and Ivory Coast, which do not have interest rate and exchange rate policies.

Chapter 3 examines whether FMs are more affected by IMF macroeconomic forecast changes than the financially more developed EMs, given the greater challenges related to the availability and quality of macroeconomic data. This study focuses on sovereign Eurobonds for FMs and covers 15 FM countries and five EM control countries for the period 2001–2018. It applies a unique daily bond return dataset. Applying an event study methodology, we analyse the data using unbalanced panel regression to explore whether there is an abnormal return generated after the IMF makes changes to forecasts in their WEO. The analysis focuses on the impact of changes in the next year's forecasts on the various countries' GDP, CPI and current account. The emphasis is on the forecast changes, not on the forecast changes in relation to the actual macroeconomic data, as the aim is to identify investors reliance on the outlook produced by the IMF as they invest in the future state of the economy'. Given that the impact of a change in MEFs may differ per country, the analysis applies a custom-made index composed of all three equally weighted variables, as recommended by the Organisation for Economic Co-operation and Development's (OECD) handbook on index creation (2008). Applying an event study to identify the impact of forecast changes in the WEO on FM sovereign bond yield, this empirical analysis follows the work of Gurkaynak and Wright (2013) and Ederington et al.

(2015). For the FM sample, the findings indicate no significant effect from the IMF's macro forecast changes, implying that the level of financial development of an individual country does not impact our results. This suggests that IMF forecast changes may already be well embedded prior to the database release.

In Chapter 4, we investigate whether EM benchmark sovereign CDS prices (using Brazil, China, the Itraxx Asia [excluding Japan's CDS index], South Africa and Russia as EM CDS samples) have a leading effect on FM sovereign Eurobond yields, using sovereign Eurobonds from eight SSA countries as the sample FM. Given the established link between CDS prices and bond yields and the higher liquidity of the EM CDS contracts in the sample, it is natural to wonder if they have a leading effect on the relatively less liquid FM Eurobonds. The CDS market trades 24 hours a day, and the analysis takes the daily prices at 7:30 am GMT. For the FM Eurobonds, for which the market opens later, the yields are taken at 8:30 am GMT. Through the application of the Baba, Engel, Kraft and Kroner (BEKK) model, using daily prices from 1 January 2014 until 5 May 2020, our analysis demonstrates that the volatility spillover from the relatively more liquid EM CDS's price changes does exert a leading effect on FM Eurobond yields. In 39.1% of cases, when augmenting the pair model from a 2 x 2 to a 7 x 7 model to capture the potential spillover effect from a higher number of variables, the results show that the signs and multiplier remain the same. South Africa's and Turkey's CDS prices are the most coherent leading indicators for SSA Eurobond yields in our sample.

Chapter 2. MEFs that Impact the Yield Curve in SSA

2.1 Introduction

In recent years, EMs have increased in overall importance across all financial asset classes. The dramatic rise of EM countries is evidenced by their contribution to the global GDP rising from 20.8% in 2000 to 38.8% in 2016 and 59% in 2018[4]. In today's context, the EM forms part of many investment portfolios, from those of EM specialist investors to those of conservative benchmark institutional investors. Burger et al. (2012) identified a growing trend of foreign investors participating in EM domestic bond markets.

When considering the wider EM literature, SSA, with the exclusion of South Africa, is a subgroup of countries within the EM that are mostly referred to as FMs. The definition of an FM country can vary and often tends to refer to countries that are classified as low-income countries by the World Bank. Hence, South Africa tends to be excluded from the list of FM countries, as the World Bank does not consider it a low-income country[5]. However, SSA typically represents close to if not more than half of the countries included in the FM group. FMs have not been investigated extensively. One of the main reasons is the difficulty in gathering and accessing data. Nevertheless, in 2006–2016, the SSA region issued a total of 31 USD denominated sovereign Eurobonds, at a total value of USD 25.6 billion (Table 2.1), indicating that SSA should not be overlooked as an investment outlet. At present, the majority of SSA Eurobond debt is included in the main EM bond indices. One such index is the benchmark JPM

[4] www.imf.org World Economic Outlook database.
[5] www.worldbank.org

EMBI, where SSA Eurobonds accounted for 4.5% of the total index in 2017[6], a number that rose to 6.7% in 2020[7].

One of the reasons why SSA has grown in importance for investors is the higher yields SSA debt instruments carry for both USD denominated Eurobonds and local currency debt instruments compared with many of their EM peers. For instance, local currency treasury and bond yields in both Zambia and Ghana offer a yield of more than 20%. Among the yields on the USD denominated Eurobonds, Angola's 2025 maturing Eurobond offers a yield of over 8%, while Nigeria's 2023 maturing USD Eurobond offers a yield of just under 6%[8]. Numerous factors account for local currency debt instruments in SSA commanding higher yields than their respective USD denominated Eurobonds. These factors include high and sometimes double-digit local inflation, high local currency volatility compared with the USD, a large concentration of issuances in local currency debt at the short end of the yield curve and the shallow depth of the local market.

The SSA investible countries are more heterogeneous than many investors might appreciate. In Table 2.1, the findings from the Ibrahim Index illustrate that there is significant difference across SSA countries in terms of human and economic development, especially between the CEs, such as Angola or Nigeria, and the CIs, such as Kenya or Rwanda, the latter scoring higher across the board in all categories. CIs most likely score higher because they are less reliant on one or few key commodities' exports for core government revenue generation. Furthermore, although some SSA

6 JPM Emerging Markets Bond Index (EMBI) Monitor June 2017, excluding South Africa.

7 JPM Emerging Markets Bond Index (EMBI) Monitor July 2020, excluding South Africa.

8 See Appendix 2D for more details.

countries are the least financially developed, according to the IMF growth forecasts, the region benefits from some of the world's highest GDP growth rates (Figure 2.1).

While SSA Eurobonds remain on the fringes of the global EM Eurobond indices, it cannot be refuted that SSA Eurobonds have outperformed the benchmark JPM EMBI since 2008 (Figure 2.2). To illustrate these countries' quick evolution, we should note that, at the same time, the SSA Eurobonds have become more integrated into the wider EM debt asset class. At the end of 2007, only Gabon and Ghana had issued Eurobonds (not counting countries' Eurobonds in default or countries in the process of restructuring), while by the end of 2016, 14 nations had done so[9].

However, clear difference exists between the local bond market and the country's respective international Eurobond market. One of the key elements is the main investor base. The local market is dominated by the local investor base, while the Eurobond market is dominated by foreign investors who might not necessarily invest in the country's local sovereign debt markets, despite the fact that SSA offers some of the highest real interest rates in the wider EM universe. This could be because information is either not readily available or not accessible enough to enable investors to evaluate the risks. Hence, from an investor's perspective, one notices certain differences in behaviour between the local bond/T-bill and international bond market. This was the motivation behind analysing whether the macroeconomic determinants for both markets are the same.

The study outlined in this chapter aims to answer the following questions: What is the impact of MEFs on the yield curve of both Eurobonds and local currency issued

[9] Only a handful usually do not feature in the indices, such as the Tanzania 2020 Floating Rate Note, the Angola 2019 loan participating note and the Rwanda 2023 Eurobond, mostly due to the bond structure of issuance size. For more details, see Section 2.3.

bonds in SSA? Is the response of Eurobonds and local currency denominated bonds different, signalling investors' different perceptions of the factors that shape the yield curve of Eurobonds and bonds denominated in the local currency? Is the response of debt instruments of CEs different from that of CIs, highlighting the different issues faced by these countries in light of the high volatility of commodity prices? Do bond yields behave differently in CFA countries, which do not have the use of the exchange and monetary policy instruments?

To the best of my knowledge, this is the first study to investigate the impact of MEFs on both the local bond and treasury yields as well as Eurobonds in SSA. The outcome offers a better understanding of the underlying drivers of the SSA debt markets. The more traditional approach in the EM literature has been to analyse local currency debt markets separate from their respective countries' sovereign hard currency external debt. Thus, our analysis will allow investors to achieve a better risk and reward analysis of the bond yields, given their macroeconomic scenarios, encouraging them to invest more in those markets.

The two research projects that most closely resemble this study focused only on the Eurobond yields. Those projects were conducted by Gevorkyan and Kvangraven (2016) and Senga et al. (2018)[10]. This analysis differs from those studies in several ways. First, and of great importance, the dataset used in this study is unique. This analysis uses proprietary macroeconomic data, namely mpr, cpi, qgdp, bot and fxres, at quarterly intervals for the period Q1 2006 to Q2 2016 for a sample of African countries. The data were collected by Duet Asset Management[11]. The African

[10] The financial press has also highlighted the importance of SSA for investors (Rintoul, 2013 and Bowman, 2013).

[11] The utilisation of both cpi and mpr in the study are due to the distinct nature of the FM financial development. Due to the underbanked nature of FMs, leading to a small amount

economic database was manually collected from a combination of various local African official sources, such as individual countries' central banks and statistics offices, and the IMF, the African Development Bank and Trading Economics. The amalgamation of economic data collected by Duet Asset Management provides greater availability of economic data, which are often difficult to obtain on Africa, as data are not regularly posted or updated on easily accessible data portals. Even when data are available, time delays can play an important role in how price and yields for the various debt instruments react. This study's approach to data is in contrast to that of Gevorkyan and Kvangraven (2016), whose research was based on data from Bloomberg, which often appear with time lags and are not always available. The data collected for this study are timelier, which is important considering investors' sensitivity to MEFs. Senga et al. (2018) used an international source, namely, the IMF, and subsequently conducted monthly interpolations for key variables. The use of monthly interpolations implies that investors do not have the actual information on a monthly basis, which may impact their sensitivity to MEFs. Second, we follow Bekaert (2010) and investigate the impact of MEFs at various points on the yield curve. This was not examined in previous studies.

The existing literature on the relationship between the state of an economy and its respective term structure of interest rates is vast, with the majority of the research concentrating on the US (e.g. Bekaert et al., 2010; Rudebusch and Wu, 2008; Evans and Marshall, 2007; Ang et al., 2006; Ang and Piazzesi, 2003; Fleming and Remolona, 1999; Taylor, 1993). Those studies drew from the strand of literature that uses various

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of bank credit and other forms of lending to the population, movements in mpr do not directly affect large amounts of the population. Furthermore, central bank movements in the mpr are much bigger in FMs than in EMs or DMs, while at the same time, central banks have a significantly higher tolerance for inflationary pressures.

MEFs, also known as factor models, in term structure models. This was first examined by Kozicki and Tinseley (2001), followed by Ang and Piazzesi (2003). The advantage that factor models present is that they impose only a no-arbitrage condition and no other conditions on an economy in equilibrium (Ang and Piazzesi, 2003). The various studies using macroeconomic factors such as inflation and interest rates in a term structure model found that the approach improves the ability to explain low-frequency bond yield movements. Methodologically, we use panel analysis, similar to Jaramillo and Weber (2013), who focused on 26 EM countries but only included South Africa from the African continent. They found that fiscal variables impact 10-year local currency bond yields, conditional on global risk aversion. Using a panel methodology on SSA bonds allows an analysis of the behaviour of the local currency and Eurobonds term structure of our group of African countries, which has not been covered in previous studies. The advantage of panel data is that it allows to control for heterogeneity in the regression model by accounting for this heterogeneity as being either fixed or random.

The study excludes South Africa, as that country is substantially more financially developed than the rest of SSA. According to the 2013 IMF's country rankings based on financial development, South Africa ranked 28th, while the first country in our SSA sample to enter the rankings was Kenya, which ranked 115th (Svirydzenka, 2016).

This study's main results can be summarised as follows. First, the local treasury and bond yields and the Eurobonds are predominantly impacted by two factors, namely, the local mpr and the bot**,** and the impact seems to be *greatest* at the *short* end for local instruments and at the *long* end for the Eurobonds. The impact is contemporaneous for the former and stronger but with a lag for the latter.

Second, global risk aversion, proxied by the VIX, is only important for the Eurobonds – as expected, since investors in Eurobonds are predominantly foreigners – and the impact increases over time.

Third, when comparing CEs with CIs, the results show that for the former, the bot has a key impact on local treasury and bond yields, while for the latter, it is the mpr, the cpi and the amount of fxres that stand out as the main determinants. Where Eurobonds are concerned, global risk aversion impacts CIs significantly more than CEs. This suggests that investors – contrary to the development indices, which are lower for CEs than for CIs – have little concern about a global risk-off scenario, as the cash flows for their exports generate sufficient USD to service their foreign currency debt. Overall, the explanatory power is high for most models, confirming previous studies' results relating to the importance of MEFs. Finally, the results are robust to the exclusion of the CFA countries, Senegal and Ivory Coast, which do not have interest rate and exchange rate policies.

Our analysis allows policymakers to gain a better understanding of the impact their local monetary, economic and fiscal policies have on their local and international debt yields, which will encourage a deepening of their debt markets. Investors, on the other hand, will benefit from this study by the increase in knowledge about the impact of economic fundamentals on their investments.

The remainder of this chapter is organised as follows. Section 2.2 presents some stylised facts relevant to the analysis. Section 2.3 explains the model, while Sections 2.4 and 2.5 present the data and the empirical results, respectively. Section 2.6 summarises the conclusions.

2.2 Stylised Facts

As SSA includes some of the financially and economically least developed countries, it is important to highlight certain facts and local monetary and other policy actions to put this research in context. Specifically, this section deals with countries that have issued Eurobonds (Subsection 2.1), local government treasury and bond issuances (Subsection 2.2), the CFA Zone (Subsection 2.3) and the FX markets in SSA (Subsection 2.4).

2.2.1 Countries that Have Issued Eurobonds

The African continent counts 54 countries, 48 of which are part of the SSA region[12]. As South Africa is economically and financially substantially more developed than the other SSA countries, it was excluded from our sample. At the time this study was conducted, there were 16 countries in SSA that had successfully issued one or numerous Eurobonds. However, we could not include all of them, as not all were regular issuers of local debt instruments, which we required for our analysis. Thus, the final selection of countries in the sample was reduced to nine: Angola, Ivory Coast, Ghana, Kenya, Namibia, Nigeria, Rwanda, Senegal and Zambia[13].

Table 2.3 lists the present and on-the-run Eurobond issuances from SSA. As shown, Angola and Tanzania each issued a loan participation note (LPN), which is not a Eurobond. Nevertheless, in both cases, these bonds were regarded and traded by the financial markets similarly to any regular SSA Eurobond, and the LPN settled on a regular trade date plus two days through Euroclear or Clearstream. Angola's 2019

[12] https://data.worldbank.org/region/sub-saharan-africa

[13] Ghana is the only country in the sample that has a fourth Eurobond outstanding. However, as the fourth Eurobond was only trading for a short time prior to the end of our sample period, it was left out of the analysis.

maturing LPN was included in the sample, while Tanzania's floating LPN was excluded, as it is highly illiquid and, due to the floating component of the coupon and the continuous amortisation of its principle, does not trade similar to other SSA Eurobonds. In addition, we did not include Mozambique, as the country defaulted in January 2017, which resulted in the Eurobond prices being influenced by idiosyncratic debt restructuring negotiations.

Finally, Ivory Coast and the Republic of Congo have restructured Eurobonds (Table 2.3), and since their restructuring, these bonds trade in the same manner as other issued sovereign Eurobonds. The sample used in this study includes the Ivory Coast Eurobonds, while the Republic of Congo Eurobond was left out, as it rarely trades in the financial markets since it was restructured and is not included in the mainstream EM debt indices.

Another important aspect is that bid and offer spreads in SSA Eurobonds are wide by EM standards. The price spread can vary between 50 and 100 or even 200 basis points, and during time of market stress, it will widen even more. This movement is irrespective of maturity. Hence, yields can vary substantially for Eurobonds that have a short time left to maturity, as a 100 or 200 basis point bid and offer spread can translate to several percentage points yield difference due to the short time frame.

2.2.2 Local Government Treasury and Bond Issuances

SSA counties are not homogenous in their issuance of either treasury bills or bonds in local currency. While there are certain issuance tenors or maturities[14] that are regularly used by the local debt management office (DMO), it is not always the case that they unilaterally apply to all countries.

[14] The terms tenor and maturity are considered interchangeable in this analysis.

For example, Kenya does not regularly issue a 3-year local bond; thus, for our models, we considered the 2-year bond equivalent to the 3-year bond. Similarly, Nigeria started issuing 3-month T-bills only a few months prior to the writing of this analysis. Some of the countries experienced periods when governments or DMOs did not issue local debt instruments, such as during political elections, or issued a Eurobond or obtained a bilateral loan, implying that there was no need to borrow from their respective local markets. This resulted in interruptions in the observations (see Appendix 2D for a graphical representation of local treasury and bond yields).

As shown in Figures in Appendix 2D, in most countries, the local treasury and bond yields are higher than their respective USD denominated Eurobond yields. The following may explain the difference. First, inflation rates are high, in some countries reaching double digits; hence, a higher yield is needed to justify holding the instruments to compensate for the negative inflation impact on real returns. Second, governments are usually the main issuers of debt in a market. Local investors, who are the main investors in their own local markets, may have little confidence in their own government's institutions, leading them to expect higher returns to compensate for the possibility of default. Third, FX volatility is greater than in developed markets, and hedging costs are high. International investors need the return on their investment to be high enough to be able to absorb potential local currency depreciation compared with the USD. Fourth, there is a lack of liquidity and market depth in local currency debt instruments in SSA compared to their respective Eurobonds, and there is even a lack of FX liquidity in some countries. As a result, investors require a higher expected return to cover the underlying risks to their investments.

2.2.3 The CFA Zones

The CFA zones comprise 14 different countries in SSA, and each one of these countries is affiliated with one of two monetary unions: the West Africa Monetary Union (WAMU), which was created in 1994 and is composed of Benin, Burkina Faso, Ivory Coast, Guinea-Bissau, Mali, Niger, Senegal and Togo; and the Central African Economic and Monetary Union (CAEMC), which is composed of Cameroon, Chad, the Republic of Congo, Equatorial Guinea and Gabon. According to the IMF (2016), the CAEMC and the WAMU combined account for 14% of Africa's population and 12% of the continent's GDP. Both CFA zones have a central bank and peg their currency to the Euro (the Bank of France guaranteeing the FX convertibility). As a consequence of this pegging, the countries are less prone to high inflation than their peers. Furthermore, the unions impact monetary policy. The countries cannot issue more of their own currency, devalue their currency at will or change their monetary policy rate, as the central banks set one rate for their respective union.

2.2.4 The FX Markets in SSA

FX markets in SSA not only differ from country to country but also between CEs and CIs. SSA has numerous countries with either a pegged or a crawling peg exchange rate system, while some countries have free-floating FX regimes. Countries such as Nigeria and Angola peg their currencies to the USD, while due to former post-colonial agreements with France, the CFA zones peg their currency to the Euro. It is common practice for SSA central banks to intervene in the FX markets, either to provide liquidity in the form of selling USD when demand is high or to smooth potential spikes in FX volatility. SSA contains mainly import-dependent countries; local manufacturing is usually only a small part of the economy, and high value-added products, such as cars, mobile phones and computers, are imported. Many of the countries also need to import basic products, such as rice. The impact of FX devaluations is often felt by the entire population, more so than when central banks change their stance on monetary policy rates, as SSA is largely under-banked[15].

Central banks monitor FX movements and often provide liquidity to the market. The impact of FX devaluations is reflected in inflation rates, especially since consumer price indices are dominated by two categories: energy costs (petrol/fuel) and food costs. Hence, the central banks have gradually moved towards inflation targeting and use interest rates in conjunction with FX liquidity interventions as their main policy tools.

2.3 The Methodology

Applying the typical methodology used for developed economies, we estimated an unbalanced panel model in line with previous studies, such as a study by Jaramillo and Weber (2013), as the sample did not have an equal number of observations across the dependent and independent variables for all the countries. One of the key advantages for panel analysis is that the data usually contain more degrees of freedom and sample variability than usual cross-sectional data, hence improving the efficiency of econometric estimates (Hsiao, 2007) The panel model regressions we conducted were both fixed effects and random effects models. Due to the limited amount of available data, the analysis did not use a model to investigate the possible bidirectional causality issues.

We estimated the fixed effects regression as presented by the following equation:

[15] The World Bank data shows that for the whole of SSA, inclusive of South Africa, only 34% of the population had a bank account in 2014, while only 6% of the population had a formal form of borrowing.

$$r_{it} = \alpha_{\mathrm{i}} + \beta' x_{it} + \varepsilon_{it} \quad (1)$$

where r_{it} represents the nominal yields for local treasury bills and local bonds and the bond price for Eurobonds; x_{it} denotes the vector of explanatory variables, which include MEFs, both local and global; α_i is a time variant that is introduced to allow for heterogeneity between countries in the form of fixed effects, as SSA financial markets have country-specific peculiarities that affect their bond and treasury markets due to their low level of financial development; and ε_i represents the unobservable random errors.

The random effects equivalent is represented by:

$$r_{it} = \alpha_1 + \beta' x_{it} + \gamma z_{it} + \varepsilon_{it} \quad (2)$$

The difference between the fixed and random effects models is that the latter allows for the estimation of the coefficient γ, which is the effects from the time-invariant covariates, z_{it}.

To determine whether the random effects or the fixed effects model was the most appropriate to use for each debt instrument, Hausman's (1978) specification test was conducted to test if the unique errors ε_i are correlated with the regressors. The null hypothesis is that they are not.

We used ordinary least squares (OLS) to estimate our panel model and the mean group estimator of Pesaran and Smith (1995) to average the panel-specific coefficients estimated via OLS with robust standard errors. An additional robustness check was performed by applying Equations (1) and (2) with a lag effect on x_{it} of 1 quarter, or x_{it-1}. This allowed us to also investigate if any changes to macroeconomic and global variables require more time to impact local bond and treasury yields or Eurobond prices.

The selection of explanatory macroeconomic variables used in Equations (1) and (2) followed the existing literature on domestic bond yields used in developed countries. The most often used macroeconomic variables are economic growth and inflation (Bekaert et al., 2010; Andritzky et al., 2007; Ang et al., 2006; Ang and Piazzessi, 2003). For this study, we expanded the list to a total of five domestic macroeconomic variables: economic growth, cpi, monetary policy rates, bot and fxres. It was crucial to analyse the effects of both monetary policy interest rates and inflation, which are more disconnected for FMs than for their peers (please refer to previously provided explanations). Furthermore, this study added two global risk factors: the VIX, which is the global volatility or risk aversion measure, and the 10-year US Treasury yield. As demonstrated by numerous authors, global risk aversion is one of the underlying drivers of EM bond yields (Remolana et al., 2008; Eichengreen and Mody, 2000). Additional information about the explanatory and dependent variables is provided in Sections 2.3.1 and 2.3.2, respectively, as is their expected impact on the dependent variable.

As mentioned, macroeconomic data are not as abundant for SSA as for other EMs or for developed countries. Therefore, certain variables, such as the fiscal balance, could not be used, as they are not published systematically for many of the countries.

Regarding the independent variables, we used short-term treasury bills (T-bills) because they dominate the SSA debt markets (Christensen, 2004), as evidenced by the statistics presented in Table 2.4. The model closely followed the existing literature (Bekaert et al., 2010) and selected various points on the yield curve, and we used the average accepted yields at issuance auctions for local bonds and treasuries. We arbitrarily selected T-bills with 3-, 6- and 12-month maturities. Among the local sovereign bonds, we selected those with 3- and 5-year maturities; the longer maturities are not yet common in SSA, given that governments finance themselves predominantly at the short end of the yield curve.

The analysis presented here will extend to the SSA Eurobonds, often referred to as SSA external sovereign debt. As Eurobonds tend to be relatively more liquid in terms of trading, we selected all the current 'on-the-run' as well as 'off-the-run'[16] Eurobonds that had not matured by 31 December 2016 (Table 2.3). As the Eurobonds in the sample had different maturities, a novel methodology was applied to create subsets: Eurobond 1, denoting the *next maturing* Eurobond for a given country; Eurobond 2, being the *second to mature*; and Eurobond 3, representing the *third to mature* Eurobond for a given country. This methodology allowed for the Eurobonds presently in issue to be classified into one of three categories. We omitted Ghana's fourth Eurobond, as no other country in the sample had a fourth on-the-run Eurobond.

2.3.1 Explanatory Variables

Quarterly GDP: In the existing literature, the data used for economic growth are often quarterly real GDP (qgdp) percentage of change on a year-on-year basis. Generally, a high qgdp is perceived as a positive signal for the market; thus, it can be expected that a high qgdp will bring the yields of local currency treasuries and bonds down. However, as this study analysed the effect of the qgdp on Eurobond prices, we hypothesised that with a high qgdp, Eurobond prices will increase.

Consumer Price Index: The inflation figure is usually represented by the consumer price index (cpi) in percentage of change on a year-on-year basis. A rise in inflation rate is expected to lead to an increase in local currency treasury and bond yields as investors demand a higher return on their local debt instruments to make up

[16] The definition of 'off-the-run' is any debt instrument that is no longer the latest one to have been issued for that tenor.

for the loss in purchasing power. While an increase in cpi can be expected to cause a yield increase for local currency instruments, no immediate reaction in Eurobond prices is expected, as foreign investors react to rising inflationary pressures only when there is substantial weakening of the foreign exchange rate or over the medium term and there is a clear impact on the sovereign debt servicing capacity.

Monetary Policy Rate: The interest rate or monetary policy rate (mpr) is another key independent variable that has been used in several studies (Andritkzy et al., 2007; Morales, 2010; Nowak et al., 2011). It is measured in percentage terms at the end of the period. As the mpr is the risk-free rate in the various markets included in the sample, it was expected that a change in mpr by a monetary policy authority would have an effect on the respective local treasury and bond yields, with a rise in the mpr causing a yield increase for local currency treasuries and bonds. However, the impact on Eurobond prices was presumed to be limited, as Eurobonds are denominated in USD and therefore less sensitive to local mpr changes. Furthermore, changes in mpr often have only limited impact on the country's currency compared with the USD, given the limited depth of the foreign exchange market. In addition, due to limited leveraging/banking penetration within SSA economies, there is limited transmission to the economy, so a rise in mpr does not always foster a slowdown in the economy.

Balance of Trade: The balance of trade (bot) is defined as the difference between imports and exports of goods and services. It is denominated in USD and is divided by the country's GDP, which is also denominated in USD for the period, to generate a percentage figure and smooth out the various countries' differences in economic size. It was expected that a rise (improvement) in bot would be shown as a positive macroeconomic effect on local currency treasury and bond yields and thus reduce the yields, while the positive effect on the respective Eurobond would be expressed as an increase in price. Additionally, it was expected that the CEs would be more sensitive to a change in bot than the CIs. As fiscal data for many of these countries are not published systematically, this study used bot as an indicator of revenue for the government. This was especially useful when we compared the CEs with the CIs. For example, in 2016, the government of Nigeria received the equivalent of only 6% of the GDP from tax revenues, while oil exports accounted for 35% of the country's GDP and constituted 90% of the country's exports[17]. Therefore, bot proved to be a valid indicator of certain commodity exporters' financial revenues.

Foreign Exchange Reserves: Foreign exchange reserves (fxres) are measured in USD and are divided by the country's GDP in USD for the period to generate a percentage and smooth out the difference in the various countries' economic size. Fxres is an explanatory macroeconomic variable. It is an important factor for foreign investors when analysing a country's macroeconomic conditions. Furthermore, it is a key metric for the IMF, as the global financial crisis of 2007–2009 demonstrated[18]. Three main benefits are derived from increasing foreign exchange reserves: The reserves can be used as a macroeconomic policy instrument to stabilise the economy; they can allow for more frequent FX interventions by the central bank, if required; and the increase can send a positive signal to foreign investors when the latter consider investing in a country's external debt (Gevorkyan and Kvangraven, 2016). A rise in fxres will be regarded as a positive macroeconomic effect; thus, it will have a negative effect on local currency treasury and bond yields but a positive impact on Eurobond prices.

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[17] http://www.opec.org/opec_web/en/about_us/167.htm

[18] IMF: Assessing Reserve Adequacy, (2011) Monetary and Capital Markets, Research, and Strategy, Policy and Review Departments.

US Treasury Yields: The model followed the existing literature and used the 10-year US Treasury yield (ust) as a proxy for risk aversion, in line with numerous previous studies, such as by Jaramillo and Weber (2013). The expected effect from a rise in ust is primarily a negative impact on Eurobond prices. As the ust is largely regarded as the equivalent of a base rate for EM investments, an upward change in the ust will under normal circumstances be reflected in an upward movement in EM Eurobond yields (or a drop in Eurobond prices). However, we would expect either limited or no immediate effect on the local currency treasury and bond yields. The ust is taken as an actual percentage number at the end of the period.

VIX: We used the VIX (vix), the Chicago Board Options Exchange S&P 500 Volatility Index, as another risk aversion proxy. The VIX is regularly used as a global risk aversion proxy (Jaramillo and Weber, 2013; Özatay et al., 2009). The expectation was that an increase in vix would have a negative effect on the Eurobond prices but limited or no effect on local treasury and bond yields, as these instruments are still outside the mainstream financial markets. Vix is taken as an actual percentage number at the end of the period.

Our expectation was that global risk factors would show no effect on the local currency treasuries and currency bonds but would have an impact on the Eurobonds. CEs were expected to show a positive effect from a growing trade balance on the back of increases in commodity prices that, in turn, would lower the local treasury and bond yields and increase Eurobond prices. (For a summary of the expected effects of all explanatory variables, refer to Appendix E.)

It should be noted that variables dropped out if the data series comprising variables were not complete for a country, hence the difference in the number of observations. Consequently, there is a change in the number of observations between the models with x_{it} and x_{it-1}.

To create a country comparable study, we followed the market and academic convention with respect to using the yields for the local T-bills and bonds (local currency denominated bonds are quoted by yield). We used the average yields accepted at the official auctions; to a great degree, those yields reflect the impact of the different macroeconomic data that are released.

However, in the case of Eurobonds, the bid and offer spread can vary substantially and can impact yields (Section 2.2.1); hence, contrary to academic studies such as by Gevorkyan and Kvangraven (2016) and Senga et al. (2018), who used Eurobond yields, we followed the financial market convention and used the prices of the USD denominated sovereign Eurobonds. Aside from financial market convention, another reason to use Eurobond prices as opposed to yields is that when higher-yielding or coupon-paying fixed income instruments that trade on wider bid and offer spreads experience a widening of the bid and offer spreads close to maturity, the impact on the bonds' yield is high and disproportionate[19].

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[19] An example of the above is the following: The Ghana, 8.5% Coupon, USD denominated Eurobond, issued on 27 September 2007 and maturing on 4 October 2017, is a semi-annual paying coupon bond, repaying at 100% or full par value. With 1 year still left to maturity, a price drop from 100% to 99% and 98% results in a yield to maturity change from 8.5% to 9.57% to 10.66%, respectively. Given that bonds so near maturity often fall outside the liquidity and rules of indices, the prices can be less volatile, but the bid and offer spread can widen substantially. Hence, it is not uncommon for so close to maturity bonds to have a 1 to 2 percentage point price movement, which can result in a much higher yield impact than the price change due to the higher coupon payment and shorter duration.

2.4 Data and Research Strategy

Subsection 2.4.1.1 presents information about the local MEFs and the unique aspects of the DAM Africa Economic Database (DAM aed), Subsection 2.4.1.2 provides a breakdown of the global factors, and Subsection 2.4.2 explains the strategy used in this research.

2.4.1 Data

2.4.1.1 Local MEFs and DAM aed

In this study, we used proprietary data at quarterly frequency for the macroeconomic variables, namely mpr, cpi, qgdp, bot and fxres, for the period Q1 2006–Q2 2016. The data, provided by DAM for our sample of African countries[20], contained 1,101 observations. The African economic database was manually collected from a combination of various local African official sources, such as individual countries' central banks and statistics offices, and the IMF, the African Development Bank and Trading Economics. Detailed information about the sources of data can be found in Appendix 2C. The amalgamation of economic data collected by DAM is unique and provides a far bigger dataset than is usually available for SSA economic data, which are often difficult to obtain because data are not regularly posted or updated on easily accessible data portals. Even if the data are available, time delays can play an important role in how prices and yields of the various debt instruments react. This study's approach contrasts with the approach used by Gevorkyan and Kvangraven (2016), whose research was based on data from Bloomberg. Data provided on Bloomberg often experience time lags, and not all the relevant data are available. Data

[20] For four countries in our sample, namely Angola, Ivory Coast, Senegal and Zambia, we only had annual data. We used interpolations based on industrial production, which is published quarterly, to obtain quarterly observations of the GDP.

provided by the sources used in this study are timelier, which is important in terms of investors' sensitivity to MEFs. Senga et al. (2018) used international sources and monthly interpolations for key variables. The use of monthly interpolations implies that investors do not have the actual information on a monthly basis, impacting their sensitivity to MEFs.

Our study focused on Namibia, Ghana, Senegal, Rwanda, Ivory Coast, Angola[21], Kenya, Zambia and Nigeria, as these countries have issued both local debt and sovereign Eurobonds or USD denominated LPNs that trade as a proxy for outstanding typical Eurobond instruments. The sample period ranged from Q1 2006 to the end of Q2 2016, with only one exception for Angola, where the last local currency bond and treasury auction took place on the 6 July 2016 and was included in the sample period. The above sample period was selected on the basis of data availability. The start of the period deliberately coincides with when the majority of the countries in the sample began publishing the required data with improved regularity.

2.4.1.2 Global Factors, Treasury and Bond Yields and Eurobond Prices

The global factors, that is, the 10-year ust and vix, were collected from Bloomberg.

We decided to use the VIX rather than the move index, which is a specific index that measures bond option volatility, for two reasons. While the two indices are relatively highly correlated, the VIX has been used more extensively as a volatility index in the existing literature[22].

[21] Angola issued a 2019 maturing LPN that traded through Euroclear and thus was predominantly traded as a Eurobond, even though its structure differs from that of the classic bullet Eurobond.

[22] For the period of the analysis, the correlation between the VIX and the move index was 0.668.

The global factors and all the Eurobond prices were collected from Bloomberg, while the yields for local currency treasuries and bonds were collected via a combination of the DAM aed and Bloomberg.

2.4.2 Research Strategy

Our first model includes all the countries in the sample (Angola, Ghana, Ivory Coast, Kenya, Namibia, Nigeria, Rwanda, Senegal and Zambia). This model acted as our base model.

As mentioned, not all SSA investible countries share the same attributes in terms of economic, financial and human development indicators (please refer to the Mo Ibrahim Index, Appendix 2A). The Mo Ibrahim index clearly shows that there are significant differences across countries and especially between the CEs, such as Angola and Nigeria, and CIs, such as Kenya and Rwanda – the latter scoring higher across the board in all the categories – most likely because they are less reliant on one or several key commodity exports for revenue generation. Furthermore, compared to the CEs, the CIs' economic growth performance has been higher (Figure 2.1). These differences motivated us to divide the sample into CIs (Ivory Coast, Kenya, Namibia, Rwanda and Senegal) and CEs (Angola, Ghana. Nigeria and Zambia). It was expected that CEs would see a higher pass-through effect from positive or negative variations in the trade balance, as the exported commodities are often the main source of government revenues. Hence, it was thought that investors would be more sensitive to swings in commodity prices for CEs, for which the balance of trade would be a lead indicator.

We tested the robustness of the results by testing whether the inclusion of the two CFA countries, namely, Ivory Coast and Senegal, whose currency is tied to the Euro and who have common central bank monetary policies, impacted our results.

2.5 Empirical Results

This section first presents the preliminary results and descriptive statistics, followed by the empirical findings and their discussion and, finally, the robustness test.

2.5.1 Preliminary Results and Descriptive Statistics

The descriptive statistics are presented in Table 2.4. In terms of observations, the numbers for local debt instruments drop significantly when maturities are longer than 12 months (Section 2.2). The majority of SSA countries finance themselves through short-dated debt instruments. Looking at the Eurobonds, we see a pattern that is similar to that of the local currency debt instruments in that euro1 has more observations than both euro2 and euro3. However, this could be due to euro1 generally having been issued long before euro2 and euro3. What stands out from the local MEFs is the high and at the same time highly variable rate of inflation, which explains the higher yields in local bonds compared with Eurobonds.

As stated, the Hausman test was applied to decide whether we should use fixed effects or random effects estimation. The results can be found in Table 2.5, which shows that in the majority of the cases, fixed effects estimation is more appropriate.

Appendix 2A, Table 2A1 presents the correlation matrix. We can make the following observations. Overall, correlations are low. As expected, there is a negative correlation between mpr and cpi, at −0.317; if mpr moves up, it will increase borrowing costs and reduce aggregate demand and inflation pressures. Mpr also has a negative correlation with qgdp, which indicates that during a hiking cycle, mpr might affect a country's growth negatively because credit flows to industries and individuals become more expensive. The highest negative correlation is between cpi and fxres, at −0.399, as an increase in cpi causes a decrease in bot and a reduction in fxres.

The results of the Jarque–Bera test are shown in Appendix 2A, Table 2A2. They show that all local currency treasury and bond yields as well as euro1 and euro3 are not normally distributed, euro two being the notable exception.

As the analysis was conducted using unbalanced panel regression, we tested whether the variables have a unit root using a panel augmented Dickey–Fuller (ADF) test, as it is the most appropriate unit root test for unbalanced panel models. The results of the panel ADF test reject the null hypothesis of a unit root presence in the data for both independent and dependent variables, thus demonstrating that there is no systematic unpredictable pattern in the data (Appendix 2B)[23]. However, bearing in mind the possibility of cross-sectional dependence – especially for the Eurobonds analysis because foreign investors are expected to look at correlations across different SSA markets when they construct their portfolios – and the fact that ignoring cross-sectional dependence could lead to over-rejection of the unit root hypothesis (O'Connell, 1998), we employed the panel unit root test developed by Pesaran (2007), which allows for cross-sectional dependence in data. The outcome of the test confirmed the absence of unit root[24].

2.5.2 Empirical Results

2.5.2.1 Findings of the Base Model

We began our analysis by examining the results of our base model, which included all the sample countries. The results are presented in Table 2.6. The list of abbreviations used in our analysis is presented in Table 2.2. We first focus our attention on the local T-bills and bonds. Mpr is positive and significant across all local T-bills

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[23] The abbreviations of variables used in our analysis can be found in Appendix 2B, Table 1B.

[24] The results are not reported but can be made available by the authors upon request.

and bonds, with a high R^2 value. This positive impact is in line with our expectations. However, its impact is highest at the *short* end, with p-values for mtb_3 of 11.65 and an R^2 value of 0.68. The results are robust when allowing for a lagged effect, although the impact diminishes. For instance, for mtb_3lag, the p-value is 5.94 for an R^2 value of 0.68. The other significant MEF is bot. As expected, its impact is negative and highly significant across all monthly local T-bills, since an increase will be perceived as a positive macroeconomic effect. The greatest negative impact is on mtb_3, at −22.24. The results were found to be robust when allowing for lagged effect, but the impact diminished. There is no impact at the long end. These effects, again, are consistent with our a priori expectations. The importance of bot was to be expected, as the SSA countries in our sample are either CEs or CIs, and the trade balance highlights the health of the economy; therefore, an increase (improvement) in bot should bring treasury yields down. Yet, this relationship does not hold for the local currency bond yields. The other MEFs do not seem to have an impact on either the short or the long instruments. The global factors have no impact, except for vix on the 6-month T-bill. This is to be expected, as the main investors are locals. The R^2 value diminishes with maturity at the short end, but it is quite high for the 5-year bond, reaching 81%[25].

For the Eurobonds, the picture is somewhat different. Mpr is significant across most of the Eurobonds but negative in terms of bond prices, with the only noteworthy exception being euro3, where it is shown to be positive, with a highly significant p-value of 4.21. The negative impact is highest at the lagged medium segment of the Eurobonds, as the euro2 lag has a p-value of −11.47 for an R^2 value of 0.46. The results

[25] In view of the high R^2 value, we examined whether there are any individual effects by running our base model with OLS and comparing the results with those of the fixed effects estimation. The outcome continued to show that mpr is the primary driver behind the movement in the local bond yields. In addition, the R^2 value was even higher than in the fixed effects model, reaching 89% (the results can be made available by the authors upon request).

are robust when allowing for a lagged effect, and the impact increases, indicating that the effect takes time to impact Eurobond prices, as a hike in mpr would typically cool down an overheating economy and strengthen the country's exchange rate against the USD. These effects depend on several factors, given the limited depth of the FX market and the limited banking penetration in those countries.

A significant divergence is bot, as it does not affect local bonds but impacts Eurobonds. Its impact increases in significance and in p-value with the maturity of Eurobonds, as evidenced by the p-values of 5.67 for euro2 and 5.11 for euro3 versus 3.2 for euro1, but the lagged effect is reduced, indicating a more immediate impact. Among the other MEFs, only cpi is significant for euro3. The most important difference between the local debt instruments and Eurobonds is the significance of global factors. Vix is negative and significant, and the results are robust when allowing for a lagged effect. Its impact is greatest at the long end of the yield curve. Ust has a negative and significant impact as well, but only on the short instruments. The R^2 value increases with maturity, reaching 69% for euro3[26].

2.5.4.2 CIs Versus CEs

The results for the CIs (Ivory Coast, Kenya, Namibia, Rwanda and Senegal) are presented in Table 2.7. The results for the CEs (Angola, Ghana, Nigeria and Zambia) can be found in Table 2.8. For this part of the study, we were not able to estimate euro3 and euro3lag for the CIs or b_5 and b_5lag for the CEs because, due to the sporadic

[26] To check the robustness of our results, we estimated the Eurobond regressions using yields instead of prices. There are no differences with the results when using Eurobond prices in terms of which variables are statistically significant and the sign of the impact, but there are differences in terms of size of the coefficients (these results are not reported but can be made available by the authors upon request). However, for the reasons mentioned in Section 3.2, we believe the results using prices are more accurate.

nature of the FM universe in terms of local bond issuances, we did not have enough observations.

Looking first at the local T-bills and bonds for CEs, we note that mpr does not impact the local debt instruments at all. This is not the case for CIs, where the impact is positive and significant across all local debt instruments, with the highest impact at the short end of the local yield curve. The highest outcome is for mtb_12, showing a highly significant positive p-value of 23.67 and an R^2 value of 0.67. The results are robust when allowing for a lagged effect, but the overall effect diminishes. For instance, the p-value for mtb_12 is reduced to 4.26 and the R^2 value to 40. The impact of mpr was found to be similar to that in the base model.

As expected, bot has a significant negative effect on the local treasury yields in CEs. An increase in bot brings the local treasury yields down because it results in the government receiving more revenue from the country's commodity exports and therefore needing to borrow less in the market. This causes the local treasury and bond yields to compress. The impact is negative and significant at the short end, where mtb_3 stands out with a highly significant p-value of -4.06 and an R^2value of 0.79. When bot is lagged, the effect is decreased but still present. In CIs, the impact of bot is rather different; its impact is mostly on the euro1 and euro2 but moves from being a significant positive effect on euro1 to being a highly significant negative effect on euro2. This suggests that investors see the difference in impact between the short and medium segments of the Eurobonds. Bot has a positive effect on mtb_3 yields, but this is not confirmed under the lagged results or on the b_5 yields. The impact on the b_3 bond is negative and not confirmed when lagged. The other domestic and global MEFs do not impact the local instruments in CEs. Fxres has an impact, however, on local debt instruments in CIs. The effect is positive and significant at the short end and negative at the long end. Overall, the R^2 value increases with maturity for both groups of countries, reaching 77% for b3 in CEs and 95% for b5 in CIs.

Turning to the Eurobonds, the impact of mpr is negative and significant for euro2 – with a p-value of −2.89 and an R^2 value of 0.70 – and was confirmed to be even greater and more significant by the lagged values for CEs, with a p-value of −4.60. However, the situation is different for CIs. Similar to mpr's impact on the local debt instruments, its impact is negative and significant for all instruments and remains robust when lagged (please note that this refers to prices of bonds, not yields). Regarding the other MEFs, there is a sporadic impact for both groups of countries; however, it is not consistent across the various points of the yield curve. For example, for CEs, an increase in fxres has a significant positive effect on the nearer-to-maturity euro1 bond price, while an increase in qgdp has a positive effect on euro3 prices. Bot has a positive and significant impact on euro2 in CEs and a negative and significant impact on euro1 and euro2 in CIs. However, what is overwhelmingly clear is that the global factors, particularly vix, impact Eurobonds of both groups of countries but significantly more so in CIs, and the impact increases when lagged. Similar to for local debt instruments, R^2 values for Eurobonds are high, reaching 84% for euro3 in CEs and 91% for euro2 in CIs.

2.6 Discussion

The analysis revealed the factors that drive the yield curve in SSA, especially with regard to the local debt, which had not been examined in previous studies. The more detailed analysis of CIs and CEs brought out the differences in the factors that drive the yield curve of local debt and Eurobonds in these two groups of countries.

The main results can be summarised as follows. First, the two domestic MEFs that predominantly impact the local treasury and bond yields, as well as the Eurobonds, are mpr and bot. The impact was found to be greatest at the short end for the local instruments and at the long end for the Eurobonds; its effect is contemporaneous for the former and stronger, with a lag, for the latter. Second, global risk aversion, proxied by vix, is only important for Eurobonds – as expected, since investors in Eurobonds are predominantly foreigners – and the impact increases on the longer instruments. Third, SSA is composed of many different countries with different economic resources. When considering the CEs versus the CIs, the results show that for the former, bot has a key impact on the local treasury and bond yields, while for the latter, mpr, cpi and fxres stand out as the main determinants. Thus, our analysis of CIs and CEs showed that the results of the base model regarding the impact of mpr were driven by the CIs, while the results of the impact of bot were driven by the CEs. When it comes to Eurobonds, global risk aversion has a significantly greater impact on CIs than on CEs. This indicates that investors in the latter group are less worried about a global risk-off scenario, as their exports may generate sufficient USD to service their foreign currency debt.

These findings confirm the importance of MEFs found in previous studies on local debt instruments in DMs, such as the US, and other EMs. However, there are some differences in the types of MEFs that are important for these countries. In the US, inflation and output-related factors predominate, while in EMs, such as Brazil and Chile, it is the exchange rate and expected inflation (Matsumura and Moreira, 2011) and the monetary policy rate (Morales, 2010). In our study on SSA, mpr and bot were found to be the dominant factors. It is not surprising that there are such differences, as the economic and financial environment differs between DMs and EMs and between EMs and SSA markets, the latter being the least developed in the EM world.

For the Eurobonds, mpr and bot were found to be the most important MEFs at the long end. Their effect is strong and impacts with a lag. Global risk aversion, represented by vix, is important, more so for the CIs than for the CEs. These results regarding the importance of the global factors are in line with those of Gervorkyan and Kvangraven (2016) and Senga et al. (2018), who examined the drivers of Eurobonds and found that global factors influence those bonds. In addition, Senga et al. (2018) found that local factors such as GDP growth and inflation drive Eurobonds. However, our findings, derived by using proprietary data that are timely, emphasise the importance of other local factors, such as mpr and bot.

2.7 Robustness Test

We checked the robustness of our results by estimating the base model but excluding the CFA zone countries of Ivory Coast and Senegal, which share a common currency pegged to the Euro, together with the other union members. The CFA members have a common central bank, which dictates the monetary policy for all the members. We compared the results of all the countries in the sample with a subsample of all the countries except Ivory Coast and Senegal. This allowed us to examine whether the CFA exerted specific influence on our analysis due to the policy constraints imposed on monetary and exchange rate policies. Do these constraints give investors more confidence in government policies?

Table 2.9 presents the results when the two CFA countries were excluded. Overall, the findings confirm the results obtained using the base model (Section 2.5.1). Mpr and bot remain the dominant factors affecting both the local bond and treasury yields. Furthermore, both global factors affect the Eurobond prices but do not show a material impact on the local currency instruments. In conclusion, the inclusion of Ivory Coast and Senegal did *not* impact our results.

2.8 Discussion and Concluding Comments

This chapter looked at the impact of local and global MEFs on both Eurobonds and local currency issued bonds in SSA at different points on the yield curve over the period Q1 2006–Q2 2016. The limited existing literature on SSA focuses primarily on the Eurobond market and disregards local currency issued bonds and T-bills. Considering investors' growing interest in the FM market, this study aimed to fill this gap. It used a unique proprietary dataset provided by the DAM aed database, which is a dataset collected from local authorities, central banks and independent international sources across SSA. The analysis was conducted with the use of unbalanced panel regression to investigate the effect of local macroeconomic and global factors on SSA countries' local treasury and bond yields and Eurobond prices at different points on the yield curve.

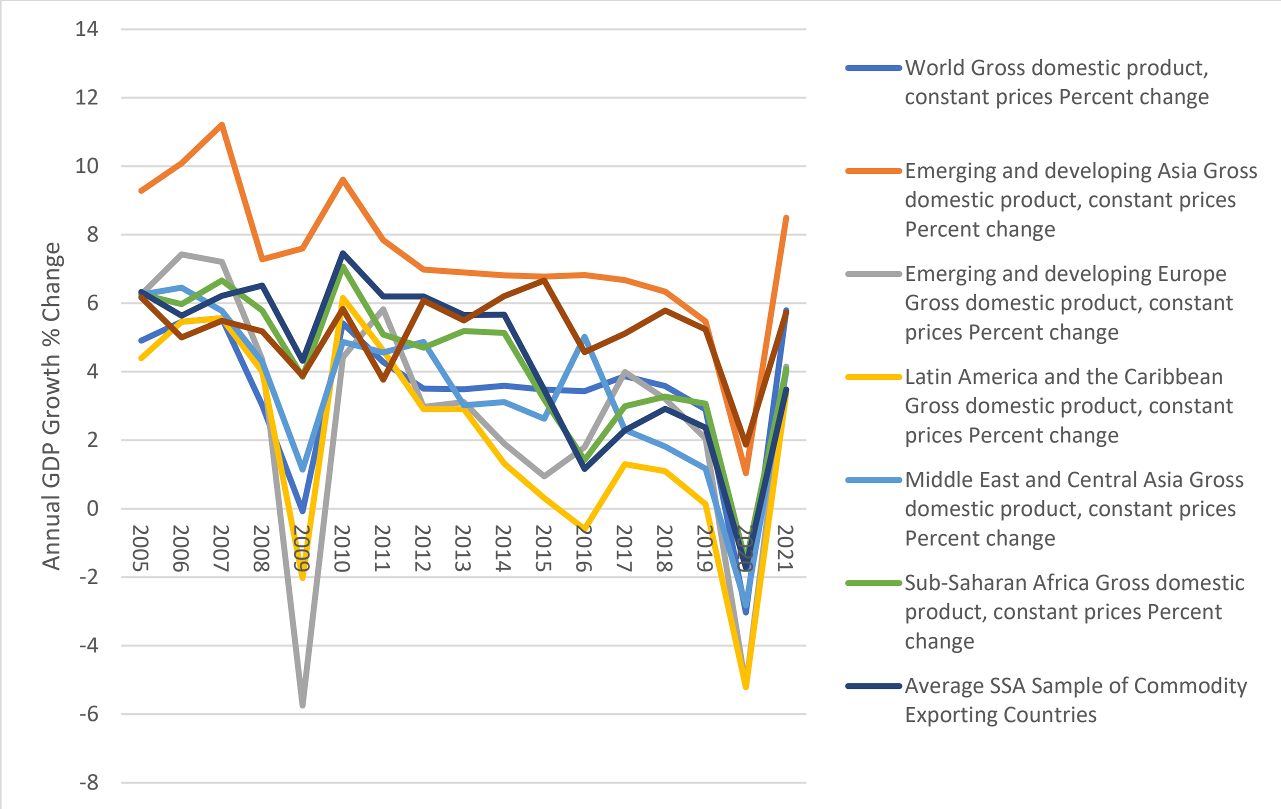
The results confirm the importance of MEFs to explain the yield curve on local debt instruments found in previous studies on domestic bonds in DMs and EMs. More precisely, the two domestic MEFs that stand out as impacting predominantly the local treasury and bond yields (as well as the Eurobonds) are mpr and bot. The impact seems to be greatest at the short end for the local instruments and at the long end for the Eurobonds. Furthermore, it is contemporaneous for the former and stronger, with a lag, for the latter. The R^2 value is high in most models, confirming previous studies' results regarding the importance of macro factors.

We found that interest rates can be used to explain low-frequency bond yield movements. This is in line with Schiller's (2015) finding that a central bank can more successfully influence the *short* end of the yield curve through mpr than the long end. Additionally, our results show that global risk aversion, proxied by vix, is only important for the Eurobonds, as expected, and the impact increases with time. This confirms the importance of global factors found in previous studies (Senga et al., 2018; Gevorkyan and Kvangraven, 2016).

When dividing the countries into CIs and CEs, the results show that for the former, bot has a key impact on the local treasury and bond yields, while for the latter, mpr, cpi and fxres stand out as exerting some impact. Furthermore, the results show global risk aversion impacts both groups, but the impact is significantly greater for CIs. This shows that the impact of MEFs differs among the SSA countries. In addition, the results indicate that the impact is different at different points on the yield curve. Finally, the results highlight the impact of domestic MEFs on the yield curve and the role that governments can play in fostering the depth and development of their debt markets through the adoption of the right policies.

It should be borne in mind that these findings are based on a short history of data, which did not allow us to explore the impact of additional macroeconomic variables, such as the exchange rate and institutional quality. Furthermore, we were unable to allow for bidirectional causality between the yields of the debt instruments and the MEFs.

Figure 2.1 IMF growth forecast for various global regions

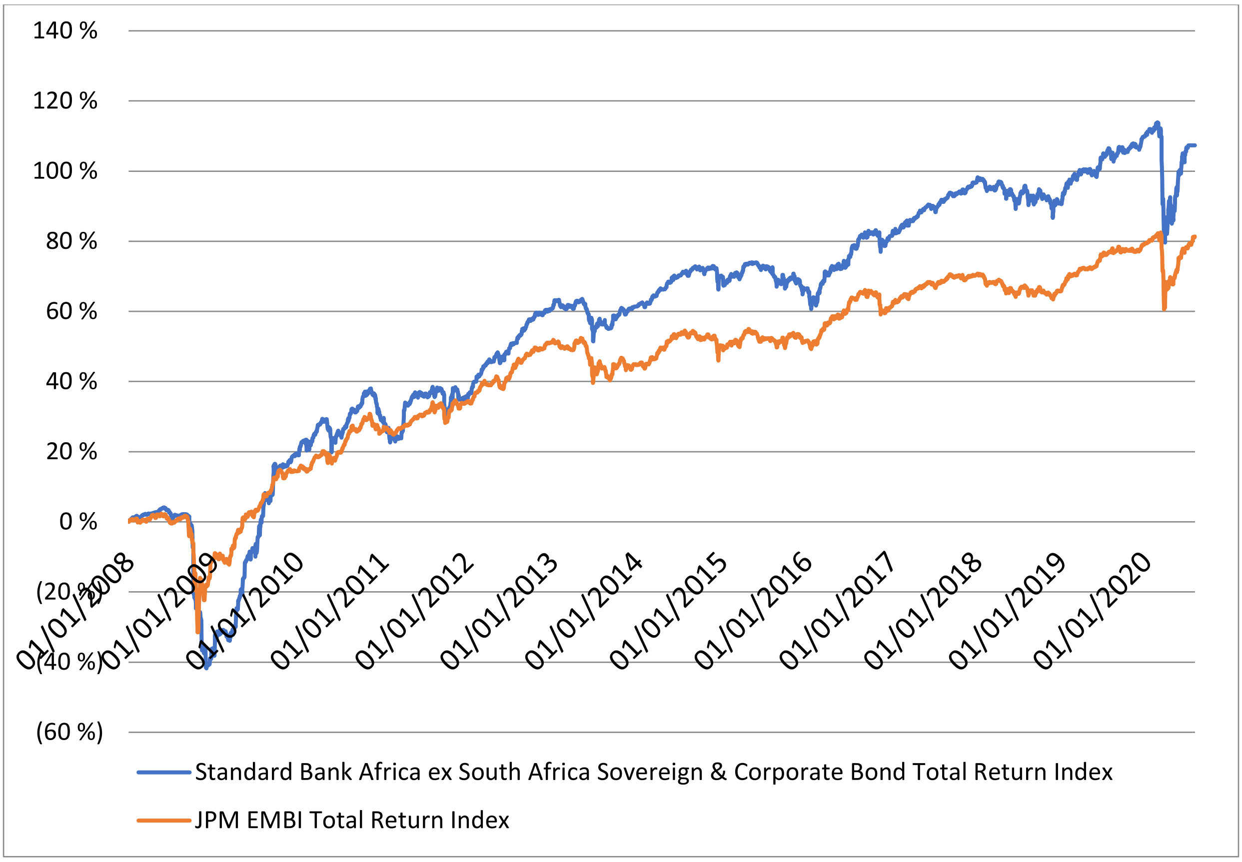


Sources: IMF WEO 2020, Bloomberg Data. As of 31/07/2020, Bloomberg Data and Duet Internal Estimation.

Note: SSA sample of commodity-exporting countries: Angola, Cameroon, Democratic Republoc of Congo, Gabon, Ghana, Nigeria, Republic of Congo and Zambia.

SSA sample of commodity-importing countries: Ivory Coast, Kenya, Namibia, Rwanda, Senegal and Uganda.

Figure 2.2 SSA Eurobond performance versus the JPM EMBI



Sources: JP Morgan, Standard Bank, Bloomberg and Duet Asset Management internal estimates.

Table 2.1 Mo Ibrahim Index

The Mo Ibrahim Index shows that on average, the CIs (Ivory Coast, Kenya, Namibia, Rwanda and Senegal) score higher across all five categories than the CEs (Angola, Ghana, Nigeria, Zambia), even if the CEs outperform the entire African continent.

Grouping of Countries	**Changes from 2006 to 2015 Score 0 to 100 (100=best)**										**2014 Export Data**		
Commodity Exporters	**Overall Governance**	**Change Over Period**	**Safety & Rule of Law**	**Change Over Period**	**Participation & Human Rights**	**Change Over Period**	**Sustainable Economic Opportunity**	**Change Over Period**	**Human Development**	**Change Over Period**	**Main Export(s)**	**Top Exports**	**Top 3 of Total Exports**
Angola	39.2	5.0	44.3	0.9	35.5	4.5	30.4	3.3	46.7	11.2	Petroleum; Crude	96%	Petroleum 96%
Ghana	63.9	−2.1	70	−2.6	73.1	0.1	48.4	−4.2	64.2	−1.6	Petroleum; Cocoa beans, raw/roasted; Gold	72%	Petroleum 32.5%
Nigeria	46.5	2.5	42.8	−6.0	53.1	6.1	39.5	5.1	50.7	5.0	Petroleum; Gas	93.70%	Petroleum 81.4%
Zambia	58.8	4.3	66.5	2.7	61.4	3.8	46.4	1.0	61.0	9.7	Copper; Tobacco	65.50%	Copper 59.7%
Average Commodity Exporters	52.1		55.1		55.8		41.7		55.6				

Commodity Importers	Overall Governance	Change Over Period	Safety & Rule of Law	Change Over Period	Participation & Human Rights	Change Over Period	Sustainable Economic Opportunity	Change Over Period	Human Development	Change Over Period	Main Export(s)	Top Exports	Top 3 of Total Exports
Ivory Coast	52.3	13.1	55.1	17.3	54.3	18.6	48.4	8.7	51.4	7.8	Cocoa beans	47.10%	Cocoa beans 33.9%
Kenya	58.9	5.1	56.3	0.8	60.6	3.6	54.8	7.8	63.8	8.0	Tea; Flowers; Petroleum and other oils	35.50%	Tea 15.9%
Rwanda	62.3	8.4	61.5	1.1	51.6	8.8	65.1	9.4	71.2	14.4	Minerals; Tin; Coffee	62.30%	Minerals 27%
Senegal	60.8	3.7	65.5	4.8	69.8	0.9	51.4	3.2	56.6	6.1	Gold; Fish; Phosphoric acids	34.40%	Gold 16.8%
Namibia	69.8	3.6	76.1	1.3	76.1	6.0	62.2	5.7	64.7	1.1	Diamonds; Zinc; Fish	48.50%	Diamonds 28%
Average Commodity Importers	60.8		62.9		62.5		56.3		61.5				
Continental African Average	50.0	1.0	52.1	−2.8	50.0	2.4	42.9	1.8	55.0	2.9			

Sources: http://mo.ibrahim.foundation/iiag/; export data from the AFDB website: http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/AEO_2016_Report_Full_English.pdf

Table 2.2 Abbreviations

Dependent and independent variables	**Abbreviation of dependent variables and their equivalent abbreviation with the applied 1 quarter lag**
3-month T-bill	mtb_3 / mtb_3lag
6-month T-bill	mtb_6 / mtb_6lag
12-month T-bill	mtb_12 / mtb_12lag
3-year bond	b_3 / b_3lag
5-year bond	b_5 / b_5lag
Eurobond 1	euro1 / euro1lag
Eurobond 2	euro2 / euro2lag
Eurobond 3	euro3 / euro3lag
Monetary policy rate	mpr
Consumer price index	cpi
Quarterly real GDP	qgdp
Industrial production	indpr
Balance of trade	bot
VIX Index	vix
10-year US Treasury yield	ust

Table 2.3 Current on-the-run Eurobond issuances from SSA countries

Country of Issue	Date of Issue	Maturity Date	Amount Issued in USD billion
Ghana	27/09/2007	04/10/2017	0.750
Gabon	05/12/2007	12/12/2017	1.00
Republic of Congo (Restructured)	07/12/2007	30/06/2029	0. 477
Seychelles	14/01/2010	01/01/2026	0.168
Ivory Coast (Restructured)	15/03/2010	31/12/2032	2.519
Nigeria	21/01/2011	28/01/2021	0.500
Senegal	06/05/2011	13/05/2021	0.500
Namibia	27/10/2011	03/11/2021	0.500
Angola (Loan Participating Note)	10/08/2012	17/08/2019	1.000
Zambia	13/09/2012	20/09/2022	0.750
Tanzania (Floating Rate Loan Participating Note)	27/02/2013	09/03/2020	0.600
Rwanda	16/04/2013	02/05/2023	0.400
Nigeria	02/07/2013	12/07/2018	0.500
Nigeria	02/07/2013	12/07/2023	0.500
Ghana	25/07/2013	07/08/2023	1.000
Gabon	04/12/2013	12/12/2024	1.500
Zambia	07/04/2014	14/04/2024	1.000
Kenya	16/06/2014	24/06/2019	0.750
Kenya	16/06/2014	24/06/2024	2.000
Ivory Coast	16/07/2014	23/07/2024	0.750
Senegal	23/07/2014	30/07/2024	0.500
Ethiopia	04/12/2014	11/12/2024	1.000
Ivory Coast	24/02/2015	03/03/2028	1.000
Gabon	09/06/2015	16/06/2025	0.500
Zambia	14/07/2015	30/07/2027	1.250
Ghana	07/10/2015	14/10/2030	1.000
Namibia	22/10/2015	29/10/2025	0.750
Angola	04/11/2015	12/11/2025	1.500
Cameroon	12/11/2015	19/11/2025	0.750
Mozambique*	09/03/2016	18/01/2023	0.726
The total amount of Eurobonds			25.663

Note: * Mozambique defaulted on this bond in 2017. Angola and Tanzania issued loan participation notes, which are traded in the financial markets in a similar way to Eurobonds.

Source: Bloomberg and Duet Asset Management internal estimates.

Table 2.4 Descriptive statistics

	Denominations (%)	Observa-tion	Mean	Standard Deviation	Min.	Max.
mtb_3	Yield	197.00	10.22	6.28	1.73	25.90
mtb_6	Yield	231.00	11.17	6.27	1.68	28.87
mtb_12	Yield	228.00	11.48	5.81	2.61	28.00
b_3	Yield	96.00	12.16	5.79	4.86	25.40
b_5	Yield	74.00	11.77	5.81	5.64	28.50
euro1	Price	152.00	101.45	9.91	56.75	121.40
euro2	Price	74.00	98.56	8.83	79.40	118.66
euro3	Price	49.00	85.70	16.70	42.62	108.23
euro4	Price	3.00	102.15	3.98	98.35	106.29
mpr	%	273.00	10.01	5.70	3.50	30.00
cpi	%	258.00	18.56	32.50	−5.04	118.10
qgdp	%	272.00	2.64	3.55	−9.87	14.40
bot	Exports–imports/GDP	217.00	0.09	0.76	−2.81	5.87
fxres	Foreign exchange reserves/GDP	305.00	0.10	0.06	0.00	0.28
vix	%	307.00	20.81	8.39	11.39	44.14
ust	%	307.00	2.68	0.84	1.36	5.13

Table 2.5 Hausman test results

Hausman test results		mtb_3	mtb_6	mtb_12	b_3	b_5	euro1	euro2	euro3
All Countries	Base Model	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects*	Fixed Effects	Fixed Effects	Random Effects
	Lags	Random Effects	Fixed Effects	Fixed Effects*	Fixed Effects	Fixed Effects*	Fixed Effects	Random Effects	Fixed Effects*
Commodity Exporting Countries	Base Model	Random Effects	Fixed Effects	Fixed Effects*	Random Effects	$	Fixed Effects	Random Effects	Random Effects
	Lags	Random Effects	Random Effects	Random Effects	Random Effects	$	Fixed Effects*	Random Effects	Fixed Effects
Commodity Importing Countries	Base Model	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Fixed Effects	Random Effects	$
	Lags	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects*	Fixed Effects	Random Effects	$
No CFA Zone	Base Model	Random Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Random Effects
	Lags	Random Effects	Fixed Effects	Fixed Effects	Random Effects	Fixed Effects	Fixed Effects	Random Effects	Fixed Effects
Interpolated QGDP	Base Model	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	$	Random Effects
	Lags	$	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	$	Random Effects

Note: $ indicates no results could be obtained due to too few observations to conduct the Hausman Test; * denotes the Hausman test was conducted sigmaless.

This table shows the outcome of the Hausman test, indicating which results were subsequently used in the analysis. For instance, for the base model with all the countries in the sample, the Hausman test results showed prob > Chi-squared ≤ 0.05 for mtb_6; thus, we used the fixed effects results. When the outcome of the Hausman test showed a prob > Chi-squared > 0.05, we used the random effects results. In the table, $ indicates that no results could be obtained due to too few observations to conduct the Hausman Test, and * denotes where the Hausman test was conducted sigmaless, meaning that both covariance matrices were based on the estimated disturbance from the consistent estimator. The decision to use the sigmaless Hausman test was based on whether both the regular Hausman test and the sigmaless Hausman test could provide the same result to determine the selection of either the fixed effects or random effects model.

Table 2.6 Results for all countries in the sample

	mtb_3	mtb_3 lag	mtb_6	mtb_6 lag	mtb_12	mtb_12 lag	b_3	b_3 lag	b_5	b_5 lag	euro1	euro1 lag	euro2	euro2 lag	euro3	euro3 lag
mpr	11.65***	5.94***	10.41***	4.19**	7.66***	3.79*	2.87*	1.55	8.10**	4.34*	−3.29*	−7.23***	−2.42	- 11.47***	4.21***	−6.17**
	(0.092)	(0.186)	(0.110)	(0.206)	(0.126)	(0.191)	(0.246)	(0.319)	(0.254)	(0.541)	(0.355)	(0.195)	(0.835)	(0.082)	(0.242)	(0.221)
cpi	4.02*	0.38	1.99	1.26	0.46	−0.24	0.90	1.16	−0.92	0.01	−1.33	−1.41	−0.03	−0.67	−2.46**	−7.95**
	(0.014)	(0.011)	(0.041)	(0.048)	(0.023)	(0.028)	(0.110)	(0.104)	(0.059)	(0.065)	(0.343)	(0.155)	(1.768)	(0.014)	(0.447)	(0.231)
qgdp	−1.19	−0.73	−0.84	−0.87	−0.58	−0.73	−0.09	−0.30	0.50	0.83	2.43	0.79	2.17	−0.11	0.63	0.04
	(0.059)	(0.092)	(0.062)	(0.064)	(0.054)	(0.048)	(0.131)	(0.184)	(0.022)	(0.072)	(0.127)	(0.260)	(0.527)	(0.925)	(1.009)	(0.820)
bot	−22.24***	−8.25***	−10.28***	−7.17***	−8.40***	−6.77***	−1.22	2.16	2.15	−0.24	3.20*	1.03	5.67**	2.55*	5.11***	−0.54
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.009)	(0.071)	(0.055)
fxres	−0.18	−0.58	−1.12	−1.81	−0.54	−1.62	−0.91	−0.97	2.54	1.34	1.68	1.77	0.20	−2.21*	−1.17	−0.01
	(0.119)	(0.269)	(0.063)	(0.141)	(0.087)	(0.114)	(0.278)	(0.365)	(0.264)	(0.454)	(0.356)	(0.873)	(1.546)	(0.573)	(0.712)	(1.704)
vix	2.02	1.38	3.33*	2.67*	0.71	0.69	1.02	0.50	0.53	0.08	−7.33***	−5.50**	−4.36**	−1.93	−9.08***	−3.50*
	(0.035)	(0.065)	(0.019)	(0.025)	(0.028)	(0.030)	(0.073)	(0.055)	(0.078)	(0.042)	(0.112)	(0.120)	(0.160)	(0.325)	(0.092)	(0.218)
ust	−0.28	−0.01	−0.03	0.05	−1.08	−0.81	−1.41	−0.17	7.75**	1.73	−1.44	−3.24*	−5.30**	−0.96	0.75	0.27
	(0.384)	(0.411)	(0.282)	(0.404)	(0.464)	(0.569)	(0.445)	(0.344)	(0.204)	(0.590)	(1.789)	(1.119)	(1.468)	(3.703)	(2.258)	(1.720)
No. obs	108	106	141	139	144	142	62	61	34	34	86	91	48	53	30	33
Hausman Results	Fixed effects	Random effects	Fixed effects	Fixed effects	Fixed effects	Fixed effects[i]	Fixed effects	Fixed effects	Fixed effects[i]	Fixed effects[i]	Fixed effects	Fixed effects	Fixed effects	Random effects	Random effects	Fixed effects[i]
R2	0.68	0.68	0.51	0.45	0.70	0.63	0.17	0.00	0.81	0.85	0.00	0.03	0.33	0.46	0.69	0.15

Note: This study used information on the sample countries (Angola, Ghana, Ivory Coast, Kenya, Namibia, Nigeria, Rwanda, Senegal and Zambia) from the Duet Asset Management Africa economic database, as well as Bloomberg prices for the Eurobonds and average accepted auction yields for the local treasuries and bond yields, for Q1 2006–Q2 2016. Please note that for Angola, the last monetary policy rate data used were from 6 days post the end of Q2 2016. Robust standard errors are in parentheses. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; [i] indicates sigmaless Hausman test result.

Table 2.7 Results for the commodity-importing countries

	mtb_3	mtb_3 lag	mtb_6	mtb_6 lag	mtb_12	mtb_12 lag	b_3	b_3 lag	b_5	b_5 lag	euro1	euro1 lag	euro2	euro2 lag	euro3	euro3 lag
mpr	21.67***	2.74**	17.13***	4.10***	23.67***	4.26***	0.38	-0.25	7.11***	11.64***	-10.32**	-9.66**	-16.19***	-15.16***	$	$
	(0.039)	(0.155)	(0.052)	(0.137)	(0.038)	(0.137)	(0.400)	(0.503)	(0.180)	(0.093)	(0.259)	(0.217)	(0.265)	(0.169)	$	$
cpi	-0.05	-2.02*	-1.05	-1.91	-4.23***	-2.38**	-2.05*	-2.70**	-2.73**	-0.45	4.09	0.64	-4.43***	-1.64	$	$
	(0.002)	(0.007)	(0.003)	(0.007)	(0.002)	(0.007)	(0.022)	(0.020)	(0.001)	(0.006)	(0.018)	(0.046)	(0.030)	(0.024)	$	$
qgdp	-0.90	-0.61	-0.59	-0.39	-0.53	-0.22	-0.62	-0.73	0.96	-0.28	-4.71*	1.41	0.20	2.09*	$	$
	(0.074)	(0.099)	(0.080)	(0.059)	(0.051)	(0.037)	(0.207)	(0.613)	(0.040)	(0.059)	(0.038)	(0.032)	(0.658)	(0.436)	$	$
bot	2.97**	-0.34	-0.51	-0.31	1.06	-0.52	-2.92**	-0.45	2.78**	-0.28	17.44**	-0.25	-11.05***	-41.8***	$	$
	(0.000)	(0.007)	(0.000)	(0.008)	(0.002)	(0.007)	(0.031)	(0.001)	(0.021)	(0.015)	(0.007)	(0.032)	(0.251)	(0.092)	$	$
fxres	0.49	-0.33	4.67***	-0.52	10.82***	-1.52	-2.05	-1.41	1.4	-2.65**	-8.53**	-0.88	0.46	6.89***	$	$
	(0.039)	(0.071)	(0.012)	(0.062)	(0.004)	(0.042)	(0.594)	(0.160)	(0.251)	(0.038)	(0.097)	(0.182)	(0.263)	(0.257)	$	$
vix	0.95	0.98	0.37	0.66	0.22	0.69	1.49	0.37	-0.33	0.55	-5.80*	-7.18*	-20.91***	-61.66***	$	$
	(0.063)	(0.089)	(0.052)	(0.083)	(0.053)	(0.065)	(0.070)	(0.083)	(0.057)	(0.030)	(0.042)	(0.026)	(0.013)	(0.009)	$	$
ust	-0.66	0.27	-1.10	0.10	-1.02	-0.17	-0.61	0.09	0.35	0.95	-3.77	-2.61	-52.25***	1.10	$	$
	(0.269)	(0.651)	(0.296)	(0.555)	(0.349)	(0.519)	(3.228)	(0.739)	(1.145)	(0.776)	(1.549)	(1.669)	(0.072)	(0.668)	$	$
No. obs	60	58	60	59	63	62	22	21	22	22	29	32	11	13		
Hausman Results	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects	Random Effects[i]	Fixed Effects	Fixed Effects	Random Effects	Random Effects		
R2	0.59	0.29	0.63	0.34	0.67	0.40	0.70	0.65	0.92	0.95	0.41	0.25	0.91	0.87		

Note: This study used information on the sample's CIs (Ivory Coast, Kenya, Namibia, Rwanda and Senegal) from the Duet Asset Management Africa economic database, as well as Bloomberg prices for the Eurobonds and average accepted auction yields for the local treasuries and bond yields, for Q1 2006–Q2 2016. Robust standard errors are in parentheses. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; [i] denotes sigmaless Hausman test result; $ indicates insufficient number of observations.

Table 2.8 Results for the commodity-exporting countries

	mtb_3	mtb_3 lag	mtb_6	mtb_6 lag	mtb_12	mtb_12 lag	b_3	b_3 lag	b_5	b_5 lag	euro1	euro1 lag	euro2	euro2 lag	euro3	euro3 lag
mpr	0.76	0.23	1.03	0.76	1.44	0.85	1.93	1.40	$	$	-0.04	-1.58	-2.89**	-4.60***	-1.30	-1.09
	(0.784)	(1.273)	(0.620)	(0.500)	(0.612)	(0.637)	(0.500)	(0.617)	$	$	(1.054)	(0.762)	(0.629)	(0.408)	(1.975)	(1.757)
cpi	0.97	0.82	1.80	1.27	0.26	0.31	-0.38	-0.05	$	$	-2.06	-1.18	0.57	0.87	0.93	-0.15
	(0.579)	(1.007)	(0.477)	(0.403)	(0.464)	(0.475)	(0.444)	(0.537)	$	$	(0.830)	(0.519)	(0.503)	(0.540)	(1.387)	(4.078)
qgdp	-0.70	-1.60	-0.16	-1.08	-0.05	-1.28	-0.92	-1.04	$	$	15.58**	-0.81	1.45	0.21	12.09***	0.95
	(0.221)	(0.088)	(0.188)	(0.279)	(0.226)	(0.284)	(0.284)	(0.257)	$	$	(0.034)	(0.305)	(0.833)	(1.487)	(0.162)	(0.805)
bot	-4.06***	-2.79	-6.80*	-5.10***	-6.57*	-4.59***	0.23	0.83	$	$	1.74	1.89	12.25***	8.25***	0.01	-1.32
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	$	$	(0.000)	(0.000)	(0.003)	(0.003)	(0.161)	(0.077)
fxres	-0.33	-0.61	0.19	-1.46	-0.84	-1.69	-0.24	-0.84	$	$	5.20*	2.36	0.17	-0.40	-0.08	2.04
	(0.119)	(0.357)	(0.122)	(0.211)	(0.070)	(0.127)	(0.400)	(0.389)	$	$	(0.082)	(0.750)	(1.287)	(2.037)	(0.427)	(0.880)
vix	-0.21	-0.21	-0.07	-1.33	0.09	-1.46	-0.27	-0.14	$	$	-5.21*	-3.29	-3.66***	-1.94	-0.59	-2.49
	(0.149)	(0.242)	(0.082)	(0.029)	(0.107)	(0.048)	(0.090)	(0.127)	$	$	(0.150)	(0.237)	(0.195)	(0.338)	(0.553)	(0.332)
ust	-1.09	-0.80	-1.21	-1.07	-0.79	-0.80	-1.29	-0.69	$	$	-0.21	-1.64	-5.78***	-2.38*	-0.14	-1.33
	(1.550)	(2.881)	(1.229)	(1.470)	(1.176)	(1.534)	(0.532)	(0.954)	$	$	(3.079)	(1.510)	(1.400)	(3.501)	(2.406)	(2.422)
No. obs	48	48	81	80	81	80	40	40			57	59	37	40	19	22
Hausman Results	Random Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects[i]	Random Effects	Random Effects	Random Effects			Fixed Effects	Fixed Effects[i]	Random Effects	Random Effects	Random Effects	Fixed Effects
R2	0.79	0.71	0.68	0.70	0.60	0.57	0.77	0.70			0.02	0.09	0.70	0.53	0.84	0.35

Note: This study used information on the sample's CEs (Angola, Ghana, Nigeria and Zambia) from the Duet Asset Management Africa economic database, as well as Bloomberg prices for the Eurobonds and average accepted auction yields for the local treasuries and bond yields, for Q3 2007–Q2 2016. Please note that for Angola, the last monetary policy rate data used were from 6 days post the end of Q2 2016. Robust standard errors are in parentheses. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; [i] denotes sigmaless Hausman test result; $ indicates insufficient number of observations.

Table 2.9 Results for all countries excluding the CFA zone

	mtb_3	mtb_3 lag	mtb_6	mtb_6 lag	mtb_12	mtb_12 lag	b_3	b_3 lag	b_5	b_5 lag	euro1	euro1 lag	euro2	euro2 lag	euro3	euro3 lag
mpr	21.67***	2.74**	17.13***	4.10***	23.67***	4.26***	0.38	−0.25	7.11***	11.64***	−10.32**	−9.66**	−16.19***	−15.16***	$	$
	(0.039)	(0.155)	(0.052)	(0.137)	(0.038)	(0.137)	(0.400)	(0.503)	(0.180)	(0.093)	(0.259)	(0.217)	(0.265)	(0.169)	$	$
cpi	−0.05	−2.02*	−1.05	−1.91	−4.23***	−2.38**	−2.05*	−2.70**	−2.73**	−0.45	4.09	0.64	−4.43***	−1.64	$	$
	(0.002)	(0.007)	(0.003)	(0.007)	(0.002)	(0.007)	(0.022)	(0.020)	(0.001)	(0.006)	(0.018)	(0.046)	(0.030)	(0.024)	$	$
qgdp	−0.90	−0.61	−0.59	−0.39	−0.53	−0.22	−0.62	−0.73	0.96	−0.28	−4.71*	1.41	0.20	2.09*	$	$
	(0.074)	(0.099)	(0.080)	(0.059)	(0.051)	(0.037)	(0.207)	(0.613)	(0.040)	(0.059)	(0.038)	(0.032)	(0.658)	(0.436)	$	$
bp	2.97**	−0.34	−0.51	−0.31	1.06	−0.52	−2.92**	−0.45	2.78**	−0.28	17.44**	−0.25	−11.05***	−41.8***	$	$
	(0.000)	(0.007)	(0.000)	(0.008)	(0.002)	(0.007)	(0.031)	(0.001)	(0.021)	(0.015)	(0.007)	(0.032)	(0.251)	(0.092)	$	$
fxres	0.49	−0.33	4.67***	−0.52	10.82***	−1.52	−2.05	−1.41	1.4	−2.65**	−8.53**	−0.88	0.46	6.89***	$	$
	(0.039)	(0.071)	(0.012)	(0.062)	(0.004)	(0.042)	(0.594)	(0.160)	(0.251)	(0.038)	(0.097)	(0.182)	(0.263)	(0.257)	$	$
vix	0.95	0.98	0.37	0.66	0.22	0.69	1.49	0.37	−0.33	0.55	−5.80*	−7.18*	−20.91***	−61.66***	$	$
	(0.063)	(0.089)	(0.052)	(0.083)	(0.053)	(0.065)	(0.070)	(0.083)	(0.057)	(0.030)	(0.042)	(0.026)	(0.013)	(0.009)	$	$
ust	−0.66	0.27	−1.10	0.10	−1.02	−0.17	−0.61	0.09	0.35	0.95	−3.77	−2.61	−52.25***	1.10	$	$
	(0.269)	(0.651)	(0.296)	(0.555)	(0.349)	(0.519)	(3.228)	(0.739)	(1.145)	(0.776)	(1.549)	(1.669)	(0.072)	(0.668)	$	$
No. obs	60	58	60	59	63	62	22	21	22	22	29	32	11	13		
Hausman Results	Random effects	Random effects	Random effects	Random effects	Random effects	Random effects	Random effects	Random effects	Random effects	Random effects[i]	Fixed effects	Fixed effects	Random effects	Random effects		
R2	0.59	0.29	0.63	0.34	0.67	0.40	0.70	0.65	0.92	0.95	0.41	0.25	0.91	0.87		

Note: This study used information on all the sample countries excluding the CFA zone (Angola, Ghana, Kenya, Namibia, Nigeria, Rwanda and Zambia) from the Duet Asset Management Africa economic database, as well as Bloomberg prices for the Eurobonds and average accepted auction yields for the local treasuries and bond yields, fort Q3 2007–Q2 2016. Please note that for Angola, the last monetary policy rate data used were from 6 days post the end of Q2 2016. Robust standard errors are in parentheses. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; [i] denotes sigmaless Hausman test result; $ indicates insufficient number of observations.

Appendix 2A. Correlation Matrix & Bera–Jarque Results

Table 2A1 Correlation matrix

	mpr	cpi	qgdp	bp	fxres	vix	ust
mpr	1						
cpi	−0.317	1					
qgdp	−0.23	−0.031	1				
bp	−0.077	0.032	0.022	1			
fxres	−0.007	−0.399	0.263	0.029	1		
vix	0.034	0.038	−0.046	0.034	0.113	1	
ust	−0.071	0.113	0.153	0.104	0.065	0.098	1

Table 2A2 Brea–Jarque test results

				Joint	
Variable	**Obs**	**Pr(Skewness)**	**Pr(Kurtosis)**	**Adj Chi2(2)**	**Prob > Chi2**
mtb_3	197	0.000	0.202	27.74	0.000
mtb_6	231	0.000	0.194	27.25	0.000
mtb_12	228	0.000	0.343	18.88	0.000
b_3	96	0.001	0.636	8.75	0.012
b_5	74	0.000	0.077	15.23	0.000
euro1	152	0.000	0.000	39.71	0.000
euro2	74	0.686	0.865	0.19	0.908
euro3	49	0.001	0.276	9.57	0.008

The test statistic outcome of Prob > Chi(2) allowed us to strongly reject the null hypothesis that the yields for the T-bills and local bonds as well as the Eurobond prices for euro1 and euro3 are normally distributed. It is only for euro2 where Prob > Chi(2) is greater than 0.05, thus implying significance at a 5% level.

Appendix 2B. Panel Unit Root Results

As the debt instruments as well as the variables are all non-zero, we included the drift option. We did not specify the trend option. We used one lag, as we did not have enough observations for a different lag structure. Choi (2001) indicated that the best trade-off between sample size and explanatory power is the inverse normal Z statistic. In the table, the result for the inverse normal Z statistic shows that we rejected the null hypothesis of a unit root presence. Unfortunately, the model did not have sufficient observations to generate a result for b_3 and b_5.

Table 2B1 Panel unit root test results

	Dependent Variables								Independent Variables							
	mtb_3	mtb_6	mtb_12	b_3	b_5	euro1	euro2	euro3	mpr	cpi	qgdp	indpr	bp	fxres	vix	ust
inverse chi2	40.467***	49.832***	51.041***	$	$	66.048***	28.243	11.913	46.917***	71.354***	110.612***	54.483***	85.962***	102.380***	103.829***	68.216***
inverse normal	-3.9786***	-4.898***	-5.044***	$	$	-5.664***	-3.196**	-1.884*	-3.920***	-5.486***	-7.994***	-5.341***	-6.861***	-7.407***	-8.114***	-5.981***
inverse log	-4.3669***	-5.180***	-5.321***	$	$	-6.046***	-3.084*	-1.801*	-4.039***	-6.777***	-10.131***	-6.168***	-8.883***	-9.467***	-9.632***	-6.291***
modified inv. Chi2	5.8108***	6.771***	7.000***	$	$	8.008***	3.315**	1.707*	4.819***	9.785***	15.435***	8.671***	13.599***	14.063***	14.304***	8.369***
Number of panels	8	8	9			9	8	4	9	8	9	6	7	9	9	9
Avg. number of periods	24.63	28.88	25.33			16.89	9.25	12.25	30.33	32.25	30.22	26.5	31	33.89	34.11	34.11

Note: *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; $ denotes insufficient number of observations.

Appendix 2C. Data Sources

The table that follows shows the data sources used in the study. The Duet Asset Management African economic database is abbreviated as DAM aed. The remaining abbreviations are as follows: mtb_3 is the 3-month Treasury bill, mtb_6 is the 6-month Treasury bill, mtb_12 is the 12-month Treasury bill, b_3 is the local currency 3-year government bond, b_5 is the local currency 5-year government bond, euro1 is the first Eurobond to mature, euro2 is the next Eurobond to mature, and euro3 is the third Eurobond to mature. During the sample period, Kenya did not issue a 3-year local currency government bond; thus, we used the 2-year local government bond instead. For the global factors, ust stands for US 10-year Treasury yield, and vix is the VIX. Mpr means the monetary policy rate, cpi means the consumer price index, qgdp stands for the quarter's GDP growth in percentage on a year-on-year basis, bot means balance of trade and fxres stands for foreign exchange reserves. The global factors, ust and vix, were sourced from Bloomberg for all the countries.

Table 2C1 Data sources

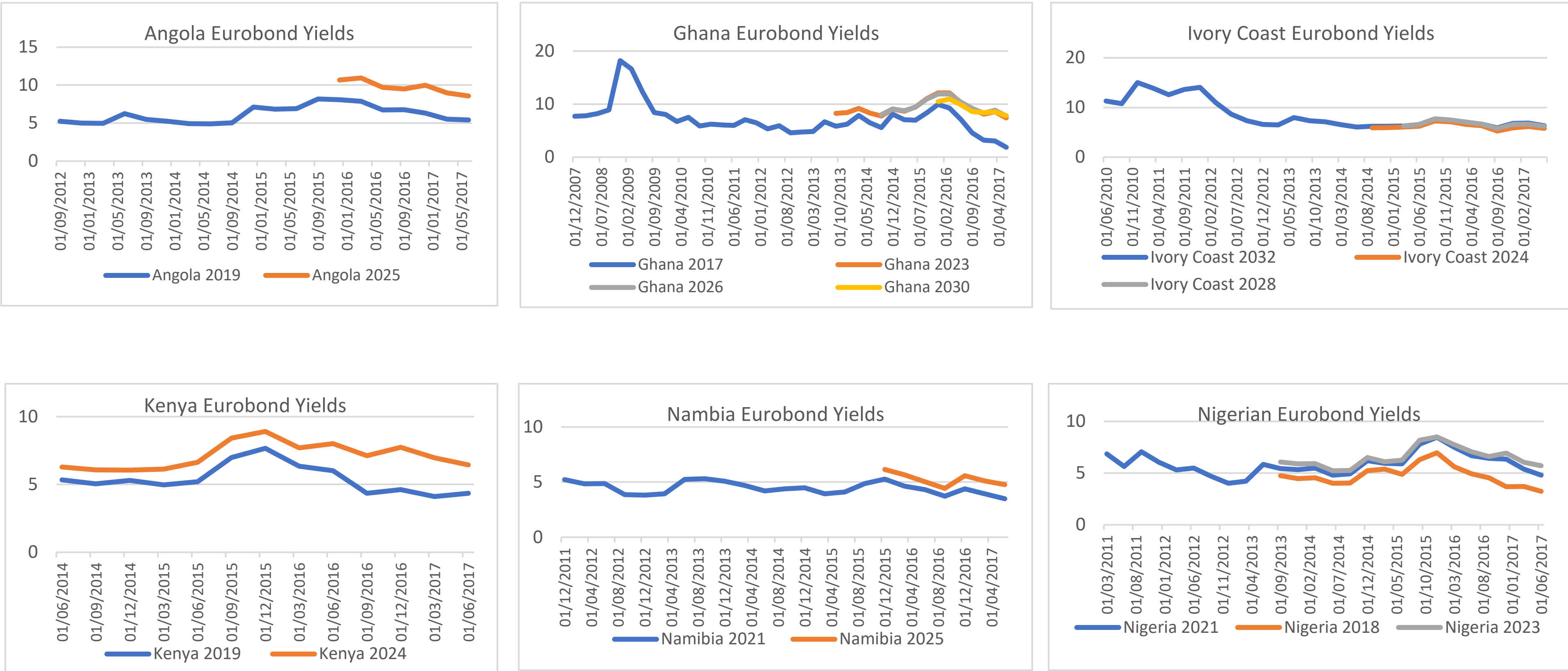
Country	Descriptor	Start Date	Gaps	Source	Country	Descriptor	Start Date	Gaps	Source	Country	Descriptor	Start Date	Gaps	Source
Angola*	mtb_3	Q3 2008	Yes	Bloomberg	Kenya	mtb_3	Q2 2006	Yes	Bloomberg	Rwanda	mtb_3	Q1 2010	Yes	DAM aed
	mtb_6	Q3 2008	Yes	Bloomberg		mtb_6	Q2 2006	Yes	Bloomberg		mtb_6	Q1 2010	Yes	DAM aed
	mtb_12	Q4 2008	Yes	Bloomberg		mtb_12	Q2 2009	Yes	Bloomberg		mtb_12	Q1 2010	Yes	DAM aed
	b_3	Q1 2015	Yes	Bloomberg		b_3	Q2 2009	Yes	Bloomberg		b_3	N/A	N/A	N/A
	b-5	Q3 2014	Yes	Bloomberg		b-5	Q2 2006	Yes	Bloomberg		b-5	N/A	N/A	N/A
	euro1	Q3 2012	No	Bloomberg		euro1	Q1 2014	No	Bloomberg		euro1	Q2 2012	No	Bloomberg
	euro2	Q4 2015	No	Bloomberg		euro2	Q1 2014	No	Bloomberg		euro2	N/A	N/A	N/A
	euro3	N/A	N/A	N/A		euro3	N/A	N/A	N/A		euro3	N/A	N/A	N/A
	mpr	Q1 2008	No	DAM aed		mpr	Q2 2006	No	DAM aed		mpr	Q1 2010	No	DAM aed
	cpi	Q1 2008	Yes	DAM aed		cpi	Q1 2010	Yes	DAM aed		cpi	Q1 2010	No	DAM aed
	qgdp	Q1 2008	Yes	DAM aed		qgdp	Q2 2009	Yes	DAM aed		qgdp	Q1 2010	No	DAM aed
	bot	N/A	N/A	DAM aed		bot	Q2 2009	No	DAM aed		bot	Q4 2010	Yes	DAM aed
	fxres	Q1 2008	Yes	DAM aed		fxres	Q2 2006	No	DAM aed		fxres	Q1 2010	No	DAM aed

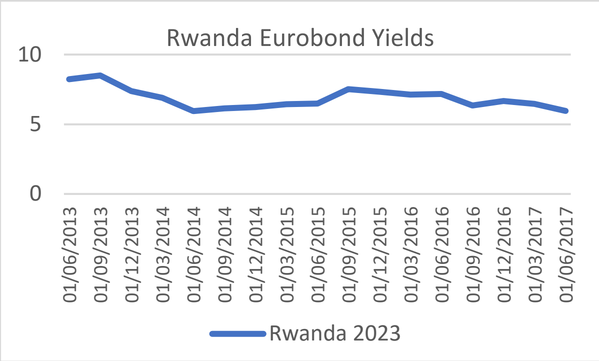
Ghana	mtb_3	Q3 2007	Yes	Bloomberg	Namibia	mtb_3	Q1 2006	Yes	Bloomberg	Senegal*	mtb_3	Q4 2015	Yes	DAM aed
	mtb_6	Q3 2007	Yes	Bloomberg		mtb_6	Q2 2006	Yes	Bloomberg		mtb_6	N/A	N/A	DAM aed
	mtb_12	Q3 2007	Yes	Bloomberg		mtb_12	Q1 2006	Yes	Bloomberg		mtb_12	Q4 2011	Yes	DAM aed
	b_3	Q3 2010	Yes	Bloomberg		b_3	Q3 2011	Yes	Bloomberg		b_3	Q1 2011	Yes	DAM aed
	b-5	N/A	N/A	N/A		b-5	Q3 2011	Yes	Bloomberg		b-5	Q3 2009	Yes	DAM aed
	euro1	Q3 2007	No	Bloomberg		euro1	Q3 2011	No	Bloomberg		euro1	Q1 2011	No	Bloomberg
	euro2	Q1 2015	No	Bloomberg		euro2	Q4 2014	No	Bloomberg		euro2	Q2 2014	No	Bloomberg
	euro3	Q3 2014	No	Bloomberg		euro3	N/A	N/A	N/A		euro3	N/A	N/A	N/A
	mpr	Q3 2007	No	DAM aed		mpr	Q1 2007	No	DAM aed		mpr	Q1 2010	No	DAM aed
	cpi	Q3 2007	Yes	DAM aed		cpi	Q1 2006	Yes	DAM aed		cpi	Q1 2009	No	DAM aed
	qgdp	Q3 2007	Yes	DAM aed		qgdp	Q1 2006	Yes	DAM aed		qgdp	Q1 2009	No	DAM aed
	bot	Q3 2007	No	DAM aed		bot	Q1 2006	No	DAM aed		bot	N/A	N/A	DAM aed
	fxres	Q3 2007	No	DAM aed		fxres	Q1 2006	No	DAM aed		fxres	Q1 2009	No	DAM aed
Ivory Coast *	mtb_3	Q2 2013	Yes	DAM aed	Nigeria	mtb_3	N/A	N/A	N/A	Zambia*	mtb_3	Q1 2009	Yes	DAM aed
	mtb_6	Q2 2012	Yes	DAM aed		mtb_6	Q3 2007	Yes	DAM aed		mtb_6	Q1 2009	No	DAM aed
	mtb_12	Q4 2011	Yes	DAM aed		mtb_12	Q3 2007	Yes	DAM aed		mtb_12	Q1 2009	No	DAM aed
	b_3	Q2 2008	Yes	DAM aed		b_3	Q3 2008	Yes	DAM aed		b_3	Q2 2009	Yes	DAM aed
	b-5	Q2 2009	Yes	DAM aed		b-5	N/A	N/A	N/A		b-5	Q2 2009	Yes	DAM aed
	euro1	Q3 2014	No	Bloomberg		euro1	Q3 2013	No	Bloomberg		euro1	Q3 2012	No	Bloomberg
	euro2	Q1 2015	No	Bloomberg		euro2	Q3 2011	No	Bloomberg		euro2	Q2 2014	No	Bloomberg
	euro3	Q2 2010	No	Bloomberg		euro3	Q3 2013	No	Bloomberg		euro3	Q3 2015	No	Bloomberg
	mpr	Q4 2010	No	DAM aed		mpr	Q4 2007	No	DAM aed		mpr	Q1 2012	No	DAM aed
	cpi	Q3 2008	No	DAM aed		cpi	Q4 2007	Yes	DAM aed		cpi	Q1 2009	Yes	DAM aed
	qgdp	Q3 2008	Yes	DAM aed		qgdp	Q4 2007	Yes	DAM aed		qgdp	Q1 2009	Yes	DAM aed
	bot	Q3 2008	Yes	DAM aed		bot	Q4 2007	No	DAM aed		bot	Q2 2009	No	DAM aed
	fxres	Q2 2008	No	DAM aed		fxres	Q4 2007	No	DAM aed		fxres	Q2 2009	No	DAM aed
Global Factors	ust	Q2 2006	No	Bloomberg										
	vix	Q2 2006	No	Bloomberg										

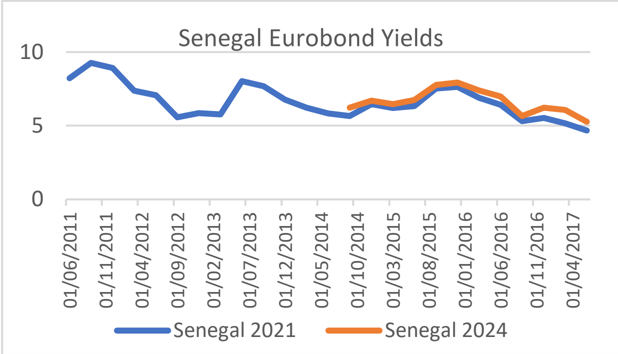
Note: * denotes the countries where the qgdp was interpolated.

Appendix 2D. Treasury & Local Bond Yields and Eurobond Prices

Figure 2D1 Eurobond yields for sample countries




Rwanda Eurobond Yields
10
5
0
01/06/2013
01/09/2013
01/12/2013
01/03/2014
01/06/2014
01/09/2014
01/12/2014
01/03/2015
01/06/2015
01/09/2015
01/12/2015
01/03/2016
01/06/2016
01/09/2016
01/12/2016
01/03/2017
01/06/2017
Rwanda 2023


Senegal Eurobond Yields
10
5
0
01/06/2011
01/11/2011
01/04/2012
01/09/2012
01/02/2013
01/07/2013
01/12/2013
01/05/2014
01/10/2014
01/03/2015
01/08/2015
01/01/2016
01/06/2016
01/11/2016
01/04/2017
Senegal 2021
Senegal 2024

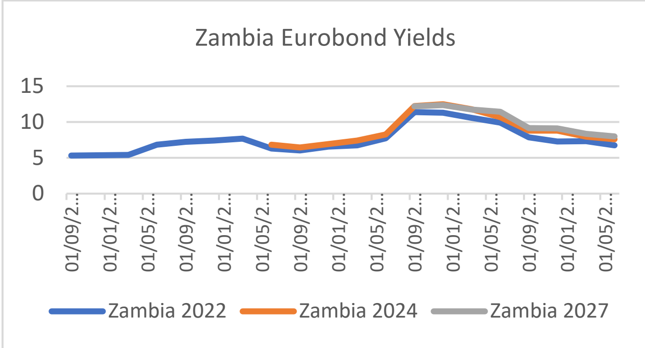
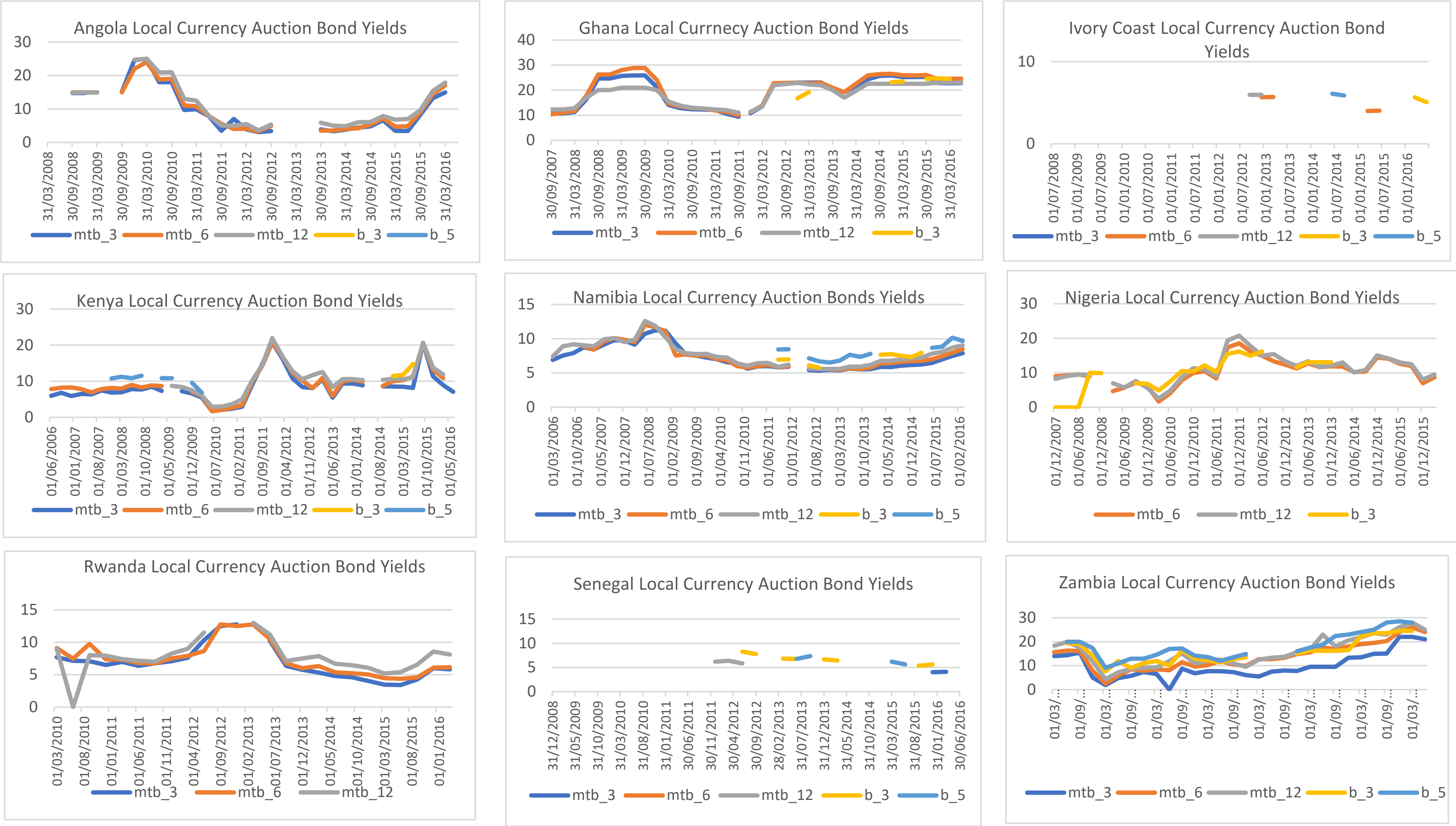

Zambia Eurobond Yields
15
10
5
0
Zambia 2022
Zambia 2024
Zambia 2027

Figure 2D2 Local currency bond and treasury yields



Appendix 2E. Expected Impacts of MEFs

Table 2E1 shows the expected results for the base model (for both CEs and CIs). The minus sign indicates a negative effect on the yields or Eurobond prices if the independent variable changes. For example, if the qgdp grows, the local currency treasury bill yields in the base model is expected to have a lower yield. The plus sign denotes an expected positive effect of the independent variable. 'No effect' indicates the expectation that the relevant independent variable has no effect on the dependent variables. The base model comprises Angola, Ghana, Kenya, Ivory Coast, Namibia, Nigeria, Rwanda Senegal and Zambia. The CEs are Angola, Ghana, Nigeria and Zambia, and the CIs are Kenya, Ivory Coast, Namibia, Rwanda and Senegal.

Table 2E1 Summary of expected results

Base Model	Independent Variable	Local Currency Treasury Bills Yields	Local Currency Bond Yields	Eurobond Prices
Macroeconomic Data	qgdp	−	−	+
	cpi	+	+	no effect
	mpr	+	+	no effect
	bp	−	−	+
	fx	−	−	+
Global Risk Measures	vix	no effect	no effect	−
	ust	no effect	no effect	−

Commodity-Exporting Countries	Independent Variable	Local Currency Treasury Bills Yields	Local Currency Bond Yields	Eurobond Prices
Macroeconomic Data	qgdp	−	−	+
	cpi	+	+	no effect
	mpr	+	+	no effect
	bp	−	−	+
	fx	−	−	+
Global Risk Measures	vix	no effect	no effect	−
	ust	no effect	no effect	−

Commodity-Importing Countries	Independent Variables	Local Currency Treasury Bills Yields	Local Currency Bond Yields	Eurobond Prices
Macroeconomic Data	qgdp	−	−	+
	cpi	+	+	no effect
	mpr	+	+	no effect
	bp	+	+	−
	fx	−	−	+
Global Risk Measures	vix	no effect	no effect	-

Chapter 3. Do IMF Macroeconomic Forecast Changes Impact FMs' Hard Currency Sovereign Bond Yields?

3.1 Introduction

This paper compares the responses of FMs to *changes* in the IMF macroeconomic forecast announcements relative to those of a control group of EMs. It offers insights into whether the announcements impact local sovereign (dollar) rates and whether the entire group of countries, both FMs and EMs, can be considered a homogeneous group. It hypothesises that the relative paucity of high quality, timely macroeconomic data on FM causes agents' increased reliance on data from agencies such as the IMF, which are generally considered more trustworthy and credible than other sources.

This chapter investigates the impact of key IMF macroeconomic forecast changes on the sovereign debt capital markets by investigating the FMs' sovereign Eurobonds' response to macro forecast announcements, using the unique proprietary set of daily bond returns. It considers that FMs are typically less financially developed than other EM countries. The FM sample consists of 15 FMs selected from the JP Morgan NEXGEM[27] index (Table 3.1), while the control group comprises financially more developed EM countries, namely Brazil, China, Indonesia, Russia, South Africa

[27] In December 2011, JP Morgan introduced the Next Generation Markets (NEXGEM) index, which was one of the first fixed income indices tracking sovereign government bonds issued by FMs (www.morganmarkets.com). The index has been back-created to December 2001 and was launched for 18 countries.

and Turkey[28]. The study covers the period 2000–2018. Given that FMs are at a lower level of financial development and data transparency than EMs, we expect them to be more sensitive to IMF forecast changes, emphasising the crucial role the IMF plays in understanding the capital markets of developing countries in a world where credible data are limited.

Over the past several years, EM debt instruments have increased in importance for investment managers, as the asset class as a whole has benefited from the so-called ‘hunt for yield’ by investors resulting from the compressed bond yield environment in the DMs. However, EM countries are not a homogenous group.

Many studies on EMs omit FM countries, yet the latter have received larger portfolio flows over the period 2000–2014 relative to their GDP than their EM counterparts, with an increase of 0.6% in GDP compared with no change for other EM countries (Abidi et al., 2019). This strongly suggests that an EM investor can no longer ignore FM flows (Delvaux et al., 2020), and as a result, FM countries have become more integrated with the wider financial markets (Abidi et al., 2019). Consequently, these countries have become more vulnerable to exogenous shocks from the global financial markets. In FM countries, the effects of these shocks have increased due to weak policy buffers, insufficient financial resources and lack of depth in their financial markets (Gündüz, 2016).

At the same time, and not surprisingly, Svirydzenka’s (2016) analysis of 183 countries over the period 1980–2013 demonstrates that the FM countries score lower on the IMF financial development index than, for example, countries such as Brazil, China, Russia, South Africa and Turkey. In our sample of 15 FM countries, the average

[28] The average financial development ranking for the FM countries in the sample is 110, while for the EM control countries it is 31 (Table 3.1).

IMF financial development ranking of 183 countries is 110 (Table 3.1), while the average ranking for our control group is 31 (note that the higher the ranking, the less financially developed the country is). For example, Senegal and Ghana are the lowest ranked FM countries in our sample at 147 and 143, respectively, and from the EM control group, Brazil and South Africa are ranked 25 and 28, respectively.

The lack of timely macroeconomic data is a feature of FM countries, and Choi and Hashimoto (2018) showed that a higher degree of data transparency can have a positive impact on sovereign EM bond yields by lowering the spreads by up to 13% over the course of a year. Furthermore, issues related to data accessibility, trust and/or costs can be analysed through a concept developed by Ahnert and Bertsch (2015) known as the 'wake-up call theory'[29]. The authors, with the use of global coordination games, predict that during normal times of calm markets, investors do not have a strong incentive to obtain expensive fundamental data; hence, market prices may not fully reflect fundamental information. Alternately, during a crisis event, investors are encouraged to acquire fundamental information and spend more time collecting the necessary data. Audzeyeva and Fuertes (2018) found evidence of the wake-up call theory holding when analysing post-Lehman default credit spreads for Brazil, Mexico, the Philippines and Turkey.

Furthermore, local data are published with a delay, and it is well established that governments often succumb to pressures to produce budget balance forecasts that are too optimistic and that they systematically underperform those forecasts (Frankel, 2011). Senga et al. (2018) showed that macroeconomic data from the IMF have a

[29] As per the definition by Ahnert and Bertsch (2015), it considers the linkage between countries and regions in the sense that a crisis in the first region serves as a wake-up call to investors in the second region. It induces them to reassess the regional fundamentals and acquire information about the macro shock that they did not have prior to the crisis event.

substantial impact on SSA Eurobond yields, while in contrast, Delvaux et al. (2018) demonstrated that local macroeconomic data have only a limited material impact on SSA Eurobond prices relative to global factors.

Hence, one would expect that the difficulties related to the quality, consistency and timely publication of the macroeconomic data for FMs and the associated wake-up call theory would intensify the surprise effect on the FMs once the data are published and accessible.

One solution to the lack of quality data for FMs is the data provided by the IMF through its reports such as Article IV for individual countries or the data on the WEO database[30]. The database is updated twice a year, usually in April and October (often referred to as the spring and autumn update, respectively). Since the IMF is the main source of data utilised by the market, one would expect the publication of the data, especially for the countries with low data quality, to have a great effect on their Eurobonds.

Thus, we hypothesise that IMF data announcements can have a substantial impact on sovereign lending markets, *even though the IMF is not actually a general analyst or indeed a creditor* (Guzman and Heyman, 2015). In addition, we question whether the FM and EM markets respond similarly and can be treated as a single entity in this context.

Previous studies did not consider the effect of changes in IMF macroeconomic forecasts on FMs that do not negotiate with the IMF or have an IMF-funded programme. Even for the EM as a whole, there has been little research on the impact of macroeconomic announcements on the local capital markets (Andritzky et al., 2007).

[30] http://www.imf.org/external/pubs/ft/weo/2018/01/weodata/index.aspx

The findings by An et al. (2017) show that WEO forecasts are more pessimistic than market consensus forecasts, although the analysis did not consider what the effect is on FMs' Eurobond prices. Most of the previous studies on the effect of changes in macroeconomic forecasts or monetary policy on EMs' asset classes focused on the US and its effect on EMs (Balcilar et al., 2017; Bowman et al., 2015; Hayo et al., 2012).

In this study, we employ an event study methodology, using a unique set of daily data over the period in which the IMF released its bi-annual WEO, that is, 2000–2018. We expect to find *little evidence* that IMF forecast revisions impact FM bond prices or yields and, perhaps of even greater macroeconomic interest, we expect that FMs *behave surprisingly similarly* to EMs, suggesting that in many ways, the two markets can be considered a *homogeneous group* for capital market modelling.

The remainder of this chapter is structured as follows. Section 3.2 describes the nature of WEO forecasts. In Section 3.3, we critically review the relevant existing literature, including that relating to IMF activities, and in Section 3.4, we present our model. Sections 3.5 and 3.6 outline the data and the research methodology, respectively, describing panel data estimation. The detailed empirical results are outlined in Section 3.7. The last two sections in this chapter, Sections 3.8 and 3.9, present the robustness tests and concluding remarks, respectively.

3.2 The WEO Database and Macro Forecasting for EMs and FMs

The WEO database encompasses specific macroeconomic variables from the statistical appendix of the WEO report.

The first model on which the WEO database was based was the multiple exchange rate model (MERM), which was developed by Paul Armington in 1969 but subsequently underwent several model adjustments. The next empirical model was developed by the IMF itself and was called the World Trade Model (WTM). It was introduced in the late 1970s to complement the MERM. The WTM was a partial-equilibrium global model designed to estimate the effects of international trade on domestic economies. In 1986, the IMF developed a scaled-down version of the Federal Reserve's Multi-Country Model. The IMF's version was called MINIMOD. It had fewer equations than the original model, and it incorporated endogenous, forward-looking, model-consistent expectations (Boughton, 1997).

The WEO data are a representation of the analyses and forecasts conducted by IMF staff. The IMF regroups the data most frequently requested by readers. The data are normally released twice a year, in April and September/October (www.imf.org). Data are available for as far back as 1980. Historical data and projections are based on the data collected directly by the IMF's country desk officers in relation to their missions. The data are updated on a continuous basis as and when information becomes available, while structural breaks in the data are adjusted using splicing or other methods to smooth out the data series (WEO, October 2018).

Changes in forecasts vary from country to country; however, it appears that overall variations in macroeconomic forecasts for FMs versus, for example, our control group of EMs, are higher for certain variables. For example, in Table 3.1, the GDP forecast change over similar periods is −0.16% for FMs versus −0.10% for EMs (column 1), while the standard deviation (column 2) is 1.05 for FMs and 0.49 for EMs. For the CPI (Table 3.2), the spring-to- autumn forecast change for the following year is 0.54% for FMs versus 0.23% for the EM control group (column 1), and the average standard deviation (column 2) is 2.45 for the FM versus only 0.60 for the EM. Finally, looking at the current account forecast changes in Table 3.3, the current accounts over the same periods witness a smaller average change for the FM than for the EM on an absolute basis (column 1), at −0.02% and 0.04%, respectively; however, the average standard deviation is higher for the FM than for the EM, at 2.73 and 0.95 respectively (column 2)[31]. These changes in forecasts clearly demonstrate that *for the FM, the corrections are greater in magnitude than for the EM.*

This leads us to believe that the IMF is 'better' at forecasting macroeconomic trends for the financially more developed countries than for the FMs, at least in the sense that half-yearly revisions are certainly smaller for the former. Of course, that in itself does not shed light on any differences in sovereign bonds' responses to shocks in FM versus EM countries.

3.3 Literature Review

Our analysis relates broadly to two strands of existing literature. The first strand concentrates on the effect of macroeconomic data and forecasts, specifically on sovereign yield curves, whereas the second strand relates to the impact of news, economic data releases by the IMF and individual countries' programme negotiations when facing financial stress.

Economic forecasts are a core input component of all the decisions made for the future and as such determine the accuracy, credibility and reliability of macroeconomic and microeconomic decisions (Sinclair et al., 2012). The traditional approach to validating forecasts is to calculate the error component relative to each variable (Sinclair et al., 2012).

[31] Similar information for individual countries can be made available by the authors upon request.

There is a large amount of available literature on the impact of forecasts and their effects on investment decisions and on economic effects and potential policy decisions that need to be taken. However, these works mainly focus on the US and other advanced economies. Studies on EMs are limited. Andritzky et al. (2007) considered 12 EM countries over the period 1998−2004 and applied a generalised autoregressive conditionally heteroscedastic (GARCH) model to determine the impact of GDP announcements, industrial production, consumer price, trade balance, fiscal balance, local interest rates and country ratings on their respective bond spreads. The authors found that most *domestic* macroeconomic announcements do not appear to have a direct influence on sovereign spreads, although the announcements were found to have a significant negative effect on volatility. On the other hand, US interest rate changes and credit rating actions do have an effect on spreads and volatility. However, of the 12 countries in their sample, only Venezuela could be deemed to be an FM. The lack of available research for the less-developed EM countries, such as the FMs, is due to the difficulties in obtaining data (Delvaux et al., 2018).

In contrast, there has been more research on the IMF as an institution and on its policies. Since its establishment, the IMF as an institution has been criticised regarding its structure and lending practices (Evrensel, 2002). As described by Brealey and Kaplanis (2004), the IMF has two commonly stated roles within the realm of resolving countries' financial crises. First, it acts as lender of last resort. Second, it advises and encourages policy reforms in countries affected by financial crises. Typically, the criticism regards the IMF pertains to the effectiveness of the IMF programmes (Evrensel, 2002) and the moral hazard induced by those programmes (Hayo and Kuta, 2005).

By examining 291 IMF programmes that were approved over the period 1993–2009, Atoyan and Conway (2010) demonstrated that the accuracy of IMF macroeconomic forecasts over the following years diverged from the actual macroeconomic data later generated by the country. The main reasons for the discrepancies are mismeasurement of initial data and conditions, failure to consider country-specific differences when forming programmes and, to a lesser extent, failure to reflect the dynamic time-series process of the actual data; policy forecast errors; and random errors in data.

However, Atoyan and Conway (2010) showed that the IMF forecasting capabilities have improved over time for the shorter horizon, noting that the qualitative impact of forecast errors is typically small. The authors, as well as Guzman and Heyman (2015), confirmed in their analysis that the IMF's forward-looking projections in their Debt Sustainability Analysis (DSA) have repeatedly been biased and, as a result, have distorted the timing of sovereign debt restructurings and the consequent process of renegotiation. The authors highlighted that the IMF forecast performance for crisis economies has been poor, mainly due to its estimation of growth possibilities as well as countries' alternative policy impacts.

The IMF generates its own macroeconomic forecasts, which can be accessed through its online portals (Section 3.2). The forecasts come out twice a year, during spring (typically in April) and autumn (typically in October), and the IMF issues and updates the WEO database. However, the accuracy of the IMF's forecasts for key macroeconomic variables varies by country. As shown in Table 3.4, the actual difference in GDP forecast between the two IMF WEO update periods and the actual GDP growth figures for the period are very close for FMs and EMs, meaning the WEO has a similar capacity in forecast errors for both (column 2). However, for both CPI and current account, the accuracy is on average worse for FM countries (columns 3–6). For example, for the spring forecast versus actual, the results are 1.18 and 1.07, respectively, for FMs and 0.17 and 0.55, respectively, for EMs. This highlights that the forecast challenges for FMs are higher than for EMs for both the CPI and current account. However, for GDP, the difference for the EM countries is slightly larger than for the FM countries. The main driver for that EM difference is Turkey, which has a correction in the GDP reading that is actually greater than for most FM countries, thus pushing up the average. Table 3.4 shows that in general, the IMF forecasts, with the exception of the GDP changes in Turkey, are less reliable for the majority of FMs than for EM countries.

However, as Franses et al. (2014) emphasised, the literature assumes that macroeconomic forecasts from the IMF, the World Bank, the OECD, the Federal Reserve Board and the European Central Bank (ECB) are based on not only econometric models but also human intuition. When comparing the forecasts of two models, one generated from purely an econometric model and the other containing both the econometric model and human intuition, the authors found that the latter does not present a significantly better forecast than the pure econometric model.

Nevertheless, Gündüz's (2016) results show that in the short term, IMF programmes have a positive link to a wide range of macroeconomic results. The effect on short-term growth is most important for low-income countries that are subject to substantial macroeconomic imbalances and strong exogenous shocks. For these countries, the effect on growth can increase by between 1.5% and 3.5% more than for the control group used in Gündüz's (2016) study.

One the other hand, Fratzscher and Reynaud (2011) analysed the financial impact of the IMF Article IV Public Information Notices (PINs) and the role the PIN releases play in ‘defensive surveillance’. Their findings show that financial markets are positively impacted by more favourable PIN publications, while the IMF surveillance is more important for countries with large outstanding IMF loans. This is in line with the findings of Eichengreen et al. (2006), who demonstrated that IMF assistance and increased transparency have a positive effect on a country’s sovereign Eurobond yields.

There is a clear gap in the literature, as to our knowledge, neither the IMF nor the studies on EMs have covered the impact of IMF forecast changes on FMs’ sovereign bond yields. Changes in macroeconomic forecasts can be substantial, as shown in Tables 3.1–3.3, and the IMF does not have the same level of accuracy in its forecasts for all the countries (Table 3.4).

Given that accessing macroeconomic data is more challenging for FMs (see Delvaux et al., 2018), could this mean that investors put more weight on data published by the IMF? Are the effects bigger for the financially less developed FMs than for the more developed EMs?

To answer these questions, we conducted an event study, following Gürkaynak and Wright (2013), to isolate the impact of forecast revisions of macroeconomic variables published by the IMF on FM sovereign bond yields. The study aimed to investigate the impact of an equally weighted aggregate macroeconomic variable created from selected individual macroeconomic variables. The change in sovereign bond yield was compared with the change in yield in the JP Morgan NEXGEM index over the same period to identify any abnormal return that would be the consequence of the IMF’s forecast change over that period.

3.4 The Model

Our empirical analysis used an event study to isolate the influence of the forecast revision (Gurkaynak and Wright, 2013; Ederington et al., 2015) by the IMF and the impact on the FM sovereign bond yields. Before presenting our final equation for the panel regression, the next section will first explain each of the equation's components.

3.4.1 Deriving the Final Equation for the Event Study

The aim of this study was to calibrate the impact of *changes* in IMF macro forecasts on sovereign bond yields. However, we were presented with the following challenges. Which of the macro forecasts should be taken into account? How do we control for other bond market influences that may be occurring at the same time? Furthermore, the IMF forecast *changes* for several key macro variables took place simultaneously, which implies it would not be possible to separate the influence of each one of them individually.

Hence, we proceeded as follows: (i) we selected the macro variables that we thought had an impact on the sovereign bond yields, namely GDP growth, cpi and current account balance; (ii) we created a composite macroeconomic indicator consisting of our three equally weighted macro variables, following Nardo et al. (2005) and the OECD's handbook on index creation (2008), as applied in the study conducted by Svirydzenka (2016); (iii) we computed the aggregated change of the variable over successive forecast updates; (iv) we controlled for possible wider bond market developments by adding the 10-year US Treasury yield, which allowed us to capture the overall global market movements over the period of the event study. Finally, by combining the above components, we measured how the changes in the IMF macroeconomic forecasts impacted the Eurobond yields, defined by the return above or below the overall market return of the entire EM Eurobond market.

3.4.2 Selection of IMF Macroeconomic Variables

The WEO database is usually updated in the spring and the autumn each year, (Section 3.2). The model considered the change in forecast for the next calendar year from the IMF WEO database over a period of 1 year and over a period of 6 months. The WEO's macroeconomic data covered the period 2000–2018. The macroeconomic indicators that were applied are the following: the percentage of GDP growth year-on-year (GDP); the annual percentage change of the CPI (CPI); and the current account balance to GDP (CA).

The first step was to calculate the composite IMF macroeconomic forecast, and the second step was to capture the changes in the IMF macroeconomic composite.

3.4.3 Selection of Time Frames

For the changes in macroeconomic forecasts, the periods for analysis were defined as: (a) the day the WEO database update is released, reported as $WEOt0$; (b) the previously released WEO database update, indicated by $WEOt - 1$; and (c) the following WEO database update release, indicated by $WEOt + 1$[32].

3.4.4 Creation of the Composite Macroeconomic Forecast

As discussed in Section 3.2, the IMF releases all the macroeconomic variables at the same time; thus, it is not possible to ascertain the individual impact of each macroeconomic variable, and their importance could vary in each country. Hence, in

[32] This clarifies why we refer to our approach as that of an event study.

our analysis, we calculated a single equally weighted composite variable, MFi, consisting of GDP, CA and CPI, as reported in Equation (3) below.

Our composite indicator captures the underlying multidimensional drivers that may have an impact on the bond yields.

$$MFi_{C_{(WEOto)}} = Mi_{CGDP_{(WEOt0)}} + Mi_{CCPI_{(WEOt0)}} + Mi_{Cc\_a_{(WEOt0)}} \quad (3)$$

where $MFi_{C_{(WEOt0)}}$ is the composite macroeconomic variable from the combined IMF macroeconomic forecasts at time $WEOto$, as described in Section 3.2, for country i; $Mi_{CGDP_{(WEOt0)}}$is the IMF GDP growth forecast (in percentage terms) at time t for the following year as given by the WEO update for country i; $Mi_{CGDP_{(WEOto)}}$ represents the IMF CPI percentage forecast for the following year in the WEO update at time $WEOto$ for country i; and $M_{Cc\_a_{(WEOto)}}$ is the IMF current account forecast as a percentage of the GDP for the following year as given by the WEO update at time $tWEOt0$ for country i.

3.4.5 Changes in the IMF Composite Forecast

To capture the changes in the IMF macroeconomic composite, we aggregated the three equally weighted sources of macroeconomic change of each component of the composite variable, that is, GDP, CA, and CPI.

Equation (4) represents how the *changes* in IMF 1-year forecasts were calculated for the period between the spring and autumn WEO releases. Next, we analysed the WEO forecast releases for spring–spring, and finally, the WEO autumn – autumn 1-year forecast changes.

Equation (4) identifies the forecast change in macroeconomic variables in the WEO as follows (similar to An et al. [2018]):

$$IMFF_{C_{i_{(WEOt-1,WEOt0)_{t0}}}} = MFi_{C_{(WEOt-1)}} - MFi_{C_{(WEOto)}} \quad (4)$$

where $IMFF_{C_{i_{(WEOt-1,WEOt0)_{t0}}}}$ represents the change in the composite macroeconomic variable for country i over the period $(WEOt-1, WEOt0)$; $MFi_{C_{(WEOt-1)}}$ is the macroeconomic data from the previous forecast, that is, the analysis measures the changes between, for example, the GDP forecast for 2009 issued in the spring 2008 WEO update and the autumn 2008 WEO update, and it separately measures the differences for the 2009 GDP forecast between the autumn 2007 and autumn 2008 as well as between spring 2007 and spring 2008; and $MFi_{C_{(WEOto)}}$ is the current macroeconomic forecast from the last WEO forecasts.

3.4.5.1 Changes in the IMF Composite Forecast for the Spring and Autumn WEO Releases

To clarify our analysis, we considered the changes for three different time periods. Given that the variations in forecasts were not of the same magnitude between the various time segments assessed in this analysis, it was important to run the regressions for various time periods: (i) the change of the composite macroeconomic variable between the spring forecast for 1 year (S) ahead and the autumn forecast for 1 year ahead (F); (ii) the change in the S forecasts for 1 year with the S forecast the next year for the year ahead; and (iii) the change in the F forecasts for 1 year with the F forecast the next year for the year ahead. Hence, Equation (4) looks like Equation (5):

$$IMFF_{C_{i_{((S)WEOt-1,((S)WEOt0)_{t0}}}} = MFi_{C_{(S)WEOt-1}} - MFi_{C_{(S)WEOto}} \quad (5)$$

where $IMFF_{C_{i_{((S)WEOt-1,((F)WEOt0)_{t0}}}}$ represents the independent variable created from the composite macroeconomic variable change in forecast between the previous WEO release in spring or the previous year release $MFi_{C_{(S)WEOt-1}}$versus the latest release in forecast for the latest or current WEO release in spring $MFi_{C_{(F)WEOto}}$. We analysed the three different time frames to identify if any specific forecast period was relatively more sensitive to generating abnormal bond yield returns.

3.4.5.2 Actual Abnormal Bond Returns (Dependent Variable)

This section explains the abnormal returns in bond yields, which is our dependent variable. In the analysis of the impact of macroeconomic forecast changes on the day-to-day FM Eurobond yields, $t0$ represents the Eurobond yield on the day of the WEO database release, while $t-1$ represents the previous trading day and $t+1$ is the following trading day. Following Bessembinder et al. (2009), we defined abnormal returns in bond yields as in Equation (6):

$$ABNR_{C_{i_{AVGR_{(t-1,t+1)n}}}} = Ri_{(t-1,t+1)_n} - BM_{(t-1,t+1)_n} \quad (6)$$

where $ABNR_{C_{i_{AVGR_{(t-1,t+1)n}}}}$ represents the abnormal return of bond yield n for country i over the period $t-1$ to $t+1$; $Ri_{(t-1,t+1)_n}$ states the return of the bond yield n for country i over the period $t-1$ to $t+1$; and $BM_{(t-1,t+1)_n}$ is the mean return on a benchmark rating/maturity matched portfolio corresponding to bond n. We followed the equity event methodology by comparing the yield return generated over that period with its benchmark, which was made up of the other FM Eurobonds in our sample that had the same credit rating as country i at the time $t0$ equally weighted in the benchmark. In this case, $Ri_{(t-1,t+1)_n}$ is the return generated over the specified period for one of the bonds selected from our sample in Appendix 3A1, and $BM_{(t-1,t+1)_n}$ is the corresponding mean yield return of the similar rated bond from the sample of bonds included in the NEXGEM index.

3.4.6 The Final Equations for the Panel Regression

To identify the model of best fit, fixed effects regression and random effects regression were conducted, followed by a Hausman test to identify the model of best fit.

3.4.6.1 Fixed Effects Model

As the final applied model was to be an unbalanced panel regression model, the fixed effects regression followed Equation (7):

$$r_{it} = \alpha_{\mathrm{i}} + \beta' x_{it} + \varepsilon_{it} \quad (7)$$

where r_{it} represents the dependent variable, in this case the abnormal return for the various FM Eurobond yields $ABNR_{C_{i_{AVGR_{(t-1,t+1)n}}}}$, as per Equation (6); x_{it}, the independent variable, is the change in IMF forecasts $IMFF_{C_{i_{((S)WEOt-1,((S)WEOt0)_{t0}}}}$, as per Equation (5); and the overall global market movements during the event study are captured by $MACROF_{Index_{(t-1,t+1)}}$, which represents the changes in yields during the period between $t-1$ and $t+1$ of the event for each of the following: the 10-year US Treasury (UST), EMBI and NEXGEM. The coefficient for the independent variables is represented by β, while the uncorrelated error term is represented by ε_{t0}. The time frames covered from t −1 to t + 1, with t0 representing the day of the WEO release. In market research, broadening the observation window increases the number of observations and reduces the likelihood of t-test type II errors, although it also increases the likelihood of other market events impacting the bond yields (Ederington et al., 2015). Gürkaynak and Wright (2013) suggested keeping the window around the event as short as possible to reduce feedback risk in Equation (3), leaving no reason to be concerned about endogeneity in a regression for $ABNR_{C_{i_{AVGR_{(t-1,t+1)n}}}}$. The final analysis was performed via an unbalanced panel regression to examine the determinants of the abnormal return yields for each country in our sample.

The final step was to ascertain if the financial development of an FM has an impact. This was done by adding a dummy variable, which had the value of 0 for the EM control countries and the value of 1 for the FM countries (Equation 8).

$$r_{it} = \alpha_{\mathrm{i}} + \beta' x_{it} + d_{C_i} + \varepsilon_{it} \tag{8}$$

where D_{C_i} represents the dummy variable for country C_i.

3.4.6.2 Random Effects Model

The random effects model is represented by the following equation:

$$r_{it} = \alpha_1 + \beta' x_{it} + \gamma z_{it} + \varepsilon_{it} \tag{9}$$

where the denomination of estimation of the coefficient γ signifies the effects from the time-invariant covariates z_{it}.

Following the analysis of the random effects model, as per the methodology laid out above, the addition of the dummy variable accounted for a country's financial development, represented by following equation:

$$r_{it} = \alpha_1 + \beta' x_{it} + \gamma z_{it} + d_{C_i} + \varepsilon_{it} \tag{10}$$

3.4.7 Credit Ratings – Not all Countries Have the Same Providers

It was important to take any rating changes into account because the ratings had not been static over the period of the study, as the Moody's Sovereign Credit Ratings from 2000 to 2018 show. It should be noted that for countries where the Moody's rating was not available, we used the rating of Standard & Poor's (S&P). Following the methodology laid out by Ederington et al. (2015), the various ratings were categorised into six rating classes (A and Baa, Ba, B1, B2, B3 and below B3). In line with the approach taken by practitioners when considering the various credit ratings from different rating agencies, the ratings were not calibrated but were considered equivalent to one another. Table 2.5 shows the credit rating for each country in the sample on an annual basis and how it changed over the analysis period. The highest rating was for China, at A3, while Ecuador and Jamaica had the lowest rating, Caa3.

One of the principal challenges is to ascertain the difference between the market response to specific events or information changes, such as the *changes* in IMF forecasts, versus the response to other market events that occur at the time (Galil and Soffer, 2011). According to Steiner and Heinke (2001), Bessembinder (2009) and Erdington (2015), certain bond yield changes can be significant at even as low as 5 basis points for Aaa-rated bonds. These authors suggested that if a typical bond earns a risk premium of 100–150 basis points a year, 15–25 basis points is most likely an abnormal return.

The next step in our research strategy was to compare the results of the FM with those of the five EM control countries to identify whether FM countries' Eurobond yields are more sensitive to IMF macroeconomic forecast changes than the financially more developed EM control countries.

3.5 Data

3.5.1 Selection of Market Variables

To take the general market movements into account, we took the following approach. (i) We compared the bond yield movements relative to the NEXGEM index movement. The NEXGEM index represents the FM bond universe; therefore, it allowed us to discern how the overall higher-yielding bonds had reacted over the period used in our event studies. (ii) Following the analysis by Delvaux et al. (2018), we utilised the 10-year US Treasury yield as a general market risk indicator, using the continuously updated 10-year US Treasury index given by Bloomberg. (iii) For the general risk levels for specifically EMs, we additionally used the JPM EMBI, which covers all the EMs' sovereign Eurobonds issued in USD.

The findings by Vu et al. (2015) demonstrate that the lower a bond's credit rating, the bigger the negative effect of a rating downgrade on its bond yields (spread widening). This contrasts with a strong positive reaction to positive news for higher-rated bonds. Overall, bondholders are more risk-averse than equity holders and therefore have a bigger reaction to negative news (Defond and Zhang, 2014). Thus, one can see the importance of factoring in how the general FM bonds reacted over the specific period to ascertain an abnormal return on a bond in response to changes in IMF forecasts. We therefore paid close attention to the sovereign credit ratings during our analysis.

3.5.2 Country Selection Process

As of December 2018, there are 36 FM countries in the NEXGEM index. However, many of the countries listed in the index were only added in recent years. To allow for the highest number of observations, we decided to focus on a list of 15 countries that had been included in the index since its launch in December 2000 and were still part of the index in December 2018. The list of countries used in this study can be found in Table 3.1. The average IMF financial development ranking position of our sample of FM is 109 (out of 183), with French Polynesia ranking at 183 (bearing in mind that Iraq has no ranking due to the impact of the war). This average ranking is not far off 'the average over the time NEXGEM has been in existence up to December 2018, which was 110. Hence, the sample is a good proxy for the current financial development of the FM countries included in NEXGEM[33]. The average development index ranking for our control group of EM countries is 31. We selected these EM countries because they are present in most EM bond indices and are deemed liquid for trading, thus allowing us to contrast and compare their results with the ones for the FM countries.

The NEXGEM inclusion criteria are as follows: 1) JPM EMBIG/Diversified Index membership; 2) a credit rating of Ba1/BB+ or lower by both Moody's and S&P; 3) non-EU member and not seeking EU membership; and 4) Eurobond weightings of less than 2% of the EMBIG/Diversified Index for the past 12 consecutive months. The Eurobond needs to have at least 2.5 years until maturity to enter the index, while to maintain index inclusion, it needs to have at least one year until maturity. Details of the NEXGEM index can be found at https://markets.jpmorgan.com/research/CFP?page=nexgem.

We selected five EM countries, namely, South Africa, Brazil, China, Russia and Turkey, for our control group. In Table 3.1, those countries are listed with their respective financial development rankings. Their average financial development ranking is 31, whereas the average ranking of the selected FM countries is 109.

The IMF data were obtained from the IMF website (www.imf.org). The forecast changes were obtained from the WEO database, which can be found on the IMF website. It should be noted that the website listed no updates for the following periods: spring 2005, spring 2004, autumn 2002 and autumn 2001.

[33] NEXGEM's pricing history goes back further than December 2011, as JP Morgan extrapolated price and performance data back to 31 December 2001. Those data are available from JP Morgan and Bloomberg.

The daily bond yields for the sovereign Eurobonds were obtained from Bloomberg and, in cases of missing observations, were completed with information from the DAM FM proprietary database. The use of daily pricing significantly increases the power of event study tests (Besseminder et al., 2009; Maul and Schiereck, 2017). Bloomberg reports the last price of the day, and this is the one used in our study, even though this last price does not reflect whether any actual trading has taken place and could be just the result of 'marking' by market makers. The existing literature on corporate bonds uses Trade Reporting and Compliance Engine (TRACE) data to capture bond price movement based on actual trades (Bessembinder et al., 2009; Ederington et al., 2015; Maul and Schiereck, 2017). However, our analysis did not find enough data points containing trading volumes, given that the relevant bonds are sovereign bonds and not corporate bonds such as in the work by Bessembinder et al. (2009).

The historic sovereign credit ratings from Moody's or S&P (Table 3.5) were obtained from Bloomberg. Given the changes in credit ratings throughout the period of this study, with variations to credit outlooks, we used only end-of-year credit ratings.

If a Eurobond did not have a Moody's credit rating but had an S&P credit rating, we applied the score of the latter by converting it on a non-calibrated basis to the approximate Moody's equivalent score, as is a common approach by practitioners in financial markets. In this study, this approach was used for the following countries in the sample: Gabon, Ghana, Iraq and Nigeria. Table 3A1 (Appendix 3A) presents the Moody's credit ratings or the transposed Moody's credit ratings at the end of the year for each country.

Not all the countries had a credit rating throughout the entire time of our analysis. Where this was the case, they were attributed the 'not rated' (NR) status.

The list of selected bonds is presented in Appendix 3B, Table 3B1. The bond yields were collected from Bloomberg. As described by Bessembinder et al. (2009), bonds have certain unique characteristics that must be considered, namely, the issuers may have multiple bond issues outstanding while the maturity profiles for each bond differ, resulting in nearer-to-maturity bonds typically becoming less sensitive to risk factors as time passes. In addition, a lack of liquidity is often associated with reduced Eurobond issuance sizes and/or reduced size representation in the different bond indices, and this needs to be taken into account when calculating abnormal returns. In our study, these elements were accounted for. We compared the abnormal returns generated by each sovereign Eurobond with those of its peers with similar credit ratings.

The actual changes in IMF GDP growth forecasts for the FM countries are reported in Tables 3.1–3.3, which show the changes between the forecasts from the IMF as well as the year-on-year changes. From spring to autumn of the same year, the average change is −0.16% in GDP growth for the 1-year forecast, while the spring-to-spring (column 3) average change is marginally smaller at −0.15% in GDP growth for the 1-year forecast. The biggest difference can be seen in the autumn-to-autumn (column 5) change of −0.30% in GDP growth for the 1-year forecast. This means that the IMF tends to overestimate GDP growth for each forecast category. In addition, we can see that the standard deviation of the GDP 1-year forecast corrections increases for each one of the three forecast periods (columns 2, 4 and 6 in Table 3.1).

The IMF's changes in CPI growth forecasts are shown in Table 3.2. It highlights that for spring-to-autumn in the same year, the 1-year forecast of the average change is up by 0.54% on inflation expectation (column 1), while for spring-to-spring (column 3), the year-on-year forecast is lower at an average 0.24% increase for FM. The largest increase in CPI forecast changes is for the autumn-to-autumn 1-year forecast reported in column 5, at 0.97%.

Two countries dropped out of the FM sample during our estimation period: Jordan was removed because there were only eight observations, and Belize was removed due to trading at default levels for most of the period, which resulted in the prices remaining static.

3.6 Methodology

Our research strategy was as follows. We first estimated the unbalanced panel regression for the overall sample of countries, including both FMs and EMs, based on Equation (8). A dummy variable was applied, taking the value of 0 for the control group of countries and 1 for the FMs that ranked higher than 40 in the IMF financial development index. The second panel analysis repeated the exercise, this time using the actual IMF financial development ranking instead of the dummy variable. Both exercises allowed us to measure whether FMs are more sensitive to IMF forecast *changes* than the respective EMs, which took the value 0. We estimated a third panel for the FMs.

Similar to Delvaux et al. (2018), we estimated an unbalanced panel model for all the countries in the sample, for both fixed effects and random effects, choosing the most appropriate model based on Hausman’s (1978) test. For all the regressions, the test indicated that the random effects model was the most appropriate model to use. It should be noted that due to the limited amount of available data, we could not investigate possible bidirectional causality issues.

3.7 The Empirical Results

The first analysis covered the overall sample using panel regression. This was followed by the various robustness tests. For the acronyms applied in the analysis, see Appendix 3F.

3.7.1 Preliminary Analysis

To test for unit root presence in the panels, an ADF test was conducted on all the independent variables, and in each case, the null hypothesis of unit root presence was strongly rejected (see Appendix 3C). A correlation analysis was performed for the dependent and all independent variables (Appendix 3D). As shown in Table 3D1, we expected there to be a negative correlation between the Eurobond prices and the yield. The correlation between a country's financial development and other variables was found to be insignificant; thus, at first sight, the financial development did not appear to have a significant relationship with the other variables assessed. As one would expect, the EMBI, UST and NEXGEM show a higher degree of correlation between themselves. Furthermore, we conducted a normality test in the form of Shapiro–Wilk and Shapiro–Franca tests to test for Gaussian distribution (Appendix 3E). In Table 3E1, the outcome under V for both normality tests is 253.978, which is much greater than 1, highlighting that the series are normally distributed.

In Table 3.4, we highlight the IMF forecast accuracy, comparing the Fund's forecast for the next year for GDP, CPI and current account with the actual macroeconomic performance of the measures. The average actual GDP growth for Belarus was 2.05 points higher than the spring forecasts the previous year. The lowest GDP correction was for Ivory Coast, at just 0.25 points, while at 2.92, Iraq had the highest correction for the spring forecast (column 1). Similarly, the highest inaccuracies in forecast versus actual performance in GDP and CPI were for Iraq for the FM countries and Turkey for the EM countries (columns 1 and 2). Nevertheless, 'Table 3.4 highlights that for CPI and current account (columns 3 and 4 and columns 4 and 5, respectively), the variations between forecasts in spring and autumn are greater for FMs than for EMs. *This indicates that for the IMF, it is more challenging to make accurate broad macroeconomic projections for FM countries than for EM countries*. This can in part be explained by the quality of FM countries' local data that is produced, perhaps resulting in FM investors having a broader tolerance level for variations in forecasts.

3.7.2 Panel Results

As mentioned, we estimated three panel models of Equation 8. The first model, referred to as the 'whole sample model' (Model I), comprises the entire sample of FM and control countries to identify if there is any effect from forecast changes on the wider EM universe, which includes the FM. We differentiated the FM from the EM with a dummy variable (FinDevelopDumy), which had the value of 0 for FM countries and 1 for EM countries. In the second model, Model II, the dummy variable used the actual ranking of the financial development index, taking the value of 0 for every country that had an IMF financial development score below 40 and the value of 1 for the control group of countries in the sample. The last model (Model III) estimated the impact of forecast changes for the FM countries only.

The results of the three models (I, II and III) are presented in Table 3.6. One can make the following observations. (i) *None of the independent variables has a statistically significant impact on abnormal returns* (AbnormRT) generated by the various bonds over or below their equivalent credit ranking[34]. From a practitioner's perspective, this can be interpreted as the bond yields moving within the expected parameters of their similarly rated peers, with none of the assessed independent variables having a higher or lower impact on the outcome. There are several elements related to the signs of the coefficients. (ii) It is important to highlight that the R^2 values across all three models are low at 0.02. (iii) The signs of changes in NEXGEM yield (NexgemYLD), UST and EMBI yield (EMBIy) are consistent and negative across the various models, implying that UST, NexgemYLD and EMBI have a negative impact on AbnormRT. This indicates that an upward movement in the broader global markets' yields, represented by the US Treasury and the EMBIy and NEXGEM indices, result in reduced abnormal returns for FM bonds[35].

In contrast, changes in the macroeconomic forecasts of the IMF WEO and average yield change have a positive impact (Table 3.6). Positive changes in the IMF macroeconomic forecasts result in FM countries' Eurobond yields having a positive abnormal return. Thus, in terms of the macroeconomic data, that is, GDP growth, CPI and current account, surprises do have an impact on the generated abnormal returns and therefore matter in the pricing of the sovereign Eurobonds' risk.

[34] In the case of Iraq, since there was no IMF financial development score, we applied the average of the FM countries, that is, 110; thus, the country had a dummy variable of 1.

[35] In other words, the additional yield spread FM Eurobonds provide is reduced, as there is a broad increase in general yields in the market. One explanation to account for this is that from a practitioner's perspective, the immediate focus is on the more liquid EM Eurobonds in the portfolio, as these can be more readily traded in the market. In the immediate aftermath of larger risk-off events in the market, the FM Eurobonds tend to be less liquid and get a wider bid–offer spread.

Finally, for FM countries, the financial development ranking of the countries by applying dummy variables does not appear to have a material effect (Models I and II).

In summary, the outcome of the analysis demonstrates that the broader upward movements in yields in the EM markets tend to compress the abnormal returns generated by FM bonds, while positive macroeconomic forecast changes result in positive abnormal returns being generated.

3.8 Robustness Tests

The panel analysis examined the impact of the change in the IMF macroeconomic composite factor between the spring and autumn forecasts for the next year, the countries' financial development rating and changes in the 10-year UST over the event period. During the analysis, other individual independent variables were removed. We first removed the change in the IMF macroeconomic composite factor of the spring-to-spring and autumn-to-autumn forecast for the next year. This was followed by the removal of the NEXGEM, the average change in yield and the EMBI.

Table 3.7 reports the results of the various robustness tests (Models IV–VII) conducted for the entire sample, using the country's actual financial development ranking as the financial development measure. In other words, the models apply the complete sample data as described for Model I in Section 3.7.2 and Table 3.6. The results show that even when one independent variable after another is dropped (Models IV–VII), the impact of changes in the IMF macroeconomic composites for spring-to-spring and autumn-to-autumn periods does not increase the R^2 value. The same holds true when dropping global macroeconomic indices, such as the NEXGEM and EMBIy, and the changes in average yield. *In none of the analyses conducted did we find that* *any of the independent variables has any significant statistical impact on the dependent variable, that is, the change in abnormal return generated by the Eurobonds during the event period.*

3.9 Discussion and Concluding Comments

In this study, we investigated whether the sovereign bond yields of FMs are more affected by the IMF's macroeconomic forecast changes than those of the financially more developed EMs, given that FMs provide investors and local and international institutions with bigger challenges in terms of the quality and availability of data. Our event study used our unique daily data for the period 1 April 2001–10 October 2018 and covered 15 FM countries and five EM countries (control group). Our results show that there is *no* immediate impact from changing IMF economic forecasts, reported twice-yearly, on FM sovereign Eurobond yields' abnormal returns. This leads us to believe that *the overall changes must be already embedded in the bond yields prior to the updates and that investors in FM countries have a higher acceptance threshold for changes in macroeconomic forecasts*. One of the reasons for this may be the recurring visits by the IMF staff members to some of the countries in the sample and the subsequent ad-hoc press releases and reports, such as Article IV and the Debt Sustainability Analysis. Another reason may be that FM countries historically have been subject to higher nominal changes in macroeconomic forecasts, thus increasing the tolerance levels of local FM investors.

These findings are in line with the results obtained by Delvaux et al. (2018), who found that the sovereign Eurobonds in SSA, most of which are included in the FM sample in this study, are more affected by *global* factors than by underlying *local* sovereign developments.

Furthermore, a country’s financial development ranking does not appear to have a material effect on a country’s abnormal Eurobond returns. This is in line with the expectation from a practitioner’s point of view that because Eurobonds trade on the international markets, they are not dependent on a country’s local financial development for liquidity and settlement purposes. This may be explained by the suggestion that a country’s financial development index ranking is not defined solely by the country’s transparency and investor communication. However, for some of the countries in the sample, there is a need for IMF assistance through funded programmes or technical assistance programmes that entail more frequent visits or updates by the Fund, thereby allowing for up-to-date information to be assimilated by the market ahead of the WEO database being updated.

Table 3.1 IMF GDP forecast changes and the standard deviations

	Change Between Same-Year Spring and Autumn 1-Year Forecasts **Column 1**	Standard Deviation **Column 2**	Change Between Spring 1-Year Forecasts on a Year-on-Year Basis **Column 3**	Standard Deviation **Column 4**	Change Between Autumn 1-Year Forecasts on a Year-on-Year Basis **Column 5**	Standard Deviation **Column 6**	IMF Financial Development Ranking **Column 7**
Belarus	−0.18	1.41	0.23	2.15	−0.29	2.32	127
Ivory Coast	0.17	0.63	−0.14	1.20	−0.15	1.45	119
Ecuador	−0.14	1.32	−0.34	2.53	−0.37	1.63	104
Egypt	−0.22	0.73	−0.55	1.31	−0.56	1.24	77
El Salvador	−0.25	0.38	−0.38	1.12	−0.44	0.94	89
Gabon	0.01	0.95	0.18	1.51	0.20	1.61	134
Georgia	−0.28	1.36	−0.18	1.70	−0.31	1.84	92
Ghana	−0.81	2.39	0.18	1.60	−0.91	3.11	143
Iraq	0.02	2.14	0.03	3.30	−0.17	4.42	N.A.
Jamaica	−0.17	0.57	−0.32	1.04	−0.43	0.94	74
Nigeria	−0.06	1.05	−0.13	1.74	−0.10	1.67	131
Pakistan	−0.28	0.89	−0.29	0.99	−0.40	1.16	108
Senegal	0.01	0.27	0.03	0.75	−0.14	0.68	147
Sri Lanka	0.03	0.52	−0.33	0.89	−0.23	0.65	80
Vietnam	−0.23	1.07	−0.23	1.07	−0.18	0.83	95
Average	−0.16	1.05	−0.15	1.53	−0.30	1.63	109
Brazil	−0.32	0.78	−0.35	1.02	−0.63	1.00	25
China	−0.04	0.55	−0.18	0.96	−0.10	0.78	33
Russia	0.14	0.53	−0.45	1.12	−0.28	1.14	32
South Africa	−0.18	0.31	−0.22	0.46	−0.29	0.53	28
Turkey	−0.09	0.30	0.19	0.95	0.03	0.80	37
Average for Control Group	−0.10	0.49	−0.20	0.90	−0.25	0.85	31

Note: The lower the ranking in the IMF financial development ranking, the better it is for a country. In the period 1980–2013, there were 183 countries included. The sample countries listed in Table 3.1 are countries that were included in the NEXGEM index at its launch in December 2011 and were still included in December 2018. The NEXGEM index has the following inclusion criteria that the countries need to fulfil: 1) EMBIG/Diversified Index membership; 2) Ba1/BB+ or lower by both Moody's and S&P; 3) non-EU member and not seeking EU membership; 4) <2% weight in the EMBIG/Diversified Index for the past 12 consecutive months. The Eurobond needs to have at least 2.5 years until maturity to enter the index, and to maintain inclusion, it needs to have at least 1 year until maturity. The period this study considered is from 2000, with the 1-year forecast for 2001, until 2018. (https://markets.jpmorgan.com/research/CFP?page=nexgem)

Table 3.2 Changes in IMF CPI forecasts and the standard deviations

	Change Between Same-Year Spring and Autumn 1-Year Forecasts **Column 1**	Standard Deviation **Column 2**	Change Between Spring 1-Year Forecasts on a Year-on-Year Basis **Column 3**	Standard Deviation **Column 4**	Change Between Autumn 1-Year Forecasts on a Year-on-Year Basis **Column 5**	Standard Deviation **Column 6**	IMF Financial Development Ranking **Column 7**
Belarus	1.667223372	6.61791158	−3.962031285	25.01707598	1.709430301	11.10561296	127
Ivory Coast	0.16	0.78	0.10	0.65	0.22	0.82	119
Ecuador	0.10	0.88	0.35	1.07	0.12	1.32	104
Egypt	1.19	3.06	1.64	2.59	1.83	3.41	77
El Salvador	0.16	1.12	0.15	0.68	0.32	1.65	89
Gabon	−0.18	1.51	−0.04	2.30	0.16	0.83	134
Georgia	0.14	1.61	0.01	1.39	0.37	1.92	92
Ghana	1.23	1.79	2.09	2.90	2.49	3.94	143
Iraq	−1.16	5.55	−0.84	7.23	1.45	11.00	N.A.
Jamaica	0.35	1.64	0.31	2.00	0.87	2.76	74
Nigeria	0.82	2.79	1.92	1.86	1.62	3.11	131
Pakistan	1.56	4.01	0.60	2.50	1.06	5.09	108
Senegal	0.08	0.36	0.01	0.34	0.07	0.52	147
Sri Lanka	1.20	2.70	0.67	1.78	1.07	3.07	80
Vietnam	0.86	2.33	0.55	2.16	1.23	2.60	95
Average	0.54	2.45	0.24	3.63	0.97	3.54	109
Brazil	0.28	0.52	0.30	0.78	0.52	0.85	25
China	0.23	0.46	−0.23	1.00	−0.01	0.87	33
Russia	0.32	1.33	0.81	1.94	0.88	1.67	32
South Africa	0.06	0.24	0.08	1.20	0.32	0.54	28
Turkey	0.24	0.46	−0.23	1.00	−6.03	31.33	37
Average for Control Group	0.23	0.60	0.15	1.18	−0.86	7.05	31

Note: The lower the ranking in the IMF financial development ranking, the better it is for a country. In the period 1980–2013, there were 183 countries included. The sample countries listed in Table 3.1 are countries that were included in the NEXGEM index at its launch in December 2011 and were still included in December 2018. The NEXGEM index has the following inclusion criteria that the countries need to fulfil: 1) EMBIG/Diversified Index membership; 2) Ba1/BB+ or lower by both Moody's and S&P; 3) non-EU member and not seeking EU membership; 4) <2% weight in the EMBIG/Diversified Index for the past 12 consecutive months. The Eurobond needs to have at least 2.5 years until maturity to enter the index, and to maintain inclusion, it needs to have at least 1 year until maturity. The period this study considered is from 2000, with the 1-year forecast for 2001, until 2018. (https://markets.jpmorgan.com/research/CFP?page=nexgem)

Table 3.3 Changes in IMF current account forecasts and the standard deviations

	Change Between Same-Year Spring and Autumn 1-Year Forecasts **Column 1**	Standard Deviation **Column 2**	Change Between Spring 1-Year Forecasts on a Year-on-Year Basis **Column 3**	Standard Deviation **Column 4**	Change Between Autumn 1-Year Forecasts on a Year-on-Year Basis **Column 5**	Standard Deviation **Column 6**	IMF Financial Development Ranking **Column 7**
Belarus	−0.05	1.98	−0.09	3.48	−0.24	3.13	127
Ivory Coast	0.32	1.80	0.91	2.06	0.36	2.25	119
Ecuador	0.18	1.63	0.48	2.54	0.33	3.06	104
Egypt	0.35	0.91	−0.09	1.81	−0.45	2.10	77
El Salvador	0.12	0.87	−0.12	1.20	−0.24	1.49	89
Gabon	2.01	5.42	1.07	7.01	1.17	6.32	134
Georgia	−0.44	2.54	−1.47	3.17	−1.50	3.20	92
Ghana	−0.98	1.78	−0.50	2.60	−0.81	2.47	143
Iraq	−1.63	10.44	−1.40	12.37	0.00	0.00	N.A.
Jamaica	−0.41	1.32	−0.80	2.34	−1.03	2.80	74
Nigeria	1.22	5.36	1.40	6.65	0.40	5.89	131
Pakistan	−0.18	0.95	−0.17	1.41	−0.11	1.62	108
Senegal	0.02	1.89	−0.54	1.39	−0.36	2.05	147
Sri Lanka	0.01	1.83	−0.03	2.42	0.16	2.46	80
Vietnam	−0.87	2.19	0.34	3.73	0.22	2.73	95
Average	−0.02	2.73	−0.07	3.61	−0.14	2.77	109
Brazil	0.15	0.49	0.14	1.10	0.24	1.18	25
China	−0.07	0.92	0.12	2.11	0.03	2.26	33
Russia	0.47	1.89	1.15	2.20	1.42	3.16	32
South Africa	0.09	0.62	−0.13	1.24	−0.00	1.52	28
Turkey	−0.44	0.82	−0.36	1.75	−0.39	1.37	37
Average for Control Group	0.04	0.95	0.18	1.68	0.26	1.90	31

Note: The lower the ranking in the IMF financial development ranking, the better it is for a country. In the period 1980–2013, there were 183 countries included. The sample countries listed in Table 3.1 are countries that were included in the NEXGEM index at its launch in December 2011 and were still included in December 2018. The NEXGEM index has the following inclusion criteria that the countries need to fulfil: 1) EMBIG/Diversified Index membership; 2) Ba1/BB+ or lower by both Moody's and S&P; 3) non-EU member and not seeking EU membership; 4) <2% weight in the EMBIG/Diversified Index for the past 12 consecutive months. The Eurobond needs to have at least 2.5 years until maturity to enter the index, and to maintain inclusion, it needs to have at least 1 year until maturity. The period this study considered is from 2000, with the 1-year forecast for 2001, until 2018. (https://markets.jpmorgan.com/research/CFP?page=nexgem)

Table 3.4 IMF macroeconomic forecast average accuracy between 2001 and 2018

IMF Forecast Accuracy for FM Countries	**GDP**		**CPI**		**Current Account**		
Country	*Actual vs Spring* ***Column 1***	*Actual vs Autumn* ***Column 2***	*Actual vs Spring* ***Column 3***	*Actual vs Autumn* ***Column 4***	*Actual vs Spring* ***Column 5***	*Actual vs Autumn* ***Column 6***	**IMF Financial Development Ranking Column 7**
Belarus	2.05	1.09	0.92	1.46	0.37	0.31	127
Ivory Coast	0.25	0.13	0.42	0.27	1.07	0.20	119
Ecuador	1.25	1.06	1.27	1.43	0.99	0.50	104
Egypt	0.55	0.37	0.47	0.5	0.07	0.80	77
El Salvador	0.35	0.02	0.15	0.15	0.48	0.64	89
Gabon	0.68	0.4	1.2	0.66	4.55	2.9	134
Georgia	0.88	0.83	0.44	0.38	0.13	0.04	92
Ghana	0.43	0.51	1.37	0.89	1.98	2.42	143
Iraq	2.92	4.41	8.25	6.95	0.87	1.10	N.A.
Jamaica	0.94	0.41	0.92	0.95	0.15	0.12	74
Nigeria	1.48	2.32	0.34	0.05	2.21	1.37	131
Pakistan	0.13	0.38	0.12	0.21	0.35	0.37	108
Senegal	0.65	0.42	0.51	0.26	1.57	1.60	147
Sri Lanka	0.37	0.32	0.96	0.04	0.70	0.51	80
Vietnam	0.39	0.39	0.29	0.13	0.53	1.27	95
Average	0.89	0.87	1.18	0.96	1.07	0.94	109
IMF Forecast Accuracy for EM Control Countries							
Brazil							25
China	1.16	0.82	0.10	0.21	0.40	0.37	33
Russia	0.54	0.54	0.13	0.48	0.59	0.91	32
South Africa	0.09	0.45	0.10	0.33	0.70	0.67	28
Turkey	1.82	1.52	0.33	0.30	0.49	0.76	37
Average for EM Control Countries	0.90	0.83	0.17	0.33	0.55	0.68	31

Note: The lower the ranking in the IMF financial development ranking, the better it is for a country. In the period 1980–2013, there were 183 countries included. The sample countries listed in Table 3.1 are countries that were included in the NEXGEM index at its launch in December 2011 and were still included in December 2018. The NEXGEM index has the following inclusion criteria that the countries need to fulfil: 1) EMBIG/Diversified Index membership; 2) Ba1/BB+ or lower by both Moody's and S&P; 3) non-EU member and not seeking EU membership; 4) <2% weight in the EMBIG/Diversified Index for the past 12 consecutive months. The Eurobond needs to have at least 2.5 years until maturity to enter the index, and to maintain inclusion, it needs to have at least 1 year until maturity. The period this study considered is from 2000, with the 1-year forecast for 2001, until 2018. (https://markets.jpmorgan.com/research/CFP?page=nexgem)

Table 3.5 Moody's equivalent sovereign credit ratings for sample countries

	Belarus	Dominican Republic	Ecuador	Egypt	El Salvador	Gabon	Georgia	Ghana	Iraq	Ivory Coast	Jamaica	Nigeria	Pakistan	Senegal	Sri Lanka	Vietnam	Brazil	Russia	China	Turkey	South Africa
2000		Ba2	Caa2													B1		B2		B1	
2001		Ba2	Caa2													B1		Ba3		B1	Baa2
2002		B1, downgraded to B2	Caa2		Baa3								B3			B1		Ba2		B1	Baa2
2003		B3	Caa2	Ba1	Baa3						B1		B2			B1		Baa3	A2	B1	Baa2
2004		B3	Caa1	Ba1	Baa3						B1		B2			Ba3		Baa3	A2	B1	Baa2
2005		B3	Caa1	Ba1	Baa3						B1		B2			Ba3		Ba2	A2	Ba3	Baa1
2006		B3	Caa1	Ba1	Baa3						B1		B1			Ba3		Baa3	A2	Ba3	Baa1
2007	B1	B2	Caa1	Ba1	Baa3	BB−					B1		B1			Ba3		Baa3	A1	Ba3	Baa1
2008	B1	B2	B3, downgraded to Caa1, then Ca	Ba1	Baa3	BB−					B1		B2, downgraded to B3			Ba3		Baa1	A1	Ba3	Baa1
2009	B1	B2	Caa3	Ba1	Ba1	BB−					B2, down graded to Caa1	B+	B3			Ba3		Baa1	A1	Ba3	A3
2010	B1	B1	Caa3	Ba1	Ba1	BB−	Ba3	B			B3	B+	B3		B1	Ba3		Baa1	Aa3	Ba2	A3
2011	B2, down graded to B3	B1	Caa2	Ba2, downgraded to Ba3, then B1 and later B2	Ba2	BB−	Ba3	B			B3	B+	B3	B1	B1	B1		Baa1	Aa3	Ba2	A3
2012	B3	B1	Caa1	B2	Ba3	BB−	Ba3	B			B3	BB	Caa1	B1	B1	B2		Baa1	Aa3	Ba1	Baa1
2013	B3	B1	Caa1	B3, downgraded to Caa1	Ba3	BB−	Ba3	B			Caa3	BB	Caa1	B1	B1	B1		Baa1	Aa3	Baa3	Baa1
2014	B3	B1	B3	Caa1	Ba3	BB−	Ba3	B−			Caa3	BB	Caa1	B1	B1	B1		Baa2	Aa3	Baa3	Baa2
2015	Caa1	B1	B3	B3	Ba3	B+	Ba3	B−	B−		Caa2	B+	B3	B1	B1	B1		Baa3, Baa1	Aa3	Baa3	Baa2
2016	Caa1	B1	B3	B3	B1, November B3	B	Ba3	B−	B-		B3	B	B3	B1	B1	B1		Baa1	Aa3	Ba1	Baa2
2017	Caa1	Baa3	B3	B3	Caa1	NR	Ba2	B−	B−		B3	B	B3	Baa3	B1	Ba3		Baa1	A1	Ba1	Baa3
2018	B3	Baa3	B3	B2	B3		Ba2	B	B−	Ba3	B3	B	B3	Baa3	B2	Ba3		Baa1	A1	Ba2	Baa3
2019	B3	Baa3	B3	B2	B3	Caa1	Ba2	B	B−	Ba3	B3	B	B3	Baa3	B2	Ba3		Baa3	A1	B1	Baa3

Note: The listed end-of-year credit ratings are as per Moody's Credit Rating Agency for all the countries in the sample and the control countries. For the countries for which there was no Moody's rating available, such as Nigeria and Gabon, we used the S&P rating on a non-calibrated basis, deemed equivalent as per market practice.

Table 3.6 Total sample analysis including financial development dummy variables

	Whole sample including dummy variables (Model I)	Whole sample including the control countries, with actual IMF financial development index score included (Model II)	Includes only the frontier market countries (Model III)
	AbnormRT	**AbnormRT**	**AbnormRT**
IMFspr_fall	**0.46**	**0.45**	**0.22**
	0.535	*0.535*	*0.669*
IMFspr_spr	**0.68**	**0.68**	**0.52**
	0.426	*0.426*	*0.538*
IMFfall_fall	**1.00**	**1.00**	**1.07**
	0.437	*0.438*	*0.575*
Avgyldcg	**1.40**	**1.40**	**1.47**
	35.538	*35.551*	*55.532*
FinDevelopDumy	**0.64**		
	4.969		
FinDevelopRank		**0.54**	
		0.054	
NexgemYLD	**−0.42**	**0.42**	**−0.27**
	17.137	*17.145*	*24.95*
UST	**−1.58**	**−1.59**	**−1.36**
	24.712	*24.718*	*36.717*
EMBIy	**−0.19**	**−0.19**	**−0.41**
	34.303	*34.322*	*50.122*
No. obs	381	381	261
No. of groups/countries	20	20	15
Hausman test results	Random effects	Random effects	Random effects
Overall R2	0.02	0.02	0.02

Note: The information is based on the Eurobonds of the following countries: Belarus, Ecuador, Egypt, El Salvador, Gabon, Georgia, Ghana, Ivory Coast, Iraq, Jamaica, Nigeria, Pakistan, Senegal, Sri Lanka and Vietnam as frontier market (FM) countries; and Brazil, China, South Africa and Turkey as the control countries. Relevant period: 15 April 2001 to 10 October 2018. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$. Model I includes the entire sample, including dummy variables for the country's respective IMF financial development index ranking, with the five control countries having a dummy variable of 0 and the FM countries having a dummy variable of 1. Model II comprises the entire sample, including the control countries and the actual IMF financial development index score. Model III includes only the FM countries in the sample. Robust standard errors are presented in italics.

Table 3.7 Robustness test for panel analysis – Model I

Robustness Test	Model I – Whole Sample, Including Dummy Variables			
	Excluding the change in IMF macroeconomic composite for spring-to-spring and autumn-to-autumn (Model IV)	Excluding the change in IMF macroeconomic composite for spring-to-spring and autumn-to-autumn and excluding the NEXGEM index (Model V)	Excluding the change in IMF macroeconomic composite for spring-to-spring and autumn-to-autumn, the NEXGEM index and the average change in yield (Model VI)	Excluding the change in IMF macroeconomic composite for spring-to-spring and autumn-to-autumn, the NEXGEM index, the average change in yield and the EMBI (Model VII)
Variables	**AbnormRT**	**AbnormRT**	**AbnormRT**	**AbnormRT**
IMFspr_fall	**1.23**	**1.2**	**1.19**	**1.21**
	0.422	*0.421*	*0.421*	*0.422*
Avgyldcg	**1.28**	**1.36**		
	35.554	*35.084*		
FinDevelopDumy	**0.55**	**0.55**	**0.57**	**0.55**
	4.819	*4.818*	*4.818*	*5.04*
NexgemYLD	**−0.43**			
	17.181			
UST	**−1.53**	**−1.68**	**−1.44**	**−0.86**
	24.715	*24.014*	*23.588*	*18.297*
EMBIy	**−0.23**	**−0.57**	**1.22**	
	34.33	*28.477*	*14.254*	
No. obs	381	381	381	381
No. of groups/countries	20	20	20	20
Hausman test results	Random effects	Random effects	Random effects	Random effects
Overall R2	0.01	0.01	0.01	0

Note: Model I includes the entire sample, including dummy variables for the country's respective IMF financial development index ranking, with the five control countries having a dummy variable of 0 and the frontier market (FM) countries having a dummy variable of 1. The information is based on the Eurobonds of the following countries: Belarus, Ecuador, Egypt, El Salvador, Gabon, Georgia, Ghana, Ivory Coast, Iraq, Jamaica, Nigeria, Pakistan, Senegal, Sri Lanka and Vietnam as frontier market (FM) countries; and Brazil, China, South Africa and Turkey as the control countries. Relevant period: 15 April 2001 to 10 October 2018. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$. Robust standard errors are presented in italics.

Appendix 3A. Country Credit Ratings

Table 3A1 Evolution of Sample Countries Credit Ratings

Year	Belarus	Ecuador	Egypt	El Salvador	Gabon	Georgia	Ghana	Iraq	Ivory Coast	Jamaica	Nigeria	Pakistan	Senegal	Sri Lanka	Vietnam	Brazil	Russia	China	Turkey	South Africa
2000		Caa2													B1	B1	B2		B1	
2001		Caa2													B1	B1	Ba3		B1	Baa2
2002		Caa2		Baa3								B3			B1	B2	Ba2		B1	Baa2
2003		Caa2	Ba1	Baa3						B1		B2			B1	B2	Baa3	A2	B1	Baa2
2004		Caa1	Ba1	Baa3						B1		B2			Ba3	B1	Baa3	A2	B1	Baa2
2005		Caa1	Ba1	Baa3						B1		B2			Ba3	Ba3	Ba2	A2	Ba3	Baa1
2006		Caa1	Ba1	Baa3						B1		B1			Ba3	Ba2	Baa3	A2	Ba3	Baa1
2007	B1	Caa1	Ba1	Baa3	Ba3					B1		B1			Ba3	Ba1	Baa3	A1	Ba3	Baa1
2008	B1	Caa1	Ba1	Baa3	Ba3					B1		B3			Ba3	Ba1	Baa1	A1	Ba3	Baa1
2009	B1	Caa3	Ba1	Ba1	Ba3					Caa1	B1	B3			Ba3	Baa3	Baa1	A1	Ba3	A3
2010	B1	Caa3	Ba1	Ba1	Ba3	Ba3	B2			B3	B1	B3		B1	Ba3	Baa3	Baa1	Aa3	Ba2	A3
2011	B3	Caa2	B2	Ba2	Ba3	Ba3	B2			B3	B1	B3	B1	B1	B1	Baa2	Baa1	Aa3	Ba2	A3
2012	B3	Caa1	B2	Ba3	Ba3	Ba3	B2			B3	Ba2	Caa1	B1	B1	B2	Baa2	Baa1	Aa3	Ba1	Baa1
2013	B3	Caa1	Caa1	Ba3	Ba3	Ba3	B2			Caa3	Ba2	Caa1	B1	B1	B1	Baa2	Baa1	Aa3	Baa3	Baa1
2014	B3	B3	Caa1	Ba3	Ba3	Ba3	B3			Caa3	Ba2	Caa1	B1	B1	B1	Baa2	Baa2	Aa3	Baa3	Baa2
2015	Caa1	B3	B3	Ba3	B1	Ba3	B3	B3		Caa2	B1	B3	B1	B1	B1	Baa3	Baa1	Aa3	Baa3	Baa2
2016	Caa1	B3	B3	B3	B2	Ba3	B3	B3		B3	B2	B3	B1	B1	B1	Ba2	Baa1	Aa3	Ba1	Baa2
2017	Caa1	B3	B3	Caa1	NR	Ba2	B3	B3		B3	B2	B3	Baa3	B1	Ba3	Ba2	Baa1	A1	Ba1	Baa3
2018	B3	B3	B2	B3	NR	Ba2	B2	B3	Ba3	B3	B2	B3	Baa3	B2	Ba3	Ba2	Baa1	A1	Ba2	Baa3
2019	B3	B3	B2	B3	Caa1	Ba2	B2	B3	Ba3	B3	B2	B3	Baa3	B2	Ba3	Ba2	Baa3	A1	B1	Baa3

Appendix 3B. Selected Frontier Market Eurobonds

Table 3B1 Selected Eurobonds

Frontier Markets	Total Eurobonds issued between 1988 and 2019	To maximise observations, the following issued Eurobond has been selected	Selected Eurobond ISIN	Selected Eurobond USD issuance amount	Amount of IMF WEO updates as per life of the Eurobond
Belarus	4	2011–2018	XS0583616239	800,000,000	14
Dominican Republic	21	2005–2018	USP3579EAD96	586,466,000	26
Ecuador	15	2000–2012	XS0115748401	1,250,000,000	24
Egypt	16	2001–2011	XS0132214130	1,000,000,000	20
El Salvador	14	2002–2023	USP01012AJ55	800,000,000	32
Gabon	4	2007–2017	XS0333225000	1,000,000,000	20
Georgia	2	2011–2021	XS0617134092	500,000,000	14
Ghana	7	2007–2017	XS0323760370	750,000,000	20
Iraq	2	2006–2028	XS0240295575	2,700,000,000	24
Ivory Coast	10	2010–2032	XS0496488395	2,519,048,000	16
Jamaica	16	2001–2022	US470160AQ50	250,000,000	34
Nigeria	13	2011–2021	XS0584435142	500,000,000	14
Pakistan	12	2007–2017	USY8793YAM40	750,000,000	24
Senegal	5	2011–2021	XS0625251854	500,000,000	14
Sri Lanka	14	2010–2020	USY2029SAF12	1,000,000,000	16
Vietnam	5	2005–2016	US92670LAD10	750,000,000	26
Control Countries					
South Africa		1997–2017	US836205AD62	500,000,000	32
Brazil		2005–2015	US105756BG46	2,100,000,000	20
China		2001–2011	XS0129936331	1,000,000,000	20
Turkey		2000–2030	US900123AL40	1,500,000,000	34
Macroeconomic Factors					
JP Morgan Next Generation Markets Index Composition Index Level (NEXGEM INDEX)			NGEMCOBY Index		36
10-yr US Treasury Yield			USGG10-YR Index		36
JPM Emerging Market Bond Index Global Blended Yield (JPM EMBI)			JPEGBLYD Index		36

Note: The bond selected for each individual country was chosen on the basis of having the highest number of data points for the analysis period (2001–2018) and an amount of outstanding bonds at issuance equivalent to or higher than USD 250 million.

Appendix 3C. Fisher ADF Test

Table 3C1 Outcome of the Fisher panel unit root test

ADF Normality Test	At First Difference
ΔIMFspr_fall	−9.845 (0.000) ***
ΔIMFspr_spr	−8.281 (0.000) ***
ΔIMFfall_fall	−10.360 (0.000) ***
Avgyldcg	−13.186 (0.000) ***
ΔNexgemYLD	−11.135 (0.000) ***
ΔUST	−10.258 (0.000) ***
ΔEMBIy	−9.881 (0.000) ***

Note: The variables are not stationary at first difference. ***, ** and * show the level of significance at 1%, 5% and 10%, respectively. As per Choi's (2001) simulation, the results suggest that the inverse normal Z statistic offers the best trade-off between size and power, which is the statistic shown in the table.

Appendix 3D. Unbalanced Panel Regression Correlations

Table 3D1 Whole-sample correlations of unbalanced panel regression

	px	Yld	chpx	AbnormRT	IMFspr_fall	IMFspr_spr	IMFfall_fall	Avgyldcg	FinDevelopDumy	NexgemYLD	UST	EMBIy	FinDevelopRank
px	1.000												
yld	−0.229	1.000											
chpx	−0.024	−0.004	1.000										
AbnormRT	−0.211	0.998	0.010	1.000									
IMFspr_fall	0.071	0.068	−0.160	0.063	1.000								
IMFspr_spr	0.055	0.069	−0.107	0.067	−0.035	1.000							
IMFfall_fall	0.091	0.100	−0.134	0.097	0.516	0.463	1.000						
Avgyldcg	−0.101	0.035	−0.061	0.034	0.026	−0.049	−0.233	1.000					
FinDevelopDumy	−0.464	0.045	0.049	0.039	−0.070	−0.038	−0.104	−0.019	1.000				
NexgemYLD	−0.088	−0.003	−0.217	−0.006	0.062	−0.021	−0.176	0.742	−0.031	1.000			
UST	−0.115	−0.036	−0.124	−0.040	0.041	0.014	−0.141	0.638	−0.055	0.614	1.000		
EMBIy	−0.097	0.017	−0.075	0.015	0.032	−0.035	−0.229	0.920	−0.029	0.832	0.630	1.000	
FinDevelopRank	−0.427	0.032	0.041	0.027	−0.087	−0.069	−0.153	−0.018	0.873	−0.020	−0.045	−0.028	1.000

Appendix 3E. Shapiro–Wilk & Shapiro–Francia Tests

Table 3E1 Normality test results

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob > z
yld	381	0.03635	253.987	13.146	0

sfrancia yld

Shapiro–Francia W' test for normal data

Variable	obs	W'	V'	z	Prob > z
yld	381	0.03635	253.987	13.146	0.00001

Appendix 3F. List of Acronyms

Table 3F1 Acronyms used in Chapter 3

AbnormRT	Abnormal return of Eurobond yield versus equivalent credit rating in the sample
yld	Change in yield
IMFspr_fall	Change in IMF macroeconomic composite for spring-to-autumn period for 1 forecast
IMFspr_spr	Change in IMF macroeconomic composite for spring-to-spring period for 1 forecast
IMFfall_fall	Change in IMF macroeconomic composite for autumn-to-autumn period for 1 forecast
AverageYLD	Average yield change for all frontier market bonds
FinDevelopDumy	Dummy variable; control countries have a score of 0 and FMs have a score of 1
FinDevelopRank	Actual IMF financial development ranking
NexgemYLD	Change in NEXGEM index yield
UST	10-year US Treasury yield change
EMBIy	Change in JPM EMBI index yield

Chapter 4. Do 5-Year EM Sovereign CDS Price Changes Lead FM Sovereign Eurobond Yields?

Application of the BEKK model to analyse spillover effects

4.1 Introduction

CDS contracts are particularly important for EM or high-yield sovereign investors because of the higher perceived investment risk associated with EM countries. When a nation is under financial stress, it can usually not liquidate its assets or enter into bankruptcy proceedings, which is what a corporate entity would do. Rather, countries go through a debt restructuring process, which often results in defaulted bonds getting exchanged for newer, longer maturity bonds with lower yields/coupon-carrying debt instruments (Ismailescu and Kazemi, 2010).

Sovereign CDS spreads are driven by not only idiosyncratic country fundamentals but also global factors (e.g. Bouri et al., 2017). Credit ratings are a key component of bond investment and portfolio construction. Analysts, investors and commentators use them to assess the creditworthiness of bond issuers rather than to ascertain the quality of the bonds themselves (Hull et al., 2004). Furthermore, as research by Norden and Weber (2009) revealed, the co-movement between CDS prices and bond prices increases the lower the credit rating of the issuing company.

However, a key question revolves around the leading potential of CDS prices on bond yields or vice versa. One well-documented element of CDS markets is that the contracts have a leading effect on the corporate bond market, implying that for corporate bonds, price discoveries largely occur in the CDS market rather than the bond market itself (Blanco et al., 2003). From a macroeconomic perspective, as with sovereign bonds, CDS contract prices move when economic indicators for the country's economy change; hence, CDS contracts incorporate economic indicators (Sensoy et al., 2017).

One possible explanation for CDS prices moving ahead of bond yields was given by Longstaff et al. (2011). The sovereign CDS market is typically more liquid than the corresponding reference country's sovereign bond market, allowing for more specific price discovery, that is, estimations of credit spreads and returns. This is particularly important when considering FMs, as the sovereign bond markets for FMs are typically much less liquid than those of the more developed EM markets (Delvaux et al., 2020).

In the realm of bond market research, many of the previous studies on CDS prices were based on the linear modelling of the relationship between CDS prices and their underlying reference corporate entity or country. Additionally, many of the studies focused on the CDS markets and the interaction between stock options and the reference entity or underlying stocks from the corporate perspective (Ngene et al., 2014). Little attention has been given to how effective CDS price changes of the relatively large and liquid benchmark EM CDS contracts impact the more illiquid sovereign FM bond yields, where the CDS in question is *not directly linked to the same underlying sovereign.* This is relevant, given that FM sovereign CDS contracts do not have the same liquidity or market depth as the larger, more developed EM sovereign CDS markets, and some do not actively trade. As Table 3.1 shows, the most actively traded EM CDS contracts are those of Mexico, Turkey, Brazil, China, Russia, Indonesia and South Africa (as per Q3 2019, Emerging Market Trade Association [EMTA]).

As previously stated, FMs often have either no actively traded CDS or limited liquidity in their respective CDS market, thus making the nature of price discovery difficult and sporadic. This is reason to question whether larger EM benchmark CDS prices are correlated with FM Eurobonds. If there is a relationship between EM benchmark CDS prices and FM Eurobonds, are the sovereign CDS prices leading the FM Eurobond yields, as numerous researchers have shown to be case for corporate Eurobonds (e.g. Blanco et al., 2005; Zhu, 2004)?

Given that sovereign CDS price movements have a leading effect on EM sovereigns (Ammer and Cai, 2011) and that the liquidity of CDS markets is a key component of this relationship, we ask several questions:

1. Do the more liquid EM sovereign CDS prices (often referred to as benchmark EM CDS) lead the less liquid FM sovereign Eurobond yields? It has been shown that global factors affect both EM CDS prices (Longstaff et al., 2011; Blanco et al., 2005) and FM sovereign Eurobond yields and prices (Delvaux et al., 2020).
2. Given that sovereign bond yields are largely affected by global factors and that CDS prices lead bond prices (Longstaff et al., 2011; Blanco et al., 2005), how well do benchmark EM 5-year CDS contracts opening in the morning predict where FM bond yields will trade later in the day, especially since the findings of Fender et al. (2012) highlight that EM CDS spreads are more linked to global and regional risk premia? Are EM benchmark CDS contracts a good predictor of where FM bond yields trade at their open?

For our empirical research, we considered the one-day price movement of EM sovereign 5-year CDS prices at 7:30 am GMT for Brazil, China, Russia, South Africa, Turkey and the Itraxx Asia (excluding Japan's index) as a global risk factor, which was compared with the subsequent one-day yield movement of individual FM sovereign bonds, in this case represented by the SSA countries of Angola, Cameroon, Egypt, Ghana, Ivory Coast, Kenya, Nigeria and Senegal as a subsample, taken at 8:30 am GMT. The time difference is to account for the difference in trading hours, as CDS markets tend to be open 24 hours on trading days, while SSA Eurobonds only trade during European trading times. Figure 4.1 shows the amalgamated sample sovereign Eurobond log yield returns versus the selected benchmark EM 5-year CDS log price returns. There is a clear correlation between the CDS price movements and the Eurobond yields.

The reason for considering selected SSA countries as a subsample is that those countries are largely ignored in academic research. From a practitioner's perspective, SSA is considered a subsegment of the broader EM universe and a proxy for FM countries.

Hence, this research fills the gap identified above, demonstrating that EM benchmark sovereign CDS prices have a leading effect on FM sovereign Eurobonds. It allows market investors and regulatory bodies to gain a better understanding of the underlying drivers of FM sovereign Eurobond yields, how those drivers are connected to the global financial markets and how to hedge their potential investment risks in an environment where FM Eurobonds are gaining in importance. Furthermore, the application of a diagonal (BEKK) model to ascertain the spillover effects of the different assets is not often found in the existing literature and provides a useful new methodology in this context. Due to its ability to deal with small matrixes, the diagonal BEKK model is better suited for this analysis than other dynamic conditional correlation models (DCC) within the multivariate GARCH universe.

The outcome of our analysis shows that in nearly 40% of cases, when augmenting the BEKK model from a pair 2x2 matrix to a 7x7 matrix and running the pairs of selected Eurobonds versus various selected EM CDS, the sign and multiplier remain the same, highlighting the robustness of the outcome. There is a spillover and thus a leading positive effect from the liquid EM sample CDS to the FM Eurobond yields. South Africa's and Turkey's CDS are the most consistent leading indicators.

The remainder of this chapter is organised as follows. Section 4.2 presents the literature review. In Section 4.3, the development of the econometric framework is outlined, while in Section 4.4, the relevant data are explained. Section 4.5 reports the empirical findings, and Section 4.6 summarises the findings.

4.2 Literature Review

A large body of existing literature looks at CDS contracts in detail and is, unsurprisingly, mainly focused on DMs and on investment-grade corporate CDS contracts and their reference bond (e.g. Blanco et al, 2005; Longstaff et al., 2005; Hull and White, 2000).

To conduct our analysis, we drew from the literature that focuses on the co-movement or leading effect of sovereign CDS contracts on bond yields[36].

Limited emphasis has been placed on sovereign CDS prices and their effect or spillover on sovereign bonds. In our analysis, we focused on the leading effect of sovereign CDS prices on Eurobond yields, regardless of a spillover of volatility from the CDS prices on the Eurobond yields.

Previous studies focused on sovereign CDS prices and sovereign bonds for developing countries, and as highlighted by Tampakoudis et al. (2019), the findings on

[36] More recent research has focused on the potential leading effect of equity prices on CDS prices and their respective reference bond yields (Ammen and Cai, 2011) and on the potential effect of equity prices leading their respective CDS prices and how commodity price changes can lead CDS prices (Bouri et al., 2017).

the lead–lag effect of EM sovereign CDS prices on their respective sovereign bond yield were often contradictory.

A logical assumption is that what affects a sovereign CDS for a given country should also affect the same country's sovereign debt price, or yield, given that the CDS contract is intended to act as insurance against the sovereign defaulting or any other credit event (Ismailescu and Philips, 2015). On the other hand, Acharya and Johnson (2007) demonstrated that CDS markets behave asymmetrically and reveal the 'bad news', that is, adverse shocks associated with credit deterioration, but not the 'good news'.

Tampakoudis et al. (2019) analysed the lead–lag relationship between sovereign CDS and the sovereign underlying bond spreads of highly indebted southern European countries by applying a Johansen cointegration test followed by the Granger causality test. Their findings highlight that during periods of economic turbulence, the CDS market leads the bond market in price discovery, incorporating new information about sovereign credit risk faster and more efficiently than the bond market. This highlights that CDS prices lead price discovery during periods when sovereign bonds are under stress and most likely less liquid in terms of trading than under normal circumstances.

The element of contagion between sovereign bond yields and CDS prices has been demonstrated by the findings of Alder and Song (2010). Following the Argentina default in December 2001, Brazil witnessed its bond yield spreads widening by 30% during its election crisis in 2002–2003. The authors further found that for the entire Latin American (LATAM) region in their sample, both the CDS spreads and sovereign bond yields widened over that period. However, CDS prices increased more during that time than the implied bond yield spreads, which in turn led the authors to reject the parity relationship between CDS spreads and bond prices for the LATAM region.

Taking the argument further, Fender et al. (2012), using a GARCH model for 12 EM country CDS prices between August 2007 and December 2011, identified that EM CDS spreads are correlated more with global and regional risk premia than with idiosyncratic country risk factors.

The EM includes a large array of markets at significantly different stages of financial and economic development. Ismailescu and Philips (2015) analysed the impact of starting CDS trading for 41 sovereign countries, comparing DMs and EMs. Their findings show that, on average, bonds in the rating categories AAA–AA had a reduction in yield of 30 basis points, while bonds in the categories B–CCC had a yield decline of approximately 150 basis points over a period of six months post the CDS trading initiation. This indicates that the financial markets attribute a greater effect to CDS contracts being available for sovereigns with lower credit ratings than to, for instance, investment-grade credit ratings.

By analysing the CDS spreads for 44 countries, Augustin (2018) identified that the influence of global and domestic risks on sovereign credit risk varies over time, especially with an increase in linkage between a country's domestic financial sector and sovereign default risk during times of distress. This is in line with the findings of Acharya et al. (2014) and Gennaioli et al. (2014).

One key reason for the disparity in results could be that CDS markets do not all have the same liquidity or efficiency (Ismailescu and Philips, 2015). For example, Sensoy et al. (2017) found that out of 16 EM countries, Thailand, China, South Korea and Malaysia had the most efficient CDS markets, while Colombia, South Africa and Turkey had the least efficient CDS markets on a log-return basis over the period between 5 January 2004 and 18 March 2016. An earlier study by Ammer and Cai (2011) analysed the daily data of nine nations. Its findings highlight the liquidity of the bond markets as a decisive factor in the lead–lag relationship between sovereign bonds and CDS prices. The authors suggested that the more bond issuances a country has, or rather, the more liquid a country's bond market is, the less likely it is that the CDS market will lead bond yields.

This leads us to the following straightforward question: Given that FM bonds are by definition less liquid (in terms of trading) than EM bonds (Delvaux et al., 2020) and that the FM CDS market is extremely shallow (or does not exist at all), do the more liquid EM sovereign CDS lead the FM countries' bond yields? Note that in our study, FM countries are represented by SSA markets.

4.3 Econometric Framework and Research Methodology

The methodology applied in this study partially follows that of Bouri et al. (2017) in terms of the test for causality in variance for EM benchmark sovereign CDS spreads and FM sovereign Eurobond yields, applying the Hafner and Herzwartz (2006) causality test and using the Lagrange multiplier (LM) methodology, as opposed to using the cross-correlation function (Hong, 2001; Cheung and Ng, 1996). This method overcomes the issues of oversizing in small and medium samples when the volatility process is leptokurtic (Hafner and Herwartz, 2006), while the analysis continues to be sensitive to the order of leads and lags.

Compared to the previous studies we mentioned, this study used a novel approach by applying a diagonal BEKK model, following the method used by Zolfaghari et al. (2020). Applying a partial BEKK model allows for asymptotic behaviour, and in this study, made it possible to measure the spillover effects of EM

CDS prices on FM Eurobonds yields. Furthermore, the diagonal BEKK model is more adaptable to analyse a small number of matrixes than other DCC models. Combining these methodologies allowed us to take into account the causality of volatility and spillover effects between asset pairs and thus the transmission from EM sovereign CDS prices to FM sovereign Eurobond yields. The extension of a classic univariate model to a multivariate model is challenging, as it needs to consider potential time-varying correlations between assets (Zolfaghari et al., 2020).

4.3.1 Multivariate Models

Our analysis focused on the BEKK model, which, as highlighted by numerous authors, such as Engle and Kroner (1995), is one of the most frequently applied models and accounts for conditional variances of one variable to depend on lagged values of other variables. As discussed by Engle and Kroner (1995), it is this feature that allows testing for the causal impact of lagged volatility of, in our case, the Eurobond yields, while at the same time producing a definitive non-negative covariance matrix.

Following the methodology laid out by Zolfahari et al. (2020), Equation (11) considers the relationship between standardised residuals and return shocks.

$$n_t = \frac{\epsilon_t}{\sqrt{h_t}} \quad (11)$$

where $\in_t$ is the error term and $h_t$is the conditional volatility.

Attributing a vector interpretation to variables, one can extend a conditional mean of financial returns equation that originally would be described as:

$$y_t = E(y_t | I_{t-1}) + \in_t \quad (12)$$

where $y_t = \Delta \log P_t$, which represents the log return of the assets and is defined as the difference between log values of prices P_t; and I_t represents the information set used at time t−1. When applying Equation (11) to Equation (12), the latter remains the same, assuming that the variables are m x 1 vectors, where m represents the number of assets.

The standardised residual $\in_t$ in a multivariate model is related to the vector n_t in the next equations:

$$\in_t = D_t^{\frac{1}{2}} n_t \quad (13)$$

where D_t= diag $(h_1, h_2, \dots, h_{mt})$ represents a diagonal matrix made of the conditional volatilities estimated by the univariate models.

Following the methodology laid out by Zolfaghari et al. (2020), we define the conditional variance matrix $\in_t$ as Q_t. Given the m x 1 vector, n_t is assumed to be i. i. d for all m elements, the conditional correlation matrix as given by n_t is presented by Γ_t, resulting in the conditional expectation by applying Equation (13) and allowing for global risk factors to be added to this equation, thus resulting in:

$$Q_t = D_t^{\frac{1}{2}} \Gamma_t D_t^{\frac{1}{2}} \quad (14)$$

The resulting conditional correlation matrix Γ_t can be written as:

$$\Gamma_t = D_t^{\frac{1}{2}} Q_t D_t^{-\frac{1}{2}} \quad (15)$$

As per Zolfaghari et al. (2020), if applicable, the model in Equation (14) for the conditional correlation matrix Γ_t can be applied to estimate Q_t, in contrast to Equation (15), that is, the model where Q_t can be applied to estimate Γ_t.

4.3.2 Diagonal BEKK

A key element highlighted by Zolfaghari et al. (2020) and McAleer et al. (2008) is that the diagonal partial BEKK model, by setting restrictions for off-diagonal components, overcomes the failings of the classic full BEKK model, which has been said to be missing the proper micro foundation and set regulatory conditions. The authors additionally noted that the diagonal BEKK model significantly reduces the number of parameters, as all off-diagonal parameters are deemed zero, allowing for asymptotic behaviour and justifying the use of the quasi-maximum likelihood estimator (QMLE) method. $\alpha + \beta < 1$ is presented by the authors as a satisfying condition for the QMLE of GARCH (1,1) to be considered asymptotically normal.

Considering a vector version of an original random coefficient univariate model in line with Zolfaghari et al. (2020):

$$\in_t = \emptyset_t \in_{t-1} + n_t \qquad (16)$$

where $\in_t$ and n_t are m x 1 vectors; $\emptyset_t$ is the m x m matrix of random coefficients; $\emptyset_t \sim i.i.d(0, A)$, where A is a positive definite matrix; and $n_t \sim i.i.d\ (0, C)$, where C is an m x m matrix. The outcome of Matrix A is crucial, as it allows for the reading of symmetric or asymmetric weights for the return shocks.

McAleer et al. (2008) demonstrated that the multivariate extension of GARCH (1,1) is given as:

$$Q_t = CC' + A_{\in_{t-1}\in'_{t-1}}A' + BQ_{t-1}B' \qquad (17)$$

In Equation (17), both A and B are m x m diagonal matrices, while C is an upper triangular matrix, as per Zolfaghari et al. (2020), and $\in_{t-1}$ represents the m x 1 disturbance vector. The parameters of the QMLE of the diagonal BEKK model are consistent and asymptotically normal.

4.3.3 The A Matrix

As described by Zolfaghari et al. (2020), the outcome of Matrix A is crucial, as it demonstrates the size of the shocks on the conditional covariance to be analysed.

4.3.3.1 Scalar Versus Diagonal BEKK

Following Zolfaghari et al. (2020), we defined diagonal as the diagonal elements of the weight in Matrix A being different when applying the diagonal BEKK model. In the case of the scalar model, 'diagonal' is defined as the cells in the weight of Matrix A being similar for the different assets. Zolfaghari et al. (2020) additionally suggested that it is more useful to compare the multipliers rather than the magnitude of the spillover effects.

4.3.3.2 Analysis of Symmetry and Asymmetry

When referring to sign patterns, we considered them as either symmetric (where both series carry the same sign, positive or negative) or asymmetric (when the signs differ between the series). The reason to analyse the signs of the spillover effects is that the signs can vary substantially due to return shocks from previous periods. As stated by Chang et al. (2019) and Zolfaghari et al. (2020), an overall pattern between different assets can be analysed by calculating the mean spillover effect.

4.3.3.3 Analysis of Covolatility[37]

In this research, covolatility is defined as the volatility between two or more financial instruments. To analyse the impact of a lagged shock to asset *i* on the covolatility between asset i and the other assets for period t, we conducted a partial covolatility spillover analysis, similar to the method applied by Zolfaghari et al. (2020). The applied definition is:

$$\frac{\partial Q_{ij,t}}{\partial \in_{i,t-1}} = A_{ii} A_{jj} \in_{j,t} \quad (18)$$

where Q represents the conditional covariance in the matrix, A is the weight in the matrix and ∈ is the residual. As demonstrated by Chang et al. (2018, 2019), a diagonal BEKK model can only analyse partial covolatility effects, not the full volatility and covolatility. However, we chose to use a diagonal BEKK model for its statistical rigour and soundness. We applied the return series r_t of the CDS log price daily changes versus the daily change in FM sovereign Eurobond yields.

4.3.3.4 Empirical Research strategy

The first set of analyses assessed the changes in EM 5-year sovereign CDS price volatility on the sample of FM sovereign Eurobond yields, that is, identification of the autoregressive conditional heteroskedasticity (ARCH) effect.

The second set of analyses examined the spillover effect of the Eurobond yield changes on EM 5-year sovereign CDS by applying the BEKK model. The latter stage allowed us to analyse if CDS price volatility has a leading effect on Eurobond yields.

4.4 The Data

The time frame chosen for this analysis is 1 January 2014 to 4 May 2020. The data for both the sovereign Eurobond yields and the CDS prices were provided by Cambridge Financial Information Services (Cambridge FIS; https://cambridgefis.com). Cambridge FIS is a financial information services firm that provides independent market data and security prices to fixed income and derivative market participants. The Cambridge FIS fixed income pricing service provides clients with a daily source of independent prices that aid in valuations, portfolio analytics, best execution reporting and risk management calculations.

The sovereign Eurobonds in SSA were selected arbitrarily to represent the wider FM universe and to have the greatest number of countries represented within the sample, with at least one Eurobond for every country. Selection was dependent on the availability of data. Where possible, we chose both a medium and a longer maturity bond for each country to analyse the EM CDS spillover effects.

CDS selection was based on the EMTA's Q3 2019 survey data (Table 4.1). We chose the most liquid CDS contracts while including only one of the larger EM countries per region. For instance, as Table 4.1 shows, Mexico's volume of traded CDS is larger than that of Brazil; nevertheless, we chose Brazil because the country has a lower credit rating than Mexico and is not likely to lead the overall LATAM markets, whereas Brazil would have greater impact. Similarly, we chose China for Asia, as opposed to both Indonesia and China, given that from an economic perspective, China is a significantly larger and more dominant market.

The analysis also included the ITRAXX Asia (excluding Japan's CDS index; Itraxx exJ), which is comprised of the 40 most liquid Asian entities with investment-grade credit ratings, published by Markit and excluding Japan. Using the Itraxx exJ allowed us to employ a general market risk index that captured the general market risk at the time of the market opening, as due to time zone differences, these markets are hours ahead of GMT.

If a Eurobond yield or CDS price was not available at precisely either 7:30 am or 8:30 am GMT, by default, we would use the next available price at the time closest to the initial two time points.

The selected period was 1 January 2014–4 May 2020, based on data availability. The SSA sovereign Eurobond markets had the most Eurobonds issued in that period, allowing us to analyse the sovereign Eurobond yields in a more liquid context than the pre–2014 period. The data selected for analysis is reported in Table

4.4.1 CDS

The primary data used in this research are based on daily observations of CDS spreads obtained from Cambridge FIS. The firm parses CDS quotes from market communications, typically in the form of indicative quotes emailed from the sell side to the buy side. These data are cleaned for spurious points, such as outliers or stale spreads. Curves displaying inversion are investigated manually to ensure accuracy. Cleaned data are then averaged into a composite price series. Consistent with the research of Senoy et al. (2017) and Ismailescu and Kazemi (2010), the focus of this study was the 5-year CDS contract, as this is the largest and most liquid part of the CDS curves (Ismailescu and Kazemi, 2010). This is in line with our hypothesis that liquidity plays a key role in volatility transmission. We selected five of the most-traded CDS contracts reported in the EMTA Q3 2019 trade volume survey (Table 4.1): the contracts of South Africa, Turkey, Russia, China and Brazil. In this thesis, we refer to them collectively as the benchmark sovereign CDS.

Another main goal of the selection process was to have one sovereign EM CDS country per geographical region; hence, South Africa for SSA, Turkey for the Middle East and North Africa, Russia for Central Eastern Europe, China for Asia and Brazil for LATAM. In terms of other CDS indices, we selected the Itraxx exJ[38].

Itraxx exJ was included to incorporate a wider global market risk parameter. The index covers the whole of Asia but excludes Japan on the basis that Japan is a

[38] Itraxx exj was selected on the basis that it captures the whole of emerging Asia, excluding Japan (the model-developed financial market in Asia), thus allowing us to capture only the emerging market movement in Asian CDS prices at the London, UK market opening times.

developed market; thus, the CDS will trade differently than typical EM sovereign CDS contracts. Choosing this index allowed for a solid global market risk measure on the basis that, although trading occurs more or less 24 hours a day, the most active trading period would be during Asian trading hours; hence, the index will already have embedded market views and risk perception when the daily price point is captured. The data were collected daily, at 7:30 am GMT, during our sample period, 1 January 2014–4 May 2020.

4.4.2 Bond Yields

While Delvaux et al. (2018) suggested using FM Eurobond prices as opposed to yields, we used bond yields in this analysis. The reason for this is the way CDS contracts are priced, as highlighted by Adler and Song (2010) and demonstrated by Duffie (1999) and Hull and White (2000). The base CDS pricing equation considers bond spreads and thus bond yields, not the cash price of the bonds. The daily mid-bond yield was obtained from Cambridge FIS, which acquires observable pricing data from trade reporting utilities and parses indicative prices from emails sent from the sell side to the buy side. Prices are organised by issuer, and an issuer-level yield curve is implied from the prices. This yield curve is used to price on- and off-the-run securities from the same issuer. For those issuers that lack sufficient liquidity to imply an issuer-level yield curve, securities are priced using a proxy curve that is chosen based on factors such as rating, sector, region and/or industry. The 17 bonds selected for this study are listed in Table 4.2, as are the descriptive statistics of the data used.

During Eurobond selection, we chose a similar set of maturities that would have the largest amount of data available across the entire SSA sovereign Eurobond realm. Furthermore, the analysis had to include a mix of two maturities: one medium-term maturity (in our case, a 4-to-5-year maturity that would roughly coincide with the life of a 5-year CDS contract) and a long maturity of more than 25 years to determine if there is a change in sensitivity at different maturities. If the bond in question was not issued as of 1 January 2014, the data were taken as of the time the bond was issued at the later date.

The daily yield was taken as of 8:30 am GMT. For this analysis, we chose to use Eurobond yields as opposed to Eurobond prices, given that overall, the existing literature focuses on yields rather than prices.

'Return' is defined as the yield received from the current pricing source at the set time on a given date, also referred to as last yield. If last yield was not available, a mid-yield was computed from bid-ask spread. In situations where only the bid or ask was available (thus making it impossible to calculate the mid), the model applied whichever yield was available as the yield at the time.

The log returns used in the analysis were computed by taking the difference between the CDS price from the day before and that of the next day. The same calculation was used for the Eurobond yields but using the mid-yield between bid and offer on the bonds from the day before to the next day.

4.5 Empirical Results

4.5.1 Preliminary Results and Descriptive Statistics

In Figure 4.1, we can see that the average SSA Eurobond yield and the South Africa (SA) CDS appear to be closely correlated.

In Table 4.3, we report the correlations between the benchmark EM CDS prices that were used and the various Eurobond yields in our sample. We see that there is a correlation between the benchmark sovereign CDS price returns and some of the sovereign Eurobonds, as one would expect. For example, the lowest correlation for SA

CDS is with the Egypt 2025 Eurobond, at 0.37, while the highest correlation is between Nigeria 2047 and the SA CDS, at 0.60. At −0.01, the lowest correlation exists between Angola 2048 and the Itraxx exJ. The highest correlations between bond yields and CDS prices are for South Africa and Turkey, especially for the longer-maturity bonds, with one notable exception: Angola 2025 has a slightly higher correlation with the South Africa CDS than the Turkey CDS .

In Table 4.4, we see the results of the Bera–Jarque test for normality. Those results show that, as expected, the Eurobond log yield returns are not normally distributed. This outcome was taken into account when selecting the best fit GARCH models in our analysis. We tested for stationarity in our series by applying the ADF test (ADF, 1979). The results show that there was no presence of unit root in the log return of the Eurobond yields (Table 4.4).

The outcome of the Lagrange Multiplier Autoregressive Conditional Heteroskedasticity test (LM ARCH) is presented in Table 4.5, showing that all the variables reject the null hypothesis of no ARCH effect at 1 lag, demonstrating that the sample has the presence of ARCH effects. Following the methodology outlined in Section 4.3, the outcomes of the Akaike Information Criterion (AIC) were applied to define the best fit multivariate BEKK model.

4.5.2 Model Selection Process

To find the GARCH model with the best fit, our first step was to apply the Gaussian distribution, followed by the t-distribution to subsequently identify which distribution allowed for the best fit model.

We analysed the effect of CDS price volatility on Eurobond yields first, followed by the effect of Eurobond yield volatility on CDS prices. In each part, the analysis repeated the following steps. The first regression was the GARCH (1,1), as per Bollerslev (1986), using the Gaussian distribution assumption (Table 4.5). The second regression was the GARCH (1,1) using the Student t distribution (Table 4.5). Student t distribution was applied as a result of the outcome of the normality tests (Section 4.5.1), which highlighted that the sample data were not normally distributed, as reported in Table 4.4. The stationarity conditions were respected and met for both models in all the cases, that is, as α & $\beta < 1$[39].

In summary, the outcome of these steps led us to select the models with the best fit, as presented in the outcome summary in Table 4.6, which presents the symmetry and asymmetry in signs and whether the applied matrix is scalar or diagonal. Considering the AIC results for best fit (Appendix 4A) for Kenya 2024, Angola 2025, Ivory Coast 2040, Senegal 2024 and Ghana 2049, the GARCH (1,1) model had the highest AIC results, while the remaining Eurobonds in the sample had their highest AIC scores when applying the AR-(GJR)-GARCH (1,1)[40] model.

The causality variance test for the models of best fit, applying the LM analysis, is shown in Table 4.5. The null hypothesis that there is no ARCH effect in any case is rejected, demonstrating that the independent variables (CDS prices) have predictive power over the dependent variables (Eurobond yield changes).

4.5.3 Empirical Results

This section explores the outcomes of the analysis (see the model selection process set out in Section 4.3) of the impact of the price variance of EM sovereign 5-year CDS on the sample FM Eurobond yields. First, we want to emphasise that for all

[39] The table can be made available upon request to the authors.

[40] The novel approach of using a GJR-GARCH model was based on it being better suited for this analysis than the usual GARCH specifications, as it captures asymmetric volatility clustering.

the models, the stationarity conditions were met (α & β < 1). The models we selected for their best fit are presented in the outcome summary (Table 4.6).

Partial Covolatility Spillover Effects

In the next phase, we analysed best fit BEKK models using the Akaike test (Section 4.3). To conduct this analysis, as per Bouri et al. (2017) and Zolfaghari et al. (2020), we applied the AIC test for error distribution, choosing the model with the highest value. Table 4.6 shows that for most of the pairs, the model of best fit is the diagonal BEKK, using a normal distribution. In the cases where the AIC value was the same for the scalar and diagonal BEKK, we chose to use the diagonal BEKK. As a standard, we applied the Autoregressive Moving-Average Model (ARMA; 1,1). In the case of the model failing, we verified alternatively ARMA (2,2) and ARMA (0,0).

The best fit pair model that selected the scalar BEKK with a normal distribution was Nigeria 2025 with the SA, China and Itraxx exJ CDS and with all CDS combined applied (Table 4.6). The AIC results demonstrate that the Gaussian distribution is the overall best fit for our sample. The same was largely confirmed by the outcomes of the Wald Chi-squared test. As we used a relatively large Eurobond and CDS sample, certain pair models failed to generate any results due to the model breaking. The Eurobonds in our sample for which the models failed to generate valid pairs or outcomes were Kenya 2024, Angola 2025, Cameroon 2025, Ivory Coast 2024, Senegal 2024, Ghana 2049 and Egypt 2025. The most recurrent pairs among the Eurobonds that failed to generate any results were Itraxx exJ (89% of the time), followed by Russia CDS (78%) and Brazil and China CDS (67% each). The models selected based on best fit were utilised for further analysis.

As the next step, we analysed the covolatility spillover effects by testing the 7x7 Matrix A in the diagonal BEKK model. By augmenting the matrix from 2x2 to

7x7, we captured more variables, thus including all the CDS in the sample versus only individual pairs, as this could have an impact on the covolatility spillover. Table 4.7 presents the outcome for the diagonal BEKK weights and mean return shocks. It shows the individual pair results and the pair of the selected Eurobonds with all CDS combined as an equally weighted index. The results highlight that the coefficients are statistically significant for most individual pairs but not for Nigeria 2047, Ivory Coast 2040, Ivory Coast 2024 and Senegal 2048, where the coefficients are not statistically significant. When considering the outcome of the individual Eurobonds and all the CDS combined ($A_{(i,i)}$), we notice again that the majority of coefficients are significant. The exception is the coefficients of Angola 2025, Ivory Coast 2040 and 2024, and Egypt 2025. The highest weighted coefficient results are for Angola 2025 with SA CDS, followed by Senegal with China CDS and Itraxx exJ, while the lowest weight is for Senegal 2024 with Brazil CDS.

Not all the weights are positive: Nigeria 2047, Kenya 2048 and 2024, Angola 2048 and Senegal 2024 and 2048 have negatively weighted pairs. As highlighted by Zolfaghari et al. (2020), the magnitude of the volatility spillover effect cannot yet be understood. To understand the real impact, we need to multiply the weight of each asset by the return shock. Table 4.7 shows the outcome of the return shocks($\hat{\in}_l$). The majority of the numbers are positive. The largest recorded shocks are for all the CDS combined for Nigeria 2025 with the application of the scalar BEKK model, followed by the shocks of Senegal 2024 in the case of China and Itraxx exJ CDS.

Using those results, we then employed the statistically significant element of Matrix A to calculate the covolatility spillover effects, utilising the formula presented by Zolfaghari et al. (2020), $A_{ii} x A_{jj} x \in_{j,t-1}$, as outlined in Section 4.3.

Analysis of Spillover Patterns

In this section, we analyse the spillover patterns for the different pairs (2x2 and 7x7) in the BEKK model. We follow the method laid out by Zolfaghari et al. (2020) and Chang et al. (2019) in analysing the patterns of weight in Matrix A for the 7x7 and 2x2 pairs. Tables 4.9 and 4.10 show the partial covolatility spillover effects of the Eurobonds and CDS, respectively. The underlying principle is that a return shock in asset i (CDS) with an effect on the asset j (FM Eurobond yields) can be compared with the opposite return shock of asset j on asset i.

In Table 4.10, presenting the results for the 2x2 pairs, the majority of the pairs show diagonal BEKK with symmetric signs (D, Sym). The exceptions for the diagonal BEKK models are the pairs of Gabon 2025 and all CDS that are asymmetric or not identical in signs, followed by Ivory Coast and China CDS, Kenya 2024 and Turkey CDS, Senegal 2024, and Brazil CDS. Asymmetric signs indicate that the spillover effects between the two assets i and j have different directional effects. The notable exceptions of pairs that have a scalar BEKK model, meaning their multiplier on the contrary to the diagonal BEKK model do not change, can be found for Nigeria 2047 and 2025, Kenya 2048, Angola 2048 and 2025, Ivory Coast 2040, Senegal 2048 and 2024, Ghana 2049, and Gabon 2025. Asymmetries in signs for the scalar BEKK models are present for Angola 2025 and Brazil CDS, Ivory Coast 2040 and Itraxx exJ CDS, Senegal 2048 and China CDS, Senegal 2024 and SA CDS, and Gabon 2025 and SA CDS.

For the 7x7 pairs in Table 4.9, the majority show the best model defined as diagonal and symmetry in signs (D, Sym). The notable exceptions are Ivory Coast 2024, Nigeria 2025 and Nigeria 2047, which use the scalar model. Asymmetries in signs are present for most of the models with some CDS. The Turkey and Russia 5-year CDS show this most frequently.

Table 4.8, following the presentation method applied by Zolfaghari et al. (2020), demonstrates that the majority of the models do not share similarities across the pairs, although it is important to note that the basic 2x2 model did not generate results for some or most of the Eurobond and CDS combinations for Kenya 2024, Angola 2025, Cameroon 2025, Ivory Coast 2024, Senegal 2024, Ghana 2049 and Egypt 2025. In 39.1% of the cases, the weight and multiplier remain the same. When considering the models that generated an outcome for both 2x2 and 7x7, we notice that the majority have similarity in signs 73% of the time, and the same applies to certain Eurobond and CDS pairs.

Covolatility Effects

We analysed the covolatility spillover effects from one asset to another by testing the significance of the estimates in Matrix A in the diagonal or scalar BEKK model, as demonstrated by Zolfahari et al. (2020). 'The null hypothesis was rejected if the spillover effects from the CDS on the Eurobonds or vice versa demonstrated covolatility between them. The outcome of the BEKK model applying the model of best fit as per the AIC results is presented in Table 4.11. With the exclusion of Ghana 2049, where the model did not generate any results, the outcomes are significant. All the coefficients are significant at the $p \leq 0.01$ level, except for Ivory Coast 2040.

4.5.3.1 Covolatility Spillover Effects

We followed the research conducted by Chang et al. (2019) and Zolfagari et al. (2020) to calculate the average covolatility spillover effect of the CDS price changes on the SSA Eurobonds in our sample. The outcome is presented in Table 4.12. Note that the outcome shows mixed positive and negative signs. The highest numbers are reported for Senegal 2024 with Brazil/China CDS and Brazil/Itraxx exJ. Senegal 2024 shows the lowest numbers in combination with China CDS/Itraxx exJ.

4.5.4 Interpretation of Economic Effects

The following section examines the economic effects of the analysis conducted in this research.

Correlation Effects

As shown in Table 4.3, the SSA Eurobonds have a high degree of positive correlation with the selected EM CDS, ranging between 0.6 for Nigeria 2047 and the SA CDS and 0.19 for Itraxx exJ CDS and Angola 2025. The only notable exception is a small negative correlation of −0.01 between Itraxx exJ CDS and Angola 2048. The positive correlations demonstrate that the bond yields move up when the CDS prices – or alternatively, the price of hedging the credit risk – of the selected EM countries increase.

Itraxx exJ CDS overall demonstrates the lowest correlation with the SSA Eurobonds, while the CDS contracts within the SSA time zone of South Africa, Turkey and Russia have the highest correlations with the Eurobonds.

From an economic perspective, it can be assumed that oil-exporting countries, such as Angola, Nigeria and Ghana, would have a high degree of correlation with other oil exporters, such as Russia. While the CDS markets for SSA are highly illiquid or practically non-existent, from a geographic perspective, the SA CDS is the closest to the majority of the selected SSA Eurobonds, so a higher degree of a correlation is assumed.

Patterns

In Table 4.8 we notice there is no pattern for Ghana 2049 and Angola 2025, as the 7x7 model did not generate any results, thus not allowing for a pattern comparison to take place between the 2x2 pairs and the 7x7 models. The analysed patterns give an insight into the leading element originating from the connection between the EM CDS and the Eurobonds in our sample.

Table 4.8 demonstrates that of the total 161 pair analyses, 39.1% have similarities in both signs and multipliers. As illustrated by Zolfaghari et al. (2020), the same patterns indicate that even after including additional EM CDS contracts (in other words, increasing the weight of Matrix A in the model), the resulting structure of the pattern remains robust for both multipliers and signs. In 73% of the cases, the sign is the same between the 2x2 and the 7x7 models, while in 44% of the cases, the multiplier is the same.

Certain models did not generate any results, allowing us to compare patterns for Kenya 2024–Russia/Brazil/Itraxx CDS; Angola 2025–all the CDS combined; Cameroon 2025–Russia/China/Brazil/Itraxx CDS; Ivory Coast 2024–SA/Russia/China/Brazil/ITRAX CDS; Senegal 2024–Russia/China/Itraxx CDS; Ghana 2049–Itraxx/all the CDS combined; and Egypt 2025–SA/Turkey/Russia/China/Brazil/Itraxx CDS.

Interestingly, the same patterns occur most frequently for the SSA Eurobonds with Turkey CDS, followed by SA CDS, at seven and six times, respectively. For the CDS of Russia and China, the same patterns between the 2x2 and 7x7 models appear four times, while Brazil and Itraxx exJ CDS only have the same patterns for Eurobonds in three instances.

Thus, the models show that the highest degree of robustness is found in Turkey CDS and not SA CDS. This can be explained by the fact that Turkey's bond yields and CDS prices are more volatile than SA's. In addition, Delvaux et al. (2020) showed that the IMF's economic forecast corrections for Turkey are higher than for SA. As a result, in terms of volatility in relation to general market risk, Turkey is considered closer to SSA Eurobonds.

The surprising element is that the pattern for Russia CDS with SSA Eurobonds is most consistent not for oil-exporting countries but importing countries: Kenya 2048, Ivory Coast 2040, Ivory Coast 2024 and Senegal 2048. To a certain degree, this can be explained by the fact that these countries are more advanced in terms of economic development than some of their peers (Delvaux et al., 2018). Of the CDS selected within the SSA time zone, Russia CDS has the lowest price volatility.

Covolatility

By interpreting the results presented in Table 4.9, which shows the covolatility spillover effects, they can be used to determine the hedge ratios (Zolfahari et al., 2020) for portfolio management. The model shows the impact of the return shocks of asset i at t-1 and how it impacts asset j at time t. In our case, a negative result allows the use of the CDS as a hedge for Eurobond exposure in the portfolio. Furthermore, the patterns and hedging elements allow us to analyse whether there is a relevant lead indication of the CDS for the selected Eurobonds.

Positive results for Nigeria 2047 are registered for both Turkey and Itraxx exJ, while negative results are registered for SA, Russia, China and Brazil. Unfortunately, the model did not generate a result for Nigeria 2025. As an economy that is larger than SA and an oil-exporting country with a high degree of economic activity with China, it makes sense for these CDS to have a high degree of connection with the country's Eurobonds.

In the case of Kenya, we can see that Russia and China CDS have a negative effect on both Eurobonds, while for the shorter maturity bond, Turkey and Itraxx exJ CDS show positive results.

In the case of Angola, negative results are presented for the longer maturity in the case of Turkey, Russia and Brazil CDS. Like Russia, Angola is highly reliant on oil exportation, and it has strong economic links with Brazil. However, the Angola 2025 Eurobond pattern is more diverse, as certain combinations of CDS generate a negative outcome.

For Cameroon 2025, on the other hand, all the results shown in Table 4.9 are positive. This is to some degree due to the country having only a small number of Eurobonds outstanding, which reduces the amount of bond trading taking place. The Ivory Coast shows a more diverse pattern for the 2040 Eurobond, while the shorter maturity bond model failed to generate a conclusive result. In the case of Senegal, there is again a diverse pattern that demonstrates negative and positive outcomes across the various CDS selected. For Egypt 2025, we note that there are negative results for SA and Brazil CDS, allowing us not only to consider using these CDS to hedge out a holding but also to consider them as a lead indicator of where the Eurobond will open in trading.

4.6 Conclusion

Our analysis used a BEKK model to test whether the more liquid benchmark EM CDS lead FM sovereign Eurobonds (in our case, for SSA) through volatility spillover. We tested the BEKK models by applying different weights for Matrix A, similar to the analysis by Zolfaghari et al. (2020), and then compared the results for volatility spillover patterns.

The result is in line with our expectations, which were based on an investment practitioner's point of view. The correlation between the selected EM 5-year CDS prices and the FM Eurobond yields are generally high and statistically significant, with the highest correlation being between the Nigeria 2047 Eurobond and SA CDS, at 0.6. The few exceptions include the correlation between Angola 2048 and Itraxx exJ EM CDS, the lowest to be recorded at −0.01. Furthermore, the findings are in line with those of Ammer and Cai (2011), who suggested that the more bond issuances a sovereign has, or rather, the more liquid a sovereign bond market is, the less likely the CDS market will be to lead bond yields.

The split between the spillover patterns from the BEKK model indicates that for 39.1% of the models, the signs and multipliers remain coherent when augmenting the analysis from the 2x2 to the 7x7 model, which demonstrates the robustness of the models. In 73% of the cases, the sign remains the same, while in 44% of cases, the multiplier stays the same.

The CDS contracts that are the best lead indicators for the FM Eurobonds in the sample are the 5-year South Africa and Turkey CDS contracts. Given that the Eurobond sample consists of SSA countries and that South Africa is one of the leading economies on the African continent, it is unsurprising that the South Africa CDS prices have a stronger lead effect. The effect of the Turkey CDS can be partially explained by the fact that the economy actually shares many macroeconomic revisions, similar to or even more than some of the sample Eurobond countries (Delvaux et al., 2020), and Turkey trades in the same time zone as SSA. Our findings are in line with the arguments of Longstaff et al. (2011), who stated that liquidity plays a crucial role in price discovery and that the more liquid instruments can therefore lead the less liquid ones. In our case, the EM CDS prices lead the FM sovereign Eurobond yields.

Table 4.1 EMTA survey data in USD million as of 11 December 2019

	3Q 2019	2Q 2019	3Q 2018	% Δ3Q vs 2Q	% Δ3Q vs 3Q
Sovereign					
Argentina	15,039	14,980	22,854	0%	-34%
Brazil	40,873	34,109	63,174	20%	-35%
Chile	3,212	2,863	4,822	12%	-33%
China	50,185	33,145	44,759	51%	12%
Colombia	17,257	10,340	11,248	67%	53%
Dominican Republic	0	0	0	N/A	N/A
Ecuador	0	7	0	-100%	N/A
Hungary	222	51	41	339%	445%
Indonesia	32,678	21,225	42,901	54%	-24%
Lebanon	709	919	673	-23%	5%
Malaysia	14,699	8,242	19,290	78%	-24%
Mexico	35,117	25,914	40,809	36%	-14%
Panama	304	523	940	-42%	-68%
Peru	3,364	2,922	3,517	15%	-4%
Philippines	6,550	4,532	8,611	45%	-24%
Poland	116	33	9	245%	1176%
Qatar	2,683	1,417	N/A	89%	N/A
Russia	16,564	11,373	30,948	46%	-46%
Saudi Arabia	5,610	1,923	N/A	192%	N/A
South Africa	28,980	16,304	33,058	78%	-12%
Turkey	44,370	34,582	73,162	28%	-39%
Ukraine	137	10	0	1266%	N/A
Uruguay	2	53	0	-96%	N/A

Note: The EMTA survey data indicate that the top 7 traded EM CDS by volume are Mexico, Turkey, Brazil, China, Russia, Indonesia and South Africa. In Q3 2019, the average daily trading amount for Brazil, China, Russia, South Africa and Turkey is USD 2.8 billion [(USD 180.8 billion)/(63 trading days)].

Table 4.2 Data descriptions

Bond Name	Isin/ Identifiers/ Bloomberg Code	Coupon	Issuance Amount in USD Billion	Maturity	Start Date	End Date	Data Points	Oil/ Metals Exporter	Mid-Price Time Between Bid/Offer	Lagged Bond	Data Points	Mean	Standard Deviation	Min	Max	Variance	Skewness	Kurtosis
Nigeria 2047	AQ122937	7.63%	1.5	28 November 2047	22/11/2017	05/05/2020	636	Yes	8:30am GMT	LNigeria_47	632	0.000	0.140	−0.081	0.107	0.000	0.338	12.946
Nigeria 2025	AV671778	7.63%	1.1	21 November 2025	16/11/2018	05/05/2020	337	Yes	8:30am GMT	LNigeria_25	373	−0.001	0.190	−0.109	0.095	0.000	−0.662	10.862
Kenya 2048	AR264853	8.25%	1	28 February 2048	22/02/2018	05/05/2020	564	No	8:30am GMT	LKenya_48	558	0.000	0.011	−0.055	0.042	0.000	−0.450	5.386
Kenya 2024	EK3389005	6.88%	2	24 June 2024	20/06/2014	05/05/2020	1522	No	8:30am GMT	LKenya_24	1509	0.000	0.017	−0.108	0.157	0.000	1.465	19.554
Angola 2048	AS464350	9.38%	1.75	8 May 2048	04/05/2018	05/05/2020	515	Yes	8:30am GMT	LAngola_48	512	0.000	0.018	−0.137	0.200	0.000	1.953	36.844
Angola 2025	XS1318576086	9.50%	1.5	12 November 2025	09/11/2015	05/05/2020	1165	Yes	8:30am GMT	LAngola_25	1160	0.000	0.025	−0.150	0.309	0.001	5.235	62.405
Cameroon 2025	QJ781466	9.50%	0.75	19 November 2025	19/11/2015	05/05/2020	1136	Yes	8:30am GMT	LCameroon_25	1119	0.000	0.015	−0.070	0.226	0.000	4.813	63.464
Ivory Coast 2040	ZQ063071	6.88%	0.85	17 October 2040	19/03/2018	05/05/2020	553	No	8:30am GMT	LIV_40	547	0.000	0.010	−0.060	0.056	0.000	−0.136	7.33
Ivory Coast 2024	EK3927382	5.75%	0.75	23 July 2024	21/07/2014	05/05/2020	1480	No	8:30am GMT	LIV_24	1458	0.000	0.014	−0.106	0.092	0.000	−0.119	8.485
Senegal 2048	AR493943	6.75%	1	13 March 2048	08/03/2018	05/05/2020	557	No	8:30am GMT	LSenegal_48	552	0.000	0.010	−0.052	0.062	0.000	−0.211	7.494
Senegal 2024	EK4044732	6.25%	0.5	30 July 2024	28/07/2014	05/05/2020	1480	No	8:30am GMT	LSenegal_24	1457	0.000	0.014	−0.082	0.128	0.000	0.570	10.621
Ghana 2049	AS613891	8.63%	1	16 June 2049	14/05/2018	05/05/2020	1953	Yes	8:30am GMT	LGHana_49	1433	0.000	0.016	−0.080	0.242	0.000	2.276	37.406
Egypt 2025	EK960161	5.88%	1.5	11 June 2025	08/06/2015	05/05/2020	1272	No	8:30am GMT	LEgypt_47	1246	0.000	0.070	−0.090	0.254	0.000	−0.377	6.82
South Africa CDS	REPSOU CDS USD SR 5Y D14	N/A		5 years	01/01/2014	04/05/2020	1653	Yes	7:30am GMT	LSA_CDS	1652	0.000	0.027	−0.148	0.186	0.001	0.661	8.573
Turkey CDS	TURKEY CDS USD SR 5Y D14	N/A		5 years	01/01/2014	04/05/2020	1653	No	7:30am GMT	LTurkey_CDS	1652	0.000	0.029	−0.134	0.246	0.001	0.917	9.99
Russia CDS	RUSSIA CDS USD SR 5Y D14	N/A		5 years	01/01/2014	04/05/2020	1640	Yes	7:30am GMT	LRussia_CDS	1624	0.000	0.035	−0.213	0.283	0.001	0.531	12.49
China CDS	CHINAGOV CDS USD SR 5Y D14	N/A		5 years	01/01/2014	04/05/2020	1650	No	7:30am GMT	LChina_CDS	1647	0.000	0.030	−0.297	0.190	0.001	0.255	12.891
Brazil CDS	BRAZIL CDS USD SR 5Y D14	N/A		5 years	01/01/2014	04/05/2020	1653	Yes	7:30am GMT	LBrazil_CDS	1650	0.000	0.034	−0.299	0.267	0.001	0.748	17.456
ITRAXX Asia EX Japan CDS	ITRX EXJP IG CDSI GEN 5Y Corp	N/A		N.A.	01/01/2014	04/05/2020	1583	No	7:30am GMT	LITRX_exJ	1556	0.000	0.035	−0.413	0.536	0.001	2.584	72.216

Table 4.3 Correlations

-	LSA_CDS	LTurkey_ CDS	LRussia_ CDS	LChina_ CDS	LBrazil_ CDS	LITRXX_ exJ	LNigeria_ 47	LNigeria_ 25	LZambia_ 27	LZambia_ 24	LKenya_ 48	LKenya_ 24	LAngola_ 48	LAngola_ 25	LCameroon_ 25	LIV_ 40	LIV_ 24	LSenegal_ 48	Lsenegal_ 24
LSA_CDS	1																		
LTurkey_CDS	0.7307	1																	
LRussia_CDS	0.6224	0.5783	1																
LChina_CDS	0.4399	0.3937	0.3624	1															
LBrazil_CDS	0.5764	0.4968	0.5087	0.3316	1														
LITRX_exJ	0.2374	0.2126	0.1954	0.5933	0.1360	1													
LNigeria_47	0.6012	0.5654	0.6153	0.4065	0.4961	0.2797	1												
LNigeria_25	0.5866	0.6222	0.6458	0.5168	0.4714	0.3047	0.8444	1											
LZambia_27	0.3461	0.3475	0.3914	0.2879	0.3687	0.2516	0.5089	0.4631	1										
LZambia_24	0.2688	0.2566	0.2283	0.2085	0.2073	0.1763	0.2864	0.2855	0.5741	1									
LKenya_48	0.4964	0.4427	0.4717	0.4663	0.3786	0.3430	0.8167	0.7029	0.4088	0.2729	1								
LKenya_24	0.4533	0.4157	0.4229	0.3680	0.3517	0.3360	0.7734	0.6587	0.5004	0.3580	0.8512	1							
LAngola_48	0.5181	0.4342	0.4743	0.2981	0.4397	−0.0164	0.6443	0.5835	0.4453	0.0897	0.4680	0.393	1						
LAngola_25	0.5272	0.4619	0.5672	0.3925	0.4995	0.1997	0.6638	0.5764	0.5278	0.3380	0.4912	0.5783	0.8603	1					
LCameroon_25	0.3501	0.3512	0.4222	0.3377	0.3228	0.2414	0.6443	0.5132	0.4945	0.3104	0.6438	0.6744	0.3650	0.5743	1				
LIV_40	0.4974	0.4867	0.5108	0.4525	0.3378	0.3133	0.7302	0.7087	0.3718	0.2572	0.7612	0.6811	0.4488	0.4742	0.6128	1			
LIV_24	0.4666	0.4440	0.3753	0.3846	0.3041	0.2787	0.6959	0.6216	0.3798	0.3064	0.6796	0.5721	0.4601	0.4896	0.4704	0.6912	1		
LSenegal_48	0.5928	0.5171	0.5125	0.5016	0.4316	0.2792	0.7849	0.7077	0.4064	0.2457	0.7824	0.6965	0.5614	0.5129	0.6713	0.7586	0.753	1	
LSenegal_24	0.4536	0.4252	0.3987	0.3627	0.2790	0.2496	0.6548	0.6682	0.3879	0.3228	0.6453	0.6643	0.4351	0.5256	0.5174	0.6806	0.6012	0.6353	1

Note: This table covers the selected bonds and CDS from 1 January 2014 to 4 May 2020. If the Eurobond or CDS contract had not yet been issued on 1 January, their first recorded trade date is the start date. Bond mid-yields are taken daily at 8:30am GMT for Nigeria 2047 & 2024, Kenya 2048 & 2024, Angola 2048 & 2025, Cameroon 2025, Ivory Coast 2040 & 2024, Senegal 2048 & 2024, Ghana 2049 and Egypt 2025, while five-year CDS prices are taken daily at 7:30am GMT for Brazil, China, Itraxx exJ CDS, SA, Turkey and Russia.

There is a high level of correlation between the sovereign benchmark CDS. Nigeria 2047 and Senegal 2048 have a higher degree of correlation with the CDS for South Africa, Turkey and Russia, while the Angola Eurobonds only have a higher correlation with the South Africa CDS. In addition, cross-correlation between the Eurobonds is relatively high.

Table 4.4 Bera–Jacque normality test, skewness and kurtosis tests and augmented Dickey–Fuller unit root test

		Skewness/Kurtosis Tests for Normality				Shapiro–Wilk W Test for Normal Data				Unit Root Test			
				Joint									
Variable	Observations	Pr (Skewness)	Pr(Kurtosis)	adj chi2 (2)	Prob > chi2	W	V	z	Prob>z	Variable	Lags Applied	Observations	ADF Unit Root Outcome
LNigeria_47	632	0.0006	0	.	0	0.87861	50.460	9.524	0	LNigeria_47	2	250	No presence of unit root
LNigeria_25	373	0	0	69.31	0	0.87332	32.761	8.276	0	LNigeria_25	2	148	No presence of unit root
LKenya_48	558	0	0	42.53	0	0.96710	12.220	6.047	0	LKenya_48	2	220	No presence of unit root
LKenya_24	1509	0	0	.	0	0.83869	148.026	12.579	0	LKenya_24	2	589	No presence of unit root
LAngola_48	512	0	0	.	0	0.72919	93.067	10.909	0	LAngola_48	2	204	No presence of unit root
LAngola_25	1160	0	0	.	0	0.59717	290.854	14.133	0	LAngola_25	2	459	No presence of unit root
LCameroon_25	1119	0	0	.	0	0.70995	202.662	13.214	0	LCameroon_25	2	432	No presence of unit root
LIV_40	547	0.1900	0	49.31	0	0.95436	16.648	6.787	0	LIV_40	2	215	No presence of unit root
LIV_24	1458	0.0632	0	.	0	0.93915	54.114	10.033	0	LIV_24	2	561	No presence of unit root
LSenegal_48	552	0.0422	0	52.90	0	0.94779	19.203	7.135	0	LSenegal_48	2	218	No presence of unit root
LSenegal_24	1457	0	0	.	0	0.92557	66.152	10.537	0	LSenegal_24	2	565	No presence of unit root
LGHana_49	1433	0	0	.	0	0.87383	110.449	11.818	0	LGHana_49	2	562	No presence of unit root
LEgypt_25	1264	0	0	.	0	0.95840	32.480	8.701	0	LEgypt_25	2	499	No presence of unit root
										CDS Variable			

Note: The CDS price is taken daily at 7:30am GMT, and the Eurobond mid-yield is taken at 8:30am GMT. The data in the graph are generated from the log returns taken from the change of one day to another. The table covers the selected Eurobonds and CDS returns from 1 January 2014 to 4 May 2020. If a Eurobond had not yet been issued on 1 January, the first recorded trade date is the start date. The Shapiro–Wilk test shows that the Eurobond log-returns are not normally distributed (column V), and the scores are far from the 95% confidence interval [1.2, 2.4]. In addition, the table shows there is no presence of unit root in the returns of the Eurobonds or the CDS contracts.

Table 4.5 Outcome of the GARCH (1,1) model using the Gaussian normal distribution assumption

		South Africa CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS
Mean Equation	Constant	0	0	0	0	0
	AR(1)	−0.259	0.096	−0.188	0.707*	0.571
Variance Equation	Constant	0	0	0	0	0
	ARCH	0.264	0.284***	0.404***	0.287***	0.323***
	GARCH	0.678	0.664***	0.529***	0.377***	0.627***
	Asymmetric term	–	0.087	–	–	–
Diagnostic Test	Ljung-box (9)	13.150	18.080*	27.149***	9.897	30.172***
LM Arch Effect Test	H0 no ARCH effect at 1 lag	Strongly reject	Strongly reject	Strongly reject	Strongly reject	Strongly reject

		Itraxx exJ	Nigeria 2047	Nigeria 2025	Kenya 2048	Kenya 2024
Mean Equation	Constant	0	0	−0.001	0	0
	AR(1)	−0.135**	3.923	−0.169	−0.113	0.540
Variance Equation	Constant	0	0	0	0	0
	ARCH	0.426***	0.238	0.651***	0.136	0.157***
	GARCH	0.564***	0.706	0.284**	0.739**	0.225**
	Asymmetric term	–	–	–	0.188	0.7272***
Diagnostic Test	Ljung-box (9)	250.411***	40.9395***	8.404***	20.182***	111.59***
LM Arch Effect Test	H0 no ARCH effect at 1 lag	Strongly reject	Strongly reject	Strongly reject	Strongly reject	Strongly reject

		Angola 2048	Angola 2025	Cameroon 2025	Ivory Coast 2040	Ivory Coast 2024
Mean Equation	Constant	0	0	0	0	0
	AR(1)	−0.034	0.235	−0.031	−8.575	0.270
Variance Equation	Constant	0	0	0	0	0
	ARCH	0.562***	0.617***	0.36***	0.194	0.292**
	GARCH	0.298***	0.340***	0.444**	0.476	0.702***
	Asymmetric term	–	–	–	–	–
Diagnostic Test	Ljung-box (9)	88.402***	159.063***	264.491***	18.813*	22.834***
LM Arch Effect Test	***H0 no ARCH Effect at 1 lag***	***Strongly reject***	***Strongly reject***	***Reject***	***Strongly reject***	***Strongly reject***

		Senegal 2048	Senegal 2024	Ghana 2049	Egypt 2025
Mean Equation	Constant	0	0	0	0
	AR(1)	0.353	0.257	0.188	0.455
Variance Equation	Constant	0	0	0	0
	ARCH	0.247***	0.361***	0.398***	0.035
	GARCH	1.138***	0.450**	0.479***	1.146***
	Asymmetric term	0.053	–	–	0.117**
Diagnostic Test	Ljung-box (9)	7.577	18.679*	28.886***	63.643***
LM Arch Effect Test	H0 no ARCH effect at 1 lag	Strongly reject	Strongly reject	Reject	Strongly reject

Note: The table covers the bonds and CDS in the selection from 1 January 2014 to 4 May 2020. If a Eurobond or CDS contract had not yet been issued on 1 January, the first recorded trade date is the start date. The bond mid-yields are taken daily at 8:30am GMT for Nigeria 2047 & 2024, Kenya 2048 & 2024, Angola 2048 & 2025, Cameroon 2025, Ivory Coast 2040 & 2024, Senegal 2048 & 2024, Ghana 2049 and Egypt 2025, while 5-year CDS prices are taken daily at 7:30am GMT for Brazil, China, Itraxx exJ CDS, SA, Turkey and Russia. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$. The sum of coefficients for ARCH (lag1), GARCH (lag1) and the asymmetric term fulfil the stationarity condition for GARCH models. The outcome of the heteroskedasticity LM ARCH test shows that the null hypothesis of no ARCH effect is rejected for all the variables in the selection, with the vast majority strongly rejecting it.

Table 4.6 Selection of model of best fit using the information criterion for selection

	SA CDS			Turkey CDS			Russia CDS			China CDS			Brazil CDS			ITRAX ex Japan CDS		
Eurobond	**Multiplier**	**Normal**	**Student's**	**Multiplier**	**Normal**	**Student's**	**Multiplier**	**Normal**	**Student's**	**Multiplier**	**Normal**	**Student's**	**Multiplier**	**Normal**	**Student's**	**Multiplier**	**Normal**	**Student's**
Nigeria 47	Scalar	X		Scalar	X		Scalar	X		Scalar	X		Scalar	X		Diagonal	X	
Nigeria 25	Diagonal	X		Scalar	X		Diagonal	X		Scalar	X		Scalar	X		Diagonal	X	
Kenya 48	Scalar	X		Scalar	X		Diagonal	X		Diagonal	X		Diagonal	X		Diagonal	X	
Kenya 24	Diagonal		X	Diagonal	X		Diagonal		X	Diagonal	X		Diagonal		X	Scalar	X	
Angola 48	Diagonal	X		Scalar	X		Scalar	X		Diagonal	X		Scalar	X		Scalar	X	
Angola 25	Scalar	X		Scalar	X		Scalar	X		Scalar	X		Scalar	X		Scalar		X
Cameroon 25	Scalar	X		Diagonal	X		Diagonal	X		Diagonal		X	Diagonal	X		Diagonal	X	
Ivory Coast 40	Diagonal	X		Diagonal	X		Scalar	X		Diagonal	X		Scalar	X		Scalar	X	
Ivory Coast 24*	Scalar	X		Scalar	X		Scalar	X		Scalar	X		Scalar		X	Scalar	X	
Senegal 48	Diagonal	X		Diagonal	X		Scalar	X		Diagonal	X		Scalar	X		Scalar	X	
Senegal 24*	Scalar	X		Scalar	X		Scalar	X		Scalar	X		Scalar		X	Scalar	X	
Ghana 49**	Scalar	X		Scalar	X		Scalar	X		Scalar	X		Scalar		X	Model Failed		
Gabon 25***	Diagonal	X		Diagonal	X		Scalar		X	Diagonal	X		Scalar		X	Model Failed		
Egypt 25****	Diagonal	X		Diagonal	X		Diagonal	X		Diagonal	X		Diagonal	X		Diagonal	X	

* All Ivory Coast 2024 models were on ARMA (0,0)

** Senegal 24 for Brazil and Itraxx exJ was on ARMA (0,0)

*** Ghana 49 for China, Brazil and Itraxx exJ CDS was on ARMA (0,0)

**** Gabon 25 for all the CDS except Brazil CDS was on ARMA (0,0)

***** Egypt 25 for all the CDS except China CDS was on ARMA (0,0)

Note: The table covers the bonds and CDS in the selection from 1 January 2014 to 4 May 2020. If a Eurobond or CDS contract had not yet been issued on 1 January, the first recorded trade date is the start date. The bond mid-yields are taken daily at 8:30am GMT for Nigeria 2047 & 2024, Kenya 2048 & 2024, Angola 2048 & 2025, Cameroon 2025, Ivory Coast 2040 & 2024, Senegal 2048 & 2024, Ghana 2049 and Egypt 2025, while 5-year CDS prices are taken daily at 7:30am GMT for Brazil, China, Itraxx exJ CDS, SA, Turkey and Russia. The sum of coefficients for ARCH (lag1), GARCH (lag1) and the asymmetric term fulfil the stationarity condition for GARCH Models. If the scalar and diagonal BEKK presented the same AIC outcome, we took the diagonal BEKK as model of best fit.

Table 4.7 BEKK weights and mean return shocks for Eurobonds and CDS – 7x7 portfolio

j	i	$A_{(i,i)}$	$\hat{\epsilon}_l$	Significance Level	j	i	$A_{(i,i)}$	$\hat{\epsilon}_l$	Significance Level
Nigeria 2047	SA CDS	0.244029	−0.000930		Nigeria 2047 all CDS Combined	SA CDS	−0.000970	0.261929	***
	Turkey CDS	0.320402	0.000620			Turkey CDS	−0.000290	0.261929	***
	Russia CDS	0.336347	−0.000970			Russia CDS	−0.001160	0.261929	***
	China CDS	0.145761	−0.000260			China CDS	−0.000540	0.261929	***
	Brazil CDS	0.245294	−0.000370			Brazil CDS	−0.000330	0.261929	***
	Itraxx exJ CDS	0.066282	0.000125			Itraxx exJ CDS	0.000108	0.261929	***
Nigeria 2025 (Scalar BEKK)	SA CDS	0.9090	0.002029	***	Nigeria 2025 all CDS combined	SA CDS	0.002029	0.9091	***
	Turkey CDS	0.0909	0.004043	***		Turkey CDS	0.004043	0.9091	***
	Russia CDS	0.9000	0.004117	***		Russia CDS	0.004117	0.9091	***
	China CDS	0.9000	0.003983	***		China CDS	0.003983	0.9091	***
	Brazil CDS	0.9000	0.000830	***		Brazil CDS	0.008300	0.9091	***
	Itraxx exJ CDS	0.9000	0.005228	***		Itraxx exJ CDS	0.005228	0.9091	***
Kenya 2048	SA CDS	0	0		Kenya 2048 all CDS combined	SA CDS	0.000088	0	
	Turkey CDS	−0.44945	0.001523	***		Turkey CDS	0.001523	−0.00495	***
	Russia CDS	−0.24525	−0.000220	*		Russia CDS	−0.000220	−0.24525	*
	China CDS	−0.24720	−0.000010			China CDS	−0.000010	−0.24720	
	Brazil CDS	−0.23500	0.000346	**		Brazil CDS	0.000346	−0.23500	**
	Itraxx exJ CDS	−0.32047	0.000738	**		Itraxx exJ CDS	0.000738	−0.32047	**
Kenya 2024	SA CDS	0.166272	0.002091	***	Kenya 2024 all CDS combined	SA CDS	0.002091	0.166272	***
	Turkey CDS	0.548548	−0.004410	***		Turkey CDS	−0.004410	0.548548	***
	Russia CDS	0.160486	−0.006790	***		Russia CDS	−0.006790	0.160486	***
	China CDS	0.157592	−0.002000	***		China CDS	−0.002000	0.157592	***
	Brazil CDS	0.160530	0.004472	***		Brazil CDS	0.004472	0.160530	***
	Itraxx exJ CDS	0.150716	−0.000240	***		Itraxx exJ CDS	−0.000240	0.150716	***

j	i	$A_{(i,i)}$	$\widehat{\epsilon}_l$	Significance Level	j	i	$A_{(i,i)}$	$\widehat{\epsilon}_l$	Significance Level
Angola 2048	SA CDS	0.40093	0	***	Angola 2048 all CDS combined	SA CDS	0.000193	0.40093	*
	Turkey CDS	0.568999	−0.000240	***		Turkey CDS	−0.000240	0.568999	***
	Russia CDS	0.315660	−0.001030	**		Russia CDS	−0.001030	0.315660	**
	China CDS	0.304600	0.000881	**		China CDS	0.000881	0.304600	**
	Brazil CDS	0.328966	−0.000900	***		Brazil CDS	−0.000900	0.328966	***
	Itraxx exJ CDS	0.279275	0.001374	***		Itraxx exJ CDS	0.001374	0.279275	*
Angola 2025	SA CDS	0.979510	0.002388	***	Angola 2025 all CDS combined (ARMA 0,0)	SA CDS	−0.000250	0.000053	
	Turkey CDS	0.224978	−0.001020			Turkey CDS	−0.000120	0.000053	
	Russia CDS	−0.554020	−0.000022	***		Russia CDS	0.000311	0.000053	
	China CDS	0.208970	0.003939			China CDS	0.002499	0.000053	
	Brazil CDS	0.354885	−0.003150	***		Brazil CDS	−0.000500	0.000053	
	Itraxx exJ CDS	0.110526	0.001584			Itraxx exJ CDS	0.001173	0.000053	
Cameroon 2025	SA CDS	0.020972	0.008807	***	Cameroon 2025 all CDS combined	SA CDS	0.008807	0.020972	***
	Turkey CDS	0.001799	0.009637	***		Turkey CDS	0.009637	0.001799	***
	Russia CDS	0.064386	0.014922	***		Russia CDS	0.014922	0.064386	***
	China CDS	0.112108	0.006941	***		China CDS	0.006941	0.112108	***
	Brazil CDS	0.144388	0.015434	***		Brazil CDS	0.015434	0.144388	***
	Itraxx exJ CDS	0.103595	0.001893	***		Itraxx exJ CDS	0.001893	0.103595	***
Ivory Coast 2040	SA CDS	0.121671	0.000865		Ivory Coast 2040 all CDS combined	SA CDS	0.000865	0.121671	
	Turkey CDS	0.198166	0.004285			Turkey CDS	0.004285	0.198166	
	Russia CDS	0.621573	−0.003820			Russia CDS	−0.003820	0.621573	
	China CDS	0.361305	−0.003470			China CDS	−0.003470	0.361305	
	Brazil CDS	−0.278220	0.004321			Brazil CDS	0.004321	−0.278210	
	Itraxx exJ CDS	0.240668	−0.000680			Itraxx exJ CDS	−0.000670	0.240668	

j	i	$A_{(i,i)}$	$\widehat{\epsilon}_l$	Significance Level	j	i	$A_{(i,i)}$	$\widehat{\epsilon}_l$	Significance Level
Ivory Coast 2024	SA CDS		0.004689	***	Ivory Coast 2024 all CDS combined	SA CDS	0.005185	0.436621	
	Turkey CDS		0.006379	***		Turkey CDS	0.006408	0.436621	
	Russia CDS		0.027826	***		Russia CDS	0.028546	0.436621	
	China CDS		0.008546	***		China CDS	0.008444	0.436621	
	Brazil CDS		0.014961	***		Brazil CDS	0.020030	0.436621	
	Itraxx exJ CDS		0.010422	***		Itraxx exJ CDS	0.000336	0.436621	
Senegal 2048	SA CDS	0.072196	0.000296	***	Senegal 2048 all CDS combined	SA CDS	0.000296	0.072196	***
	Turkey CDS	-0.18807	0.007209	***		Turkey CDS	0.007209	-0.18807	***
	Russia CDS	-0.36267	0.001925	***		Russia CDS	0.001925	-0.36267	***
	China CDS	-0.45612	-0.00209	***		China CDS	-0.00209	-0.45612	***
	Brazil CDS	0.206378	0.001524	***		Brazil CDS	0.001524	0.206378	***
	Itraxx exJ CDS	-0.24159	-0.00089	***		Itraxx exJ CDS	-0.00089	-0.24159	***
Senegal 2024	SA CDS	0.481025	-0.0021	***	Senegal 2024 all CDS combined	SA CDS	-0.0021	0.481025	
	Turkey CDS	0.06951	0.00062	***		Turkey CDS	0.00062	0.06951	***
	Russia CDS	0.352193	0.003175	***		Russia CDS	0.003175	0.352193	***
	China CDS	0.874789	-0.00379	***		China CDS	-0.00379	0.874789	***
	Brazil CDS	-0.92886	-0.00651	***		Brazil CDS	-0.00651	-0.92886	***
	Itraxx exJ CDS	0.828453	-0.00351	***		Itraxx exJ CDS	-0.00351	0.828453	***
Egypt 2025	SA CDS	0.13567	-0.0002	***	Egypt 2025 and all CDS combined	SA CDS	-0.0002	0.13567	
	Turkey CDS	0.144039	0.001122			Turkey CDS	0.001122	0.144039	
	Russia CDS	0.17494	0.008741			Russia CDS	0.008741	0.17494	
	China CDS	0.182723	0.007249			China CDS	0.007249	0.182723	
	Brazil CDS	0.114075	-0.00453			Brazil CDS	-0.00453	0.114075	
	Itraxx exJ CDS	0.209584	0.016469			Itraxx exJ CDS	0.016469	0.209584	

Note: The table covers the bonds and CDS in the selection from 1 January 2014 to 4 May 2020. If a Eurobond or CDS contract had not yet been issued on 1 January, the first recorded trade date is the start date. The bond mid-yields are taken daily at 8:30am GMT for Nigeria 2047 & 2024, Kenya 2048 & 2024, Angola 2048 & 2025, Cameroon 2025, Ivory Coast 2040 & 2024, Senegal 2048 & 2024, Ghana 2049 and Egypt 2025, while 5-year CDS prices are taken daily at 7:30am GMT for Brazil, China, Itraxx exJ CDS, SA, Turkey and Russia. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; $A_{(i,i)}$ represents the weights; and $\widehat{\in}_l$ represents the mean return shock.

Table 4.8 Spillover patterns – 7x7 and 2x2 portfolios

Nigeria 2047	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(N, Y)					
Turkey CDS	(N, Y)	(N, Y)				
Russia CDS	(N, Y)	(N, Y)	(N, Y)			
China CDS	(N, Y)	(N, N)	(N, Y)	(N, Y)		
Brazil CDS	(N, Y)	(N, Y)	(N, Y)	(N, Y)	(N, Y)	
Itraxx exJ CDS	(Y, Y)	(Y,N)	(Y, Y)	(Y, Y)	(Y, Y)	(Y, Y)

Nigeria 2025	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	**(Y, Y)**	_	_	_	_	_
Turkey CDS	**(N, Y)**	**(N, Y)**	_	_	_	_
Russia CDS	**(N, Y)**	**(N, Y)**	**(N, Y)**	_	_	_
China CDS	**(Y, Y)**	**(Y, Y)**	**(Y, Y)**	**(Y, Y)**	_	_
Brazil CDS	**(N, Y)**	**(N, Y)**	**(N, Y)**	**(N, Y)**	**(N, Y)**	_
Itraxx exJ CDS	**(Y, Y)**	**(Y, Y)**	**(Y, Y)**	**(Y, Y)**	**(Y, Y)**	**(Y, Y)**

Kenya 2048	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(Y, Y)					
Turkey CDS	(Y, Y)	(Y, Y)				
Russia CDS	(Y, Y)	(Y, N)	(Y, Y)			
China CDS	(Y, Y)	(Y, N)	(Y, N)	(Y, Y)		
Brazil CDS	(N, Y)	(Y, N)	(N, Y)	(N, Y)	(Y, Y)	
Itraxx exJ CDS	(N, Y)	(Y, N)	(N, N)	(N, Y)	(Y, Y)	(N, Y)

Kenya 2024	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(Y,N)					
Turkey CDS	(Y, Y)	(Y, Y)				
Russia CDS!	(N, N)	(N, N)	(N, N)			
China CDS	(N, N)	(N, N)	(N, N)	(N, N)		
Brazil CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	
Itraxx exJ CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)

Angola 2048	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(Y, Y)					
Turkey CDS	(Y, Y)	(Y, Y)				
Russia CDS	(Y, N)	(N, N)	(N, Y)			
China CDS	(Y, Y)	(Y, N)	(Y, N)	(Y, Y)		
Brazil CDS	(N, Y)	(N, N)	(N, Y)	(N, N)	(N, Y)	
Itraxx exJ CDS	(N, Y)	(N, N)	(N, Y)	(N, Y)	(N, Y)	(N, Y)

Angola 2025	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(N, Y)					
Turkey CDS	(N, Y)	(N, Y)				
Russia CDS	(N, Y)	(N, Y)	(N, Y)			
China CDS	(N, Y)	(N, N)	(N, N)	(N, Y)		
Brazil CDS	(N, N)	(N, Y)	(N, N)	(N, N)	(N, N)	
Itraxx exJ CDS!	(Y, N)	(N, Y)	(N, N)	(Y,N)	(N, N)	(N, N)

Cameroon 2025	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(Y, Y)					
Turkey CDS	(Y, N)	(Y, N)				
Russia CDS!	(N, N)	(N, N)	(N, N)			
China CDS!	(N, N)	(N, N)	(N, N)	(N, N)		
Brazil CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	
Itraxx exJ CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)

Ivory Coast 2040	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(Y, Y)					
Turkey CDS	(Y, Y)	(Y, Y)				
Russia CDS	(Y, Y)	(Y, N)	(Y, Y)			
China CDS	(Y, Y)	(Y, N)	(Y, N)	(Y, N)		
Brazil CDS	(N, Y)	(N, N)	(N, Y)	(N, Y)	(Y, N)	
Itraxx exJ CDS	(N, Y)	(N, N)	(N, N)	(N, N)	(N, Y)	(N, N)

Ivory Coast 2024	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS!	(N, N)					
Turkey CDS	(Y, Y)	(Y, Y)				
Russia CDS!	(N, N)	(N, N)	(N, N)			
China CDS!	(N, N)	(N, N)	(N, N)	(N, N)		
Brazil CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	
Itraxx exJ CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)

Senegal 2048	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(Y, Y)					
Turkey CDS	(Y, Y)	(Y, Y)				
Russia CDS	(Y, Y)	(Y, Y)	(Y, Y)			
China CDS	(N, N)	(N, Y)	(N, Y)	(N, N)		
Brazil CDS	(Y, Y)	(Y, Y)	(Y, Y)	(Y, Y)	(Y, Y)	
Itraxx exJ CDS	(Y, Y)	(Y, N)	(Y, Y)	(Y, Y)	(Y, N)	(Y, Y)

Senegal 2024	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(N, N)					
Turkey CDS	(Y, Y)	(Y, Y)				
Russia CDS!	(N, N)	(N, N)	(N, N)			
China CDS!	(N, N)	(N, N)	(N, N)	(N, N)		
Brazil CDS	(Y, Y)	(Y, Y)	(Y, Y)	(Y, Y)	(Y, Y)	
Itraxx exJ CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)

Egypt 2025	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS!	(N, N)					
Turkey CDS!	(N, N)	(N, N)				
Russia CD/S!	(N, N)	(N, N)	(N, N)			
China CDS!	(N, N)	(N, N)	(N, N)	(N, N)		
Brazil CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	
Itraxx exJ CDS!	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)	(N, N)

Note: The right side of the (N/Y) entry denotes the sign similarity with Y for Yes or N for No, while the left side of the entry denotes similarity of multipliers. ! indicates the model failed in the 2x2 combination. The table covers the bonds and CDS in the selection from 1 January 2014 to 4 May 2020. If a Eurobond or CDS contract had not yet been issued on 1 January, the first recorded trade date is the start date. The bond mid-yields are taken daily at 8:30am GMT for Nigeria 2047 & 2024, Kenya 2048 & 2024, Angola 2048 & 2025, Cameroon 2025, Ivory Coast 2040 & 2024, Senegal 2048 & 2024, Ghana 2049 and Egypt 2025, while 5-year CDS prices are taken daily at 7:30am GMT for Brazil, China, Itraxx exJ CDS, SA, Turkey and Russia.

Table 4.9 Scalar and diagonal BEKK signs of return shocks – 7x7 portfolio

Nigeria 2047	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(S, Sym)					
Turkey CDS	(S, Sym)	(S, Sym)				
Russia CDS	(S, Sym)	(S, Sym)	(S, Sym)			
China CDS	(S, Sym)	(S, Asym)	(S, Sym)	(S, Sym)		
Brazil CDS	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	
Itraxx exJ CDS	(S, Sym)	(S, Asym)	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)

Nigeria 2025	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(S, Sym)					
Turkey CDS	(S, Sym)	(S, Sym)				
Russia CDS	(S, Sym)	(S, Sym)	(S, Sym)			
China CDS	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)		
Brazil CDS	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	
Itraxx exJ CDS	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)

Kenya 2048	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Sym)					
Turkey CDS	(D, Sym)	(D, Sym)				
Russia CDS	(D, Sym)	(D, Asym)	(D, Sym)			
China CDS	(D, Sym)	(D, Asym)	(D, Asym)	(D, Sym)		
Brazil CDS	(D, Sym)	(D, Asym)	(D, Sym)	(D, Sym)	(D, Sym)	
Itraxx exJ CDS	(D, Sym)	(D, Asym)	(D, Asym)	(D, Sym)	(D, Sym)	(D, Sym)

Kenya 2024	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Asym)					
Turkey CDS	(D, Asym)	(D, Asym)				
Russia CDS	(D, Asym)	(D, Asym)	(D, Asym)			
China CDS	(D, Asym)	(D, Asym)	(D, Asym)	(D, Asym)		
Brazil CDS	(D, Asym)	(D, Sym)	(D, Sym)	(D, Asym)	(D, Sym)	
Itraxx exJ CDS	(D, Asym)	(D, Asym)	(D, Asym)	(D, Asym)	(D, Asym)	(D, Asym)

Angola 2048	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Sym)					
Turkey CDS	(D, Sym)	(D, Sym)				
Russia CDS	(D, Sym)	(D, Asym)	(D, Sym)			
China CDS	(D, Sym)	(D, Asym)	(D, Asym)	(D, Sym)		
Brazil CDS	(D, Sym)	(D, Asym)	(D, Sym)	(D, Asym)	(D, Sym)	
Itraxx exJ CDS	(D, Sym)	(D, Asym)	(D, Asym)	(D, Sym)	(D, Sym)	(D, Sym)

Angola 2025	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Sym)					
Turkey CDS	(D, Sym)	(D, Sym)				
Russia CDS	(D, Sym)	(D, Sym)	(D, Sym)			
China CDS	(D, Sym)	(D, Asym)	(D, Asym)	(D, Sym)		
Brazil CDS	(D, Sym)	(D, Asym)	(D, Sym)	(D, Sym)	(D, Sym)	
Itraxx exJ CDS	(D, Sym)	(D, Sym)	(D, Asym)	(D, Sym)	(D, Asym)	(D, Sym)

Cameroon 2025	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Sym)					
Turkey CDS	(D, Asym)	(D, Asym)				
Russia CDS	(D, Asym)	(D, Sym)	(D, Sym)			
China CDS	(D, Sym)	(D, Sym)	(D, Asym)	(D, Sym)		
Brazil CDS	(D, Asym)	(D, Sym)	(D, Asym)	(D, Asym)	(D, Sym)	
Itraxx exJ CDS	(D, Asym)	(D, Asym)	(D, Asym)	(D, Asym)	(D, Asym)	(D, Asym)

Ivory Coast 2040	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Sym)					
Turkey CDS	(D, Sym)	(D, Sym)				
Russia CDS	(D, Sym)	(D, Asym)	(D, Sym)			
China CDS	(D, Asym)	(D, Sym)	(D, Sym)	(D, Sym)		
Brazil CDS	(D, Sym)	(D, Asym)	(D, Sym)	(D, Sym)	(D, Sym)	
Itraxx exJ CDS	(D, Asym)	(D, Sym)	(D, Sym)	(D, Sym)	(D, Asym)	(D, Sym)

Ivory Coast 2024	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(S, Sym)					
Turkey CDS	(S, Sym)	(S, Sym)				
Russia CDS	(S, Asym)	(S, Sym)	(S, Asym)			
China CDS	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)		
Brazil CDS	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	
Itraxx exJ CDS	(S, Asym)	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)	(S, Sym)

Senegal 2048	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Sym)					
Turkey CDS	(D, Sym)	(D, Sym)				
Russia CDS	(D, Sym)	(D, Sym)	(D, Sym)			
China CDS	(D, Sym)	(D, Asym)	(D, Asym)	(D, Sym)		
Brazil CDS	(D, Sym)	(D, Sym)	(D, Sym)	(D, Sym)	(D, Sym)	
Itraxx exJ CDS	(D, Sym)	(D, Asym)	(D, Sym)	(D, Sym)	(D, Asym)	(D, Sym)

Senegal 2024	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Sym)					
Turkey CDS	(D, Sym)	(D, Sym)				
Russia CDS	(D, Sym)	(D, Asym)	(D, Sym)			
China CDS	(D, Sym)	(D, Asym)	(D, Sym)	(D, Sym)		
Brazil CDS	(D, Sym)	(D, Sym)	(D, Asym)	(D, Asym)	(D, Sym)	
Itraxx exJ CDS	(D, Sym)	(D, Sym)	(D, Sym)	(D, Sym)	(D, Asym)	(D, Sym)

Egypt 2025	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	Itraxx exJ CDS
SA CDS	(D, Asym)					
Turkey CDS	(D, Asym)	(D, Asym)				
Russia CDS	(D, Asym)	(D, Sym)	(D, Asym)			
China CDS	(D, Asym)	(D, Sym)	(D, Sym)	D, Sym)		
Brazil CDS	(D, Asym)	(D, Asym)	(D, Asym)	(D, Sym)	(D, Asym)	
Itraxx exJ CDS	(D, Asym)	(D, Sym)	(D, Sym)	(D, Sym)	(D, Sym)	(D, Sym)

Note: The right side of each entry, (Sym/Asym), denotes symmetry or asymmetry in sign. The left side of each entry, (S/D), indicates scalar or diagonal. The table covers the bonds and CDS in the selection from 1 January 2014 to 4 May 2020. If a Eurobond or CDS contract had not yet been issued on 1 January, the first recorded trade date is the start date. The bond mid-yields are taken daily at 8:30am GMT for Nigeria 2047 & 2024, Kenya 2048 & 2024, Angola 2048 & 2025, Cameroon 2025, Ivory Coast 2040 & 2024, Senegal 2048 & 2024, Ghana 2049 and Egypt 2025, while 5-year CDS prices are taken daily at 7:30am GMT for Brazil, China, Itraxx exJ CDS, SA, Turkey and Russia.

Table 4.10 Scalar and diagonal BEKK signs of return shocks – 2x2 portfolio

Nigeria 2047		**Nigeria 2025**		**Kenya 2048**		**Kenya 2024**	
SA CDS	(D, Sym)	SA CDS	(S, Sym)	SA CDS	(D, Sym)	SA CDS	(D, Sym)
Turkey CDS	(D, Sym)	Turkey CDS	(D, Sym)	Turkey CDS	(D, Sym)	Turkey CDS	(D, Asym)
Russia CDS	(D, Sym)	Russia CDS	(D, Sym)	Russia CDS	(D, Sym)	Russia CDS	–
China CDS	(D, Sym)	China CDS	(S, Sym)	China CDS	(D, Sym)	China CDS	–
Brazil CDS	(D, Sym)	Brazil CDS	(D, Sym)	Brazil CDS	(S, Sym)	Brazil CDS	–
Itraxx exJ CDS	(S, Sym)	Itraxx exJ CDS	(S, Sym)	Itraxx exJ CDS	(S, Sym)	Itraxx exJ CDS	–
Angola 2048		**Angola 2025**		**Cameroon 2025**		**Ivory Coast 2040**	
SA CDS	(D, Sym)	SA CDS	(S, Sym)	SA CDS	(D, Sym)	SA CDS	(D, Sym)
Turkey CDS	(D, Sym)	Turkey CDS	(S, Sym)	Turkey CDS	(D, Sym)	Turkey CDS	(D, Sym)
Russia CDS	(S, Sym)	Russia CDS	(S, Sym)	Russia CDS	–	Russia CDS	(D, Sym)
China CDS	(D, Sym)	China CDS	(S, Sym)	China CDS	–	China CDS	(D, Asym)
Brazil CDS	(S, Sym)	Brazil CDS	(S, Asym)	Brazil CDS	–	Brazil CDS	(S, Sym)
Itraxx exJ CDS	(S, Sym)	Itraxx exJ CDS	(S, Sym)	Itraxx exJ CDS	–	Itraxx exJ CDS	(S, Asym)
Ivory Coast 2024		**Senegal 2048**		**Senegal 2024**		**Ghana 2049**	
SA CDS	–	SA CDS	(D, Sym)	SA CDS	(S, Asym)	SA CDS	(S, Sym)
Turkey CDS	(S, Sym)	Turkey CDS	(D, Sym)	Turkey CDS	(D, Sym)	Turkey CDS	(S, Sym)
Russia CDS	–	Russia CDS	(D, Sym)	Russia CDS	–	Russia CDS	(D, Sym)
China CDS	–	China CDS	(S, Asym)	China CDS	–	China CDS	(S, Sym)
Brazil CDS	–	Brazil CDS	(D, Sym)	Brazil CDS	(D, Asym)	Brazil CDS	(S, Sym)
Itraxx exJ CDS	–	Itraxx exJ CDS	(D, Sym)	Itraxx exJ CDS	–	Itraxx exJ CDS	–
Egypt 2025 (ARMA 1,1; ARMA 0,0; ARMA 2,2 all failed)							
SA CDS	–						
Turkey CDS	–						
Russia CDS	–						
China CDS	–						
Brazil CDS	–						
Itraxx exJ CDS	–						

Note: The right side of each entry, (Sym/Asym), denotes symmetry or asymmetry in sign.
The left side of each entry, (S/D), indicates scalar or diagonal.

Table 4.11 Diagonal and scalar BEKK model

Mean Equation	SA CDS	Turkey CDS	Russia CDS	China CDS	Brazil CDS	iTraxx ex Japan CDS Index
Nigeria 2047(-1)	1.501*** *0.17*	1.548*** *0.222*	1.212*** *0.14*	0.678*** *0.172*	0.751*** *0.14*	0.624*** *0.16*
Nigeria 2025 (-1)	0.365*** *0.18*	0.195*** *0.221*	0.324*** *0.237*	0.182*** *0.232*	-0.002*** *0.267*	-0.289*** *0.202*
Kenya 2048 (-1)	1.607*** *0.158*	1.594*** *0.191*	1.294*** *0.188*	0.854*** *0.207*	0.967*** *0.182*	0.793*** *0.196*
Kenya 2024 (-1)	-0.756*** *0.091*	-1.292*** *0.166*	-2.510*** *0.375*	-0.683*** *0.499*	0.517*** *0.021*	-0.820*** *0.181*
Angola 2048 (-1)	1.865*** *0.19*	1.842*** *0.248*	1.299*** *0.195*	0.926*** *0.208*	0.794*** *0.19*	0.783*** *0.193*
Angola 2025 (-1)!	1.044*** *0.064*	0.770*** *0.099*	0.868*** *0.095*	0.614*** *0.153*	0.278* *0.106*	0.558*** *0.145*
Cameroon 2025 (-1)	0.017*** *49.566*	0.000*** *225.28*	-0.008*** *236.84*	0.006*** *161.64*	0.002*** *264.65*	-0.007*** *71.46*
Ivory Coast 2040 (-1)	1.844** *0.516*	2.144* *0.889*	1.662* *0.603*	0.485 *0.284*	0.821 *0.741*	0.663* *0.283*
Ivory Coast 2024 (-1)	0.481*** *0*	0.196*** *0.004*	-1.072*** *0.001*	0.082*** *0.004*	0.399*** *0*	0.199*** *0.002*
Senegal 2048 (-1)	1.973*** *0.324*	1.967** *0.632*	1.628** *0.575*	0.834 *0.494*	0.914** *0.282*	0.917* *0.384*
Senegal 2024 (-1)	1.668*** *0.694*	1.333*** *0.584*	2.322*** *1.021*	2.005*** *0.557*	1.135*** *0.282*	0.990*** *0.509*
Ghana 2049 (-1)						
Egypt 2025 (-1)	0.000195*** *0.002375*	0.00112*** *0*	0.008*** *0*	0.007*** *0*	-0.004*** *0*	0.016*** *0.001*

Nigeria 2047			
Scalar BEKK Gaussian Distribution	**C**	**A**	**B**
SA CDS	0.006***	0.261***	0.261***
	0.001	*0.035*	*0.035*
Turkey CDS	0.005**	0.261***	0.261***
	0.002	*0.035*	*0.035*
Russia CDS	0.005***	0.261***	0.261***
	0.001	*0.035*	*0.035*
China CDS	0.007***	0.261***	0.261***
	0.001	*0.035*	*0.035*
Brazil CDS	0.006***	0.261***	0.261***
	0.001	*0.035*	*0.035*
ITRAX ex Japan CDS Index	0.003***	0.261***	0.261***
	0	*0.035*	*0.035*

Nigeria 2025			
Scalar BEKK Gaussian Distribution	**C**	**A**	**B**
SA CDS	0.017***	0.909***	0.000***
	0.003	*0.227*	*0*
Turkey CDS	0.009***	0.909***	0.000***
	0.001	*0.227*	*0*
Russia CDS	0.009***	0.909***	0.000***
	0.002	*0.227*	*0*
China CDS	0.014***	0.909***	0.000***
	0.003	*0.227*	*0*
Brazil CDS	0.009***	0.909***	0.000***
	0.002	*0.227*	*0*
iTraxx ex Japan CDS Index	0.006***	0.909***	0.000***
	0.001	*0.227*	*0*

Kenya 2048			
Diagonal BEKK Gaussian Distribution	**C**	**A**	**B**
SA CDS	0.012***	0	0.860***
	0.002	*0*	*0.069*
Turkey CDS	0.010*	-0.449***	0.432*
	0.004	*0.12*	*0.212*
Russia CDS	0.011**	-0.245*	0.722***
	0.003	*0.108*	*0.086*
China CDS	0.013	-0.247	0.498
	0.011	*0.166*	*0.278*
Brazil CDS	0.004	-0.234**	0.943***
	0.002	*0.075*	*0.016*
iTraxx ex Japan CDS Index	0.001	-0.320*	0.362
	0.003	*0.111*	0.456

Kenya 2024			
Diagonal BEKK Student Distribution	**C**	**A**	**B**
SA CDS	0.012***	0.166***	0.726***
	0.003	*0.322*	*0.757*
Turkey CDS	0.008***	0.548***	0.725***
	0.002	*2.05*	*0.322*
Russia CDS	0.008***	0.160***	0.727***
	0.003	*0.318*	*0.76*
China CDS	0.016***	0.157***	0.728***
	0	*0.311*	*0.757*
Brazil CDS	0.002***	0.160***	0.728***
	0	*0.328*	*0.746*
iTraxx ex Japan CDS Index	0.000***	*0.150****	0.728***
	0	*0.292*	*0.753*

Angola 2048			
Diagonal BEKK Normal Distribution	C	A	B
SA CDS	0.020***	0.400***	0
	0.001	*0.114*	*0.272*
Turkey CDS	0.020***	0.568***	-0.375*
	0.003	*0.127*	*0.18*
Russia CDS	0.012***	0.315**	-0.583***
	0.003	*0.1*	*0.139*
China CDS	0.021***	0.304**	-0.435*
	0.003	*0.094*	*0.197*
Brazil CDS	0.022***	0.328***	0.063
	0.001	*0.078*	*0.322*
iTraxx ex Japan CDS Index	0.007***	0.279**	-0.591**
	0.002	*0.095*	*0.2*

Angola 2025!			
Diagonal BEKK Normal Distribution	C	A	B
SA CDS	0.020***	0.979***	0.201**
	0.002	*0.268*	*0.072*
Turkey CDS	0.006	0.224	0.706***
	0.004	*0.118*	*0.094*
Russia CDS	0.012***	-0.554***	0.196*
	0.001	*0.086*	*0.072*
China CDS	0.011***	0.208	0.193**
	0.003	*0.179*	*0.063*
Brazil CDS	0.009***	0.354***	0.197*
	0.002	*0.095*	*0.084*
iTraxx ex Japan CDS Index	0	0.11	0.190**
	0	*0.182*	*0.059*

Cameroon 2025			
Diagonal BEKK Normal Distribution	C	A	B
SA CDS	0.007***	0.020***	0.744***
	0.004	*1.441*	*0.252*
Turkey CDS	0.006***	0.001***	0.774***
	0.003	*1.208*	*0.209*
Russia CDS	0.007***	0.064***	0.717***
	0.011	*1.81*	*0.281*
China CDS	0.014***	0.112***	0.682***
	0.008	*1.263*	*0.333*
Brazil CDS	0.002***	0.144***	0.656***
	0.001	*2.791*	*0.227*
iTraxx ex Japan CDS Index	0.000***	0.103***	0.685***
	0	*1.038*	0.323

Ivory Coast 2040			
Diagonal BEKK Normal Distribution	C	A	B
SA CDS	0.019***	0.121	0
	0.001	*0.319*	*2.405*
Turkey CDS	0.004	0.198	0.732
	0.021	*0.455*	*0.935*
Russia CDS	0.012	0.621*	0.338
	0.011	*0.275*	*0.258*
China CDS	0.124	0.361	-0.615***
	0.007	*0.197*	*0.12*
Brazil CDS	0.010*	-0.278	-0.429
	0.003	*0.204*	*0.666*
iTraxx ex Japan CDS Index	0	*0.24*	-0.681**
	0	*0.208*	*0.168*

Ivory Coast 2024				Senegal 2024			
Scalar BEKK Student Distribution	C	A	B	Diagonal BEKK Student Distribution	C	A	B
SA CDS	0.007***	0.001***	0.953***	SA CDS	0.017***	0.481***	0.769***
	0	*0.001*	*0.067*		*0.006*	*0.35*	*0.102*
Turkey CDS	0.005***	0.001***	0.953***	Turkey CDS	0.000***	0.069***	0.383***
	0.001	*0.001*	*0.067*		*0.003*	*0.137*	*0.214*
Russia CDS	0.005***	0.001***	0.953***	Russia CDS	0.000***	0.325***	0.454***
	0.004	*0.001*	*0.067*		*0.038*	*0.197*	*0.289*
China CDS	0.004***	0.001***	0.953***	China CDS	0.000***	0.874***	0.484***
	0.001	*0.001*	*0.067*		*0*	*0.304*	*0.345*
Brazil CDS	0.002***	0.001***	0.953***	Brazil CDS	0***	-0.928***	0.370***
	0	*0.001*	*0.067*		*0*	*0.35*	*0.101*
iTraxx ex Japan CDS Index	0.000***	0.001***	0.953***	ITRAX ex Japan CDS Index	0.000***	0.828***	0.453***
	0	*0.001*	*0.067*		*0*	*5.907*	*0.343*
Senegal 2048				**Egypt 2025**			
Diagonal BEKK Gaussian Distribution	C	A	B	Diagonal BEKK Student Distribution	C	A	B
SA CDS	0.006	0.072*	0.942	SA CDS	-0.005***	0.135***	0.806***
	0.075	*2.596*	*1.127*		*0*	*0.234*	*0.234*
Turkey CDS	0.002	-0.188	0.97	Turkey CDS	0.000***	0.144***	0.802***
	0.159	*0.289*	*0.475*		*0*	*0.137*	*0.222*
Russia CDS	0.004*	-0.362	0.732	Russia CDS	-0.001***	0.174***	0.794***
	0.113	*1.28*	*2.085*		*0*	*0.376*	*0.2*
China CDS	0.019*	-0.456	0.445	China CDS	0.000***	0.182***	0.792***
	0.384	*0.883*	*0.587*		*0.001*	*0.174*	*0.239*
Brazil CDS	0.003**	0.206	0.902	Brazil CDS	0.000***	0.114***	0.809***
	0.525	*0.706*	*0.325*		*0.002*	*0.208*	*0.25*
iTraxx ex Japan CDS Index	0	-0.241	0.559	iTraxx ex Japan CDS Index	0.000***	*0.209****	0.838***
	0	*0.774*	1.468		*0.001*	*0.347*	*0.267*

Note: *** p ≤ 0.001; ** p ≤ 0.01; * p ≤ 0.05. The table covers the bonds and CDS in the selection from 1 January 2014 to 4 May 2020. If a Eurobond or CDS contract had not yet been issued on 1 January, the first recorded trade date is the start date. The bond mid-yields are taken daily at 8:30am GMT for Nigeria 2047 & 2024, Kenya 2048 & 2024, Angola 2048 & 2025, Cameroon 2025, Ivory Coast 2040 & 2024, Senegal 2048 & 2024, Ghana 2049 and Egypt 2025, while 5-year CDS prices are taken daily at 7:30am GMT for Brazil, China, Itraxx exJ CDS, SA, Turkey and Russia.

Table 4.12 Covolatility spillover

Euro bond	j	i				i				i				i				i				i			
Nigeria 47		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx (C))	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**
	SA CDS					−0.000072871	0.244029	0.320402	−0.000932	−0.000076497	0.244029	0.336347	−0.000932	−0.000033151	0.244029	0.145761	−0.000932	−0.000055788	0.244029	0.245294	−0.000932	−0.000015075	0.244029	0.066282	−0.000932
	Turkey CDS	0.000048476	0.320402	0.244029	0.00062					0.000066815	0.320402	0.336347	0.00062	0.000028955	0.320402	0.145761	0.00062	0.000048727	0.320402	0.245294	0.00062	0.000013167	0.320402	0.066282	0.00062
	Russia CDS	−0.000079288	0.336347	0.244029	−0.000966	−0.000104102	0.336347	0.320402	−0.000966					−0.000047359	0.336347	0.145761	−0.000966	−0.000079699	0.336347	0.245294	−0.000966	−0.000021536	0.336347	0.066282	−0.000966
	China CDS	−0.000009213	0.145761	0.244029	−0.000259	−0.000012698	0.145761	0.336347	−0.000259	−0.000012096	0.145761	0.320402	−0.000259					−0.00000926	0.145761	0.245294	−0.000259	−0.000002502	0.145761	0.066282	−0.000259
	Brazil CDS	−0.000021848	0.245294	0.244029	−0.000365	−0.000028686	0.245294	0.320402	−0.000365	−0.000030114	0.245294	0.336347	−0.000365	−0.00001305	0.245294	0.145761	−0.000365					−0.000005934	0.245294	0.066282	−0.000365
	Itraxx exJ CDS	0.000002022	0.066282	0.244029	0.000125	0.000002655	0.066282	0.320402	0.000125	0.000002787	0.066282	0.336347	0.000125	0.000001208	0.066282	0.145761	0.000125	0.000002032	0.066282	0.245294	0.000125				
Nigeria 2025 model failed		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx (C))	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**
	SA CDS					–			0	–			0	–			0	–			0	–			0
	Turkey CDS	–			0.004043					–			0.004043	–			0.004043	–			0.004043	–			0.004043
	Russia CDS	–			0.004117	–			0.004117					–			0.004117	–			0.004117	–			0.004117
	China CDS	–			0.003983	–			0.003983	–			0.003983					–			0.003983	–			0.003983

	Brazil CDS	–			0.00083	–			0.00083	–			0.00083	–			0.00083					–			0.00083
	Itraxx exJ CDS index	–			0.005228	–			0.005228	–			0.005228	–			0.005228	–			0.005228				
Kenya 2048		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx(C))	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**
	SA CDS					–	0	0.320402	0	–	−0.24525	0.336347	0	–	−0.2472	0.145761	0	–	−0.235	0.245294	0	–	−0.32047	0.066282	0
	Turkey CDS	–	0.320402	0	0.001523					0.000164128	0.320402	0.336347	0.001523	0.000071127	0.320402	0.145761	0.001523	0.000119697	0.320402	0.245294	0.001523	0.000032344	0.320402	0.066282	0.001523
	Russia CDS	–	0.336347	0	−0.00022	-0.000023709	0.336347	0.320402	−0.00022					−0.000010786	0.336347	0.145761	−0.00022	−0.000018151	0.336347	0.245294	−0.00022	−0.000004905	0.336347	0.066282	−0.00022
	China CDS	–	0.145761	0	−0.00001	-0.00000049	0.145761	0.336347	−0.00001	-0.000000467	0.145761	0.320402	−0.00001					−0.000000358	0.145761	0.245294	−0.00001	−0.000000097	0.145761	0.066282	−0.00001
	Brazil CDS	–	0.245294	0	0.000346	0.000027193	0.245294	0.320402	0.000346	0.000028546	0.245294	0.336347	0.000346	0.000012371	0.245294	0.145761	0.000346					0.000005625	0.245294	0.066282	0.000346
	Itraxx exJ CDS	–	0.066282	0	0.000728	0.00001546	0.066282	0.320402	0.000728	0.00001623	0.066282	0.336347	0.000728	0.000007033	0.066282	0.145761	0.000728	0.000011836	0.066282	0.245294	0.000728				
Kenya 2024		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx(C))	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**
	SA CDS					0.000190716	0.166272	0.548548	0.002091	0.000055797	0.166272	0.160486	0.002091	0.000054791	0.166272	0.157592	0.002091	0.000055812	0.166272	0.16053	0.002091	0.0000524	0.166272	0.150716	0.002091
	Turkey CDS	−0.000402502	0.548548	0.166272	−0.004413					−0.000388495	0.548548	0.160486	−0.004413	−0.00038149	0.548548	0.157592	−0.004413	−0.000388602	0.548548	0.16053	−0.004413	−0.000364845	0.548548	0.150716	−0.004413
	Russia CDS	−0.000181293	0.160486	0.166272	−0.006794	−0.000598105	0.160486	0.548548	−0.006794					−0.000171829	0.160486	0.157592	−0.006794	−0.000175033	0.160486	0.16053	−0.006794	−0.000164332	0.160486	0.150716	−0.006794

		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
	China CDS	−0.000052406	0.157592	0.166272	−0.002	−0.000050583	0.157592	0.160486	−0.002	−0.000172894	0.157592	0.548548	−0.002					-0.000050596	0.157592	0.16053	-0.002	-0.000047503	0.157592	0.150716	-0.002
	Brazil CDS	0.000119365	0.16053	0.166272	0.004472	0.000393797	0.16053	0.548548	0.004472	0.000115211	0.16053	0.160486	0.004472	0.000113134	0.16053	0.157592	0.004472					0.000108198	0.16053	0.150716	0.004472
	Itraxx exJ CDS	−0.000006115	0.150716	0.166272	−0.000244	−0.000020173	0.150716	0.548548	−0.000244	−0.000005902	0.150716	0.160486	−0.000244	−0.000005795	0.150716	0.157592	−0.000244	−0.000005903	0.150716	0.16053	−0.000244				
Angola 2048		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx(C))	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**
	SA CDS					–	0.40093	0.568999	0	–	0.40093	0.31566	0	–	0.40093	0.3046	0	–	0.40093	0.328966	0	–	0.40093	0.279275	0
	Turkey CDS	−0.000055207	0.568999	0.40093	−0.000242					−0.000043466	0.568999	0.31566	−0.000242	−0.000041943	0.568999	0.3046	−0.000242	−0.000045298	0.568999	0.328966	−0.000242	−0.000038456	0.568999	0.279275	−0.000242
	Russia CDS	−0.000130101	0.31566	0.40093	−0.001028	−0.000184639	0.31566	0.568999	−0.001028					−0.000098842	0.31566	0.3046	−0.001028	−0.000106749	0.31566	0.328966	−0.001028	−0.000090624	0.31566	0.279275	−0.001028
	China CDS	0.000107591	0.3046	0.40093	0.000881	0.000084708	0.3046	0.31566	0.000881	0.000152692	0.3046	0.568999	0.000881					0.000088279	0.3046	0.328966	0.000881	0.000074944	0.3046	0.279275	0.000881
	Brazil CDS	−0.000118967	0.328966	0.40093	−0.000902	−0.000168838	0.328966	0.568999	−0.000902	−0.000093665	0.328966	0.31566	−0.000902	−0.000090383	0.328966	0.3046	−0.000902					−0.000082869	0.328966	0.279275	−0.000902
	Itraxx exJ CDS	0.000153846	0.279275	0.40093	0.001374	0.000218338	0.279275	0.568999	0.001374	0.000121126	0.279275	0.31566	0.001374	0.000116882	0.279275	0.3046	0.001374	0.000126232	0.279275	0.328966	0.001374				
Angola 2025		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx(C))	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**
	SA CDS					0.000526239	0.97951	0.224978	0.002388	−0.001295891	0.97951	−0.55402	0.002388	0.000488795	0.97951	0.20897	0.002388	0.000830101	0.97951	0.354885	0.002388	0.000258528	0.97951	0.110526	0.002388
	Turkey CDS	−0.000223894	0.224978	0.97951	−0.001016					0.000126637	0.224978	−0.55402	−0.001016	−0.000047766	0.224978	0.20897	−0.001016	−0.000081119	0.224978	0.354885	−0.001016	−0.000025264	0.224978	0.110526	−0.001016

	Russia CDS	0.000011939	−0.55402	0.97951	−0.000022	0.000002742	−0.55402	0.224978	−0.000022					0.000002547	−0.55402	0.20897	−0.000022	0.000004325	−0.55402	0.354885	−0.000022	0.000001347	−0.55402	0.110526	−0.000022
	China CDS	0.000806267	0.20897	0.97951	0.003939	−0.000456032	0.20897	−0.55402	0.003939	0.000185187	0.20897	0.224978	0.003939					0.000292117	0.20897	0.354885	0.003939	0.000090978	0.20897	0.110526	0.003939
	Brazil CDS	−0.001094287	0.354885	0.97951	−0.003148	−0.00025134	0.354885	0.224978	−0.003148	0.000618939	0.354885	−0.55402	−0.003148	−0.000233457	0.354885	0.20897	−0.003148					−0.000123477	0.354885	0.110526	−0.003148
	Itraxx exJ CDS	0.000171486	0.110526	0.97951	0.001584	0.000039388	0.110526	0.224978	0.001584	−0.000096994	0.110526	−0.55402	0.001584	0.000036585	0.110526	0.20897	0.001584	0.000062131	0.110526	0.354885	0.001584				
Cameroon 2025		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx(C))	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**
	SA CDS					0.000000332	0.020972	0.001799	0.008807	0.000011892	0.020972	0.064386	0.008807	0.000020706	0.020972	0.112108	0.008807	0.000026669	0.020972	0.144388	0.008807	0.000019134	0.020972	0.103595	0.008807
	Turkey CDS	0.000000364	0.001799	0.020972	0.009637					0.000001116	0.001799	0.064386	0.009637	0.000001944	0.001799	0.112108	0.009637	0.000002503	0.001799	0.144388	0.009637	0.000001796	0.001799	0.103595	0.009637
	Russia CDS	0.000020149	0.064386	0.020972	0.014922	0.000001728	0.064386	0.001799	0.014922					0.00010771	0.064386	0.112108	0.014922	0.000138723	0.064386	0.144388	0.014922	0.000138723	0.064386	0.144388	0.014922
	China CDS	0.000016319	0.112108	0.020972	0.006941	0.000050101	0.112108	0.064386	0.006941	0.0000014	0.112108	0.001799	0.006941					0.000112354	0.112108	0.144388	0.006941	0.000080612	0.112108	0.103595	0.006941
	Brazil CDS	0.000046736	0.144388	0.020972	0.015434	0.000004009	0.144388	0.001799	0.015434	0.000143483	0.144388	0.064386	0.015434	0.000249831	0.144388	0.112108	0.015434					0.00023086	0.144388	0.103595	0.015434
	Itraxx exJ CDS	0.000004113	0.103595	0.020972	0.001893	0.000000353	0.103595	0.001799	0.001893	0.000012626	0.103595	0.064386	0.001893	0.000021985	0.103595	0.112108	0.001893	0.000028315	0.103595	0.144388	0.001893				
Ivory Coast 2040		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx(C))	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**
	SA CDS					0.000020856	0.121671	0.198166	0.000865	0.000065418	0.121671	0.621573	0.000865	0.000038026	0.121671	0.361305	0.000865	−0.000029281	0.121671	−0.27822	0.000865	0.000025329	0.121671	0.240668	0.000865
	Turkey	0.000103316	0.198166	0.121671	0.004285					0.000527803	0.198166	0.621573	0.004285	0.000306799	0.198166	0.361305	0.004285	−0.000236248	0.198166	−0.27822	0.004285	0.000204361	0.198166	0.240668	0.004285

	CDS																								
	Russia CDS	−0.000288745	0.621573	0.121671	−0.003818	−0.000470281	0.621573	0.198166	−0.003818					−0.000857437	0.621573	0.361305	−0.003818	0.000660262	0.621573	−0.27822	−0.003818	−0.000571145	0.621573	0.240668	−0.003818
	China CDS	−0.000152323	0.361305	0.121671	−0.003465	−0.000778161	0.361305	0.621573	−0.003465	−0.000248088	0.361305	0.198166	−0.003465					0.00034831	0.361305	−0.27822	−0.003465	−0.000301298	0.361305	0.240668	−0.003465
	Brazil CDS	−0.000146271	−0.27822	0.121671	0.004321	−0.000238233	−0.27822	0.198166	0.004321	−0.000747248	−0.27822	0.621573	0.004321	−0.000434357	−0.27822	0.361305	0.004321					−0.000289328	−0.27822	0.240668	0.004321
	Itraxx exJ CDS	−0.000019853	0.240668	0.121671	−0.000678	−0.000032335	0.240668	0.198166	−0.000678	−0.000101424	0.240668	0.621573	−0.000678	−0.000058955	0.240668	0.361305	−0.000678	0.000045398	0.240668	−0.27822	−0.000678				
Ivory Coast 2024 Model Failed		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx (C))	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**
	SA CDS					–	0	0	0.004689	–	0	0	0.004689	–	0	0	0.004689	–	0	0	0.004689	–	0	0	0.004689
	Turkey CDS	–	0	0	0.006379					–	0	0	0.006379	–	0	0	0.006379	–	0	0	0.006379	–	0	0	0.006379
	Russia CDS	–	0	0	0.027826	–	0	0	0.027826					–	0	0	0.027826	–	0	0	0.027826	–	0	0	0.027826
	China CDS	–	0	0	0.008546	–	0	0	0.008546	–	0	0	0.008546					–	0	0	0.008546	–	0	0	0.008546
	Brazil CDS	–	0	0	0.014961	–	0	0	0.014961	–	0	0	0.014961	–	0	0	0.014961					–	0	0	0.014961
	Itraxx exJ CDS	–	0	0	0.010422	–	0	0	0.010422	–	0	0	0.010422	–	0	0	0.010422	–	0	0	0.010422				
Senegal 2048						Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx (C))	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**
	SA CDS					−0.000004019	0.072196	−0.188807	0.000296	−0.00000775	0.072196	−0.36267	0.000296	−0.000009747	0.072196	−0.45612	0.000296	0.00000441	0.072196	0.206378	0.000296	−0.000005163	0.072196	−0.24159	0.000296

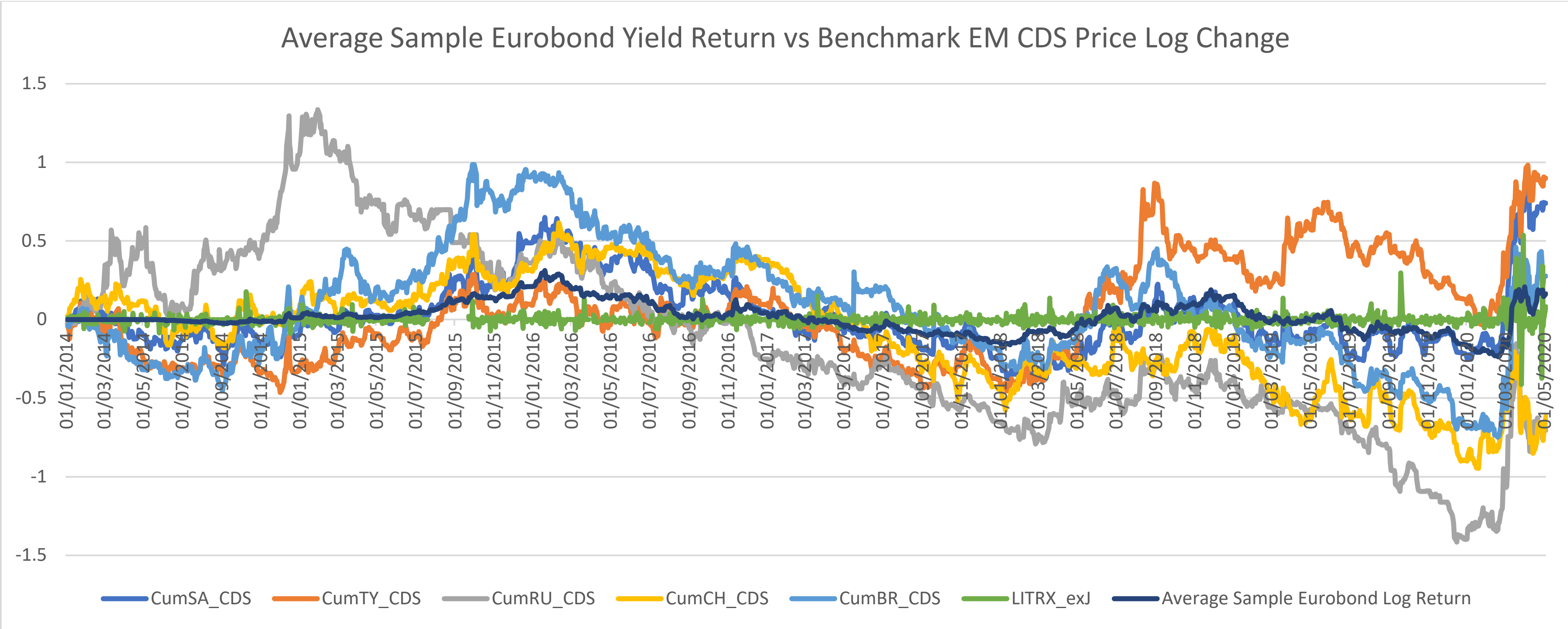
	Turkey CDS	−0.000097883	−0.18807	0.072196	0.007209					0.000491711	−0.18807	−0.36267	0.007209	0.000618406	−0.18807	−0.45612	0.007209	−0.000279807	−0.18807	0.206378	0.007209	0.000327547	−0.18807	−0.24159	0.007209
	Russia CDS	−0.000050403	−0.36267	0.072196	0.001925	0.0001313	−0.36267	−0.18807	0.001925					0.000318438	−0.36267	−0.45612	0.001925	−0.000144082	−0.36267	0.206378	0.001925	0.000168665	−0.36267	−0.24159	0.001925
	China CDS	0.000068692	−0.45612	0.072196	−0.002086	−0.000345071	−0.45612	−0.36267	−0.002086	−0.000178942	−0.45612	−0.18807	−0.002086					0.000196362	−0.45612	0.206378	−0.002086	−0.000229865	−0.45612	−0.24159	−0.002086
	Brazil CDS	0.000022707	0.206378	0.072196	0.001524	−0.000059152	0.206378	−0.18807	0.001524	−0.000114068	0.206378	−0.36267	0.001524	−0.000143459	0.206378	−0.45612	0.001524					−0.000075985	0.206378	−0.24159	0.001524
	Itraxx exJ CDS	0.000155581	−0.24159	0.072196	−0.00892	−0.000405288	−0.24159	−0.18807	−0.00892	−0.000781554	−0.24159	−0.36267	−0.00892	−0.000982931	−0.24159	−0.45612	−0.00892	0.000444741	−0.24159	0.206378	−0.00892				
Senegal 2024		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx(C))	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**	**(AxBx(C))**	**A**	**B**	**C**
	SA CDS					−0.000070082	0.481025	0.06951	−0.002096	−0.000355091	0.481025	0.352193	−0.002096	−0.000881987	0.481025	0.874789	−0.002096	0.000936503	0.481025	−0.92886	−0.002096	−0.00083527	0.481025	0.828453	−0.002096
	Turkey CDS	0.00002073	0.06951	0.481025	0.00062					0.000015178	0.06951	0.352193	0.00062	0.0000377	0.06951	0.874789	0.00062	−0.00004003	0.06951	−0.92886	0.00062	0.000035703	0.06951	0.828453	0.00062
	Russia CDS	0.000537888	0.352193	0.481025	0.003175	0.000077727	0.352193	0.06951	0.003175					0.0009782	0.352193	0.874789	0.003175	−0.001038663	0.352193	−0.92886	0.003175	0.000926387	0.352193	0.828453	0.003175
	China CDS	−0.001594394	0.874789	0.481025	−0.003789	−0.00116737	0.874789	0.352193	−0.003789	−0.000230396	0.874789	0.06951	−0.003789					0.003078777	0.874789	−0.92886	−0.003789	−0.00274597	0.874789	0.828453	−0.003789
	Brazil CDS	0.002909147	−0.92886	0.481025	−0.006511	0.000420383	−0.92886	0.06951	−0.006511	0.002129995	−0.92886	0.352193	−0.006511	0.005290555	−0.92886	0.874789	−0.006511					0.005010324	−0.92886	0.828453	−0.006511
	Itraxx exJ CDS	−0.001400352	0.828453	0.481025	−0.003514	−0.000202356	0.828453	0.06951	−0.003514	−0.001025299	0.828453	0.352193	−0.003514	−0.002546672	0.828453	0.874789	−0.003514	0.002704082	0.828453	−0.92886	−0.003514				

		SA CDS				Turkey CDS				Russia CDS				China CDS				Brazil CDS				Itraxx exJ CDS			
		(AxBx (C))	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**	**(AxBx (C))**	**A**	**B**	**C**
Egypt 2025	SA CDS					−0.000003811	0.13567	0.144039	−0.000195	−0.000004628	0.13567	0.17494	−0.000195	−0.000004834	0.13567	0.182723	−0.000195	−0.000003018	0.13567	0.114075	−0.000195	−0.000005545	0.13567	0.209584	−0.000195
	Turkey CDS	0.000021926	0.144039	0.13567	0.001122					0.000028272	0.144039	0.17494	0.001122	0.00002953	0.144039	0.182723	0.001122	0.000018436	0.144039	0.114075	0.001122	0.000033871	0.144039	0.209584	0.001122
	Russia CDS	0.00020746	0.17494	0.13567	0.008741	0.000220257	0.17494	0.144039	0.008741					0.000279411	0.17494	0.182723	0.008741	0.000174438	0.17494	0.114075	0.008741	0.000320485	0.17494	0.209584	0.008741
	China CDS	0.000179703	0.182723	0.13567	0.007249	0.000231718	0.182723	0.17494	0.007249	0.000190788	0.182723	0.144039	0.007249					0.000151099	0.182723	0.114075	0.007249	0.000277606	0.182723	0.209584	0.007249
	Brazil CDS	−0.000070124	0.114075	0.13567	−0.004531	−0.00007445	0.114075	0.144039	−0.004531	−0.000090422	0.114075	0.17494	−0.004531	−0.000094445	0.114075	0.182723	−0.004531					−0.000108328	0.114075	0.209584	−0.004531
	Itraxx exJ CDS	0.000468284	0.209584	0.13567	0.016469	0.000497171	0.209584	0.144039	0.016469	0.00060383	0.209584	0.17494	0.016469	0.000630694	0.209584	0.182723	0.016469	0.000393746	0.209584	0.114075	0.016469				

Note: The table covers the bonds and CDS in the selection from 1 January 2014 to 4 May 2020. If a Eurobond or CDS contract had not yet been issued on 1 January, the first recorded trade date is the start date. The bond mid-yields are taken daily at 8:30am GMT for Nigeria 2047 & 2024, Kenya 2048 & 2024, Angola 2048 & 2025, Cameroon 2025, Ivory Coast 2040 & 2024, Senegal 2048 & 2024, Ghana 2049 and Egypt 2025, while 5-year CDS prices are taken daily at 7:30am GMT for Brazil, China, Itraxx exJ CDS, SA, Turkey and Russia.

The covolatility model is illustrated by the following formula (Zolfaghari et al., 2020): $\frac{\partial H_{ij,t}}{\partial \epsilon_{j,t-1}} = a_{ii} x$

Figure 4.1 Benchmark CDS vs FM Eurobonds



Note: The graph covers all the sample Eurobonds and CDS returns in the selection from 1 January 2014 to 4 May 2020. If a Eurobond had not yet been issued on 1 January, the first recorded trade date is the start date. The CDS price is taken daily at 7:30am GMT, and the Eurobond mid-yield is taken at 8:30am GMT. The data in the graph were generated via the log returns taken from the change of one day to another.

Chapter 5. Concluding Remarks

5.1 The Findings

As the EM bond universe has been increasing in importance over the past years, so has that of the FM. Nevertheless, the FM subsegment remains largely under-researched. One reason for this is the challenges in gathering and accessing data. In addition, FM sovereign Eurobond and local debt markets are less liquid than those of their EM peers. However, the FM universe forms an integral part of the main EM bond indices, thus resulting in FM bond markets getting exposed to general global market risks. Academic research currently does not cover how various macroeconomic information releases impact FM bond yields and whether more liquid market instruments would lead the illiquid FM bonds. This study fills this gap by using a comprehensive empirical analysis to identify the impact of locally released macroeconomic information, the impact of the WEO updates released by the IMF and, finally, if the financially more developed EM sovereign CDS contracts lead the illiquid FM sovereign Eurobonds.

The analysis presented in Chapter 2 looks at the impact of local and global MEFs on both Eurobonds and local-currency-issued bonds in SSA at different points on the yield curve over the period Q1 2006–Q2 2016. The limited existing literature on SSA focuses on the Eurobond market and disregards the local currency bonds. Given the growing interest by investors in that market, this study attempts to fill this gap. Employing a unique proprietary dataset provided by the DAM aed, which is a dataset collected from local authorities, central banks and independent international sources across SSA, we used panel regression to investigate the effect of both local MEFs and global factors on SSA local treasury and bond yields and Eurobond prices at different points on the yield curve.

Our results confirm the importance of MEFs to explain the yield curve on local debt instruments found in previous studies on domestic bonds in DMs and EMs. More precisely, the two domestic MEFs that predominantly impact the local treasury and bond yields – as well as the Eurobonds – are the mpr and the bot. The highest impact is on the short end for the local instruments and at the long end for the Eurobonds; it is contemporaneous for the former and stronger with a lag for the latter. The R2 value is high for most models, confirming the results of previous studies on the importance of macro factors.

Thus, interest rates have a high capacity to explain low-frequency bond yield movements, which is also in line with Schiller's (2015) finding that a central bank is more successful in influencing the short end of the yield curve through the mpr than the long end. Additionally, our results show that, as expected, global risk aversion, proxied by vix, is only important for the Eurobonds and that the impact increases with time, since investors in Eurobonds are predominantly foreigners. This confirms the importance of global factors found in previous studies (Senga et al., 2018; Gevorkyan and Kvangraven, 2016).

When dividing the countries into CIs and CEs, the results show that, for the former, bot has a key impact on the local treasury and bond yields, while for the latter, the mpr, cpi and fxres stand out as exerting some impact. Furthermore, the results show that while global risk aversion impacts both groups, its impact on the CIs is significantly greater. Thus, our analysis reveals how the impact of MEFs differs within SSA. The results additionally show that the impact is different at different points on the yield curve. Finally, the results highlight the impact of domestic MEFs on the yield curve and the role that governments can play to foster the depth and development of their debt markets by adopting the right policies.

It should be borne in mind that the results are based on a short history of data, and we were not able to explore the impact of additional macroeconomic variables, such as the exchange rate and institutional quality. Further research could use a larger dataset and analyse the bidirectional causality between the yields of the debt instruments and the MEFs.

Chapter 3 explores whether the sovereign bond yields of FMs are more affected by the IMF's macroeconomic forecast changes than those of the financially more developed EMs, given that FMs provide investors and the local and international institutions with bigger challenges regarding the quality and availability of data. Our event study used our unique daily data for the period 1 April 2001 to 10 October 2018 and covered 15 FMs and five EMs as a control group. The results show that there is no immediate impact from changing IMF economic forecasts, reported twice a year, on FM sovereign Eurobonds yields' abnormal returns. This leads us to believe that the overall changes must be already embedded in the bond yields prior to the updates and that investors in FM countries have a higher acceptance threshold for changes in macroeconomic forecasts. One of the reasons for this may be the recurring visits by IMF staff members to some of the countries in the sample and subsequent ad-hoc press releases and reports, such as Article IV and the Debt Sustainability Analysis. Another reason could be that FM countries historically have been subject to higher nominal changes in macroeconomic forecasts, thus increasing the tolerance levels of FM investors in these markets.

These findings are in line with the results obtained by Delvaux et al. (2018), who found that the sovereign Eurobonds in SSA countries, which are a large part of the

FM sample in this study, are affected more by global factors than underlying local sovereign developments.

Furthermore, a country's financial development ranking does not appear to have a material effect on a its abnormal Eurobond returns, which is in line with the expectation from a practitioner's point of view that, as they trade in the international markets, Eurobonds are not dependent on a country's local financial development for liquidity and settlement purposes. This could be explained by the suggestion that a country's financial development index ranking is not defined solely by its transparency and investor communication. Some of the countries in the sample require IMF assistance through funded programmes or technical assistance programmes that entail frequent visits or updates by the fund, allowing for updated information to be assimilated by the market ahead of the WEO database being updated.

Finally, Chapter 4 outlines our use of a BEKK model to test whether the relatively more liquid benchmark EM CDS lead FM sovereign Eurobonds (in our case, for SSA) through volatility spillover. We tested the BEKK models by applying different weights to Matrix A, and the outcome is similar to that of Zolfaghari et al. (2020) in that there are high degrees of consistency. We compared the results to establish volatility spillover patterns.

The result is in line with our expectations, which were based on an investment practitioner's point of view. The correlations between the selected EM 5-year CDS prices and the FM Eurobond yields are generally high and statistically significant, with the highest between the Nigeria 2047 Eurobond and the SA CDS, at 0.6. A few exceptions include the lowest correlation between Angola 2048 and the Itraxx exJ, at −0.01. Furthermore, the findings are in line with the research conducted by Ammer and Cai (2011), who suggested that the more bond issuances a sovereign has, or rather, the more liquid a sovereign bond market is, the less likely the CDS market will be to lead bond yields.

The split between the spillover patterns from the BEKK model indicates that for 39.1% of the models, the signs and multipliers remain coherent when augmenting the analysis from the 2 x 2 to the 7 x 7 model by including robustness of the models. In 73% of cases, the signs between the models are the same, while in 44% of cases, the multiplier is the same.

The sample's CDS contracts that are the best lead indicators for the FM Eurobonds are the 5-year South Africa and Turkey CDS contracts. Given that the Eurobond sample consists of SSA countries and that South Africa is one of the leading economies on the African continent, it is not surprising that the South Africa CDS prices have a stronger lead effect. The effect of the Turkey CDS can in part be explained by the fact that the economy actually shares many macroeconomic revisions – similar to or even more so than some of the sample Eurobond countries (Delvaux et al., 2020) – and by Turkey trading in the same time zone as SSA. Our findings follow Longstaff et al.'s (2011) argument that liquidity plays a crucial role in price discovery; thus, more liquid instruments can lead the less liquid ones. In our case, the EM CDS prices lead the FM sovereign Eurobond yields.

The contributions of this study are as follows. The analysis allows practitioners to gain a better understanding of what drives FM sovereign Eurobond yields and therefore improve the assessment of risk and returns in their investment portfolios. In addition, it enables policymakers to increase their understanding of the impact of their economic data releases on their yield curves. Furthermore, it contributes to filling the gaps in the academic literature covering FM bonds, which remains an under-studied and under-researched area.

Moreover, the more investors and policymakers deepen their knowledge on how the FM investment universe differs from the realm of EM investments, the better their understanding of the underlying investment and policy risks. This is vital for any investor when making investment decisions and will contribute positively to their understanding of the risks associated with FM markets. More often than not, FM countries require fund flows to fill the funding gaps they experience; hence, it is vital that investors and development agencies are comfortable with the underlying risks they take. With this research we attempt to close, even if just in part, a small portion of that gap.

Further, in the current environment EM investors will continue to analyse and invest in FM due to the yield premium this sub-segment of the EM universe commands, especially during times of global liquidity squeezes. This premium or potential alpha generating return source will remain a core factor for many EM investors.

The author remains positive in terms of future developments of the FM debt markets and especially for the countries predominantly covered in the sub-sample of this analysis, namely SSA.

5.2 Limitations and Further Developments

A certain limitation to this study consists in the availability of consistent and timely data. In recent years, FM authorities have made a large effort to improve upon the quality of the data provided thus, making comparisons with older data at points challenging. As a result of which, for all the analysis conducted above, it would be useful to redo the study in a few years to have comparable datasets available and to cross examine the results of the different studies.

Another element that would reduce some of the limitations to this study, would be the addition of more sovereign Eurobonds into the sample. There have been numerous SSA Eurobond issuances in recent years, developing the various sovereign Eurobond curves but also in some cases increases the issuance amounts. Hence there are additional data points available to incorporate in future studies, that would allow for a better understanding on how more established FM yield curve react to various macroeconomic data announcements or global risk factors. The same is also valid for local currency debt issuances in many of the countries in the sample of this study. Additionally, one would expect that the sovereign CDS market for individual FM would also develop over the next years, once there is sufficient liquidity in those respective FM CDS contracts, it would be useful to conduct an analysis comparing how FM CDS open in the morning versus their underlying sovereign Eurobonds.

The analysis conducted in relation to the impact of the changes in macroeconomic forecasts by the IMF upon FM Eurobonds, could be improved upon the basis of analysing if there are changed in FM Eurobond yields on the day of the IMF publishing its macroeconomic reports on individual FM sovereigns.

Furthermore, since the end of 2020, there have been sovereign FM defaults, such as by Zambia and, more recently, Ghana. It would be interesting to analyse how such sovereign defaults might impact the results of this research and the various risk premiums attached for FM countries. Alas this was out of the scope of this research.

Bibliography

Abidi, N., Hacibedel, B., and Nkusu, M. (2019) 'Changing times for frontier markets: A perspective from portfolio investment flows and financial integration', *Journal of Banking and Financial Economics*, vol. 1, no. C, pp. 19–45.

Acharya, V. V., Drechsler, I., and Schnabl, P. (2014) 'A pyrrhic victory? – Bank bailouts and sovereign credit risk', *Journal of Finance*, vol. 69, no. 6, pp. 2689–2739.

Acharya, V., and Johnson, T. C. (2007) 'Insider trading in credit derivatives', *Journal of Financial Economics*, vol. 84, no. 1, pp. 110–141.

African Development Bank (2016) *Africa Economic Outlook* [Online], http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/AEO_2016_Report_Full_English.pdf

Ahnert, T., and Bertsch, C. (2015) *A wake-up call theory of contagion*, Sveriges Riksbank, Stockholm, WP 294.

Aldasoro, I., and Ehlers, T. (2018) 'The credit default swap market: What a difference a decade makes', *BIS Quarterly Review*, June, pp. 1–14.

Alder, M., and Song, J. (2010) 'The behaviour of emerging market sovereign credit default swaps premiums and bond yield spreads', *International Journal of Finance and Economics*, vol. 15, no. 1, pp. 31–58.

Allen, D. E., and McAleer, M. (2018) 'Theoretical and empirical differences between diagonal and full BEKK for risk management', *Energies*, vol. 11, no. 7, pp. 1–19.

Ammer, J., and Cai, F. (2011) 'Sovereign CDS and bond pricing dynamics in emerging markets: Does the cheapest-to-deliver option matter?', *Journal of International Financial Markets, Institutions & Money*, vol. 21, no. 3, pp. 369–387.

An, Z., Jalles, J. T., Loungani, P., and Sousa, R. M. (2017) 'Do IMF fiscal forecast add value?', *Journal of Forecasting*, vol. 37, no. 6, pp. 650–665.

Andritzky, J. R., Bannister, G. J., and Tamirisa, N. T. (2007) 'The impact of macroeconomic announcements on emerging market bonds', *Emerging Markets Review*, vol. 8, no. 1, pp. 20–37.

Ang, A., and Piazzesi, M. (2003) 'A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables', *Journal of Monetary Economics*, vol. 50, no. 4, pp. 745–787.

Ang, A., Piazzesi, M., and Wei, M. (2006) 'What does the yield curve tell us about GDP growth?', *Journal of Econometrics*, vol. 131, no. 1–2, pp. 359–403.

Arkam, F. Q. (2011) 'Policy analysis in real time using IMF's monetary model', *Economic Modelling*, vol. 28, no. 4, pp. 1696–1709.

Armington, P. S. (1969) 'A theory of demand for products distinguished by place of production', *IMF Staff Papers*, vol. 16, no. C, March, pp. 159–176.

Atoyan, R., and Conway, P. (2010) 'Projecting macroeconomic outcomes: Evidence from the IMF', *Review of International Organizations*, vol. 6, no. 3, pp. 415–441.

Audzeyeva, A., and Fuertes, A-M. (2018) 'On the predictability of emerging market sovereign credit spreads', *Journal of International Money and Finance*, vol. 88, no. C, pp. 140–157.

Augustin, P. (2018) 'The term structure of CDS spreads and sovereign credit risk', *Journal of Monetary Economics*, vol. 96, no. C, pp. 53–76.

Balcilar, M., Cakan, E., and Gupfofta, R. (2017) 'Does US news impact Asian emerging markets? Evidence from nonparametric causality-in quantiles test', *North American Journal of Economics and Finance*, vol. 41, no. C, pp. 32–43.

Beine, M., and Laurent, S. (2003) ‘Central bank intervention and jumps in double long memory models of daily exchange rates’, *Journal of Empirical Finance*, vol. 10, no. 5, pp. 641–660.

Bekaert, G., Cho, S., and Moreno, A. (2010) ‘New Keynesian macroeconomics and the term structure’, *Journal of Money, Credit and Banking*, February, vol. 42, no. 1, pp. 33–62.

Bekaert, G., Harvey, C. R., Lundblad, C. T., and Siegel, S. (2014) ‘Political risk spreads’, *Journal of International Business Studies*, May, vol. 45, no. 4, pp. 471–493.

Bessembinder, H., Kahle, K. M., Mawell, W. F., and Xu, D. (2009) ‘Measuring abnormal bond performance’, *The Review of Financial Studies*, vol. 22, no. 10, pp. 4219–4258.

Blanco, F., Brennman, S., and Marsh, I. W. (2005) ‘An empirical analysis of the dynamic relationship between investment grade bonds and credit default swaps’, *Journal of Finance*, vol. 60, no. 5, pp. 2255–2281.

Boehmer, E., Musumeci, J., and Poulsen, A. B. (1991) ‘Event-study methodology under conditions of event-induced variance’, *Journal of Financial Economics*, vol. 30, no. 2., 253–272.

Bollerslev, T. (1986) ‘Generalized autoregressive conditional heteroscedasticity’, *Journal of Econometrics*, vol. 31, no. 3, pp. 307–327.

Boughton, J. (1997) *Modeling the World Economic Outlook at the IMF: A historical review*, IMF Working Paper, WP/97/48.

Bouri, E., de Boyrie, M. E., and Pavlova, I. (2017) ‘Volatility transmission from commodity markets to sovereign CDS spreads in emerging and frontier countries’, *International Review of Financial Analysis*, vol. 49, no. C, pp. 155–165.

Bowman, A. (2013) ‘Zambian municipal bonds: Making hay while the sun still shines’, *Financial Times*, 4 January.

Bowman, D., Londono, J. M., and Sapriza, H. (2015) 'U.S. unconventional monetary policy and transmission to emerging market economies', *Journal of International Money and Finance*, vol. 55, no. C, pp. 27–59.

Brealey, R. A., and Kaplanis, E. (2004) 'The impact of IMF programs on asset values', *Journal of International Money and Finance*, vol. 23, no. 2, pp. 253–270.

Burger, J., Warnock, F., and Warnock, V. (2012) 'Emerging local currency bond markets', *Financial Analyst Journal*, vol. 68, no. C, pp. 73–93.

Chang, C. L., and McAleer, M. (2019) 'Volatility spillovers for spot, futures and ETF prices in agriculture and energy', *Energy Economics*, vol. 81, no. C, pp. 779–792.

Chan-Lau, J. A., and Kim, Y. S. (2004) 'Equity prices, credit default swaps and bond spreads in emerging markets', *IMF Working Paper*, vol. 4, no. 27, pp. 1–37.

Cheung, Y. W., and Ng, L. K. (1996) 'A causality in variance test and its application to financial market prices', *Journal of Economy*, vol. 72, no. 1-2, pp. 33–48.

Choi, I. (2001) 'Unit root tests for panel data', *Journal of International Money and Finance*, vol. 20, no. 2, pp. 249–272.

Choi, S., and Hashimoto, Y. (2018) 'Does transparency pay? Evidence from IMF data transparency policy reforms and emerging market sovereign bond spreads, *Journal of International Money and Finance*, vol. 88, no. C, pp. 171–190.

Christensen, J. (2004) *Domestic debt markets in Sub-Saharan Africa*, IMF Working Paper, WP/04/46.

Defond, M. L., and Zhang, J. (2014) 'The timeliness of the bond market reaction to bad earnings news', *Contemporary Accounting Research*, vol. 31, no. 3, pp. 911–936.

Delvaux, J. G., Phylaktis, K., and Thomas, S. (2018) *The impact of macroeconomic factors on the yield curve in emerging markets: The case of Sub-Saharan Africa*, Working Paper, pp. 1-55, SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3283342

Delvaux, J. G., Phylaktis, K., and Thomas, S. (2020) *Do IMF macroeconomic forecast changes impact hard currency sovereign bonds for frontier emerging markets*?, Working Paper

Duffie, D. (1999) 'Credit default valuation', *Financial Analyst Journal*, vol. 55, no. 3, pp. 73–87.

Ederington, L., Guan, W., and Yang, L. Z. (2015) 'Bond market event study methods', *Journal of Banking & Finance*, vol. 58, no. C, pp. 281–293.

Eichengreen, B., Kletzer, K., and Mody, A. (2006) 'The IMF in a world of private capital markets', *Journal of Banking & Finance*, vol. 30, no. 5, pp. 1335–1357.

Eichengreen, B., and Mody, A. (2000), 'What explains changing spreads on emerging-market debt?', in Edwards, S. (ed.) *Capital flows and emerging economies: Theory, evidence and controversies*, Chicago, University of Chicago Press, pp. 107–134.

Emerging Market Trading Association (EMTA), *Q3 2019 CDS Survey 11th December 2019*, www.emta.org

Evans, C. L., and Marshall, D. A. (2007) 'Economic determinants of the nominal treasury yield curve', *Journal of Monetary Economics*, vol. 54, no. 7, pp. 1986–2003.

Evrensel, A. Y. (2002) 'Effectiveness of IMF-supported stabilization programs in developing countries', *Journal of International Money and Finance*, vol. 21, no. 5, pp. 565–587.

Evrensel, A. Y., and Kutan, A. M. (2008) 'Impact of IMF-related news on capital markets: Further evidence from bond spreads in Indonesia and Korea', *Journal of International Financial Markets, Institutions and Money*, vol. 18, no. 2, pp. 147–160.

Fama, E. F., Fisher, L., Jensen, M., and Roll, R. (1969) 'The adjustment of stock prices to new information', *International Economic Review*, vol. 10, no. 1, pp. 1–21.

Fender, I., Hayo, B., and Neuenkirch, M. (2012) 'Daily pricing of emerging market sovereign CDS before and during the global financial crisis', *Journal of Banking & Finance*, vol. 36, no. 10, pp. 2786–2794.

Finra website, www.finra.org

Fisher, I. (1930) *The theory of interest: As determined by impatience to spend income and opportunity to invest it*, New York, The Macmillan Company.

Fleming, M., and Remolona, E. M. (1999) 'What moves bond prices?', *Journal of Portfolio Management*, June, vol. 25, no. 4, pp. 24–38.

Frankel, J. A. (2011) 'Over-optimism in forecasts by official budget agencies and its implications', *Oxford Review of Economic Policy*, vol. 27, no. 4, pp. 536–562.

Franses, P. H., McAleer, M., and Legerstee, R. (2014) 'Evaluating macroeconomic forecasts: A concise review of some recent developments', *Journal of Economic Surveys*, vol. 28, no. 2, pp. 195–208.

Fratzscher, M., and Reynaud, J. (2011) 'IMF surveillance and financial markets – A political economy analysis', *European Journal of Political Economy*, vol. 27, no. 3, pp. 405–422.

Galil, K., and Soffer, G. (2011) 'Good news, bad news and rating announcements: An empirical investigation', *Journal of Banking & Finance*, vol. 35, no. 11, pp. 3101–3119.

Gelos, R. G., Sahay, R., and Sandleris, G. (2011) 'Sovereign borrowing by developing countries: What determines market access?' *Journal of International Economics*, vol. 83, no. 2, pp. 243–254.

Gennaioli, N., Martin, A., and Rossi, S. (2014) 'Sovereign default, domestic banks, and financial institutions', *Journal of Finance*, vol. 69, no. 2, pp. 819–866.

Gevorkyan, A. V., and Kvangraven, I. H. (2016) 'Assessing recent determinants of borrowing costs in Sub-Saharan Africa', *Review of Development Economics*, vol. 20, no. 4, pp. 721–738.

Glosten, L. R., Jagannathan, R., and Runkie, D. E. (1993) 'On the relation between the expected value and the volatility of the nominal excess return on stocks', *Journal of Finance*, vol. 48, no. 5, pp. 1779–1801.

Gündüz, Y. B. (2016) 'The economic impact of short-term IMF engagement in low-income countries', *World Development*, vol. 87, no. C, pp. 30–49.

Gürkaynak, R. S., and Wright, J. H. (2013) 'Identification and interference using event studies', The Manchester School, Supplement 2013, pp. 48–65.

Guzman, M., and Heymann, D. (2015) 'The IMF debt sustainability analysis: Issues and problems', *Journal of Globalization and Development*, vol. 6, no. 2, pp. 387–404.

Hafner, C. M., and Herwartz, H. (2006) 'A Lagrange multiplier test for causality in variance, Economic Letters, Vol. 93, no. 1, pp. 137–141.

Hand, J. R., Holthausen, R. W., and Leftwich, R. W. (1992) 'The effect of bond rating agency announcements on bond and stock prices', *The Journal of Finance*, vol. 47, no. 2, pp. 733–752.

Hausman, J. A. (1978) 'Specification tests in econometrics', *Econometrica*, vol. 46, November, no. 6, pp. 1251–1271.

Hayo, B., and Kutan, A. M. (2005) 'IMF-related news and emerging financial markets', *Journal of International Money and Finance*, vol. 24, no. 7, pp. 1126–1142.

Hayo, B., Kutan, A. M., and Neuenkirch, M. (2012) ‘Federal reserve communications and emerging equity markets’, *Southern European Economic Journal*, vol. 78, no. 3, pp. 1041–1056.

Hong, Y. (2001) ‘A test for volatility spillover with application to exchange rates’, *Journal of Econometrics*, vol. 103, no. 1, pp. 183–224.

Hsiao, C. (2007) ‘Panel data analysis – advantages and challenges’, *TEST: An official Journal of Spanish Society of Statistics and Operations Research*, vol. 16, no. 1, pp. 1 – 22

Hull, J., Predescu, M., and White, A. (2004) ‘The relationship between credit default swap spreads, bond yields, and credit rating announcements’, *Journal of Banking & Finance*, vol. 28, no. 11, pp. 2789–2811.

Hull, J., and White, A. (2000) ‘Valuing credit default swaps I: No counterparty default risk’, *Journal of Derivatives*, vol. 10, no. 3, pp. 29–40.

IMF website, https://www.imf.org/

IMF (2011) ‘Assessing reserve adequacy’, Monetary and Capital Markets, Research, and Strategy, Policy and Review Departments, pp. 1–49.

IMF (2014) *New grouping in WEO country classifications: Low-income developing countries*, Policy Paper, June.

IMF (2017) *Nigeria 2017 Article IV*, IMF Country Report No. 17/80.

IMF (2017) *Review of the debt sustainability framework for low income countries*, IMF Policy Paper, September.

Ismailescu, I., and Kazemi, H. (2010) ‘The reaction of emerging market credit default swap spreads to sovereign credit rating changes’, *Journal of Banking & Finance*, vol. 34, no. 12, pp. 2861–2873.

Ismailescu, I., and Philips, B. (2015) ‘Credit default swaps and the market for sovereign debt’, *Journal of Banking & Finance*, vol. 52, no. C, pp. 43–61.

J. P. Morgan, *Emerging Markets Bond Index (EMBI) Monitor*, June 1 2017.

J. P. Morgan, https://markets/jpmorgan.com/#research.emerging_markets.index

Jaramillo, L., and Weber, A. (2013) ‘Bond yields in emerging economies: It matters what state you are in’, *Emerging Markets Review*, vol. 17, no. C, pp. 169–185.

Javed, F., and Mantalos, P. (2015) ‘Sensitivity of the causality in variance test to the GARCH (1,1) parameters’, *Chilean Journal of Statistics*, vol. 6, no. 1, April, pp. 49–65.

Kozicki, S., and Tinsely, P. A. (2001) ‘Shifting endpoints in the term structure of interest rates’, *Journal of Monetary Economics*, vol. 47, no. 3, pp. 613–652.

Longstaff, F. A., Pan, L., Pedersen, L. H., and Singleton, K. J. (2011) ‘How sovereign is sovereign credit risk?’, *American Economic Journal: Macroeconomics*, vol. 3, no. 2, pp. 75–103.

Matsumure, M. S., and Moreira, A. R. B. (2009) ‘Assessing macro influence on Brazilian yield curve with affine models’, *Applied Economics*, vol. 43, no. 15, pp. 1847–1867.

Maul, D., and Schiereck, D. (2017) ‘The bond event study methodology since 1974’, *Review of Quantitative Finance and Accounting*, vol. 48, no. 3, pp. 111–137.

McAleer, M. (2019) ‘What they did not tell you about algebraic (non-) existence, mathematical (ir-)regularity, and (non-) Asymptotic properties of the dynamic conditional correlation (DCC) model’, *Journal of Risk and Financial Management*, vol. 12, no. 61, pp. 1–9.

Mehl, A. (2009) ‘The yield curve as a predictor and emerging economies’, *Open Economies Review*, vol. 20, no. 5, pp. 683–716.

Mo Ibrahim website, http://mo.ibrahim.foundation/iiag/

Morales, M. (2010) 'The real yield curve and macroeconomic factors in the Chilean economy', *Applied Economics*, vol. 42, no. 27, pp. 3533–3545.

MSCI market classification, www.msci.com/market-classification

Nardo, M., Saisana, M., Saltelli, A., and Tarantola, S. (2005) *Tools for composite indicators building*, Joint Research Centre European Commission, EUR 21682 EN.

Ngene, G. M., Hassan, K. M., and Alam, N. (2014) 'Price discovery process in the emerging sovereign CDS and equity markets', *Emerging Market Review*, vol. 21, no. C, pp. 117–132.

Norden, L., and Weber, M. (2009) 'The co-movement of credit default swap, bond and stock markets: An empirical analysis', *European Financial Management*, vol. 15, no. 3, pp. 529–562.

Nowak, S., Andritzky, J., Jobst, A., and Tamirisa, N. (2011) 'Macroeconomic fundamentals, price discovery, and volatility dynamics in emerging market bonds', *Journal of Banking & Finance*, vol. 35, no.10, pp. 2584 – 2597.

OECD (2008) Handbook on constructing composite indicators: Methodology and user guide, Joint Research Centre

Opec website, http://www.opec.org/opec_web/en/about_us/167.htm

Özatay, F., Ömen, E., and Şahinbeyoğl, G. (2009) 'Emerging market sovereign spreads, global financial conditions and U.S. macroeconomic news', *Economic Modelling*, vol. 26, no.2, pp. 526–531.

Pesaran, H. M. (2007) 'A simple panel unit root test in the presence of cross-section dependence', *Journal of Applied Econometrics*, vol. 22, no. 2, pp. 265–312.

Pesaran, M. H., and Smith, R. (1995) 'Estimating long-run relationships from dynamic heterogenous panels', *Journal of Econometrics*, vol. 68, no. 1, pp. 79–113.

Polak, J. (1997) *The IMF monetary model at forty*, IMF Working Paper, No. 97/49.

Reinhart, V., and Sack, B. (2000) 'The economic consequences of disappearing government debt', *Brookings Papers on Economic Activity*, vol. 31, no. 2, pp. 163–220.

Remolona, E., M., Scatigna, M., and Wu, E. (2008) 'The dynamic pricing of sovereign risk in emerging markets: Fundamentals and risk aversion', *Journal of Fixed Income*, vol.17, no. 4, pp. 1–31.

Rintoul, F. (2013) 'Sub-Saharan market: High yields fire appetite for African Eurobonds', *Financial Times*, 3 November.

Rudebusch, G. D., and Wu, T. (2008) 'A macro-finance model of the term structure, monetary policy and the economy', *Economic Journal*, vol. 118, no. 530, pp. 906–926.

Schiller, R. J. (2015) *Irrational exuberance: Revised and expanded third versions* (3rd Ed.), Princeton University Press.

Senga, C., Cassimon, D., and Essers, D. (2018) 'Sub-Saharan African Eurobond yields: What really matters beyond global factors?', *Review of Development Finance*, vol. 8, no. 1, pp. 49–62.

Sensoy, A., Fabozzi, F. J., and Eraslan, V. (2017) 'Predictability dynamics of emerging sovereign CDS markets', *Economics Letters*, vol. 161, no. C, pp. 5–9.

Sinclair, T. M., Gamber, E. N., Stekler, H., and Reid, E. (2012) 'Jointly evaluating the Federal Reserve's forecasts of GDP growth and inflation', *International Journal of Forecasting*, vol. 28, no. 2, pp. 309–314.

Steiner, M., and Heinke, V. G. (2001) 'Event study concerning international bond price effects of credit rating actions', *International Journal of Finance and Economics*, vol. 6, no. 2, pp. 139–157.

Svirydzenka, K. (2016) *Introducing a new broad-based index of financial development*, IMF Working Paper, WP/16/5.

Sy., A. N. (2002) 'Emerging market bond spreads and sovereign credit ratings reconciling market views and economic fundamentals', *Emerging Markets Review*, vol. 3, no. 4, pp. 380–408.

Taylor, J. B. (1993) 'Discretion versus policy rules in practice', *Carnegie-Rochester Conference Series on Public Policy* (Vol. 39), pp. 195–214.

Tradingeconomics website, https://tradingeconomics.com/

Vu, R., Alsakka, R., and Gwilyn, O. A. (2015) 'The credit signals that matter most for sovereign bond spreads with split rating', *Journal of International Money and Finance*, vol. 53, no. C, pp. 174–191.

Wang, A. T. (2019) 'The information transmissions between the European sovereign CDS and the sovereign debt markets of emerging markets', *Asia Pacifica Management Review*, vol. 24, no. 2, pp. 176–189.

World Bank website, https://data.worldbank.org/region/sub-saharan-africa

Wu, T. (2006) 'Macro factors and the affine term structure of interest rates', *Journal of Money, Credit and Banking*, vol. 38, no. 7, pp. 1847–1875.

Zhu, H. (2004) *An empirical comparison of credit spreads between the bond market and the credit default swap market*, BIS Working Paper, no. 160, pp. 1–18.

Zolfaghari, M., Ghoddushi, H., and Faghihian, F. (2020) 'Volatility spillover for energy prices: A diagonal BEKK approach', *Energy Economics*, vol. 92, no. C, pp. 1–17.