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Assessing the spillover effects of U.S. monetary policy normalization on Nigeria sovereign bond yield

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Abstract

This study examines the spillover effects of U.S. monetary policy normalization on Nigeria 10-Year Treasury bond yield between 2011 and 2017, using the vector error correction model approach. Our results reveal that domestic factors, such as exchange rate and inflation, rather than the U.S. 10-Year sovereign bond yield, are the key drivers of Nigeria 10-Year bond yield. Additionally, the spillover effect from the U.S. monetary policy was amplified by oil price shocks and changes in Nigeria's monetary policy rates. Our counterfactual analysis confirms the findings.

Keywords: Tapering, Nigeria 10-year sovereign bond yield, Error correction model, Counterfactual analysis

Introduction

One of the major issues on the front burner of policy discourse is the transition of emerging market economies from the impact of monetary policy normalization in the U.S. During the Great Recession of 2007–09, the Federal Reserve (Fed) adopted an unconventional approach to monetary policy with short-term nominal interest rates within the zero nominal lower bound for more than 6 years. In addition, the Fed's balance sheet size expanded more than four times its value of 2007. The U.S. monetary policy normalization strives to return the monetary policy to a state in which the Fed's nominal interest rate is above zero and the size of the balance sheet is reduced. It is also intended to return the monetary policy process to the pre-recession era in terms of ending the zero-interest rate policy. This would simultaneously lead to an increase in short-term market interest rates and transform the composition of the Fed's asset holdings to the pre-Great Recession era.

Both researchers and policymakers acknowledge that the withdrawal of monetary stimulus and eventual increase in interest rates by the Fed would have tremendous repercussions on emerging market economies. The impact of these repercussions could take the form of portfolio reversal, financial system vulnerability, or macroeconomic instability, and eventually lead to greater financial turmoil in the global financial markets.

Over the years, Nigeria's financial market has evolved in terms of both sophistication and interconnectedness with the global financial system. The level of development has improved considerably, and it is expected to respond to major external monetary policy shocks such as the Fed's monetary policy normalization after nearly a decade of quantitative easing (QE). Furthermore, it is observed that normalization of monetary policy in the U.S. has the potential of reversing investors' sentiment in developing and emerging economies (BIS, 2018; Goes et al., 2017; and Moore et al., 2013). In the medium-term, the U.S. monetary policy normalization is expected to continue to fuel investor expectations with the threat of possible reversal of capital flows. As observed by CBN (2015), "the expected policy normalization in the U.S. could accentuate capital flow reversals from emerging and developing economies and further tighten global monetary conditions, thus exerting greater pressure on exchange rates in those countries."

The analytical spotlight on the effect of the Fed's monetary policy normalization on emerging and developing economies has focused on China, South Africa, and Brazil; Chile, Colombia, Mexico, and Peru; Mexico and other emerging economies (Goes et al., 2017; and Moore et al., 2013). To the best of our knowledge, there is no study assessing the spillover effects of the Fed's monetary policy normalization on Nigeria's sovereign bond yield. Given the relative size of Nigeria's economy in the Sub-Saharan African (SSA) region and its interconnectedness to the global financial market, a study that clarifies understanding of the spillover effects of Fed's monetary policy normalization on Nigeria is imperative.

This study, therefore, aims to address this important research gap, by examining the effects of the U.S. 10-Year bond yield on Nigeria 10-Year sovereign bond yield. To achieve this objective, the remainder of the study is structured as follows: Section 2 presents the stylized facts; Section 3 reviews related literature; Section 4 describes the methodology; Section 5 presents the discussion and results, while Section 6 concludes the study.

Stylized facts

During the Great Recession, among the challenges that confronted monetary authorities in high income countries, such as the Federal Reserve, European Central Bank, Bank of Japan, and Bank of England was the inability of conventional monetary policy instruments to stimulate demand due to weakening employment and output (Lim and Mohapatra, 2016). Specifically, interest rates were almost zero, and there was feasible presence of significant risk of very low inflation (Bank of England, 2016).

To stimulate the economy and avert the increasing risk of low inflation, monetary authorities implemented QE or quasi-fiscal operations through money injection. In the U.S., the Fed embarked on buying assets from private institutions such as financial and nonfinancial corporations and credited the institutions' accounts. Consequentially, this increased the quantity of money supply in the economy (Michaelis and Watzka, 2017). Quantitative easing was, however, disrupted when the Fed announced its decision to normalize its monetary policy in May 2013.

The Fed's announcement to unwind its unconventional monetary policy generated reaction among market participants and investors globally, especially, in emerging economies. This could be attributed to increased cross-border inter-linkages between foreign investors and emerging economies' domestic bond market. In Indonesia, Turkey, Brazil, India, and South Africa, Mishra et al. (2014) revealed that "on average, bond yields rose by 2.5 percentage points, equity markets fell by 13.75 per cent, exchange rates depreciated by 13.5 per cent, while reserves declined by 4.1 per cent during May 22–(end of) August 2013." The episode precipitated a significant burst of market pressure. However, some studies suggest that additional factors such as developments in Argentina, Turkey's increasing policy and political risks, and concerns about China's shadow banking system could have influenced the market pressure (Mishra et al. 2014; Goes et al., 2017; and Matheson, 2015).

First, to examine the spillover effects of the U.S. monetary policy normalization on Nigeria, we used anecdotal evidence to measure the effects of the announcement on exchange rate, consumer price index (CPI), interbank call rate, Nigeria 10-Year bond yield, and foreign portfolio investment (FPI). The study compared the reactions of the announcements on Nigeria and the U.S. 10-Year bond yield. Figure 1 indicates that the impact of the U.S. monetary policy normalization announcement was visible in the bond market. Nigeria 10-Year bond yield overshot the previous value immediately after the announcement by 140 basis points from 4.44% in May 2013 to 5.84% in June 2013. Similarly, the U.S. 10-Year bond yield increased by 36 basis points to 2.49% in June, 2013.

Figure 2, however, indicates that the announcement effect was not significant on interest rate, Naira exchange rate to the U.S. dollar, consumer price index (CPI), and interbank call rate. The exchange rate edged up marginally by 1.14 percentage points from 159.57% in May 2013 to 160.98% in June 2013. The interbank call rate, however, declined from 12.23% to 11.59% from May to June 2013, which represents a 0.64 percentage point decline.

The announcement effect was most significant on foreign portfolio investment compared to other variables of interest.

Figure 3 indicates that foreign portfolio investment plummeted by 21.11% immediately after the announcement, reflecting significant reversal of portfolio immediately after the announcement.

Literature review

The gradual increase in policy rates to unwind QE and restore the Fed's balance sheet has prompted a new wave of research on the likely impact on advanced, emerging, and

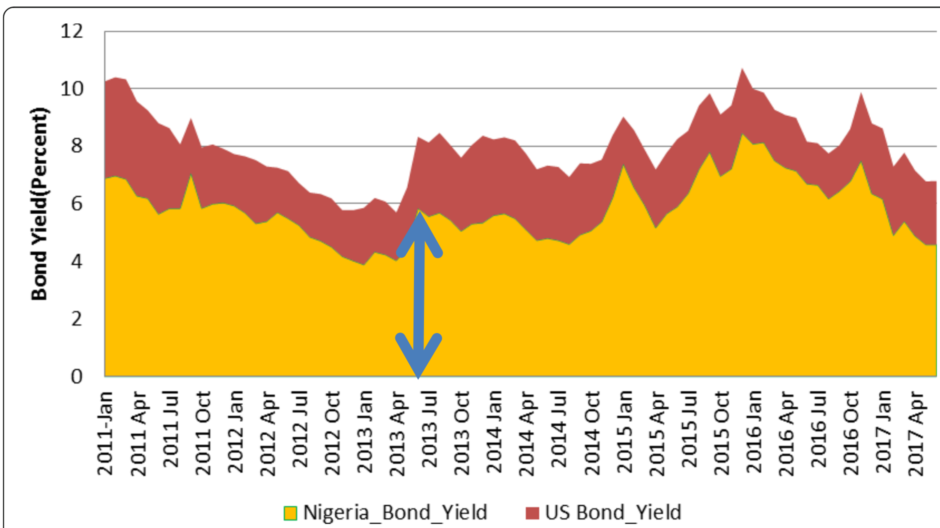

Fig. 1 Nigeria and the U.S. 10-Year Bond Yield: January 2011–June 2017

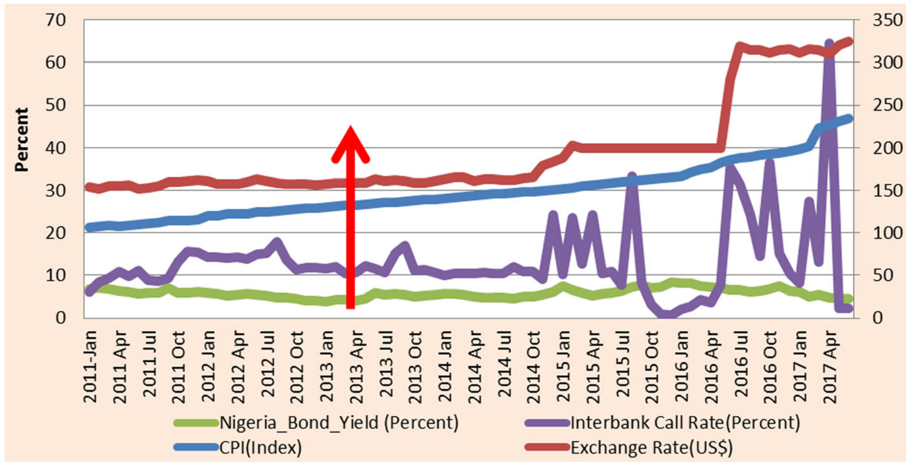

Fig. 2 CPI, Exchange Rate, Bond Yield, and Interbank Call Rate: 2011MI–2017 M4

developing economies. The U.S. monetary policy normalization may generate uncertainty about the future path of interest rates. Consequently, this could lead to spikes in longer-term yields with potential impact in emerging markets and developing countries. There is a widespread belief that in a highly integrated world, normalization of monetary policy by the U.S. will be followed by a hike in interest rates in many countries (Caceres et al., 2016 and Burns et al., 2014). Burns et al. (2014) simulated the implications of normalization of monetary policy in advanced economies like the U.S. on financial flows and crises risks in developing countries. Their findings suggest that sudden changes in market expectations as a result of monetary policy normalization would trigger global bond yield increases and a sharp reduction in capital flows to developing countries.

While empirical literature is growing, there are theoretically three channels through which QE and the accompanying policy normalization can affect domestic and international asset prices and portfolio decisions. According to Fratzscher et al. (2013) and Chen et al. (2013), QE usually involves the purchase of longer-term sovereign bonds. Following the purchase of government sovereign bonds, supply of assets to private investors and the term premium in long-term interest rates changes declined. The

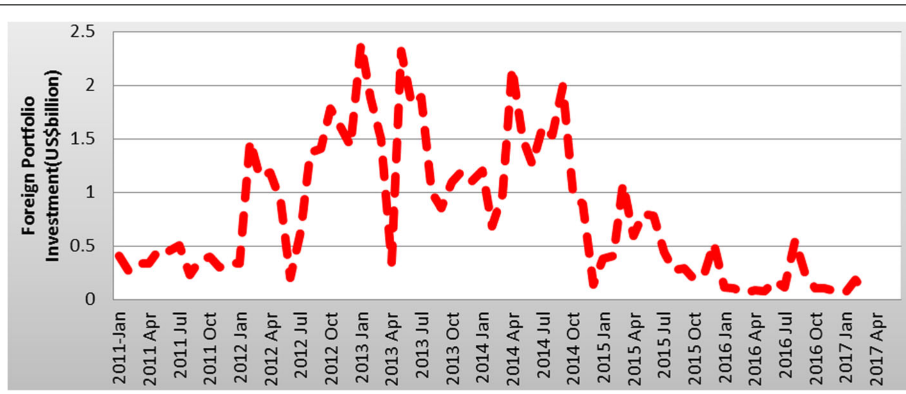

Fig. 3 Foreign Portfolio Investment: 2011–2017

changes arose as a result of imperfect substitutability between securities of different assets classes and maturities. Consequently, the demand for alternative assets in developing and emerging markets would increase as investors turn to more risky assets for higher risk-adjusted returns. However, in the event of policy normalization, there would be a reversal of the process as investors with less risky assets would experience improved returns. This channel is known as the portfolio balance channel.

Second, during QE, the general expectation is that the Fed is committed to keeping future policy rates lower than previously expected. This would trigger a decline in the risk-neutral component of bond yield in the U.S. and influence cross-border portfolio flows and asset prices in favor of emerging markets and developing economies. This is called the signaling channel. According to Bauer and Rudebusch (2013), this channel of transmission was as significant as the portfolio balance channel following the Fed's announcement of QE in 2008.

There is a general notion that QE alters the liquidity premia of securities and, by implication, the overall functioning of the financial market. This is the liquidity channel. Quantitative easing usually entails large-scale asset purchases that expand private banks' balance sheet reserves, thereby enabling banks that are liquidity constrained to extend credit to investors. This could lead to lower cost of borrowing and increased overall bank lending, including cross-border lending. A reversal of this process would occur during policy normalization by the Fed, but its ultimate impact on emerging markets and developing economies remains an empirical issue.

This study extends the literature on the role of country fundamentals in explaining the response to the U.S. monetary policy normalization. The focus is on the transmission of monetary policy on local currency bond yield. Previous studies focused on identifying the main drivers of sovereign bond yield in emerging markets. For example, Eichengreen and Mody (1998), Min (1998), Bellas et al. (2010) examined if debt variables, gross domestic product (GDP) growth, and reserves and interest rates play significant roles in explaining sovereign bond spreads. Ferrucci (2003) concludes that the degree of openness, ratio of amortization of reserves, external debt-to-GDP ratio, and ratio of current account to GDP are all significantly associated with sovereign bond spreads. Specifically, he finds that global liquidity conditions and the U.S. equity prices are correlated with sovereign bond spreads in emerging markets. In a similar study but with a larger number of countries, Presbitero et al. (2016) find size of the economy, per capita GDP, public debt, and government effectiveness as the key drivers of sovereign bond spreads in developing countries.

A few studies have examined the implications of the U.S. unconventional monetary policies on the global economy. Caceres et al. (2016) focus on the impact of the U.S. monetary policy normalization on global interest rates. They find significant correlation between the U.S. monetary policy and domestic short-term interest rates in other countries. However, they also find evidence of monetary policy autonomy in some cases, indicating that the impact of monetary policy normalization in the U.S. is not uniform across countries.

Bowman et al. (2014) analyzed the impact of the U.S. unconventional monetary policy on stock prices, government bond yields, and foreign exchange rates in emerging market economies. They find that the impact of unconventional monetary policy announcement by the Fed was significant, especially for yields on bonds denominated in local currencies; however, the magnitude and persistence of the impact differs across countries. They also find that deterioration in a country's economic conditions substantially increased its vulnerability to changes in the U.S. monetary policy normalization. In another study using an event study framework, Mishra et al. (2014) find that countries with deeper financial markets, tighter macro-prudential policy stances and stronger macroeconomic fundamentals experienced minimal loss in the value of their currencies and smaller increases in government bond yields.

However, on the differential impact of spillovers from the U.S. monetary policy normalization, Goes et al. (2017) build on the earlier studies by Cortes-Espada and Ramos-Francia (2008) and Moore et al. (2013) on Mexico; Leon (2014), Matheson (2015), and Da Silva et al. (2015) on Brazil, and conduct a comparative study of both Brazil and Mexico. Using VECM models, they find that the Brazilian yields were more sensitive than the Mexican yields during 2010–2013.

The debate has extended to studies on the ECB's monetary policy spillovers to other economies. Belke and Dubova (2018a) estimated the spillover effects of ECB's unconventional monetary policy for a set of countries and compared the outcomes with the spillover effects of the U.S. unconventional monetary policy on the same countries. They perceived that heterogeneity in results obtained from the study was largely explained by the choice of econometric frameworks as well as identified effective transmission channels and factors determining these spillovers. In addition, the study also examined the possibility of adopting a political economy approach, such as monetary policy coordination, as an appropriate response to non-pecuniary spillover effects to other regions of the world.

Beckmann et al. (2014) investigated if a cross-sectional perspective on monetary policy can explain global commodity price movements. First, the authors identified the long-run structure, which includes a proportional relationship between commodity prices and global liquidity, and their results show that the impact of a global liquidity measure on different commodity prices is significant and varies over time.

Belke et al. (2014) examined the interactions between money, interest rates, goods, and commodity prices at the global level using aggregated data from major OECD countries. The Johansen cointegrated vector autoregressive (VAR) methodology was employed and their findings support the view that when controlling for interest rate changes using different monetary policy stances, money remains a key factor in determining the long-run homogeneity of commodity prices and movements in goods prices. They find that the inclusion of commodity prices helps in identifying a significant monetary transmission process from global liquidity to other macro variables such as goods prices.

This study contributes to the literature in two ways. First, it captures the experience in recent years when several SSA countries issued international sovereign bonds for the first time, thus extending the analysis on developing countries by Presbitero et al. (2016). Second, it identifies contingency plans to mitigate the specific impact of the U.S. unconventional monetary policy on Nigeria's yield curve.

Methodology

Data sources and measurement

This study used monthly data series that ranged from 2007:01 to 2017:04 on five variables using the vector autoregressive (VAR) methodology. The variables consist of the

U.S. 10-Year Treasury Bond Yield (US10YTBY), Nigeria 10-Year Treasury Bond Yield (N10YTBY), headline consumer price index (CPIH), interbank exchange rate to the U.S. dollar (IBEXCHR), crude oil price (Brent), and interbank call rate (IBCR).

Model specification

The VAR/VECM is consistent with Sims (1980), Chen et al. (2016), Belke et al. (2017), and Belke and Dubova (2018b). This study adopted a VAR model, which has carved a niche among macroeconomists and is an enduring methodology for time-series modeling, especially in the assessment of joint dynamic behavior between the given variables and restrictions essential to determining the fundamental structural parameters.

The Johansen cointegration test was used to check the presence or otherwise of the cointegrating vector in the model using both the trace and maximum eigenvalue statistics at 1% and 5% levels of significance, respectively (Johansen, 1988).

Below is the expression of the VAR (p) model:

$$Y_t = \beta + \mathrm{A}_1 y_{t-1+ - - - - - - - - - - - +} A_{p-1} y_{t-p} + \varepsilon_t \tag{1}$$

Given that the VAR could take the VECM form where variables are of I (1) order of integration, eq. (1) could be re-written as follows:

$$\Delta y_t = \beta_0 + \beta y_{t-1} + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \dots + \beta_{p-1} \Delta y_{t-p+1} + \lambda y_{t-p} + \varepsilon_t \tag{2}$$

Where β_0 is a (6 × 1) vector of intercept with elements β_{j0} and β_i is (n × n) coefficient matrices with elements β_{jk} (i), ε_t is an independent and identically distributed n-dimensional vector with zero mean and constant variance. Thus, if β is of rank $1 < r < 6$, this implies that it can be decomposed into $\beta = \lambda\pi'$ where π is the matrix of cointegrating vectors and λ is the matrix of adjustment. Hence, introducing a linear combination process (μ') in eq. (2), yield

$$\Delta y_t = \beta_0 + \beta y_{t-1} + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \dots + \beta_{p-1} \Delta y_{t-p+1} + \lambda \left(\mu' y_{t-p} \right) + \varepsilon_t \tag{3}$$

If the variables for analysis are I (1) and cointegrated, the error correction term would be incorporated into the short-run analysis of the system to capture the adjustment for the deviation from its long-run equilibrium (Engle and Granger, 1987). Differenced and long-run equilibrium models are characteristics of the VECM model, as it captures the estimates of short-run dynamics and long-run equilibrium adjustment. The five variables employed in this study are expressed in the VECM as follows:

$$\Delta X_t = \alpha\beta' X_{t-1} + \sum_{i=1}^{p} A_i \Delta X_{t-i} + C + \varepsilon_t \tag{4}$$
$$\text{Where } X_t \Xi (\text{N10YTBY}, \text{CPIH}, \text{IBEXCHR}, \text{IBCR}, \text{US10YTBY})' \text{ is an}$$

m-dimensional vector of endogenous variables; $\alpha_t \Xi (a_{11}. \ . \ \dots\dots a_{1m})'$ is an m-dimensional vector of short-run adjustment coefficients; β′ is an (M *1) matrix of coefficients for the i cointegrating relationships among the m endogenous variables; A is an (M *M) matrix of coefficients determining the short-run dynamics of the endogenous variables; C is a vector of constants, and ε is a vector of error terms.

Equation (4) allows the decomposition of the forecast-error variance of each of the endogenous variables as well as tracing the impulse response functions (IRFs) to show

Table 1 Augmented Dikey-Fuller unit Root Tests

	Level			First Difference			Remarks
	Constant	Trend & Constant	None	Constant	Trend & Constant	None	Decision
Exchange Rate	-0.360970	-1.851276	1.040777	-6.093836***	-6.180354***	-5.963576***	1(1)
Inter-Bank Call Rate	-2.343387	-2.630810*	-0.219032	-12.57201***	-12.54419***	-12.59757***	1(1)
Nigeria Bond Yield	-1.439778	-1.613680	0.521529	-8.766411***	-8.356251***	-8.375700***	1(1)
US Bond Yield	-2.697100*	-2.436492	-1.150373	-7.805880***	-7.911789	-7.820657	1(1)
CPI	3.365203**	1.399136	3.057715**	-2.408215	-3.097197**	-0.858834	1(1)
Crude Oil Price	-0.488318	-2.443860	-0.984044	-6.876628***	-6.830839***	-6.835991***	1(1)

Test critical values:	1% level	-3.521579(***)
	5% level	-2.901217(**)
	10% level	-2.587981(*)

the sensitivity of Nigeria 10-Year sovereign bond yield to an innovation in the U.S. 10-Year sovereign bond yield.

In line with Ang and McKibbin (2007), two types of causation are expected to be conducted. They include the error correction term (ECT) ($\beta \neq 0$) and the lagged dynamic terms. By implication, the VECM framework enables the performance of two distinct types of Granger causality tests: the short-run noncausality test and the long-run causality weak exogeneity test. The Wald test is used to perform the VECM-based causality test. The direction of causality is examined using the parsimonious Granger causality tests based on the multivariate error-correction model.

Empirical results and analysis

Unit root tests

When the mean, variance, and covariance of a series are not constant over time, it implies that such series are non-stationary. When data contain unit roots, it means any result that derives from such data will be spurious. As a first step, the VAR models demand that the series under investigation be stationary. If the stationarity condition is not satisfied, other forms of VAR modelling such as a VECM model could be adopted. To this end, we employed the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) stationarity tests to ascertain the order of integration of the variables employed. The results of the unit root test in level form and first difference are presented in Tables 1 and 2. The results indicate that all the variables are nonstationary at level but stationary at first difference.

Table 2 Phillips-Perron Unit Root Tests

	Level			First Difference			Remarks
	Constant	Trend & Constant	None	Constant	Trend & Constant	None	Decision
Exchange Rate	0.473251	-1.193111	1.738914	-5.944164***	-5.953544***	-5.886270***	1(1)
Inter-Bank Call Rate	-4.296061***	-4.698666***	-0.615243	-13.75904***	-13.81169***	-13.34111***	1(1)
Nigeria Bond Yield	-2.262578	-2.421348	-0.835699	-8.851768***	-8.782396***	-8.889599***	1(1)
US Bond Yield	-2.697100**	-2.495068	-1.137484	-7.790616***	-7.886657***	-7.806582***	1(1)
CPI	3.928961***	1.544629	9.276122***	-4.376189***	-5.663140***	-1.489529	1(1)
Crude Oil Price	-0.611807	-2.612945	-0.984044	-6.817578***	-6.770279***	-6.830780***	1(1)

Test critical values:	1% level	-3.521579(***)
	5% level	-2.901217(**)
	10% level	-2.587981(*)

Table 3 Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1015.325	NA	2088950.	28.74155	28.90089	28.80491
1	-552.0382	848.2716	9.098197	16.39544	17.35150*	16.77564*
2	-532.0508	33.78148	10.58920	16.53664	18.28942	17.23367
3	-503.6191	44.04908	9.874375	16.43997	18.98947	17.45383
4	-483.6507	28.12455	11.98200	16.58171	19.92793	17.91239
5	-429.3661	68.81143*	5.729779*	15.75679*	19.89973	17.40431

* indicates lag order selected by the criterion
LR sequential modified LR test statistic (each test at 5% level), *FPE* Final prediction error, *AIC* Akaike information criterion, *SC* Schwarz information criterion, *HQ* Hannan-Quinn information criterion

Lag length criteria

The stability of the VAR model depends on the choice of the lag length selected. A shorter lag length may exclude relevant information, while a longer lag length may result in the loss of degrees of freedom. Therefore, lag selection should be guided by a relatively parsimonious model. However, EViews provides a formal menu and criteria for selecting lag length. The results of the application for the lag length selection criteria are presented in Table 3. The selected lag length, based on Schwarz and Hannan–Quinn criteria, is one lag1.

Lag structure/stability of the VAR

Usually, the principal objective of the VAR/VEC model is to predict the direction of the key variables. To achieve this goal, the model must be stable. The test for checking the stability of the VAR model was conducted using the autoregressive roots table and graph. As shown in Fig. 4, the test result indicates that the model is stable as all the eigenvalues lie inside the unit root circle.

Cointegration test

To establish the existence of a long-run equilibrium relationship between the variables, the Johansen cointegration test based on trace and maximum eigenvalue test statistics was conducted, and the results are presented in Table 4. The results for both the maximum eigenvalues and trace test statistics show at least one test statistic that is greater

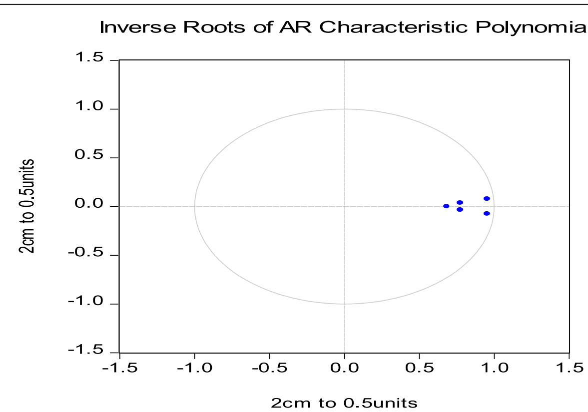

Fig. 4 Stability Test (Graph)

Table 4 Johansen Cointegration Test Based on Trace and Maximum Eigen-Values of the Stochastic matrix

Trace Test				Maximum EigenValue			
H0: Rank r	Ha: Rank = r	Trace Statistics	0.05 Critical Value	H0: Rank r	Ha: Rank = r	Statistics	0.05 Critical Value
$r = 0$	$r = 1$	84.68859	69.81889	$r = 0$	$r = 1$	39.85148	33.87687
$r <= 1$	$r = 2$	44.83710	47.85618	$r <= 1$	$r = 2$	25.59544	27.58438
$r <= 2$	$r = 3$	19.24166	29.79707	$r <= 2$	$r = 3$	14.87035	21.13162
$r <= 3$	$r = 4$	4.371317	15.49471	$r <= 3$	$r = 4$	4.189725	14.26460
$r <= 4$	$r = 5$	0.181593	3.841466	$r <= 4$	$r = 5$	0.181593	3.841466

Note: Trace tests indicate 1 cointegrating equation at the 0.05 level, while the max-eigenvalue also indicates 1 cointegrating equation
Source: Author's compilation using EViews

than the 5% critical value. Hence, we rejected the null hypothesis that there are no cointegrating variables and conclude that there is one cointegrating vector.

VECM, impulse response functions (IRF) and analysis

The IRF suggest that the response of the local currency bond yield to higher U.S. bond yield was positive, although initially insignificant (Fig. 5). However, the variance decomposition shows that the response of Nigeria bond yield to domestic fundamentals including foreign exchange and short-term interest rates were more dominant than the U.S. bond yield (Fig. 6). This suggests that the impact of U.S. bond yield shocks was indirect through the channels of exchange rate and short-term interest rates.

Observed and model-based yield estimates around "tapering talk"

In this section, we estimated responses (changes) in the 10-Year sovereign bond yield as a result of the Fed's tapering announcements, in terms of the behavior of the 10-Year sovereign bond yield months before and after the announcement.[1] The objective

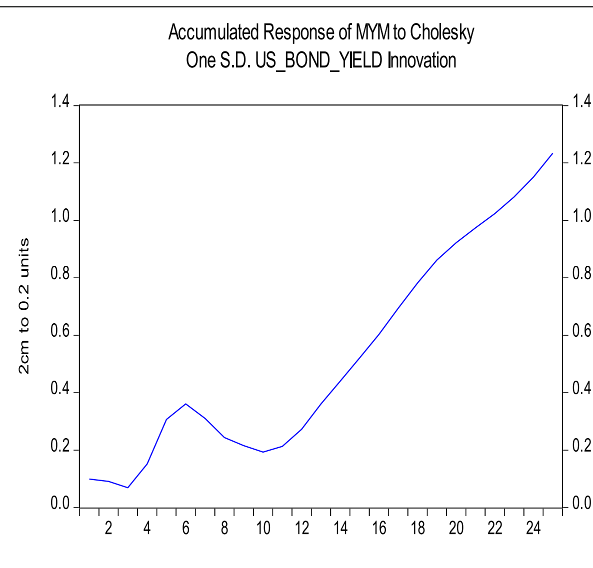

Fig. 5 Accumulated Impulse Response of Nigeria 10-Year Bond Yield to Shocks in U.S. Bond Yield

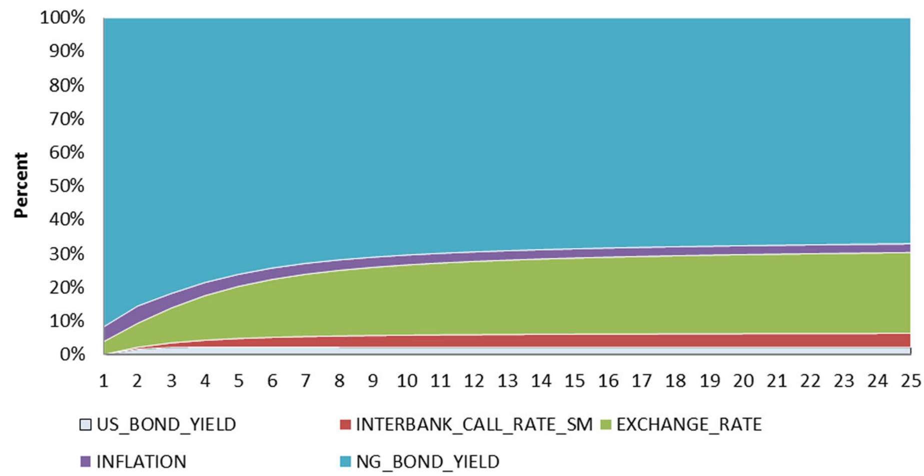

Fig. 6 Variance Decomposition of Nigeria 10-Year Bond Yield

of this analysis is to examine the impact of rising U.S. bond yield on Nigeria sovereign bond yield. Importantly, this analysis seeks to establish the predicted yield increase, and the magnitude to which the yields exceeded their model-based equilibrium values. To achieve this, the estimated parameters and historical values for all other variables (Fig. 7) were used to assess the in-sample model fit for Nigeria 10-Year bond yield. The lagged values of Nigeria 10-Year bond yield curve are model-based predictions from previous periods. Since the actual and fitted yields closely track each other over time, the in-sample fit is considered appropriate. It can be observed that the actual and fitted yields increased above 100 basis points during the preceding 3 months. The results can be explained by domestic factors: expectation of policy hike, beginning of monetary policy tightening, and perception of higher sovereign risk.

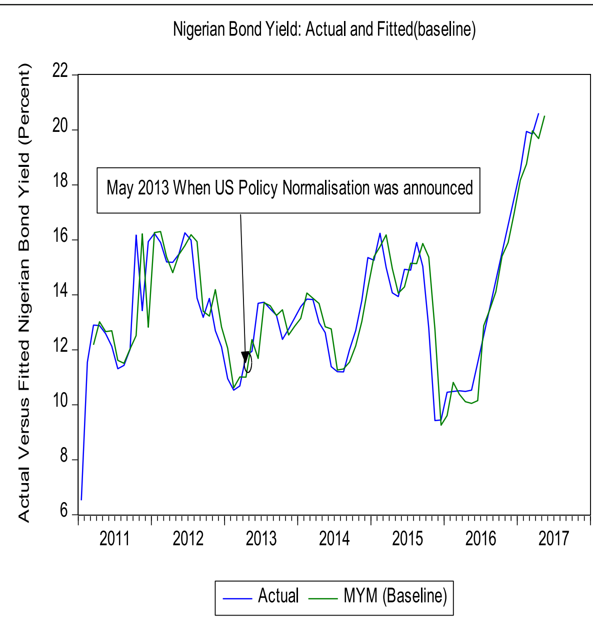

Fig. 7 Nigeria Bond Yield: Actual and Fitted (Baseline)

Counterfactual analysis

To establish the implications of a sustained rise in the U.S. Treasury yields on Nigeria's sovereign bond yield, we estimated two post-tapering scenarios for local currency sovereign bond markets. The objective of this exercise is to construct counterfactuals that could mimic predicted bond yields, if external and/or domestic fundamentals are unchanged.

Scenario 1—unchanged U.S. Treasury yield

We employed the estimated parameters and the actual values for all the variables, except the local-currency sovereign bond yields, which are fitted by the model. We used the 2.2% May 2013 U.S. Treasury bond yield. The model is not isolated from the effects of the tapering announcements, as changes in the historical values of other variables consistent with the announcement could have an indirect effect on the model. However, the model controls for the direct impact of the tapering announcement on local currency sovereign bond yield. The green line in Fig. 8 denotes the result of scenario 1. The result shows that Nigeria 10-Year bond yield would have maintained an upward trend, with or without tapering announcement, indicating that domestic macroeconomic fundamentals are the major predictors or drivers of local currency sovereign bond yield.

Scenario 2—unchanged domestic fundamentals

This scenario fixed all domestic variables at their May 2013 values, assuming there were no changes in the domestic environment, while allowing the U.S. 10-Year Treasury bond yield to take its historical values. This scenario allows us to isolate the effect of domestic factors, while effectively examining the direct impact of tapering on Nigeria 10-Year sovereign bond yields (MYM). The model predictions show that local currency yields rose above the actual historical path, confirming the positive influence of the U.S. bond yield (Fig. 9).

In Fig. 10 below, we show that the predicted path of Nigeria bond yield followed an upward trend in both scenarios. However, the rise in bond yield associated with holding the

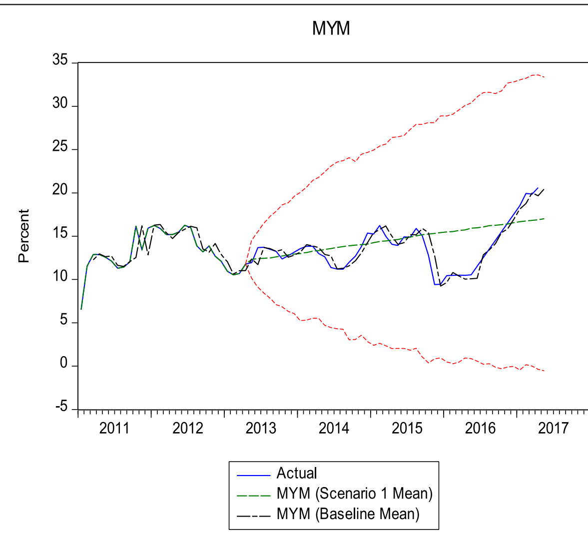

Fig. 8 Impulse Response to Unchanged U.S. Treasury Yield

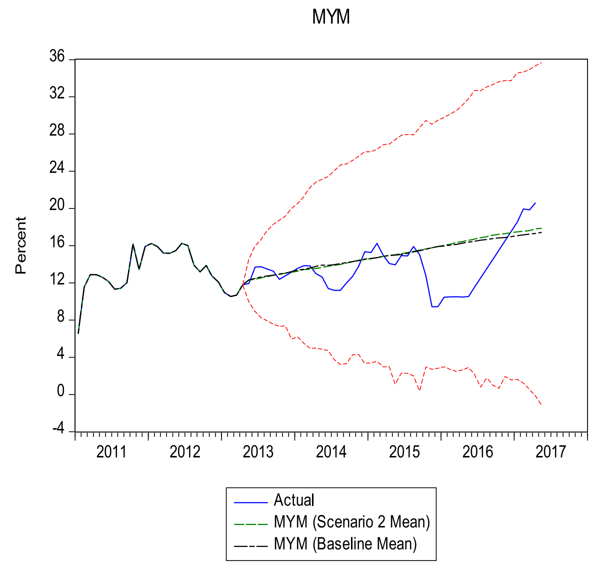

Fig. 9 Impulse Response to Unchanged Domestic Fundamentals

domestic factors unchanged was higher than those associated with holding the U.S. rate unchanged. This implies that the U.S. rate weighed a higher influence on Nigeria bond yield.

Robustness test

Our earlier results show that domestic factors such as exchange and inflation rates were the drivers of Nigeria 10-Year bond yield. There is a debate on the primary drivers of inflation and exchange rates in oil exporting countries. Using data that spanned from 1980 to 2011, Dauvin (2014) demonstrated that energy prices and terms of trade are the major determinants of real exchange rates and inflation in oil exporting countries. Similarly, Habib and Kalamova (2007), Korhonen and Juurikkala (2009), and Coudert et al. (2011) described the currency of oil producing countries as oil currencies because they appreciate with the rise in crude oil prices. Since Nigeria exports crude oil and is an import (commodities) dependent economy, introducing crude oil prices would help to capture the peculiarities of Nigeria's economy.

To address this concern, crude oil prices were introduced into our model. To make the results comparable with our earlier estimated models, we retained the exchange rate, inflation rate, and the U.S. and Nigeria 10-Year bond yields within the same time frame. The results are consistent with our earlier findings and show that domestic factors are the major drivers of Nigeria10-Year bond yield (see Fig. 10a, b, c, and d).

Conclusion

The objective of this study is to examine the spillover effects of U.S. monetary policy normalization on Nigeria 10-Year sovereign bond yield. We employed the VECM model and observed a positive response for Nigeria 10-Year Treasury bond yield to higher U.S. bond yield. However, we observed that the U.S. 10-Year bond yield had a mild impact on Nigeria 10-Year Treasury bond yield for the period under review.

The study findings strongly suggest that Nigeria 10-Year bond yield is more sensitive to domestic shocks than the Fed's monetary policy normalization. This is contrary to

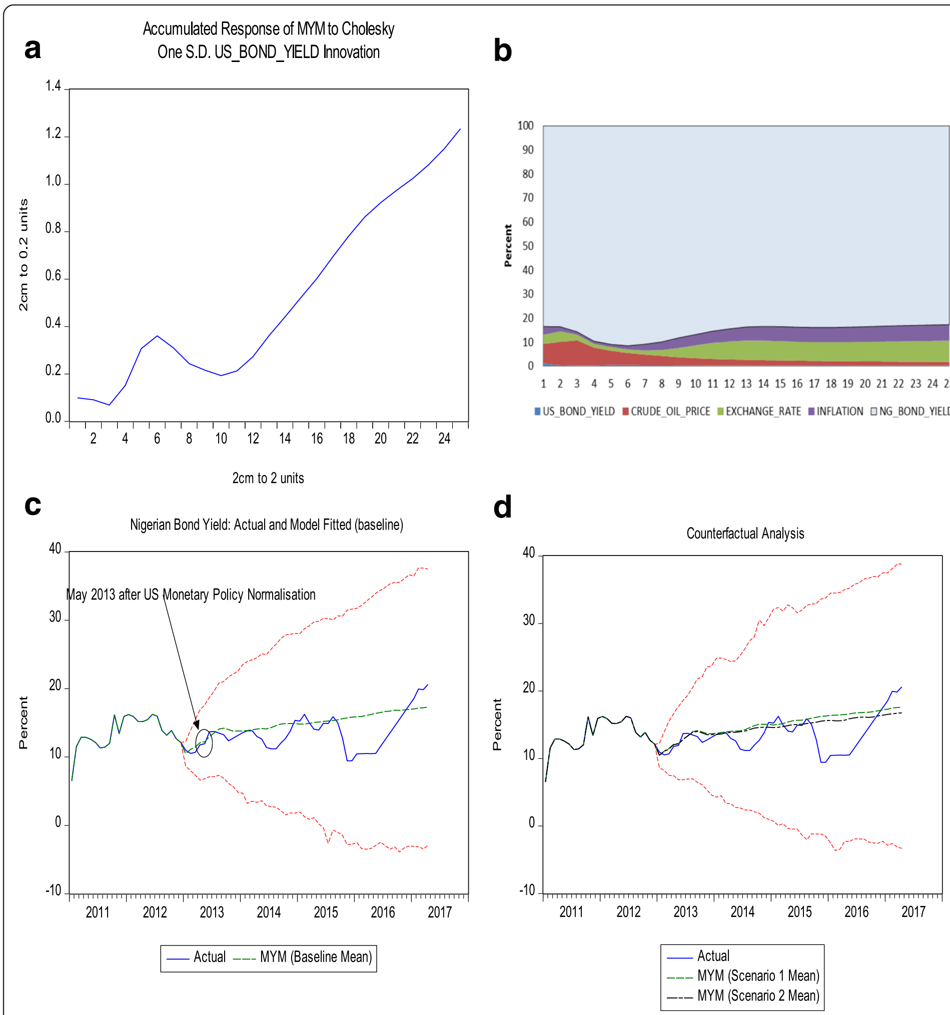

Fig. 10 Comparison of Unchanged Domestic fundamentals and Unchanged U.S. Treasury Yield. **a** Accumulated Impulse Response of Nigeria 10-Year Bond Yield to Shocks in U.S. Bond Yield (Introducing Crude Oil Prices). **b** Variance Decomposition of Nigeria 10-Year Bond Yield to Shocks in U.S. Bond Yield (Introducing Crude Oil Prices). **c** Baseline of Nigeria Bond Yield: Actual and Fitted (Introducing Crude Oil Prices). **d** Accumulated Impulse Response to Unchanged U.S. Treasury Yield (Introducing Crude Oil Prices)

Belke and Dubova (2018a, b), who reported that sovereign bond yield in emerging Asian economies responded significantly to changes in the U.S. and Eurozone bond yields. Our empirical results show that Nigeria bond yield was consistent with our model-based estimates in the weeks immediately before the U.S. Federal Reserve's tapering announcement. Our counterfactual analysis suggests that policy makers in Nigeria probably undertook measures to contend with potential spillovers from the shifts in monetary policy expectations in the U.S., while contending with domestic factors like exchange rate and inflation, which are key determinants of Nigeria's sovereign bond yield. Importantly, our result suggests that shocks from the U.S. long-term yields were amplified by oil price shocks and changes in Nigeria's policy rate.

Endnotes

[1]On May 21, 2013, the Fed announced its intention to unwind the unconventional monetary policy it embarked on during the Great Recession.

Abbreviations
ADF: Augmented Dickey-Fuller; BDC: Bureau de Change; BOP: Balance of Payment; CBN: Central bank of Nigeria; CPI: Consumer Price Index; CPIH: Headline Consumer Price Index; ECT: Error Correction Term; ERVOL: Exchange Rate Volatility; GDP: Gross Domestic Product; IBCR: Interbank Call Rate; IBEXCHR: Interbank Exchange Rate to the US Dollar; IRP: Impulse Response Function; LM: Lagrange Multiplier; N10YTBY: Nigeria Ten Year Treasury Bond Yield; PP: Phillip-Perron; SD: Standard Deviation; US10YTBY: United States Ten Year Treasury Bond Yield; VAR: Vector Autoregressive; VECM: Vector Error Correction Model

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This study should not be reported as representing the views of the Central Bank of Nigeria or International Monetary Fund. The views expressed herein are those of the author(s) and are not necessarily those of the Central Bank of Nigeria or International Monetary Fund and its Management.

Authors' contributions
The contributions of the various authors are as stated below: KMT lead author responsible for initiating the work and drafting the introduction. OJO Assistant lead author responsible for writing the literature review. UJA Responsible for writing the stylized facts. GUE and EAPU were responsible for drafting the methodology, analysis and interpretation of the results. AU Responsible for writing the conclusion and abstract as well as gathering the data from our Data Management Office. All authors read and approved the final manuscript.

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