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Spillovers in Sub-Saharan Africa's Sovereign Eurobond Yields*

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Abstract

This study investigates the possibility of spillovers among Sub-Saharan African (SSA) eurobonds from January 2015 to June 2017 using secondary market yields. Ours results indicate significant contagion effects among these bonds, effects that prove sensitive to major economic events and news announcements. They also suggest that less resilient economies transmit more to and receive less spillovers from their peers. SSA eurobond issuers can therefore increase their influence over the performance of their securities on secondary markets by mitigating their vulnerability to these effects. Besides strong macroeconomic fundamentals, an improvement in transparency and information disclosure is required in order to curb the asymmetry of information underlying investors' behavior-based spillovers and contagion, which supports to a certain extent *the market discipline hypothesis* in the case of SSA eurobonds.

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1 Introduction

The year 2016 seems to have marked the end of the Sub-Saharan African (SSA) eurobond spree with a drastic shrinkage in the number as well as the amount of eurobonds issued by SSA countries to collect financial resources through international markets. From an annual total record of over US$ 6 billion collected in 2014 and 2015, the total amount mobilized by these countries in 2016 dropped to less than US$ 1.5 billion through only two issues of US$ 750 million and US$ 727 million by Ghana and Mozambique, respectively, and in 2017, Nigeria was until June the only one to issue eurobonds worth US$ one billion. Analysts[1] attribute this decline in SSA eurobond issuance to the negative impact of low commodity prices on the economies of many of these countries, and the US tightening economic policy amid the resumption of economic growth in the developed world, factors that lowered the risk appetite of investors for SSA eurobonds and pushed up the latter's yields to dramatic levels that were by no means attractive for these countries to issue new eurobonds.

Beyond the influence of global economic factors, empirical studies have also underscored the role of country-specific factors such as the quality of macroeconomic management and the degree of vulnerability to global economic shocks in the determination and evolution of SSA eurobond yields (see Gevorkyan and Kvangraven, 2016; Senga et al., 2018). The experience of SSA eurobonds suggests that markets seem to have been able to sanction countries with erratic economic management behavior such as the absence of economic diversification and over-reliance on a limited number of commodities that exacerbated the vulnerability to global shocks, and loose public finance and debt management that put pressure on the countries' macroeconomic stability and ability to service their foreign debt (Senga et al., 2018). A case in point is the recent history of Mozambique where, in addition to allegations of eurobond proceeds' misallocation, the scandal of hidden debts in end 2017 has irked this country's creditors and donors as well as multilateral institutions thus creating nervousness around the performance of the Ematum eurobond on international markets (Cassimon et al., 2017). Likewise, cases of alarming government budget deficits and macroeconomic framework instability have been documented in Angola, Ghana and Zambia in 2014, 2015 and 2016 respectively with noticeable consequences on both their primary and secondary market eurobond yields.

While there seems to be a consensus on the influence of global and country-specific factors on SSA eurobond yields, little is still known about the possibility and extent of spillovers and contagion[2] among these assets. The literature has been prolific about the propagation of economic shocks' consequences across national borders (Alter and Beyer, 2014; Fernández-Rodríguez et al., 2015; Özatay et al., 2009; Frankel and Schmukler, 1997; Rigobon, 2016; Kaminsky et al., 2003). More specifically, Dornbusch et al. (2000) dissect the causes of contagion into two categories depending on whether they relate to the normal interdependence among market economies or to the behavior of investors. The first category, labeled "fundamentals-based" contagion, attributes the propagation of shocks (whether of a global or local nature) to the real and financial linkages across countries. It includes macroeconomic shocks that have repercussions on an international scale and local shocks transmitted through trade links, competitive devaluations, and financial integration. The second category ascribes spillovers and contagion to investors' behavior, whether rational or irrational, whose actions lead to markets' comovements that cannot be explained by real fundamentals. The authors illustrate the latter situation by, among others, the case of imperfect information where, for instance, investors tend to make decisions on the basis of some known indicators, including those revealed in other countries, which may or may not reflect the true state of the subject country's vulnerabilities. This corresponds to the so-called "wake-up call hypothesis" stating that once investors "wake up" to the weaknesses that were revealed in the crisis country, they will proceed to avoid and move out of countries that share some characteristics with the crisis country (Kaminsky et al., 2003). Another example is "herd behavior" where investors "follow the crowd" in their decision to invest or divest in a particular country, region or asset class (Dornbusch et al., 2000; Kaminsky et al., 2003; Rigobon, 2016; Guney et al., 2017).

However, the literature indicates that the presence of these causes is not sufficient in itself to trigger spillovers and contagion. Kaminsky et al. (2003) use the term "unholy trinity" to refer to three key elements that determine the materialization of contagion. The first element is the capacity of the shock to provoke a "sudden-stop", i.e. a swift and drastic reversal of capital flows. The second element relates to the surprise-characteristic of the shock since forewarning allows investors to adjust their portfolios in anticipation of the event. The third element emphasizes the role of a leveraged common creditor –be it commercial banks, hedge funds, mutual funds or bondholders– who may help propagate the contagion across national borders and cause significant immediate international repercussions.

In many respects, SSA eurobond issuers feature certain elements of the above-mentioned causes and conditions of spillovers and contagion. Firstly, their geographic proximity coupled with, in most cases, some similarities in terms of political and economic structures such as the dependence on commodity exports and relatively weak democratic rule and institutions. These commonalities make it possible for investors to treat these eurobonds' block as a single unit, thus leading to shocks from one eurobond to spillover to other markets belonging to the block. Second, not longer than a decade ago, SSA countries were completely mired into a debt-poverty spiral that hindered economic growth and development across the whole region. It is worth mentioning that this region was overwhelmingly represented among the beneficiaries of the Heavily Indebted Poor Countries (HIPC) and Multilateral Debt Relief Initiative (MDRI) initiatives that attempted to curb the protracted issue of government over-indebtedness in these poor countries via massive waves of debt forgiveness by commercial, bilateral as well as multilateral lenders. This history of over-indebtedness by SSA countries is likely to make investors more watchful about news affecting these countries' creditworthiness as a way to detect the signals for the "wake-up call" hypothesis mentioned earlier. Lastly, these eurobonds' prospectuses indicate that they are in most cases traded under "Regulation S" (i.e. to be held by any investor outside the USA market) and "Rule 144A" (i.e. meant exclusively for qualified institutional buyers in the USA) on most European and the US markets. Therefore, the possibility of these bonds to be held by common creditors cannot be ruled out, which increases the likelihood of spillovers and contagion in case of idiosyncratic shocks to one or some of them.

So far, only a few studies have investigated the interconnectedness of African security markets. Some of the few available studies on this topic have focused on the spillovers of economic growth and financial market shocks from developed and emerging markets to African economies (see Gurara and Ncube, 2013; Labuschagne et al., 2016). Others have investigated the level of economic and financial integration among African countries through the contagion of shocks to domestic economic growth and stock markets (World Bank, 2016; Collins and Biekpe, 2003). An eye-opener on the investors' behavior on African markets is the study by Guney et al. (2017) who investigate herd behavior in African frontier stock markets. The issue of the spillovers and contagion among SSA eurobonds has so far attracted little attention despite its plausibility given the strength of the above-mentioned indications. Moreover, the ongoing debate about the advantages and sustainability of SSA countries' borrowing through international capital markets entails a better grasp of the determinants of SSA eurobond yields and, more specifically, the incentives provided by these markets to borrowing countries in terms of macroeconomic management quality. In fact, the literature advances the *market discipline hypothesis* to describe how credit markets provide borrowers with incentives to restrain excess borrowing by increasing smoothly the yields with the level of borrowing and, eventually, denying the irresponsible borrower further access to credit (Bayoumi et al., 1995). Therefore, since this hypothesis implies that credit markets assign favorable yields to the disciplined borrowers and sanction the irresponsible ones with higher yields, it seems reasonable to believe that SSA countries with better economic performance may be inclined to increase transparency in order to improve their visibility and therefore get assigned yields that match their creditworthiness. This transparency may at the same time mitigate the information asymmetries underlying investors' behavior-related spillovers and contagion. Against this backdrop, the void of clue about the possibility and extent of spillovers and contagion among SSA eurobonds constitutes a gap in the literature that needs to be addressed.

This study is to our knowledge the first to investigate the degree of interconnectedness and the possibility of spillover effects among SSA eurobond yields on secondary markets. Drawing on insights from Antonakakis and Vergos (2013) and Gande and Parsley (2005), it assesses the extent to which major shocks (news) to individual securities affect the performance of their peers using the Diebold and Yilmaz (2012)'s spillover index. Our results show that, on average, 66.37% of the forecast error variance is explained by cross-SSA eurobonds yields spillovers, and that Angola is the dominant transmitter of SSA eurobond yield spillovers followed by Ghana and Zambia, while Namibia, followed by Tanzania and Rwanda are dominant receivers of SSA eurobond yield spillovers. These results indicate also higher levels of spillover effects during moments of economic distress, such as the ones related to shocks in global commodity prices, the alarming fiscal deficits in Ghana and Zambia, and default in Mozambique. We contribute to the existing literature by bringing the spillovers and contagion dimension into the analysis of the drivers of SSA eurobond yields. By doing so, we not only uncover the incompleteness of the "push" and "pull"-factor justification of SSA eurobond yields' evolutions documented in previous studies (Gevorkyan and Kvangraven, 2016; Senga et al., 2018) but also contribute to the debate about the sustainability of the SSA eurobond market by analyzing our results' implications in terms of incentives to improve the quality of macroeconomic management in borrowing countries .

Besides this introduction outlining the background and scope of our study, we summarize in Section 2 the relevant literature on spillovers and contagion affecting Africa. We elaborate on the methodology in Section 3 and present our dataset in Section 4. The results of our analysis are presented and discussed in Section 5, followed by the presentation of some robustness checks in Section 6 and the general conclusions in Section 7.

2 Literature review

Several studies have been devoted to spillover effects between emerging and developed economies, and across African economies taking different perspectives and approaches. Gurara and Ncube (2013) analyze global spillover effects on Africa using a panel of 46 African countries and 30 developed and emerging market countries. They find significant growth spillover effects to African economies from both the Euro zone economies and the BRICs. However, their results indicate that quantitative easing measures in the US, the Euro zone, the UK, and Japan could have a mild inflationary effect in addition to putting pressure on exchange rates to appreciate. Regarding intra-African growth spillovers, the World Bank (2016) review of the SSA region's progress in regional integration, intra-regional trade and cross-border financing flows concludes that shocks to growth in the two largest economies – Nigeria and South Africa – appear to have no measurable effects on other countries in the region.

Some studies have investigated the contagion and interdependence of African equity markets. For instance, in their studies covering the pre-2008 economic crisis, Collins and Biekpe (2003) find evidence of contagion from global emerging market crises to Egypt and South Africa, the largest and most traded markets in Africa during that period. They also confirm the lack of causal relationships between African markets, which suggests a relatively high degree of isolation among them. This heterogeneity of African equity markets has also been confirmed by the results of Labuschagne et al. (2016) in the context of the 2007-2009 financial crisis. Moreover, the latter study fails to reject the hypothesis of no contagion and no integration effects among the U.S., the U.K., and selected African stock markets (South Africa, Namibia, Egypt, Nigeria, Morocco and Kenya) during the global financial crisis of 2007-2009. Guney et al. (2017) explicitly investigate investors' herd behavior using a sample of eight African frontier markets for the 2002-2015 period. They find evidence of herding, attributed, according to them, to the low transparency levels prevalent in frontier stock exchanges. Besides, their results indicate an overall low level of integration of frontier markets within the global financial system as investors' behavior in the studied African frontier markets is not significantly affected by non-domestic factors.

The interdependence and contagion effects among African sovereign eurobonds have not yet been investigated, be it in calm or nervous market times. However, the experience of more developed economies sheds light on the possibility of sovereign bond yield spillovers among markets sharing some similarities such as belonging to the same economic union or geographical location, especially during moments of market distress. The case in point is the study by Antonakakis and Vergos (2013) who find highly intertwined bond yield spread spillovers among Euro zone countries during the turbulent period encompassing the global financial crisis and the Euro zone debt crisis. They also find that shocks to sovereign bond yield spreads are related to news announcements and policy changes, which corroborates to some extent the results of Gande and Parsley (2005) indicating significant spillover effects of countries' credit rating downgrades to their peers' sovereign credit spreads and those of Fernández-Rodríguez et al. (2015) suggesting strong spillover effects among European Monetary Union (EMU) sovereign bond markets amounting to slightly more than half of the total variance of the forecast errors during the 1999-2014 period. Equally interesting is study by Belke et al. (2018) which reveals a significant response of sovereign bond yields in emerging Asia to changes to US and eurozone bond yields, though with heterogeneous magnitudes across countries. Our study draws insights from these pieces of research to analyze the possibility of spillover effects among SSA eurobond yields.

3 Methodology

As in Antonakakis and Vergos (2013), Fernández-Rodríguez et al. (2015), Hwee Kwan Chow (2017) and Belke et al. (2018), this study follows the methodology of Diebold and Yilmaz (2012)[3] which departs from a generalized N-variable VAR(p), $X_t = \sum_{t=1}^{p} \Phi_i X_{t-i} + \varepsilon_t$ with $\varepsilon \sim (0, \Sigma)$ being a vector of independently and identically distributed disturbances, and analyzes the dynamics of this VAR system using variance decompositions. The latter allow for the decomposition of the forecast error variances of each variable into parts that are attributable to the various shocks to the system, hence allowing for the assessment of the fraction of the H-step-ahead error variance in forecasting x_i that is due to shocks to x_j with $j \neq i$ for each i.

This methodology relies on the generalized VAR framework of Koop et al. (1996) and Pesaran and Shin (1998), henceforth KPPS, which produces variance decompositions that are invariant to the ordering of variables in the VAR specification. It then becomes possible to distinguish between *own variance shares*, the fraction of the H-step-ahead error variances in forecasting x_i that are attributable to shocks to x_i for $i = 1, 2, \ldots, N$, and *cross variance shares* or *spillovers*, the fraction of the H-step-ahead error variances in forecasting that are due to shocks to x_j, for $i, j = 1, 2, \ldots, N$, such that $i \neq j$.

Denoting by Σ the variance matrix of the error vector ε and $\theta_{ij}^{g}(H)$ [4] the H-step-ahead forecast error variance decompositions for $H = 1, 2, \ldots$, we have

$$\theta_{ij}^{g}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i^{'} A_h \Sigma e_j \right)^2}{\sum_{h=0}^{H-1} \left(e_i^{'} A_h \Sigma A_h^{'} e_i \right)} \tag{1}$$

with σ_{jj} the standard deviation of the error term for the jth equation, and e_i the selection vector with one as the ith element and zero otherwise. The obtained $\theta_{ij}^{g}(H)$ are normalized as follows to ensure that $\sum_{j=1}^{N} \theta_{ij}^{g}(H) = 1$ and $\sum_{i,j=1}^{N} \theta_{ij}^{g}(H) = N$:

$$\tilde{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N} \theta_{ij}^{g}(H)} \tag{2}$$

The total spillover index is obtained by

$$S^{g}(H) = \frac{\sum_{\substack{i,j=1 \\ i \neq j}}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H)} \times 100 = \frac{\sum_{\substack{i,j=1 \\ i \neq j}}^{N} \tilde{\theta}_{ij}^{g}(H)}{N} \times 100 \tag{3}$$

Since in the KPPS generalized VAR framework the impulse-responses and variance decompositions are invariant to the ordering of the variables, it becomes possible to measure the *directional spillovers* in terms of 1) spillovers received by market i from all other markets, $S_{i.}^{g}(H)$, and 2) spillovers transmitted by market i to all other markets, $S_{.i}^{g}(H)$, and the *net spillovers*, i.e. the difference between the gross volatility shocks transmitted to and those received from all other markets, as follows:

$$S^g_{i\leftarrow j}(H) = \frac{\sum\limits_{\substack{j=1\\ j\neq i}}^{N} \tilde{\theta}^g_{ij}(H)}{\sum\limits_{i,j=1}^{N} \tilde{\theta}^g_{ij}(H)} \times 100 = \frac{\sum\limits_{\substack{j=1\\ j\neq i}}^{N} \tilde{\theta}^g_{ij}(H)}{N} \times 100 \tag{4}$$

$$S^g_{i\rightarrow j}(H) = \frac{\sum\limits_{\substack{j=1\\ j\neq i}}^{N} \tilde{\theta}^g_{ji}(H)}{\sum\limits_{i,j=1}^{N} \tilde{\theta}^g_{ji}(H)} \times 100 = \frac{\sum\limits_{\substack{i,j=1\\ j\neq i}}^{N} \tilde{\theta}^g_{ji}(H)}{N} \times 100 \tag{5}$$

$$S^g_{i}(H) = S^g_{i\rightarrow j}(H) - S^g_{i\leftarrow j}(H) \tag{6}$$

We construct a VARX model[5] of the selected SSA eurobond yields with the Bloomberg commodity index, the US 10 year Treasury Bond Index and the VIX index as exogenous variables. The consideration of these exogenous variables is based on the results of the studies by Gevorkyan and Kvangraven (2016), Presbitero et al. (2016) and Senga et al. (2018) indicating a significant influence of these variables (among others factors affecting global economic conditions) in the determination and evolution of SSA eurobond yields. Their inclusion in the model allows for the mitigation of the impact of global factors in our VAR dynamics. The order of our VAR is determined using the Akaike and Schwarz information criteria (the parsimonious suggestion is considered in case of divergence between the two criteria to accommodate the size of our sample), and only 5% significant coefficients are considered in the following steps of our analysis.

Based on the results of the VAR estimation, we proceed as in Antonakakis and Vergos (2013) to compute the normalized $H = 10$ days step-ahead forecast error variance decomposition in equations (1) and (2), which are then used to compute the total spillover index, as well as the directional and net spillovers as indicated in equations (3), (4), (5) and (6) respectively. These results are also used for the evaluation of impulse-response functions on a 30-day forecasting horizon.

The same procedure is carried out using 120-day rolling windows to allow for a dynamic analysis of the SSA eurobond yield spillovers. In addition to the dynamic total spillover index, we compute for each of the bonds the dynamic spillovers from and to its peers, and the net spillovers by applying the formulas above on each of the 120 day sub-samples in the rolling windows.

4 Data

This study uses daily secondary market yields of SSA eurobonds for the period of January 2015 – June 2017 collected from Thomson Reuters Datastream. The choice of January 2015 as starting point is motivated by the availability of data since, though timidly started in 2006, eurobond issues by SSA countries gained momentum in 2013 and reached their peak in 2014 with more than US$ 6.5 billion collected through six issues in this particular year. Only from then on did a sufficient number of countries issue at least one eurobond to allow for a meaningful size of our sample containing 12 SSA countries. We consider one eurobond per country in order to circumvent the influence of bond-specific characteristics in case of multiple issues. Specific details about the 12 considered eurobonds and the exogenous variables have been provided (See Table S2, available online).

[Table 1: Summary statistics]

The summary statistics presented in Table 1 illustrate the performance and resilience of the individual SSA eurobonds under consideration. With its mean and median of respectively 4.36% and 4.24%, Namibia appears to be the top performer of the group followed respectively by Tanzania, Senegal and Rwanda. Namibia dominates also the group in terms of resilience with the lowest standard deviation of 0.52% followed respectively by Rwanda and Ethiopia. At the other end, Mozambique appears to be by all standards the worst performer of the group with its 15.79% and 5.38% mean and standard deviation respectively. Less pronounced but still worrying are the cases of Angola, Ghana and Zambia whose standard deviations all exceed 1.80%. Also, strong positive correlations are observed among these bonds (See Table S1, available online). Mozambique features a rather exceptional correlation pattern with both its peers and the global factors, which is no surprise given its idiosyncratic shocks experienced during this period.

A graph presenting the evolution of the selected SSA eurobond yields over the period under study has been provided (See Figure S1, available online). The graph shows that, apart from the case of Mozambique after mid-2015, these yields seem to move in tandem and react in almost the same way to common shocks. However, there seem to be salient differences in the magnitude of their reaction to common shocks, with for instance Namibia, Rwanda and Senegal featuring a strong resilience while Ghana and Zambia showing signs of pronounced vulnerability. Once more, the oddness of Mozambique features prominently, stressing the derailing behavior of this country's yields since the suspicion of cases of hidden debt were raised by the International Monetary Fund (IMF) in May 2015.

5 Empirical results

This section presents the results of our static and dynamic spillovers analysis. As indicated earlier, the static analysis uses the whole sample (652 observations) while the dynamic one is based on 120-day rolling windows. We consider the parsimonious VAR(1) system suggested by the Schwartz information criterion to accommodate our small-size 2.5 year sample instead of the VAR(2) system suggested by the Akaike information criterion.

5.1 Static analysis of spillovers

The results of the static analysis of secondary market SSA eurobond yields are presented in Table 2. Three main messages can be drawn from these results. First, the total spillover index indicates that, overall, 66.37% of the 10-day step ahead forecast error variance across the examined eurobond yields comes from spillovers. Second, Angola appears to be the dominant spillover transmitter followed by Ghana and Zambia, while Namibia followed by Tanzania and Rwanda are deemed the dominant receivers of SSA eurobond yield spillovers. Third, with almost 90% and 60% of own spillovers respectively, Mozambique and Angola share the particularity of having the most of their 10-day step ahead forecast error variance attributed to their own idiosyncratic shocks.

[Table 2: Total and directional spillovers]

Consistent with the results of Fernández-Rodríguez et al. (2015) for the case of EMU sovereign bonds, we find an indication of substantial contagion effects among SSA eurobonds, suggesting that the evolution of secondary market yields is not only influenced by global and country-specific factors but also to a large extent by spillovers of shocks affecting their peers. For instance, our figures indicate that 83.3% of the 10-day step ahead forecast error variance of Ethiopian yields comes from spillovers against only 16.7% attributed to its own shocks. On the other hand, the dominance of Angola and Ghana in spillovers transmission is no surprise. In fact, the economy of Angola has been crippled by the recent oil price-crash that has seriously affected the public finances and spilled over to all the other sectors. The protracted worsening situation resulted in a series of credit rating downgrades in 2016 sending this country into the highly speculative territory, with serious consequences on the amount of foreign investment inflows and indeed the performance of its eurobonds on financial markets[6]. The request for an IMF bailout and the successive devaluations of the Angolan currency (the Kwanza) amid the drastic shrink in foreign reserves were in fact far from reassuring investors (Donnan, 2016).

As concerns Ghana, it is worth reminding that this country issued its debut sovereign eurobond in 2007, making it the first African beneficiary of HIPC/MDRI debt relief to tap into the international bond markets. However, it is documented that the country increased its debt amid the discovery of oil and rapid economic growth, but that the proceeds were used to increase public sector salaries instead of being invested in growth-generating infrastructure or reforms geared toward generating extra revenues to service the debt. As a result, this country faced unsustainable pressure on its public finances that affected the value of the Ghanaian currency (the cedi), leaving no option but to return to the IMF for a three-year rescue package of US $1 billion in 2014 (IMF, 2015). Ghanaian finances were further affected by plummeting commodity prices that considerably restricted the ability of the government to address the soaring prices for electricity, water and fuel, thus stoking public anger amid a perception of politicians mishandling the economic crisis and mismanaging public finances (Matthews, 2016). It is no surprise that, along the way, the deterioration of investors' confidence in the credit quality of Ghana did affect the performance of its bonds on international markets.

Furthermore, the results show negative net spillovers for Namibia, Tanzania, Rwanda, Ethiopia, Senegal, Nigeria and Kenya. Rather than a simple coincidence, these countries have in common a commendable degree of macroeconomic stability and resilience to global economic shocks thanks to improvements in economic diversification and the quality of macroeconomic management. For example, Namibia's eurobond was the only one holding an investment grade credit rating throughout our study period, indicating a sustained level of markets' confidence in the creditworthiness of this country. Also, Tanzania, Rwanda, Ethiopia and Senegal have for a long time been praised for their infrastructure development and service sector-based sustained economic growth in spite of the global shocks, particularly so for Ethiopia and Tanzania that have been projected among the world's 10 fastest growing economies of 2017 by World Bank (2017).

5.2 Dynamic analysis of spillovers

The results of the static analysis provide a general picture of spillovers among SSA eurobonds. In the following paragraphs, we resort to the dynamic analysis and present the evolution of the total spillover index using 120-day rolling windows. The same dynamic analysis is extend to the directional and net spillovers (See Figure S2, Figure S3 and Figure S4, available online).

[Figure 1: Total spillover index]

Figure 1 shows the evolution of the total spillover index over our study period. As expected, rather than being constant, this index shows a sawtoothed evolution with salient peaks that seem to be related to major news and events that affected these bonds either collectively or individually. Starting at a level of around 65% in mid-June 2015, it is observed that after a declining trend reaching a trough in end-July of the same year, this index hiked to reach a peak of 73% in August, at a time when crude oil was selling at less than 39 US$ per barrel for the first time since 2009. The index increased to 76% in reaction to the news about OPEC's failure to agree on oil production ceilings to curb these falling prices. Besides the effects of plummeting oil prices, the spillover index has been sensitive to idiosyncratic shocks affecting some of the bond issuers as well as the political and economic changes in the USA. It seems justified to relate the peak of 74.29% in April 2016 to Angola's decision to request a bailout from the IMF, and the 72.21% peak to Mozambique's surprise announcement of the intention to restructure once again its eurobond, an announcement that triggered a dramatic hike in the yields making this country the world's riskiest sovereign borrower in October 2016.

Also, the index has not been immune to the "Trump tantrum"[7] that is documented to have caused a massive sell-off of emerging markets' securities amid uncertainty about the outcomes of Mr. Trump's economic and trade policies, as well as the decision by the FED to raise interest rates in December 2016 for the second time since the 2008 financial crisis, in line with the results of Belke et al. (2018). Likewise, the index has been affected by the default of Mozambique on its interest payments due in January 2017 and, even more, the parliament's ratification of the controversial law providing government guarantee for previously-hidden debts in April 2017 corresponding to the index maximum level of 78.99%.

Despite indications of substantial levels of spillovers transmitted by Mozambique's eurobond to its peers from the dynamic analysis (See Figure S2, Figure S3 and Figure S4, available online), the overall picture drawn from the static analysis depicts a rather limited degree of interdependence between this bond and the rest of the SSA eurobonds under consideration. First, it is indicated that 88.73% of the 10-step-ahead forecast error variances of Mozambique's bond come from idiosyncratic shocks and that only 11.27% can be attributable to shocks to all the bonds taken together. Second, the bond seems to transmit in total not more than 38.84% to its peers, just a bit more than the individual contributions of Rwanda, Namibia or Tanzania. While the case of the latter three seems logical given their proven strong resilience and hence the status of net-spillover receivers, the relatively low amount of spillovers transmitted by Mozambique contrasts significantly with the performance of this bond (See Figure S1, available online). Commonsense could predict that, given their nature and frequency, the shocks that have been afflicting Mozambique could trigger investors' behavior-related effects and thus spill over to other SSA eurobonds. This aspect is better captured in the results of the dynamic analysis of spillovers to and from others, and net spillovers (See Figure S3, Figure S4 and Figure S5, available online). These graphs show that spillovers from Mozambique soared dramatically immediately after the ratification of the controversial law providing government guarantee for previously-hidden debts by Mozambique's parliament in April 2017.

5.3 Impulse responses

The impulse-response functions of our VAR system are presented in Figure 2. These graphs show the impact of a one-standard deviation shock to an individual SSA eurobond's own yields and those of its peers on a 30-day forecasting horizon. However, as stressed by Antonakakis and Vergos (2013), these results should be interpreted with care given that they have been produced in the generalized VAR framework[8] that impairs the orthogonality of shocks affecting these individual bonds. Belke et al. (2018) stress that this generalized approach allows for correlated shocks, taking into account the historically observed distribution of errors, thus suggesting that, rather than identifying the causality of spillovers, this approach relies on historical patterns to identify directionality. Moreover, the global nature of the main shocks that have affected financial markets during our study period increases the chances of synchronization and correlation of shocks across countries, making our generalized impulse-responses simply indicative of the direction of future shocks' impacts as suggested by Antonakakis and Vergos (2013).

[Figure 2: Impulse-response functions]

Our impulse-response results suggest significant but short-lived reactions of these individual bond yields to their own shocks and those affecting their peers. In almost all cases, the impact appears to die off within 20 days, except for Mozambique whose reactions seem inconsistent and non-convergent. Equally important is Angola's and Mozambique's high reaction in excess of 30% and 80% to their own shocks respectively. Consistent with the results of the directional spillovers, this observation further confirms the fact that the biggest share of impact of the shocks affecting these countries was absorbed internally, with the effects to their peers being rather limited. On the other hand, Namibia and Rwanda appear to be the least affected by their peers' shocks thus confirming their resilient status across the universe of our selected bonds.

All in all, the results of this study confirm the existence of shock-spillover effects among the selected SSA eurobonds over time, and indicate that these spillovers, as measured by the total spillovers index of Diebold and Yilmaz (2012), are responsive to events and news affecting either the global economic environment or the idiosyncratic performance of these bonds. The results of the directional spillovers analysis identify Angola followed by Ghana and Zambia as the dominant spillovers transmitters, while Namibia followed by Tanzania and Rwanda are deemed the dominant receivers of shock spillovers from their peers. These results underscore the fact that eurobonds issued by countries with strong fundamentals and resilient economies tend to receive more from and transmit less spillovers to their peers under distress. This is equally true for Mozambique despite uncertain indications of low spillovers to other from the static analysis. The results of the dynamic analysis show that this country transmitted abnormally high spillovers to other SSA eurobonds at the height of its hidden debt-related distress in April – June 2017.

6 Robustness analysis

In this paragraph, we test the robustness of our results by excluding Mozambique which can rightfully be considered as an outlier given its exceptional yield statistics (See Table 1) and evolution (See Figure S1, available online). We perform the same analysis as before to assess the extent to which the results observed above as well as the subsequent conclusions may have been influenced by the presence of Mozambique, an outlier in our sample. The results of our new analysis (without Mozambique) are presented in Table 3. We find a total spillover index of 69.2% indicating the fraction of the 10-day step ahead forecast error variance across the examined eurobonds coming from spillovers. Furthermore, these results do not indicate significant changes in the rankings as Angola remains the dominant spillover transmitter followed by Ghana and Zambia, while Namibia followed by Rwanda and Tanzania keep their positions of the dominant receivers of SSA eurobond yield spillovers.

[Table 3: Total and directional spillovers without Mozambique]

Besides the robustness to the presence of an outlier, these results indicate a low contribution of Mozambique to the total spillover index as its exclusion raises the index to 69.20% (versus 66.37% previously). In fact, in light of the formula in equation (3), it is obvious that this slight increase in the spillover index is due to a disproportionately higher reduction in the number of countries (the denominator) than the reduction of the cross-country spillovers (numerators), thus suggesting a rather marginal contribution of Mozambique to the cross-country spillovers captured by the total spillover index. This is consistent with the information in Table 2 and Figure 2, showing that shocks to Mozambique were mainly affecting its own performance that its peers[9].

As regards the soundness of the methodology, the results of the dynamic analysis show that the evolution of the spillover index no longer exhibits the effects of idiosyncratic shocks to Mozambique (See Figure S5, available online). Also, we obtain slightly higher levels of the total spillover index compared to Figure 1 (except for the Mozambique-related peaks), which is consistent with the observation made above of the static analysis.

7 Conclusion

This study has investigated yield spillovers among selected Sub-Saharan African (SSA) eurobonds for the January 2015 – June 2017 period. The results of the VAR-based spillover index indicate that 66.37% of the forecast error variance in all the 12 considered SSA eurobond yields comes from spillovers. The directional spillover-analysis points to Angola as the dominant transmitter of SSA eurobond yield spillovers followed by Ghana and Zambia, while Namibia followed by Tanzania and Rwanda appear to be the dominant receivers of SSA eurobond yield spillovers. The same analysis using 120-day rolling windows shows that the total spillover index has been responsive to major economic events and news announcements such as OPEC's failure to agree on an oil production ceiling to curb the falling prices in December 2015, Angola's decision to request a bailout from the IMF in April 2016, Mozambique's surprise announcement of the intention to restructure once again its eurobond in October 2016 and the Trump tantrum documented to have caused a massive sell-off of emerging markets' securities in November 2016 amid uncertainty about the outcomes of the newly-elected US president's economic and trade policies. At the individual level, these results underscore the fact that eurobonds from countries with weak fundamentals and less resilient economies transmit more to and receive less spillovers from their peers.

Overall, these results underscore the overwhelming importance of spillovers accounting for 66.37% of the observed SSA eurobond yields' volatility. It appears from the evolution of the total spillover index that these spillovers can be attributable to both fundamental and investors' behavior-related causes. Either way, SSA eurobond issuers had better mitigate their vulnerability to spillovers effects and contagion in order to increase their control over the performance of their securities on secondary markets. While, obviously, sustained efforts in strengthening their macroeconomic fundamentals is key, these countries should also endeavor to improve transparency and information disclosure to curb the asymmetry of information underlying investors' behavior-based spillovers and contagion. Furthermore, as revealed by Essers et al. (2016) and Dafe et al. (2018), the development of their own local currency bond market constitutes, in our view, a fruitful strategy for these countries to diversify theirs sources of funding and thus reduce their exposure, hence vulnerability, to external shocks.

The generalized VAR framework used in this analysis has the advantage of producing spillovers that are independent of the ordering of our variables in our VAR system. However, this desirable feature comes at the cost of producing impulse-responses that rather account for the correlation of shocks across the studied SSA eurobonds. As emphasized by Antonakakis and Vergos (2013) and Belke et al. (2018), this correlation of shocks constitutes a limitation to the identification of the effects pertaining to these bonds' idiosyncratic shocks. While caution is advised regarding the interpretation of the impulse-responses with a 'ceteris paribus' mindset, we still believe that our results provide good indications of the impact of shocks on our variables since, in any case, we do not expect shocks to these bonds to appear in isolation from each other given the degree of increased globalization of economies (which increases the synchronization and correlation of shocks across countries). Nonetheless, we recommend the use of a framework allowing for orthogonal shocks for future research.

Notes

[1]A detailed analysis on the by-then causes of concern about SSA eurobonds was provided among others by BNP Paribas (see https://economic-research.bnpparibas.com/html/en-US/Saharan-Africa-concern-mounting-7/22/2016,29012). Also, the African Development Bank's President was recorded by Bloomberg as stressing the impact of US economic tightening policy on SSA eurobonds (see https://www.bloombergquint.com/markets/afdb-sees-africa-eurobond-issuance-slowing-on-rate-concern).

[2]Some nuances are documented in the literature as concerns the distinction between spillovers and contagion. According to Dornbusch et al. (2000), contagion refers to the spread of market disturbances –mostly on the downside– from one country to the other, a process observed through comovements in exchange rates, stock prices, sovereign spreads, and capital flows. Kaminsky et al. (2003) refer to "contagion" as an episode in which there are significant immediate effects in a number of countries following an event – that is, when the consequences are fast and furious and evolve over a matter of hours or days. They stress that the reaction has to be "fast and furious" to be considered as contagion in contrast to "spillovers" where the international reaction to news is rather gradual and protracted but can still cumulatively have major economic consequences. Rigobon (2016) reviews the different nuances in the definition of "spillovers" and "contagion", and concludes that the distinction between the two is rather tenuous. In this study, we follow the latter author and use interchangeably this rather general definition of these two terms as "describing

very loosely the phenomenon in which a shock from one country is transmitted to another" (Rigobon, 2016, p.3).

[3] A new framework tackling the case of a "multi-country model with multiple variables per country" is now available thanks to Greenwood-Nimmo et al. (2015). However, the Diebold and Yilmaz (2012) remains suitable for our case consisting of a multi-country univariate case where different countries are represented by a single eurobond, thus making vain the consideration to intra-units connectedness besides the investigated inter-unit ones.

[4] g denotes the KPPS generalized VAR framework that circumvents the issue of order-dependent spillovers driven by the Cholesky factor orthogonalization in a simple VAR framework.

[5]VARX refers to a VAR system supplemented by exogenous variables.

[6]The history of Angola's credit ratings by different rating agencies is available on https://tradingeconomics.com/angola/rating.

[7]The "Trump tantrum" was coined by the Institute of International Finance (IIF) that estimated the investors' withdrawal out of emerging market (EM) assets in November to amount to a net outflow of US$24.2 billion (see https://international-adviser.com/trump-tantrum-hits-emerging-markets/).

[8]The framework of Diebold and Yilmaz (2009) uses an ordinary VAR setting and identifies shocks using a Cholesky factorization. However, this framework has a serious weakness of producing spillover index values that are dependent on the ordering of variables in the VAR system, which makes it less appealing in our case (See Diebold and Yilmaz (2009, p.170) for more details on this framework's drawbacks).

[9]An additional robustness check has been performed by replacing the Tanzania's floating rate eurobond by the Côte d'Ivoire's issue of 2014 and the Ghana's 2013 and Senegal's 2011 eurobonds by their succeeding issues of 2014. The purpose was to check whether the floating rate structure and/or the age of the bond, i.e. the difference in issue dates (e.g. Senegal's eurobonds of 2011 and 2014) affect the amount and direction of spillovers among SSA eurobonds. We obtain a total spillover index of 67.04% (and 71.52% without Mozambique) without significant changes to the ranking of net-spillover transmitters and receivers. These results are not reported to save space but but available from the authors upon request.

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	Mean	Min	Max	St.Dev	Median	Skew	Kurtosis
ANGOLA	7.3352	3.9856	13.5250	1.8287	7.4043	0.4402	0.5217
ETHIOPIA	7.6645	6.5155	10.0774	0.7715	7.5671	0.7235	-0.0130
GABON	8.3088	6.2410	12.9670	1.3828	8.0572	0.9013	0.5133
GHANA	10.1771	7.2302	16.8398	1.9025	9.5809	1.0553	0.6386
KENYA	7.5183	6.1371	10.0246	0.9046	7.4751	0.4478	-0.4394
MOZAMBIQUE	15.7929	7.1852	28.0906	5.3855	16.4927	0.0349	-1.0697
NAMIBIA	4.3633	3.5404	6.0483	0.5192	4.2355	1.0105	0.6196
NIGERIA	7.1503	5.4896	9.6003	0.9174	7.1239	0.2340	-0.7620
RWANDA	6.9145	5.9953	8.3213	0.5266	6.7445	0.6870	-0.2695
SENEGAL	6.3765	4.4256	8.6826	0.9381	6.4046	-0.0340	-0.6180
TANZANIA	5.8870	3.3904	10.9842	1.6614	5.5868	0.9204	0.2713
ZAMBIA	9.9799	7.1892	16.8179	2.3616	9.1427	0.8106	-0.2253
BCOM	312.6747	252.5313	347.2783	22.9378	319.3677	-0.7851	-0.4071
US10	2.0592	1.3640	2.6080	0.2926	2.1225	-0.2958	-0.9425
VIX	16.7757	11.6300	26.4200	3.0036	16.2700	0.8490	0.5327

Note: These statistics are based on 652 daily observations of secondary market yields of the selected SSA eurobonds, the US 10 year Treasury Bond index (US10), the Bloomberg commodity index (BCOM) and the market volatility index (VIX) for the period January 2015 – June 2017. Values are expressed in percentage.

Table 1: Summary statistics

	ANG	ETH	GAB	GHA	KEN	MOZ	NAM	NIG	RWA	SEN	TAN	ZAM	From others
ANGOLA	0.5995	0.0243	0.0705	0.0754	0.0412	0.0181	0.0116	0.0478	0.0112	0.0344	0.0076	0.0582	0.4005
ETHIOPIA	0.1161	0.1670	0.1234	0.1176	0.0715	0.0970	0.0239	0.0681	0.0481	0.0604	0.0137	0.0929	0.8330
GABON	0.1377	0.0462	0.2429	0.1432	0.0951	0.0420	0.0252	0.0626	0.0224	0.0576	0.0073	0.1180	0.7571
GHANA	0.1240	0.0454	0.1161	0.3098	0.0693	0.0342	0.0207	0.0486	0.0315	0.0709	0.0062	0.1234	0.6902
KENYA	0.0921	0.0502	0.1181	0.1374	0.2156	0.0341	0.0127	0.0810	0.0306	0.0731	0.0258	0.1293	0.7844
MOZAMBIQUE	0.0093	0.0351	0.0086	0.0079	0.0118	0.8873	0.0030	0.0092	0.0055	0.0010	0.0029	0.0185	0.1127
NAMIBIA	0.1111	0.0514	0.1172	0.1226	0.0857	0.0326	0.1987	0.0663	0.0579	0.0498	0.0120	0.0946	0.8013
NIGERIA	0.1512	0.0506	0.0922	0.1105	0.0787	0.0406	0.0199	0.2602	0.0355	0.0639	0.0088	0.0879	0.7398
RWANDA	0.0997	0.0487	0.1027	0.1374	0.0777	0.0348	0.0229	0.0767	0.2139	0.0705	0.0085	0.1067	0.7861
SENEGAL	0.1330	0.0554	0.1003	0.1212	0.0818	0.0076	0.0158	0.0747	0.0366	0.2458	0.0178	0.1100	0.7542
TANZANIA	0.1444	0.0264	0.0692	0.0834	0.0801	0.0144	0.0094	0.0488	0.0123	0.0458	0.3827	0.0831	0.6173
ZAMBIA	0.0729	0.0529	0.1079	0.1423	0.0897	0.0330	0.0215	0.0540	0.0278	0.0580	0.0273	0.3125	0.6875
To others	1.1915	0.4867	1.0262	1.1988	0.7828	0.3884	0.1867	0.6378	0.3194	0.5853	0.1379	1.0226	**Total spill-**
Plus own effect	1.7910	0.6537	1.2691	1.5086	0.9984	1.2757	0.3854	0.8980	0.5333	0.8311	0.5206	1.3352	**over index =**
Net spillover	0.7910	-0.3463	0.2691	0.5086	-0.0016	0.2757	-0.6146	-0.1020	-0.4667	-0.1689	-0.4794	0.3352	**66.37%**

Note: This table presents, linewise, the fraction of the spillovers received by the country in line (i) from the country in column (j), i.e. the $S^g_{i \leftarrow j}(10)$ computed as in equation (4). By construction, these spillovers sum to 1 linewise to account for 100% of the spillovers affecting country (i). Columnwise, the table contains the spillovers transmitted by the country in column (j) to the country in line (i), i.e. the $S^g_{i \rightarrow j}(10)$ computed as in equation (5). The diagonal elements correspond to the countries' own spillovers. The total spillover index corresponds to the percentage of the H-step-ahead forecast error variances attributable to other countries in the system's overall H-step-ahead forecast error variance decomposition (from and to others plus own spillovers), i.e. the $S^g(10)$ computed as in equation (3). The net spillovers in the last line correspond to the difference between the percentage of transmitted and received spillovers, i.e. the $S^g_i(10)$ computed as in equation (6).

Table 2: Total and directional spillovers

	ANG	ETH	GAB	GHA	KEN	NAM	NIG	RWA	SEN	TAN	ZAMB	From others
ANGOLA	0.6112	0.0255	0.0719	0.0769	0.0420	0.0118	0.0488	0.0114	0.0346	0.0065	0.0594	0.3888
ETHIOPIA	0.1234	0.1893	0.1387	0.1325	0.0886	0.0257	0.0761	0.0533	0.0666	0.0051	0.1008	0.8107
GABON	0.1446	0.0496	0.2526	0.1492	0.1002	0.0262	0.0654	0.0235	0.0583	0.0072	0.1231	0.7474
GHANA	0.1295	0.0484	0.1193	0.3190	0.0726	0.0214	0.0505	0.0328	0.0722	0.0065	0.1277	0.6810
KENYA	0.0955	0.0515	0.1226	0.1426	0.2237	0.0132	0.0841	0.0318	0.0752	0.0257	0.1342	0.7763
NAMIBIA	0.1149	0.0526	0.1212	0.1267	0.0887	0.2054	0.0685	0.0599	0.0517	0.0126	0.0978	0.7946
NIGERIA	0.1589	0.0543	0.0967	0.1153	0.0829	0.0207	0.2690	0.0371	0.0643	0.0086	0.0920	0.7310
RWANDA	0.1038	0.0498	0.1068	0.1427	0.0808	0.0238	0.0797	0.2220	0.0718	0.0078	0.1109	0.7780
SENEGAL	0.1293	0.0566	0.0860	0.1179	0.0806	0.0152	0.0759	0.0380	0.2718	0.0198	0.1089	0.7282
TANZANIA	0.1178	0.0120	0.0492	0.0674	0.0591	0.0074	0.0417	0.0082	0.0624	0.5001	0.0747	0.4999
ZAMBIA	0.0756	0.0543	0.1119	0.1475	0.0931	0.0223	0.0560	0.0288	0.0597	0.0266	0.3241	0.6759
To others	1.1935	0.4547	1.0242	1.2188	0.7886	0.1879	0.6466	0.3248	0.6169	0.1262	1.0295	**Total spill-**
Plus own effect	1.8047	0.6440	1.2768	1.5378	1.0123	0.3933	0.9156	0.5468	0.8886	0.6263	1.3536	**over index =**
Net spillover	0.8047	-0.3560	0.2768	0.5378	0.0123	-0.6067	-0.0844	-0.4532	-0.1114	-0.3737	0.3536	**69.20%**

Note: As in Table 2, read linewise, this table presents the fraction of the spillovers received by the country in line (i) from the country in column (j), i.e. the $S^g_{i\leftarrow j}(10)$ computed as in equation (4). By construction, these spillovers sum to 1 linewise to account for 100% of the spillovers affecting country (i). Columnwise, the table contains the spillovers transmitted by the country in column (j) to the country in line (i), i.e. the $S^g_{i\rightarrow j}(10)$ computed as in equation (5). The diagonal elements correspond to the countries' own spillovers. The total spillover index corresponds to the percentage of the H-step-ahead forecast error variances attributable to other countries in the system's overall H-step-ahead forecast error variance decomposition (from and to others plus own spillovers), i.e. the $S^g(10)$ computed as in equation (3). The net spillovers in the last line correspond to the difference between the percentage of transmitted and received spillovers, i.e. the $S^g_i(10)$ computed as in equation (6).

Table 3: Total and directional spillovers without Mozambique

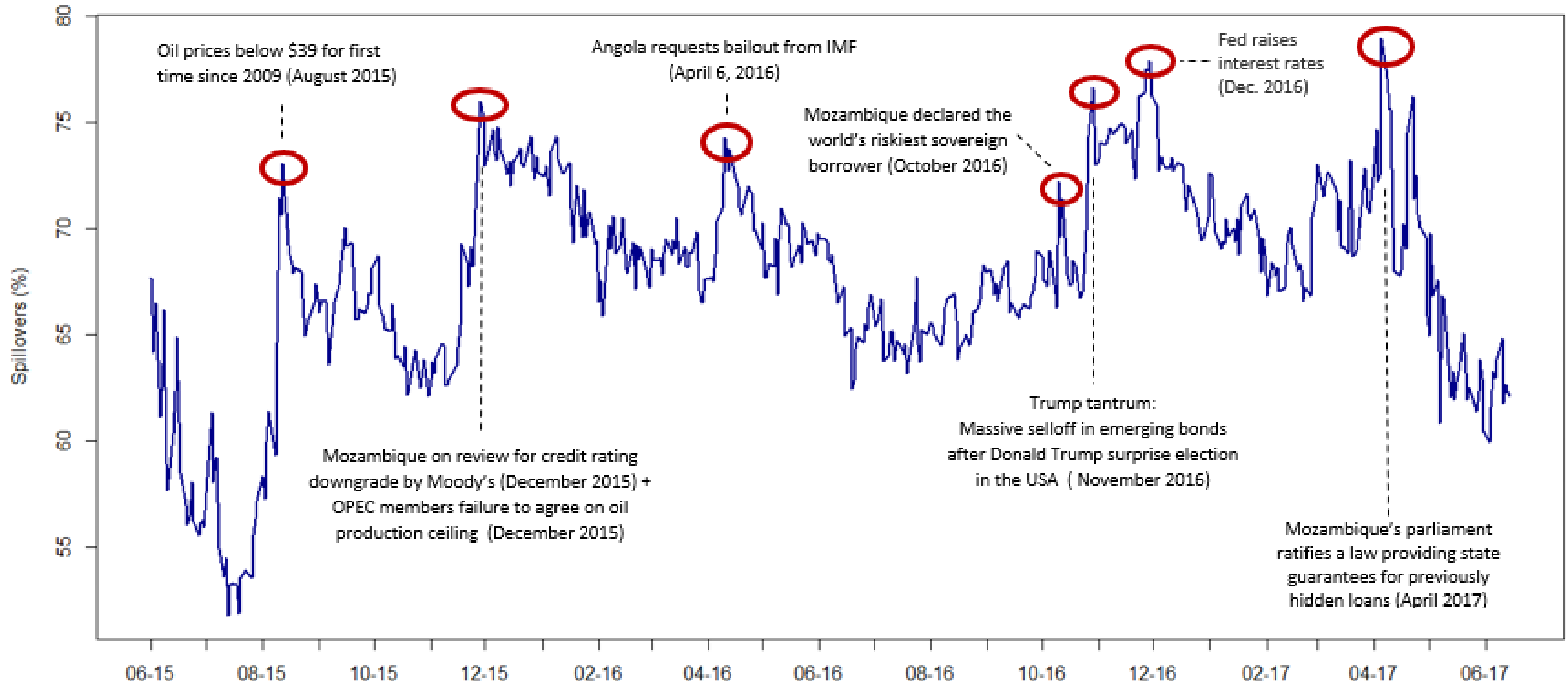

Figure 1: Total spillover index

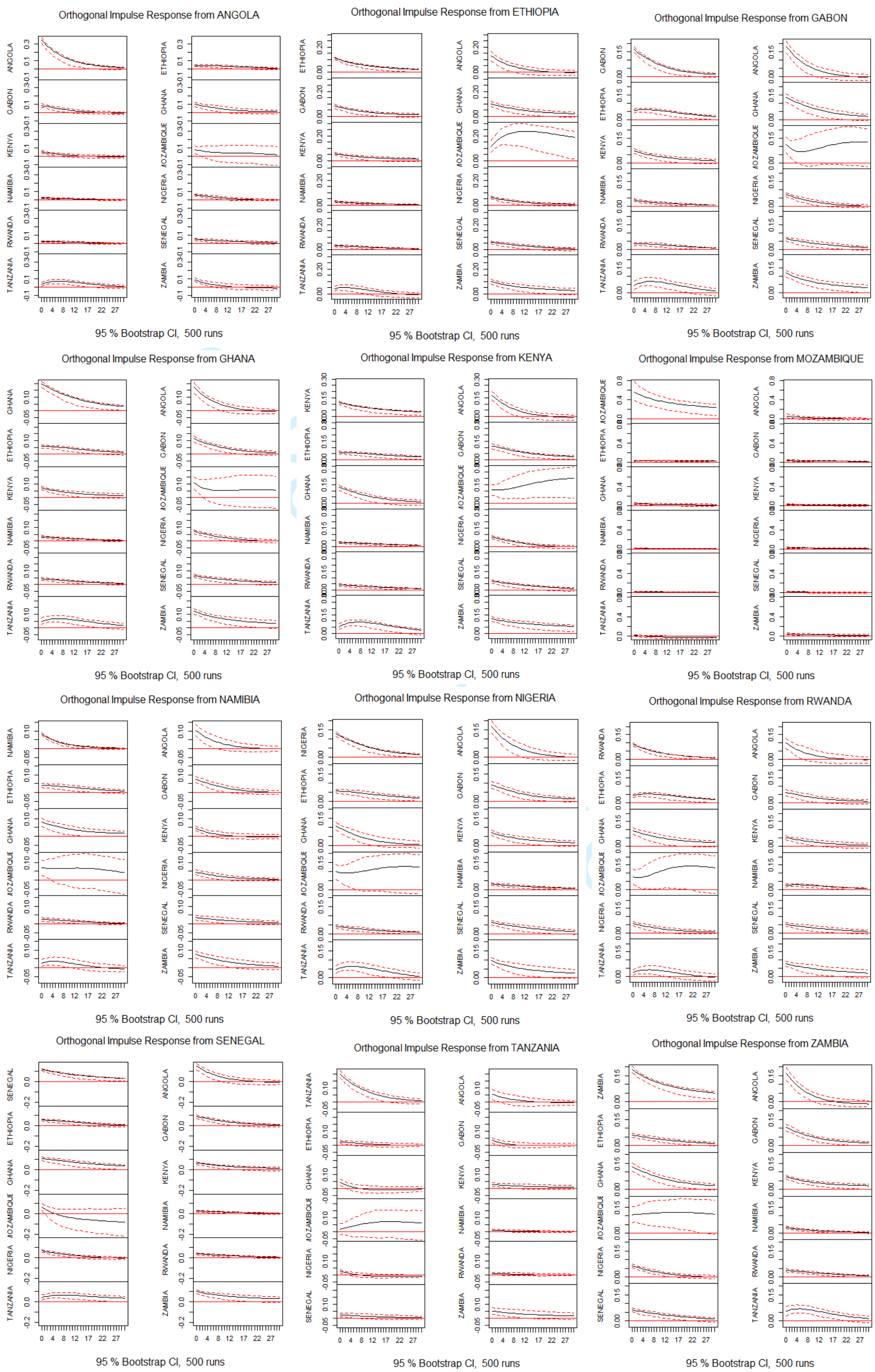

Figure 2: Impulse-response functions

	ANG	ETH	GAB	GHA	KEN	MOZ	NAM	NIG	RWA	SEN	TAN	ZAM	BCOM	US10	VIX
ANGOLA	1														
ETHIOPIA	0.59	1													
GABON	0.79	0.87	1												
GHANA	0.81	0.75	0.92	1											
KENYA	0.63	0.86	0.91	0.79	1										
MOZAMBIQUE	-0.21	0.47	0.21	-0.03	0.35	1									
NAMIBIA	0.75	0.84	0.88	0.82	0.83	0.07	1								
NIGERIA	0.86	0.80	0.90	0.84	0.79	0.03	0.87	1							
RWANDA	0.73	0.86	0.92	0.89	0.88	0.15	0.87	0.85	1						
SENEGAL	0.84	0.61	0.77	0.83	0.68	-0.33	0.80	0.81	0.81	1					
TANZANIA	0.85	0.61	0.81	0.83	0.74	-0.25	0.84	0.82	0.80	0.90	1				
ZAMBIA	0.75	0.82	0.96	0.93	0.91	0.18	0.83	0.84	0.92	0.77	0.81	1			
BCOM	-0.78	-0.63	-0.86	-0.85	-0.78	0.04	-0.79	-0.80	-0.75	-0.74	-0.87	-0.86	1		
US10	-0.34	-0.01	-0.30	-0.39	-0.12	0.11	0.04	-0.23	-0.19	-0.18	-0.16	-0.31	0.28	1	
VIX	0.82	0.51	0.70	0.73	0.53	-0.25	0.67	0.77	0.66	0.78	0.76	0.67	-0.66	-0.35	1

Notes: This correlation matrix is based on 652 daily observations of secondary market yields of the selected SSA eurobonds, the US 10 year Treasury Bond index (US10), the Bloomberg commodity index (BCOM) and the market volatility index (VIX) for the period January 2015 – June 2017. High positive correlations are observed among these yields, except for the one from Mozambique. It is also observed that, overall, these yields are negatively correlated with commodity prices (proxied here by the Bloomberg commodity index), and positively correlated with market volatility (proxied by the VIX index). Mozambique features a rather exceptional correlation pattern with both its peers and the global factors, which is no surprise given its idiosyncratic shocks experienced during this period.

Table S1: Correlation matrix

Country/issuer	Issue date	Maturity date	Size (US$ millions)	ISIN (RegS/144A)
Senegal	5/13/2011	5/13/2021	500	XS0625251854/US81720TAA34
Namibia	10/27/2011	11/3/2021	500	XS0686701953/US62987BAA08
Angola (Northern Lights III)	8/16/2012	8/16/2019	1000	XS0814512223
Tanzania (floating rate note)	2/27/2013	2/27/2020	600	XS0896119897
Rwanda	4/25/2013	5/2/2023	400	XS0925613217/US78347YAA10
Nigeria	7/12/2013	7/12/2023	500	XS0944707222/US65412ACD28
Ghana	8/7/2013	8/7/2023	1000	XS0956935398/US374422AB97
Mozambique (Ematum)	9/11/2013	9/11/2020	500	XS0969351450
Gabon	12/12/2013	12/12/2024	1500	XS1003557870/US362420AB78
Zambia	4/14/2014	4/14/2024	1000	XS1056386714/US988895AE81
Kenya	6/24/2014	6/24/2024	1500	XS1028952403/US491798AE43
Côte d'Ivoire*	7/23/2014	7/23/2024	750	XS1089413089
Senegal*	7/30/2014	7/30/2024	500	XS1090161875/US81720TAB17
Ghana*	9/11/2014	1/18/2026	1000	XS1108847531/US374422AC70
Ethiopia	12/11/2014	12/11/2024	1000	XS1151974877/US29766LAA44
Mozambique	4/16/2016	1/18/2023	726.5	XS1391003446

Source: Thomson Reuters Datastream; Eurobond prospectus documents.
Notes: Bonds marked with * have been used for robustness check. The 2016 Mozambique's sovereign eurobond is a result of the restructuring of the government guaranteed Ematum eurobond of 2013 in March 2016.

Table S2: SSA Eurobonds sample

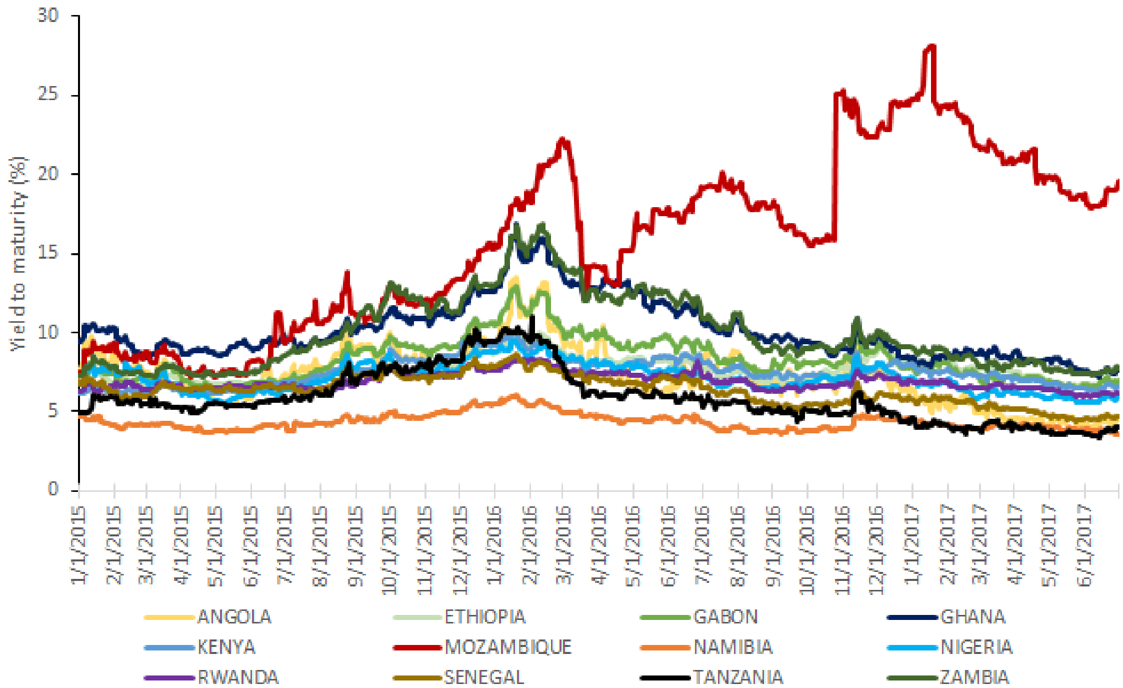

Figure S1: Yields evolution

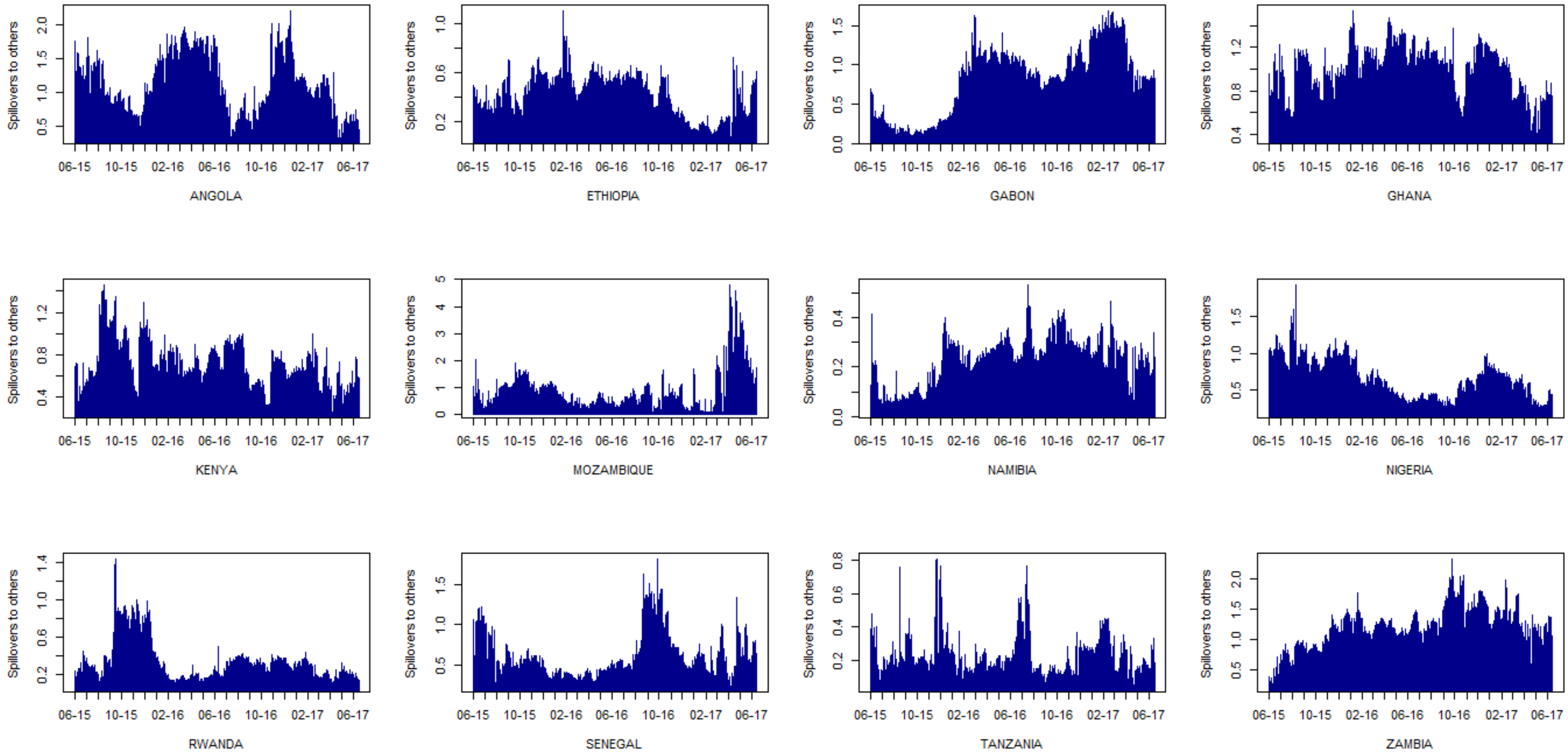

Figure S2: Spillovers to others

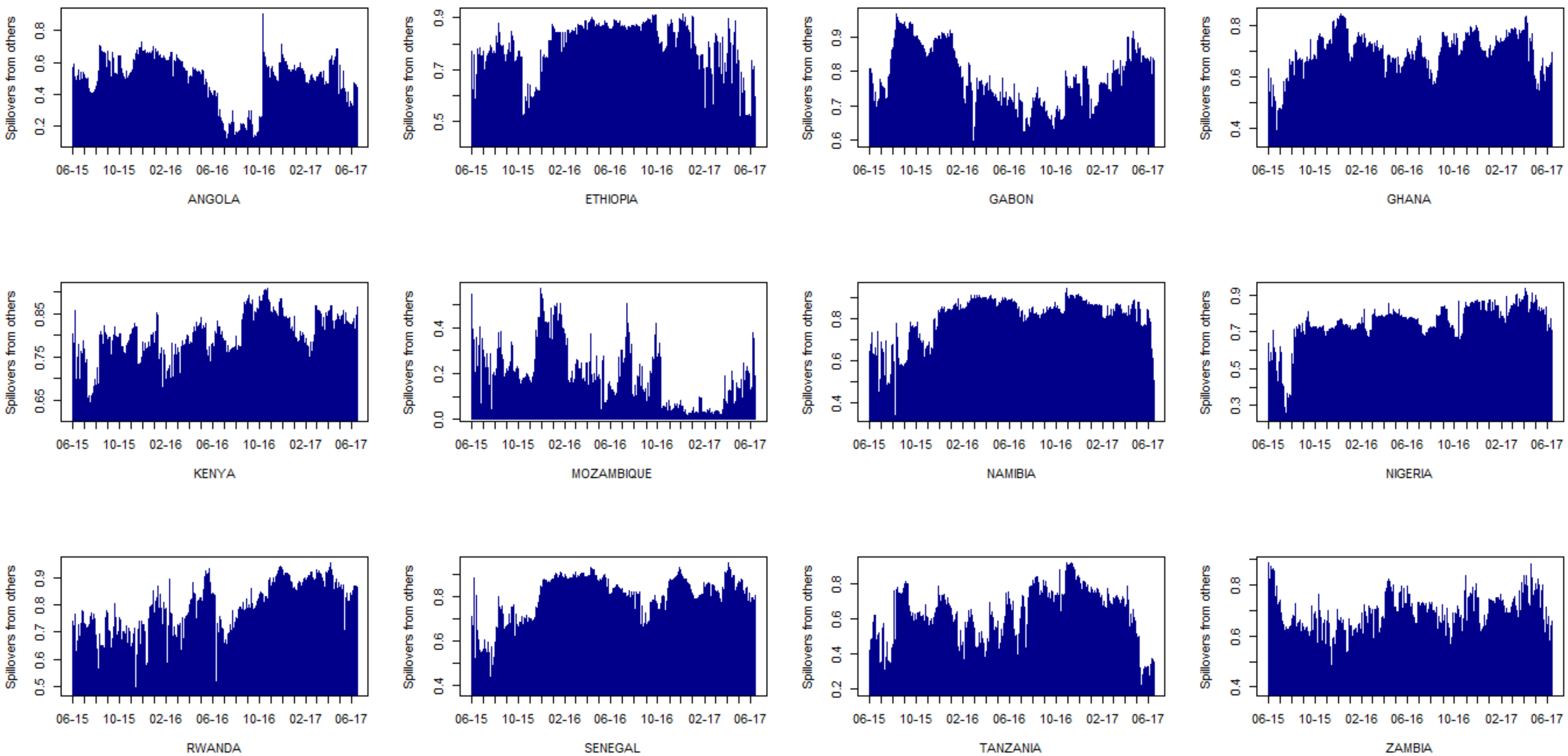

Figure S3: Spillovers from others

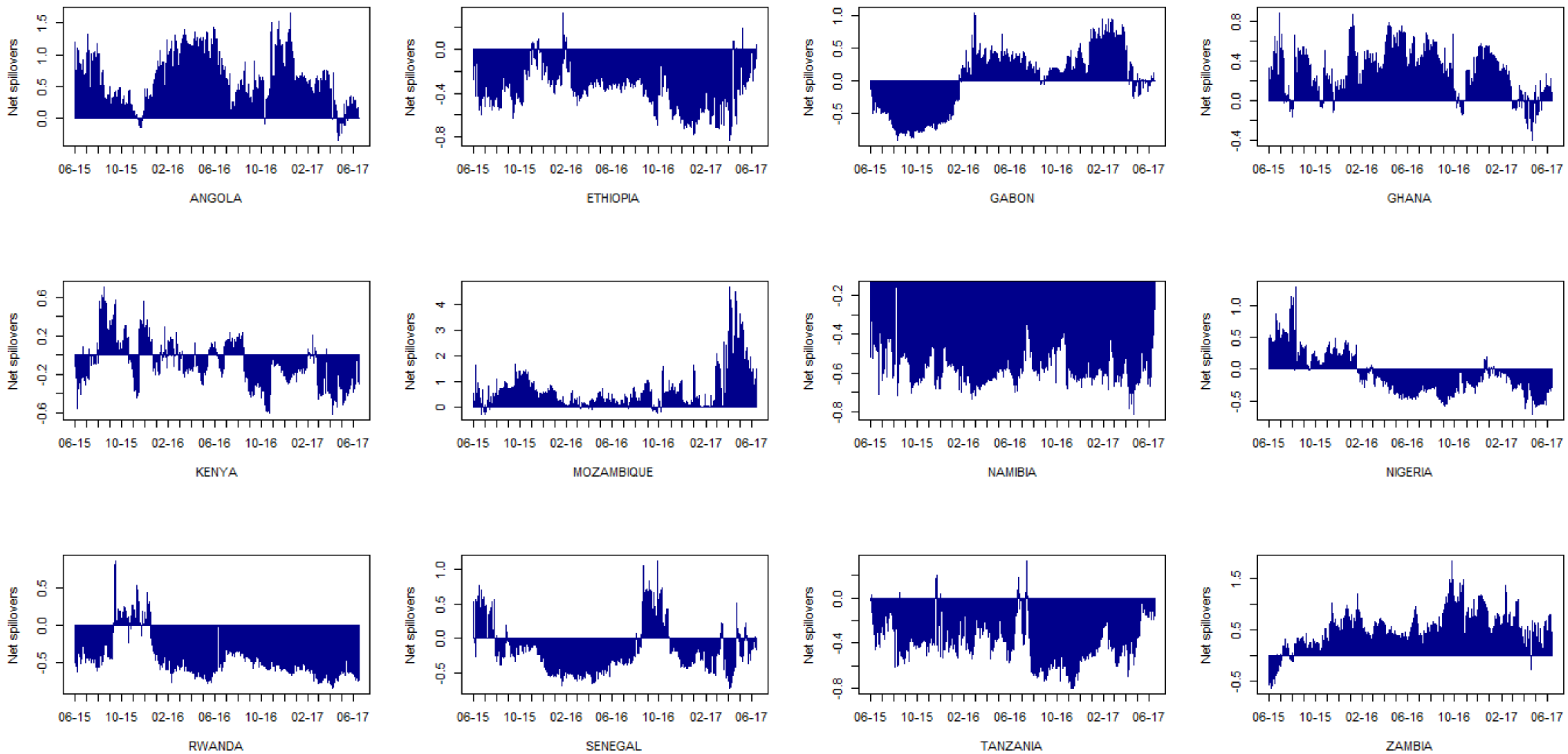

Figure S4: Net spillovers

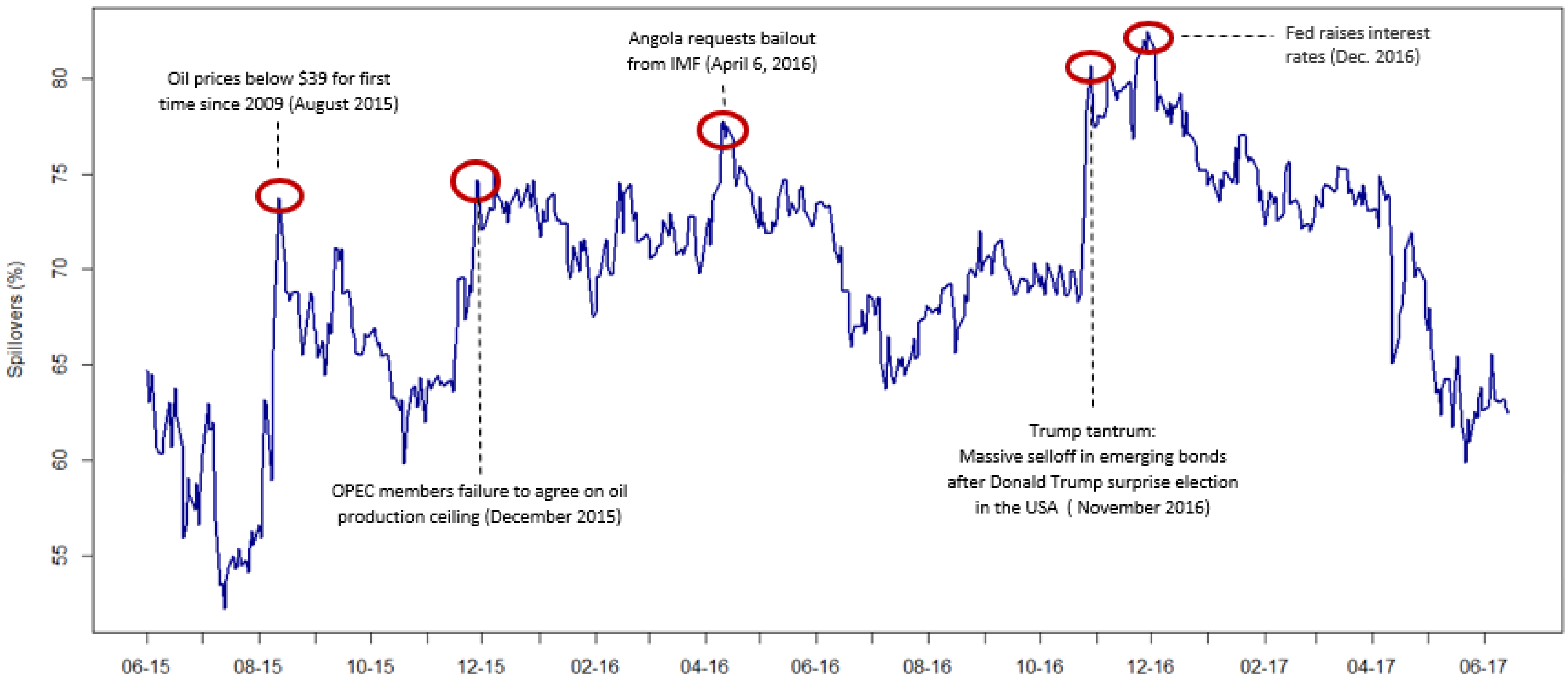

Figure S5: Total spillover index (excl. Mozambique)