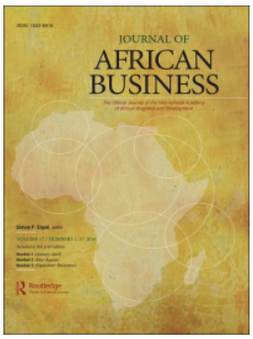

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The Impact of Derivatives Use on Systemic Risk of Africa's Banking System

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ABSTRACT

This paper contributes to the debate about Africa's financial stability by focusing on the prevalence of systemic risk in 40 listed derivatives user-banks over 2011–2017, employing the systemic risk index (SRI), and subsequently exploring how it links to the continent's financial market development. The systemic risk buildup within the industry is mainly depicted as an unstable, diluted, and possibly depleting process. Gloomy predictions persist in the subsequent attempts to uncover plausible causes of systemic risk formation. Mainly, conventional defining factors for risk exhibit irrelevance toward systemic risk development, as threats to financial stability remain confined within the industry, supported by a lack of diversification in financial services. The investigated markets may be individually subject to internal vulnerabilities that could be exacerbated by financial shocks, feedback effects, and the likelihood of contagion and failure among financial institutions.

KEYWORDS

Derivatives use; African banking market; systemic risk contribution; systemic risk sensitivity; systemic risk index

1. Introduction

Ever since the 2007/08 global financial crisis, the probability of future systemic crises in developing countries has been acknowledged, raising an understandable need to rigorously monitor and address the systemic risk formation even in remote, developing markets (Catalán & Demekas, 2015; Foggitt et al., 2017). Simply put, "systemic risk," a phenomenon that affects all countries, entails " . . . the risk of a crisis in the financial sector and its spillover to the broad economy" (Athreya, 2015, p. 6), and a "disruption to the provision of financial service caused by impairments in all or parts of the financial system" that create economic tumults (Catalán & Demekas, 2015, p. 3).

In Africa, South Africa boasts an attractive market for organized and over-the-counter (OTC) derivatives dealings. The number of options and futures trading on the Johannesburg Stock Exchange (JSE) increased from 14,947,523 in 2005 to 264,674,543 in 2018 (Keffala, 2015; World Federation of Exchanges, 2020). Aside from the current exchange-based operations in North Africa, the Nairobi Securities Exchange launched its first index futures and single stock futures in 2019. Nairobi's derivatives market, which is known as Sub-Saharan Africa's second exchange-traded market in derivatives, is slowly growing (Nairobi Securities Exchange, 2022; Reuters, 2019). Nigeria has also formalized

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derivatives market, with a 2021 endorsement of seven exchange-traded derivatives from the Nigerian Exchange Limited (NGX). The NGX is expected to launch West-Africa's first Exchange Traded Derivatives supported by NG Clearing in the risk management process, spreading the coverage of its formalized derivatives activity to the whole region (Steves, 2021). Similar initiatives are being contemplated elsewhere on the continent.

Africa's derivatives initiatives are attracting increasing research attention. Derivatives markets, normally known as the ultimate endowment of financial systems, mostly thrive on their renowned risk management function. The contracts traded in these markets form a highly innovative and complex class of financial instruments mainly used in advanced ecosystems. African economies are expected to foster their financial development through the use of derivatives, including further financial liberalization and globalization in their financial practices (financialisation). The implied financialisation, involving a process whereby financial markets gain more influence in a particular financial framework, is thus seen as a potential catalyst for Africa's financial stability and creative banking practices to improve lending to the business sector (Batuo et al., 2018; Nguema Bekale et al., 2015, 2020, 2022).

The practice of using derivatives, the underlying financial liberalization (or financialisation), and globalization in banking practices have been identified as potential sources of financial vulnerabilities in the economy. Using derivatives can expose banks or the economy to international financial shocks, cross-border contagion, systemic distress, post-crisis financial restructuring and bailouts costs, inflated pro-cyclicality and correlation of financial markets, and disruptions in financial intermediation (Akinsola & Odhiambo, 2017; Catalán & Demekas, 2015; Keffala, 2015, 2017). Derivatives have been touted as the instruments that reinforce the interdependence of market participants in the Global Financial Sector (Titova et al., 2020). The use of derivatives was highlighted as the very mechanism that triggered and helped spread risk during the 2008 Financial Crisis. In line with this, derivatives, including supposedly safe exchange-traded instruments, demonstrated their potential to drain liquid resources from banks' balance sheets. Increased illiquidity resulting from derivative use can expose the financial sector to external liquidity shocks and contagion and transmission of such shocks between banks, hence the systemic risk (Louhichi et al., 2022; Zhou, 2021).

Authors have divergent views on how the interplay between derivatives use and other underpinning financial transformations contribute to systemic risk development. The interpretations corroborating the popular "derivatives – stability" notion lead to the belief that the liberalization of derivatives markets deepens financial markets, leading to a self-efficient process that reduces the insolvency, market and systemic risks facing banks, thus mitigating the likelihood of bank crises. The structural advances then achieved, including derivatives' hedge facility (rather than speculation, which is prone to fraud), may contribute to efficiency gains in financial markets, heightened sophistication and capitalization potential for banks, enhanced resource allocation toward private sector development, stronger interbank markets capable of reducing direct institutional contagion, and steady economic prosperity. Accordingly, using derivatives can enhance bank lending capacity without a systematic increase in the financial sector's risk (Foggitt et al., 2017; Sinha & Sharma, 2016).

The derivative – fragility philosophy contrarily stipulates that using derivatives, extending to the acquired capital market sophistication, gives rise to the formation of

contagion networks in banking, leading to crises and instabilities that extend beyond the banking sector and affect businesses, governments and the economy (Mokni et al., 2016). Particularly, Over-the-Counter (OTC) derivatives dealings are known as a dynamic source of contagion and systemic risk buildup, resulting from their opacity and inclination to create moral hazards, mispricing of credits, leveraged gambling, default manipulations, and other regulatory deficiencies (Foggitt et al., 2017). Likewise, a related surge in efficiency quest can trigger systemic risk, mainly stemming from moral hazard problems (Athreya, 2015).

An alternative viewpoint stresses that the systemic risks of different derivatives classes are offsetting, leaving banks unharmed (Chang et al., 2018; Keffala, 2017). Theoretically, derivatives use and the resultant financial globalization, including in banking practices, can have heterogeneous effects on the health of the financial system and the economy, creating both positive and negative changes in the financial sector, which may even translate into economic outcomes at macroeconomic levels (Qin & Zhou, 2019; Setikiene & Butkus, 2021).

Systemic risk has been studied with an obvious focus on advanced financial systems (Chang et al., 2018; Louhichi et al., 2022; Titova et al., 2020) but also a growing emphasis on developing markets (Keffala, 2015; Sinha & Sharma, 2016; Zhou, 2021). Louhichi et al. (2022), Titova et al. (2020), and Chang et al. (2018) define the determinants of systemic risk development in the European banking system under the implied financial globalization. The region entails a vast bank-based financial ecosystem, except for the capital-based financial system in the United Kingdom. Louhichi et al. (2022) show that the added liquidity derived from financialisation exacerbates both banks' systemic risk contribution and exposure, measured by conditional value-at-risk (ΔCoVaR) and marginal expected shortfall (MES), respectively. Titova et al. (2020) model the volatility of bank stock returns against derivatives use, concluding that derivatives hedge reduces bank risk. Chang et al. (2018), instead, supports that using derivatives is irrelevant to systemic risk formation.

Qin and Zhou (2019) infer the effect of using derivatives on banks' systemic risk contribution (the MES) under bank-based and market-based financial systems. The business in financial derivatives exhibited larger effects on systemic risk where the markets rather than banks are more important in the economy. Banks in the bank-based financial systems of BRICs and Japan displayed insignificance vis-à-vis systemic risk, as their derivatives use practice remains fairly trivial. Inversely, the US market-based system amplified systemic risk in line with banks' derivatives activity. Depending on the complexity of banks' financial network, involving the degree of interconnection (when higher) of a particular system with the global financial system, a banking-based economy may, however, pose greater systemic risk threats than market-based systems (Louhichi et al., 2022).

In emerging markets, very few studies exist. For instance, Keffala (2015) finds a positive relationship between derivatives usage systemic risk. Sinha and Sharma (2016) show the opposite for Indian banks. A nascent body of literature covers Africa's transition to derivatives use, alluding to its implications for the continent's financial stability (Keffala, 2015; Nguema Bekale et al., 2020, 2022). According to Zhou (2021), African economies experience high volumes of international capital flows in both directions related to their trading ties with the rest of the world. Fluctuations in commodity

prices and currencies are a compelling reason for using related derivatives instruments in these economies. Additionally, the countries are known to provide high-risk investments. Therefore, investors usually require facilities allowing for instruments that can hedge the risk associated with their transactions, hence the need for derivatives markets.

With its long-standing formal derivatives market (since 1987) and dynamic OTC market segment, South Africa has so far managed to achieve a relatively stable development push. Yet, empirical knowledge on the relationship between the use of derivatives by African banks and the formation of systemic risk remains scarce. Obviously, most studies reflecting the individual avenues of interest in this subject or their combination focus only on South Africa, given the country's lively markets relative to other African economies (Foggitt et al., 2017; Manguzvane & Mwamba, 2019; Nguema Bekale et al., 2015; Zhou, 2021).

Zhou (2021) demonstrates that using derivatives increases systemic risk in South Africa. On a general note, Batuo et al. (2018) conclude that financialisation intensifies Africa's financial volatility and instability. Nguema Bekale et al. (2022, 2020) deliberate on the dynamics of banking (efficiency) development and (in)stability attributed to Africa's derivatives use, based on 147 banks in 14 economies. These studies corroborate the unfolding uncertainties and instability in the way African banks engage with derivatives use. Nguema Bekale et al. (2022) illustrate that using derivatives can be either unrelated or positively correlated with banking development, as in cases where the use of derivatives was linked to economic uncertainties. Nguema Bekale et al. (2020) indicate that using derivatives increases idiosyncratic bank risk-taking, possibly masking risk on a systemic scale.

As the continent strives for improved financial ecosystems toward market-based economies, it becomes important to understand the process of its systemic risk formation. The continent has suffered its fair share of banking and systemic distress despite its nascent financial history (Akinsola & Odhiambo, 2017; Misati & Nyamongo, 2012). The lack of knowledge about systemic risk resulting from derivatives use, coupled with the need to preserve Africa's financial integrity in the face of financialisation, also compels the documentation of such systemic risk dynamics. This paper then seeks to answer the following question: to what extent is systemic risk in the African banking sector impacted by derivatives use?

We selected a panel of 40 listed firms from the banking environment of 11 countries between 2011–2017. The systemic risk of banks is first quantified using the systemic risk index (SRI) of Kleinow and Nell (2015), a summative index combining the popular contagion and sensitivity dimensions of systemic risk defined by the Conditional Value at Risk (CoVaR) and Marginal Expected Shortfall (MES). Then, the systemic risk formation dynamics are investigated by modeling some bank-specific characteristics and the macroeconomic landscape defined subsequently. Following Chang et al. (2018), a seemingly unrelated regression (SUR) analysis is employed to capture the impact of derivatives use on systemic risk. The SUR does not necessarily constitute a panel technique but a device commonly employed to fit systems of multivariate equations, allowing for contemporaneous correlation between the residuals of the different equations, as in Chang et al. (2018). Using a SUR analysis, even with such a multivariate system, ultimately involves the estimation of a stacked model combining the system of equations in single equation form (Baltagi, 2008). Notwithstanding, the estimates derived by SUR

may be flawed if there is circular causality (or endogeneity) among the examined variables, such as the risk element, derivatives use, efficiency, and other factors featured in the model. Therefore, a robustness check by a generalized method of moments (GMM) model follows, controlling for the implied endogeneity between the modeled dependent and independent variables (Mokni et al., 2016; Raz, 2018). The latter estimation assumes derivatives usage to be endogenous and instrumentalizes financial liberalization (KAOPEN), capturing the extent of legal restrictions imposed on individual economies.

The study contributes to knowledge by offering an original depiction of the systemic risk status for Africa's banking sector while identifying possible pathways to ease the causes of systemic threats in this industry. Our findings may be of interest to regulators and policymakers in transitional economies. The results define some diluted systemic risk formation in Africa, including banking vulnerabilities independent of conventional systemic risk promoters.

In what follows, section 2 frames the existing theories and empirical literature about the systemic risk implications of derivatives use. Section 3 explains the implemented methodology. Results and related discussions follow under sections 4 and 5, respectively. A conclusion is reached in section 6.

2. Methodology

This section describes the methodological approach, starting with the sample selection process.

2.1. Sample selection

The original sample entails 147 derivatives-user banks from 14 countries, as modeled in Nguema Bekale et al. (2022, 2020) for the period spanning 2011–2017. The estimation of systemic risk measures depends on public market data expressing daily share prices of listed banks, which are turned into banks' equity returns. We collected the relevant share price information from Bloomberg, while data from the website investing.com was used to fill in some of the missing data points. As in Kleinow and Nell (2015), the banks presenting more than 25% zero daily returns or inconsistent accounting data for the period studied were discarded from the analysis. Therefore, we were left with 40 banks from 11 countries.

Table 1 describes the final sample covered by the study, including a breakdown of the number of data observations contributing to the quantification of systemic risk.

2.2. Systemic risk measurement: the SRI approach

As noted, the systemic risk index (SRI) of Kleinow and Nell (2015) is an inclusive measure of banks' systemic risk that combines the respective dimensions for firms' contribution and sensitivity to risk that replicate the Conditional Value at Risk (CoVaR) (Adrian & Brunnermeier, 2016) and marginal expected shortfall (MES) (Acharya et al., 2017). The constituents of the SRI then comprise the systemic risk contribution (SRC) and systemic risk sensitivity (SRS), which restrict their risk

Table 1. Distribution of Banks by Country.

Country	Number of banks	Number of observations	Percentage of observations
Botswana (BWA)	2	21,833	4.6892
Egypt (EGY)	5	55,738	11.9711
Ghana (GHA)	2	21,313	4.5775
Mauritius (MUS)	2	22,206	4.7693
Morocco (MAR)	6	71,510	15.3586
Namibia (NAM)	2	24,092	5.1744
Nigeria (NGA)	8	94,354	20.2649
South Africa (ZAF)	10	120,149	25.8050
Tanzania (TZA)	1	11,652	2.5026
Tunisia (TUN)	1	11,652	2.5026
Uganda (UGA)	1	11,104	2.3849
Total	40	465,603	100

Bank list

BWA	1. First National Bank_BWA	NGA	20. Zenith Bank_NGA
	2. Barclays Bank_BWA		21. First Bank_NGA
EGY	3. National Bank of Kuwait_EGY		22. United Bank for Africa_NGA
	4. Credit Agricole_EGY		23. Access Bank_NGA
	5. Union National Bank_EGY		24. Guaranty Trust Bank_NGA
	6. Commercial International Bank_EGY		25. Union Bank_NGA
	7. QNB ALAHLI Bank_EGY		26.Sterling Bank_NGA
GHA	8. Standard Chartered Bank_GHA		27. Wema Bank_NGA
	9. Societe Generale_GHA	ZAF	28. Standard Bank_ ZAF
MUS	10. Mauritius Commercial Bank_MUS		29. Absa Bank_ZAF
	11. CIM Financial Services_MUS		30. First National Bank_ZAF
MAR	12. Attijariwafa Bank_MAR		31. Nedbank_ZAF
	13. Banque Centrale Populaire_MAR		32. Investec Bank_ZAF
	14. Banq Marocaine du Commerce Extérieur_MAR		33. Capitec Bank_ZAF
	15. Banque Marocaine pour le Commerce et l'Industrie_MAR		34. PSG Group_ZAF
	16. Banq Marocaine du Commerce Extérieur_MAR		35. Rand Merchant Bank_ZAF
	17. Crédit du Maroc_MAR		36. Transaction Capital_ZAF
NAM	18. Standard Bank_NAM		37. Finbond Group_ZAF
	19. Nedbank_NAM	TZA	38. CRDB Bank_TZA
		TUN	39. Arab Tunisian Lease_TUN
		UGA	40.Stanbic Bank_UGA[2]

Source: Author's construct.

inspections to the banking system rather than the whole financial system. Correspondingly, the SRI relies on the contagion and transmission effects of systemic risk among banks, caused by shocks within the banking system itself. The SRI is computed as follows:

$$SRI_q^i = \frac{SRC_q^i + SRS_q^i}{2} \tag{1}$$

The SRC and SRS are respectively derived as:

$$SRC_q^i := E\left[\frac{r_{Sys,t}}{r_{i,t}} | r^i \leq VaR_q^i\right] = E\left[\frac{r_{Sys,t}}{r_{i,t}} | r^i_{q=5\%}\right], \tag{2}$$

$$SRS_q^i := E\left[\frac{r_{i,t}}{r_{Sys,t}} | r^{Sys} \leq VaR_q^{Sys}\right] = E\left[\frac{r_{i,t}}{r_{Sys,t}} | r^{sys}_{q=5\%}\right] \tag{3}$$

with $r_{i,t}$ and $r_{Sys,t}$ denoting the time-series return of the individual firms and banking system, respectively.

Similar to Kleinow and Nell (2015, p. 450–451), we opt for a 5% quantile value for q, for which the authors provide a detailed interpretational methodology on the $SRC^{i}_{q=5\%}$ and $SRS^{i}_{q=5\%}$.

2.2.1. Data requirements on systemic risk modeling

Like the CoVaR and MES, the constituents of the SRI analyze tail co-movements of individual banks' daily stock returns and those of the whole banking system (Kleinow & Nell, 2015). They incorporate the following variables:

(a) Equity returns of modeled institutions.
(b) Equity returns for the whole African banking industry, proxied by the FTSE/JSE top 40 index of companies trading on the Johannesburg Stock Exchange's (JSE). This index encompasses the volatile bearings of the top 40 largest African firms listed on the JSE, including 10 South African firms and a maximum of seven firms from other eligible African markets (Manguzvane & Mwamba, 2019).

Additionally, the CoVaR-type measures require the so-called systemic state variables to capture the time-varying nature of risk since a mere bivariate quantile regression turns out static, producing a single coefficient for individual institutions that remains constant over time (Adrian & Brunnermeier, 2016; Leukes & Mensah, 2019; Manguzvane & Mwamba, 2019; Mensah & Premaratne, 2017). To capture the essence of the global risk of the African banking industry (Leukes & Mensah, 2019; Manguzvane & Mwamba, 2019), we employed a set of lagged systematic state variables, including equity market returns, market volatility, and yield spread. The state variables are defined as follows:

(a) Equity market return is proxied by the JSE All Share Index, measuring the performance of South Africa's overall ordinary equities listed on the JSE.
(b) Market volatility is embodied by the JSE South African Volatility Index (SAVI), an indicator like the Chicago Board of Options Exchange Volatility Index (CBOE VIX), and capturing relevant risk based on a three-month forward-looking equity market volatility.
(c) Yield spread, obtained as the difference between a 10-year South African government bond yield and a three-month Treasury bill (T-bill), informs on the business cycle and future economic performance.

In the absence of global indices characterizing the overall response of Africa's financial system to the global financial ecosystem, the South African economy, with its sophisticated domestic market, fittingly embodies the total risk of African markets. The country is an eligible receptacle for global vulnerabilities and contagion and the most concrete catalyst for any globally threatening shocks rooted in Africa (Foggitt et al., 2017; Leukes & Mensah, 2019; Mensah & Premaratne, 2017).

2.3. Modeling the relationship between derivatives use and systemic risk

The dynamic of the systemic risk formation resulting from derivatives use is defined using the panel estimation presented in equation (1). Systemic risk is the dependent variable against some idiosyncratic (bank-specific) characteristics, comprising the main variable of interest, which is derivatives use. The macroeconomic (country-specific) characteristics reflecting the metamorphosis of the African banking environment are also included (Chang et al., 2018; Kleinow & Nell, 2015; Sinha & Sharma, 2016). Our model reads as:

$$\begin{aligned} SRI_{it} = {} & \gamma_0 + \gamma_1 Derivatives_{it} + \gamma_2 Efficiency_{it} + \gamma_3 MAD_{it} + \gamma_4 MID_{it} + \gamma_5 Capital_{it} + \gamma_6 Size_{it} \\ & + \gamma_7 ROA_{it} + \gamma_8 Deposit_{it} + \gamma_9 Liquidity_{it} + \gamma_{10} NIM_{it} + \gamma_{11} CreditRisk_{it} + \gamma_{12} NetChargeOffs_{it} \\ & + \gamma_{13} Ownership\_Dummy_{it} + \gamma_{14} nRGDP_{it} + \gamma_{15} MarketCapitalisation_{it} + \tau_i + \mu_t + \varepsilon_{it} \end{aligned} \quad (4)$$

where the parameters of interest include the intercept, γ_0, and the slope parameters, γ_1 to γ_{15}. ε_{it} is the random error term which is identically and independently distributed with zero mean and constant variance, σ^2.

The bank-specific effects (τ_i) and time effects (μ_t) capture the unobserved heterogeneity across banks and in the macroeconomic conditions faced by the banks over time, such as country-specific regulatory changes and industries' development levels (Al-Qaisi, 2011; Mokni et al., 2016). Variable definitions are as follows:

(a) *Derivatives*$_{it}$ and *Efficiency*$_{it}$ refer to the respective levels of banks' derivatives use and business lending efficiency, capturing the ratio of banks' outstanding amounts of derivatives to total assets and the business lending efficiency[1] of banks previously computed in Nguema Bekale et al. (2022).
(b) *MAD*$_{it}$ and *MID*$_{it}$ shows the banks' assets and income diversifications, respectively (Chang et al., 2018).
(c) *Capital*$_{it}$ involves equity capital, gauging the degree of financial leverage of banks.
(d) *Size*$_{it}$ stands for institutional size, which incorporates the natural logarithm of banks' total assets.
(e) *ROA*$_{it}$, is a measure of banks' profitability, calculated as the ratio of profit before tax to total assets.
(f) *Deposit*$_{it}$ represents the banks' deposit flows, which is the ratio of total deposits to total assets.
(g) *Liquidity*$_{it}$ includes cash and marketable securities and is measured as the ratio of total liquid assets to total assets.
(h) *NIM*$_{it}$ and *CreditRisk*$_{it}$ model banks' interest rate and credit risk exposures, described by the ratios of net interest income to total assets, and loans to total assets, respectively.
(i) *NetChargeOffs*$_{it}$ reflects loans' performance in terms of the ratio difference between loans charged-off and recoveries as a share of total loans.
(j) *Ownership_Dummy*$_{it}$, captures the industry's ownership structure. The related indices distinguish whether or not banks are African- or foreign-based, as well as distinguishing public from private institutions. The first index attributes the value one to African banks and zero otherwise, while the other takes the value one for governmental institutions and zero for privately owned banks.

The changing macroeconomic conditions are introduced to reflect the countries' macroeconomic performance and structural changes occurring for the individual economies' financial sector. These are captured by the national levels of real GDP growth ($\Delta RGDP_{it}$), and stock exchanges capitalization ($MarketCapitalisation_{it}$), which reflects the state of capital market development (Al-Qaisi, 2011; Kleinow & Nell, 2015; Mokni et al., 2016).

In equation (4), a negative relationship between derivatives practices and systemic risk development could suggest that the banks' derivatives activities alleviate systemic risk. On the contrary, a positive relationship suggests that derivatives dealings could amplify correlations among banking activities, and exacerbate the industry's systemic risk (Sinha & Sharma, 2016).

Furthermore, a negative relationship between efficiency and systemic risk would indicate that healthy competition, because of banking diversification, increases the banks' risk-shifting incentives. However, competition may damage bank efficiency, leading to correlation in bank portfolio returns linked to homogeneity in banking investments, and therefore increase systemic risk (Acharya, 2009).

Chang et al. (2018) and Sinha and Sharma (2016) suggest that diversification inherently provides hedging mechanisms with alleviating power over systemic risk. This implies that negative relationships should occur between both measures for asset diversity (MAD) and income diversity (MID) and systemic risk. Inversely, a positive correlation between banking diversification and systemic risk may imply that banking diversification causes systemic risk and increased likelihood of institutional default and failure.

The banks' equity capital can also have a negative impact on systemic risk, reinforcing their resilience and capacity to absorb financial shocks. In contrast, Raz (2018) argues that depleting capital coincides with an increasing sectorial risk appetite and, eventually, systemic risk.

Bank size may positively correlate with systemic risk, signaling the too-big-to-fail phenomenon. Accordingly, large banks would emerge to evade market discipline, exhibiting huge risk appetites and tighter networks with one another and the financial system and contributing to system-wide risk (Kleinow & Nell, 2015).

Profitability can be stabilizing and destabilizing, respectively, turning profitable banks into pillars of industry stability or gambling institutions that indulge in risky lending or non-lending activities (Kleinow & Nell, 2015).

A negative relationship between deposits and systemic risk can materialize, indicating that deposited funds provide additional capital buffers that serve as hedging devices against liquid risk and financial shocks. Where deposits encourage speculative endeavors that distract banks from their traditional lending activities, they would positively impact systemic risk (Chang et al., 2018; Kleinow & Nell, 2015).

In addition, bank liquidity mitigates adverse shocks that cause the interbank markets to dry up and should thus decrease systemic risk (Kleinow & Nell, 2015).

A net interest margins (NIMs) variable exhibiting a negative relationship with derivatives use suggest that banks actively hedge against interest rate risk using derivatives. Evidence to the contrary may indicate that banks indulge in unproductive derivatives usage, whereby institutions with low NIMs strive to build alternative incomes through

speculative mechanisms. The same principles should apply to the analysis referring to credit risk (Chang et al., 2018; Keffala, 2017; Sinha & Sharma, 2016).

Generally, net charge-off rates (net charge-offs) are assigned a positive sign in relation to systemic risk since they normally increase systemic risk (Kleinow & Nell, 2015). Turning to the ownership structure, the coefficient assigned to African banks would depend on their level of discipline (Chang et al., 2018). Similarly, favorable macroeconomic conditions (including market-based factors) may alleviate or support risk formation depending on discipline. However, we expect Africa's macroeconomic conditions and capital market improvements to have stabilizing systemic impacts (i.e. negative signs) (Kleinow & Nell, 2015; Mokni et al., 2016).

3. Results and discussion

The systemic risk prevalence of African banks is reported in Table 2, where the aggregated depictions of the distributions of the relevant risk indices are provided. A detailed description of the year-to-year systemic risk exposure by country is presented in the Appendix.

From Table 2, the systemic risk formation within Africa's banking industry appears as a diluted process. The aggregate index for the industry's systemic importance is significantly below the 50% mark throughout the years. The systemic risk contribution (SRC) credited to the industry is moderate, showing an average index ranging between 0.4878 and 0.6795 – i.e. between 48.78% and 67.95%. Therefore, individual banks have a moderate impact on systemic risk formation when experiencing difficulties. The median SRC value was at its highest in 2011 and steadily exhibited higher volatility toward its lowest value in 2017, suggesting that the banks become less contagious or less influential. The reported systemic risk sensitivity (SRS) index in the Appendix indicates that the banks across the individual countries are insensitive to externalities stemming from the broader market and remain remarkably isolated from the system's distress throughout the sampled period.

The SRI in the Appendix decodes the preeminence in systemic importance as scattered among the countries over time, likely translating Africa's low sectorial concentration and the high foreign presence in the banking industry. The systemic importance of the banks can further be understood as low, unstable and possibly deteriorating, also coinciding with the previous interpretation of the banks' contribution to risk. Moreover, the low statistics for standard deviation and the reported minimum/maximum values might underscore banks' concerted behavioral pattern, hinting that banks' systemic irrelevance is remarkably common and reflecting widespread inequalities in banks' systemic risk prevalence.

We performed a panel unit root test as required stationarity checks for both SUR and GMM estimations, appraising the stationarity of the panel data set using Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests, the outcomes of which are presented in Table 3.

Looking at Table 3, most variables featured in the subsequent SUR and GMM analyses had a p-value below the benchmarked 0.05. They are integrated at order zero, I(0). The variables initially diagnosed with unit root in level appear integrated at I(1)

Table 2. Summary Statistics of the Systemic Risk Exposure of African Banks.

Systemic risk exposure						
Year	Banks	Mean	SD	Minimum	Maximum	Median
			Systemic risk contribution (SRC)			
2011	36	0.6795	0.0702	0.5452	0.9045	0.6599
2012	39	0.5609	0.0671	0.4161	0.7236	0.5642
2013	40	0.5018	0.0438	0.4125	0.6653	0.4930
2014	40	0.5189	0.0530	0.4073	0.6597	0.5100
2015	40	0.5698	0.0505	0.4741	0.7515	0.5615
2016	40	0.5999	0.0554	0.4709	0.7731	0.5937
2017	40	0.4947	0.0371	0.3983	0.6109	0.4878
			Systemic risk sensitivity (SRS)			
2011	36	0.0009	0.0007	0.0001	0.0180	0.0008
2012	39	0.0008	0.0007	0.0005	0.0200	0.0007
2013	40	0.0008	0.0007	0.0003	0.0134	0.0007
2014	40	0.0007	0.0004	0.0003	0.0146	0.0007
2015	40	0.0008	0.0004	0.0002	0.0084	0.0007
2016	40	0.0009	0.0007	0.0002	0.0160	0.0007
2017	40	0.0008	0.0004	0.0009	0.0063	0.0007
			Systemic risk index (SRI)			
2011	36	0.3404	0.0353	0.2728	0.4534	0.3309
2012	39	0.2803	0.0336	0.2082	0.3629	0.2820
2013	40	0.2517	0.0220	0.2066	0.3353	0.2473
2014	40	0.2600	0.0266	0.2038	0.3305	0.2560
2015	40	0.2849	0.0252	0.2373	0.3794	0.2806
2016	40	0.3003	0.0278	0.2356	0.3884	0.2972
2017	40	0.2478	0.0186	0.1994	0.3068	0.2448[3]

Source: Author's construct based on risk measurements executed in Stata and R.

(P-value<0.01), achieving stationarity after first differencing. Accordingly, they were modeled in their first-difference.

Table 4 below presents the results from both the SUR and GMM estimations.

The reported statistics for the SUR and GMM estimations point to unconventional systemic risk development in Africa, with only a few exceptions. The signs of the coefficients associated with derivatives usage in both models are contradictory yet insignificant ($P-value_{SUR}=0.838>0.1$ and $P-value_{GMM}=0.835>0.1$), corroborating findings by Qin and Zhou (2019), Chang et al. (2018) and Keffala (2017). This suggests that the use of derivatives is unrelated to systemic risk formation within the banking industry. Consistently, the use of derivatives by banks remains ineffective and redundant, possibly hinting at the triviality of Africa's derivatives use practice once again. Most probably, the current extent of derivatives origination and any related financial proceedings may simply fail to achieve a substantial operational capacity with a tangible impact on broader scales.

Likewise, the insignificance of the bank's efficiency is sustained ($P-value_{SUR}=0.515>0.1$ and $P-value_{GMM}=0.278>0.1$), negating the impact of moral hazard problems at systemic levels. Coupled with the evidence on the occurrence of moral hazards at micro-levels offered by Nguema Bekale et al. (2020), this confirms that threats from Africa's financial industry, or at least its subcomponents, remain confined within the sector. Other factors – such as bank capital, size, profitability (ROA), deposit flows, interest rate risk (NIM) and loan performance (net charge-offs) – are similarly characterized as statistically irrelevant vis-à-vis systemic risk development.

Table 3. Panel Unit Root Tests Results.

Variables	Augmented Dickey-Fuller (ADF)		Phillip-Perron (PP)	
sri	−9.7060 ***		−9.7060 ***	
	(0.0000)		(0.0000)	
efficiency (Shephard)	−1.8370**		−1.8370**	
	(0.0331)		(0.0331)	
derivatives	−4.6784		−4.6784	
	(0.0000)		(0.0000)	
mad	−2.6392		−2.6392	
	(0.0042)***		(0.0042)***	
mid	−2.2550**		−2.2550**	
	(0.0121)		(0.0121)	
capital	−0.1540		−0.1540	
	(0.4388)		(0.4388)	
D.capital		−8.4168***		−8.4168***
		(0.0000)		(0.0000)
size	8.0713		8.0713	
	(1.0000)		(1.0000)	
D.size		−7.6463***		−7.6463***
		(0.0000)		(0.0000)
roa (profitability)	−5.1884***		−5.1884***	
	(0.0000)		(0.0000)	
deposit	−0.4421		−0.4421	
	(0.3292)		(0.3292)	
D.deposit		−9.7502***		−9.7502***
		(0.0000)		(0.0000)
liquidity	−3.2943***		−3.2943***	
	(0.0005)		(0.0005)	
nim	−3.7531***		−3.7531***	
	(0.0001)		(0.0001)	
creditrisk	−1.8274**		−1.8274**	
	(0.0338)		(0.0338)	
netchargeoffs	−9.8251***		−9.8251***	
	(0.0000)		(0.0000)	
marketcapitalisation	2.7710		2.7710	
	(0.9972)		(0.9972)	
D.marketcapitalisation		−3.4553***		−3.4553***
		(0.0003)		(0.0003)
ΔRGDP	−5.1172***		−5.1172***	
	(0.0000)		(0.0000)[4]	

Source: Author's construct from Stata estimates.

Both the SUR and GMM models expose the slightly negative systemic risk implications the banking sector derives from mounting liquidity and credit risk, with the respective coefficients leveling around−0.0002 and showing significance at the 5% and 10% levels. Although very marginal, the odd conflict materializing between credit risk and systemic risk buildups underlines the prevalence of wrong-way risks. The implicit positive relationship between liquidity and credit risk may confirm Chang et al. (2018)'s understanding that increased liquidity could induce heightened credit risk associated with changing financial structure and financial innovation.

Furthermore, the positive relationships (coefficients nearing 0.014) associated with the MID and their significance at the 1% and 5% levels for SUR and GMM, respectively, challenge Chang et al. (2018)'s findings, underlining a controversially behaved MID, which strengthen systemic risk buildups as banks diversify their income streams. Coupled with the documented insignificant asset diversification (MAD) component, the controversial MID might shed light on prohibitive and inefficient actions on banking diversification in Africa. However, the mutational impact of diversification on banking

Table 4. Panel Regression Results for the Determinants of Systemic Risk.

	SUR	GMM
Variables	Coef.	Coef.
derivatives	− 3.81e-05	0.0001
	(0.838)	(0.835)
efficiency (Shephard)	0.0017	0.0016
	(0.515)	(0.278)
mad	0.0006	0.0005
	(0.782)	(0.716)
mid	0.0139 ***	0.0140 **
	(0.000)	(0.023)
D.capital	− 1.32e-05	2.91e-05
	(0.896)	(0.778)
D.size	− 0.0011	− 0.0010
	(0.554)	(0.431)
roa (profitability)	− 0.0003	− 0.0003
	(0.153)	(0.414)
D.deposit	1.12e-05	6.46e-06
	(0.830)	(0.865)
liquidity	− 0.0002 **	− 0.0002 *
	(0.016)	(0.073)
nim	− 0.0002	− 0.0002
	(0.113)	(0.307)
creditrisk	− 0.0002 **	− 0.0002 *
	(0.016)	(0.062)
netchargeoffs	1.02e-06	2.54e-06
	(0.970)	(0.882)
localforeign_dummy(African)	− 0.0010	− 0.0009
	(0.532)	(0.482)
privatepublic_dummy(Public)	− 0.0009	− 0.0010
	(0.462)	(0.189)
D.marketcapitalisation	− 1.02e-05	− 8.31e-06
	(0.280)	(0.241)
ΔRGDP	−0.0005	−0.0004
	(0.159)	(0.275)
_cons	− 0.2881 ***	0.2542 ***
	(0.000)	(0.000)
	R-sq = 0.9884	R-sq = 0.9884
	RMSE = 0.0021	RMSE = 0.0021
	chi2 (58) = 19480.26	Wald chi2(58) = 84059.29
	p-value = 0.0000	p-value = 0.0000
		Test of endogeneity
		GMM C statistic chi2(1) = 0.094935
		p-value = 0.7580
		First-stage instruments validation test
		Robust F(1,169) = 2.88357
		p-value = 0.0913[5]

Source: Author's construct using sureg and ivregress estimates in Stata.

stability can still be understood in this light, even though its effects emerge to be primarily dependent on the diversifying activities of the banks. The current shift toward fee-generating and non-interest banking practices seems to fuel systemic risk formation, most likely stemming from businesses' lines outside the desired market-based intermediation.

Notably, the evidence relating to bank diversification provides a clear rationale for regulation measures to achieve a meaningful expansion of Africa's banking practices. Africa's financial institutions are far from efficient and reaching an optimal

diversification level, which damages financial health, leading to inadequate and undesirable contributions to systemic disasters.

Eventually, we uncover the abnormal insignificance of the continent's financial practice toward the evolution of globalized financial markets, supporting the ongoing concerns expressed about Africa's unfolding financial fragility. Incidentally, the statistics describing the influence derived from the countries' economic performance and financial structural changes also appear inconclusive, strengthening the concerns about criticisms about the accepted listlessness of Africa's financial system and markets. The results contradict findings by Zhou (2021) and Batuo et al. (2018). Knowing that not all levels of systemic risk are considered harmful, the operating routines of a healthy banking system must detectably generate risks that spread to other economic sectors, which is unfortunately not apparent in the context of Africa.

The robust coefficient of determination ($R^2 = 0.9884$) on both models, combined with a low value for the square root of the variance of residuals ($RMSE = 0.0021$) confirm that the models appropriately fit the data at hand. The chi-square test is statistically significant for both models, leading to the rejection of the null hypothesis that all estimated coefficients, except for the constant, are equal to zero. The reported GMM C test is highly insignificant ($p - value = 0.7580$), highlighting that the specified orthogonality is not satisfied: the derivatives use variable can be treated as exogenous. The significant first-stage F-test at 10% level ($p - value = 0.0913$), however, provides fairly robust evidence of the strength/validity of the employed instruments.

4. Conclusion and policy implications

Having determined the scope of the systemic risk emanating from derivatives use in Africa's banking ecosystem, the conclusions of this analysis indicate the precarious African financial settings. The pessimistic portrayals of Africa's systemic risk development reflect a lack of banking diversification and insignificant market-based activities.

The banks' systemic risk prevalence is fundamentally unstable, diluted and depleting in aggregate. If one considers industries beyond the banking markets, it might be argued that this might result from a lack of compliance with the rational market paradigm. Naturally, informational issues might reinforce the irrational capital market practices and the banking sector's failure to swiftly incorporate vital information into the prices of financial products. Generally, the unusual risk magnitude observed in Africa's banking environment is specific to underdeveloped financial ecosystems where price evolution displays randomized, overvalued or undervalued processes. Such irrational pricing of financial products inhibits any disentanglement of financial information.

The gloomy predictions from the identification of the causes of systemic risk development still conceal many instabilities. Even conventional defining risk factors appear insignificant to systemic risk buildups, suggesting that the financial system sustains structural vulnerabilities independent of the conceptualized risk promoters. While these financial fragilities offer insufficient conditions for systemic risk formation, they can produce financial shocks, feedback effects, contagion, and failure among financial institutions.

In all, a structural shift toward market-based financial structures can secure efficiency gains and improvements in financial systems. More than ever, policy efforts at improving

Africa's financial conditions need to promote a collective shift in financial structure to embrace market-based financing in the different economies.

Notes

1 Efficiency gauges banks' technical efficiency vis-à-vis their ability to extend credit to the business sector. Thereby, bias-corrected efficiency scores were derived using a VRS output-based DEA, based on an input–output matrix comprising three inputs such as domestic deposits, total income and non-interest expenses whereas private credit (i.e. Gross loan minus Consumer loan) was modeled as an output.

2 This table shows the breakdown of the 40 African banks and number of observations in the final sample for each country.

3 Standard deviations are denoted as "SD." The indices entail marginal measures of risk and may alternatively be expressed as percentages.

Akin to conventional risk metrics that capture downside risks, the calculated measures in this case are negative, even though they are conventionally reported as absolute values. Thus, the highest absolute measurement of downside risks implies the highest contribution or sensitivity to systemic risk (Leukes & Mensah, 2019).

4 P-values are provided in the parentheses below the coefficient estimates.

*, ** and *** respectively imply significance at 10%, 5% and 1% levels. The variable "sri" is the computed systemic risk index, while "D.capital," "D.size," "D.deposit," and "D.market-capitalisation" represent the respective first-difference equivalent for "capital," "size," "deposit flows," and "market capitalization."

5 P-values are provided in the parentheses below the coefficient estimates.

*, ** and *** respectively imply significance at 10%, 5% and 1% levels. Derivatives use was assumed endogenous for the GMM, which used the kaopen index as a proxy for financial openness. "sri" entails the systemic risk index. "D.capital," "D.size," "D.deposit," and "D. marketcapitalisation" represent the respective first-difference equivalent for "capital," "size," "deposit flows," and "market capitalization." The dummy variables capturing ownership structure entail "localforeign_dummy" and "privatepublic_dummy," distinguishing African from foreign banks and private from public institutions. "cons" represent the model's constant.

6 Standard deviations are denoted as "SD."

7 Standard deviations are denoted as "SD."

8 Standard deviations are denoted as "SD."

9 Standard deviations are denoted as "SD."

10 Standard deviations are denoted as "SD."

11 Standard deviations are denoted as "SD."

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Data availability statement

The data used in this study come from a variety of data repositories, most of which are openly available to the public. The data is accessible online via the link: https://zenodo.org/record/6686031#.Y_y0vnZBzIU. The authors confirm that all data, including that generated by transforming original variables beforehand to meet the requirements of the chosen analytical methods, are available as additional materials with this article.

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Appendix: Year-to-year distributions of the systemic risk prevalence by country

		Systemic risk contribution (SRC)				
				2011		
Country	Banks	Mean	SD	Minimum	Maximum	Median
Botswana	2	0.6795	0.0702	0.5452	0.9045	0.6599
Egypt	5	0.6795	0.0702	0.5452	0.9045	0.6599
Ghana	1	0.6795	0.0702	0.5452	0.9045	0.6599
Mauritius	1	0.6795	0.0702	0.5452	0.9045	0.6599
Morocco	6	0.6795	0.0702	0.5452	0.9045	0.6599
Namibia	2	0.6795	0.0702	0.5452	0.9045	0.6599
Nigeria	7	0.6795	0.0702	0.5452	0.9045	0.6599
South Africa	9	0.6795	0.0702	0.5452	0.9045	0.6599
Tanzania	1	0.6795	0.0703	0.5452	0.9045	0.6599
Tunisia	1	0.6795	0.0703	0.5452	0.9045	0.6599
Uganda	1	0.6795	0.0703	0.5452	0.9045	0.6599
				2012		
Botswana	2	0.5609	0.0671	0.4161	0.7236	0.5642
Egypt	5	0.5609	0.0671	0.4161	0.7236	0.5642
Ghana	1	0.5609	0.0671	0.4161	0.7236	0.5642
Mauritius	2	0.5609	0.0671	0.4161	0.7236	0.5642
Morocco	6	0.5609	0.0671	0.4161	0.7236	0.5642
Namibia	2	0.5609	0.0671	0.4161	0.7236	0.5642
Nigeria	8	0.5609	0.0671	0.4161	0.7236	0.5642
South Africa	10	0.5609	0.0671	0.4161	0.7236	0.5642
Tanzania	1	0.5609	0.0672	0.4161	0.7236	0.5642
Tunisia	1	0.5609	0.0672	0.4161	0.7236	0.5642
Uganda	1	0.5609	0.0672	0.4161	0.7236	0.5642
				2013		
Botswana	2	0.5018	0.0439	0.4126	0.6653	0.4930
Egypt	5	0.5018	0.0439	0.4126	0.6653	0.4930
Ghana	2	0.5018	0.0439	0.4126	0.6653	0.4930
Mauritius	2	0.5018	0.0439	0.4126	0.6653	0.4930
Morocco	6	0.5018	0.0438	0.4126	0.6653	0.4930
Namibia	2	0.5018	0.0439	0.4129	0.6653	0.4930
Nigeria	8	0.5018	0.0439	0.4129	0.6653	0.4930
South Africa	10	0.5018	0.0438	0.4126	0.6653	0.4930
Tanzania	1	0.5018	0.0439	0.4126	0.6653	0.4930
Tunisia	1	0.5018	0.0439	0.4126	0.6653	0.4930
Uganda	1	0.5018	0.0439	0.4126	0.6653	0.4930
				2014		
Botswana	2	0.5189	0.0530	0.4073	0.6597	0.5100
Egypt	5	0.5189	0.0530	0.4073	0.6597	0.5100
Ghana	2	0.5189	0.0530	0.4073	0.6597	0.5100
Mauritius	2	0.5189	0.0530	0.4073	0.6597	0.5100
Morocco	6	0.5189	0.0530	0.4073	0.6597	0.5100
Namibia	2	0.5189	0.0530	0.4073	0.6597	0.5100
Nigeria	8	0.5189	0.0530	0.4073	0.6597	0.5100
South Africa	10	0.5189	0.0530	0.4073	0.6597	0.5100
Tanzania	1	0.5189	0.0531	0.4073	0.6597	0.5100
Tunisia	1	0.5189	0.0531	0.4073	0.6597	0.5100
Uganda	1	0.5189	0.0531	0.4073	0.6597	0.5100[6]

(*Continued*)

(Continued).

				Systemic risk contribution (SRC)-continued		
				2015		
Botswana	2	0.5698	0.0505	0.4741	0.7516	0.5615
Egypt	5	0.5698	0.0505	0.4741	0.7516	0.5615
Ghana	2	0.5698	0.0505	0.4741	0.7516	0.5615
Mauritius	2	0.5698	0.0505	0.4741	0.7516	0.5615
Morocco	6	0.5698	0.0505	0.4741	0.7516	0.5615
Namibia	2	0.5698	0.0505	0.4741	0.7516	0.5615
Nigeria	8	0.5698	0.0505	0.4741	0.7516	0.5615
South Africa	10	0.5698	0.0505	0.4741	0.7516	0.5615
Tanzania	1	0.5698	0.0506	0.4741	0.7516	0.5615
Tunisia	1	0.5698	0.0506	0.4741	0.7516	0.5615
Uganda	1	0.5698	0.0506	0.4741	0.7516	0.5615
				2016		
Botswana	2	0.5999	0.0554	0.4709	0.7731	0.5938
Egypt	5	0.5999	0.0554	0.4709	0.7731	0.5938
Ghana	2	0.5999	0.0554	0.4709	0.7731	0.5938
Mauritius	2	0.5999	0.0554	0.4709	0.7731	0.5938
Morocco	6	0.5999	0.0554	0.4709	0.7731	0.5938
Namibia	2	0.5999	0.0554	0.4709	0.7731	0.5938
Nigeria	8	0.5999	0.0554	0.4709	0.7731	0.5938
South Africa	10	0.5999	0.0554	0.4709	0.7731	0.5938
Tanzania	1	0.5999	0.0555	0.4709	0.7731	0.5938
Tunisia	1	0.5999	0.0555	0.4709	0.7731	0.5938
Uganda	1	0.5999	0.0555	0.4709	0.7731	0.5938
				2017		
Botswana	2	0.4947	0.0372	0.3983	0.6109	0.4879
Egypt	5	0.4947	0.0372	0.3983	0.6109	0.4879
Ghana	2	0.4947	0.0372	0.3983	0.6109	0.4879
Mauritius	2	0.4947	0.0372	0.3983	0.6109	0.4879
Morocco	6	0.4947	0.0372	0.3983	0.6109	0.4879
Namibia	2	0.4947	0.0372	0.3983	0.6109	0.4879
Nigeria	8	0.4947	0.0372	0.3983	0.6108	0.4879
South Africa	10	0.4947	0.0372	0.3983	0.6109	0.4879
Tanzania	1	0.4947	0.0372	0.3983	0.6109	0.4879
Tunisia	1	0.4947	0.0372	0.3983	0.6109	0.4879
Uganda	1	0.4947	0.0372	0.3983	0.6109	0.4879[7]
				Systemic risk sensitivity (SRS)		
				2011		
Country	Banks	Mean	SD	Minimum	Maximum	Median
Botswana	2	0.0007	0.0002	0.0004	0.0014	0.0007
Egypt	5	0.0009	0.0006	0.0003	0.0056	0.0008
Ghana	1	0.0007	0.0002	0.0003	0.0018	0.0006
Mauritius	1	0.0006	0.0002	0.0003	0.0012	0.0006
Morocco	6	0.0007	0.0003	0.0001	0.0032	0.0007
Namibia	2	0.0009	0.0003	0.0004	0.0021	0.0008
Nigeria	7	0.0010	0.0004	0.0004	0.0028	0.0009
South Africa	9	0.0010	0.0011	0.0004	0.0180	0.0008

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Tanzania	1	0.0007	0.0004	0.0003	0.0032	0.0006
Tunisia	1	0.0008	0.0003	0.0004	0.0019	0.0007
Uganda	1	0.0012	0.0012	0.0004	0.0105	0.0008
				2012		
Botswana	2	0.0007	0.0002	0.0004	0.0013	0.0007
Egypt	5	0.0009	0.0005	0.0003	0.0034	0.0007
Ghana	1	0.0007	0.0002	0.0003	0.0022	0.0006
Mauritius	2	0.0006	0.0002	0.0004	0.0012	0.0005
Morocco	6	0.0007	0.0003	0.0003	0.0028	0.0006
Namibia	2	0.0008	0.0011	0.0004	0.0204	0.0008
Nigeria	8	0.0010	0.0005	0.0003	0.0064	0.0008
South Africa	10	0.0009	0.0009	0.0005	0.0191	0.0008
Tanzania	1	0.0007	0.0004	0.0003	0.0033	0.0007
Tunisia	1	0.0007	0.0004	0.0003	0.0053	0.0007
Uganda	1	0.0013	0.0021	0.0004	0.0147	0.0007
				2013		
Botswana	2	0.0006	0.0002	0.0003	0.0017	0.0006
Egypt	5	0.0008	0.0005	0.0003	0.0051	0.0007
Ghana	2	0.0007	0.0002	0.0003	0.0021	0.0006
Mauritius	2	0.0006	0.0002	0.0003	0.0016	0.0006
Morocco	6	0.0007	0.0003	0.0003	0.0029	0.0006
Namibia	2	0.0007	0.0002	0.0004	0.0019	0.0007
Nigeria	8	0.0010	0.0007	0.0003	0.0057	0.0008
South Africa	10	0.0008	0.0006	0.0004	0.0113	0.0008
Tanzania	1	0.0008	0.0004	0.0003	0.0031	0.0007
Tunisia	1	0.0007	0.0002	0.0004	0.0020	0.0007
Uganda	1	0.0020	0.0026	0.0003	0.0134	0.0007
				2014		
Botswana	2	0.0006	0.0002	0.0003	0.0016	0.0006
Egypt	5	0.0007	0.0004	0.0003	0.0036	0.0006
Ghana	2	0.0007	0.0005	0.0003	0.0050	0.0007
Mauritius	2	0.0005	0.0001	0.0003	0.0010	0.0005
Morocco	6	0.0006	0.0002	0.0003	0.0021	0.0006
Namibia	2	0.0007	0.0002	0.0004	0.0018	0.0007
Nigeria	8	0.0009	0.0005	0.0003	0.0051	0.0008
South Africa	10	0.0008	0.0004	0.0004	0.0146	0.0007
Tanzania	1	0.0007	0.0003	0.0003	0.0032	0.0007
Tunisia	1	0.0007	0.0002	0.0004	0.0020	0.0007
Uganda	1	0.0008	0.0009	0.0003	0.0076	0.0006[8]

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		Systemic risk sensitivity (SRS) – continued				
				2015		
Country	Banks	Mean	SD	Minimum	Maximum	Median
Botswana	2	0.0006	0.0001	0.0004	0.0012	0.0006
Egypt	5	0.0007	0.0003	0.0003	0.0028	0.0006
Ghana	2	0.0008	0.0004	0.0003	0.0039	0.0007
Mauritius	2	0.0006	0.0002	0.0003	0.0029	0.0006
Morocco	6	0.0007	0.0003	0.0002	0.0083	0.0006
Namibia	2	0.0008	0.0003	0.0004	0.0038	0.0008
Nigeria	8	0.0010	0.0005	0.0003	0.0064	0.0008
South Africa	10	0.0009	0.0005	0.0002	0.0084	0.0008
Tanzania	1	0.0008	0.0005	0.0004	0.0047	0.0007
Tunisia	1	0.0007	0.0002	0.0004	0.0014	0.0006
Uganda	1	0.0007	0.0002	0.0003	0.0018	0.0007
				2016		
Botswana	2	0.0006	0.0001	0.0003	0.0011	0.0005
Egypt	5	0.0008	0.0006	0.0003	0.0072	0.0006
Ghana	2	0.0007	0.0003	0.0004	0.0030	0.0007
Mauritius	2	0.0006	0.0002	0.0003	0.0015	0.0005
Morocco	6	0.0006	0.0003	0.0002	0.0050	0.0006
Namibia	2	0.0010	0.0004	0.0004	0.0028	0.0009
Nigeria	8	0.0012	0.0011	0.0003	0.0160	0.0009
South Africa	10	0.0011	0.0006	0.0004	0.0072	0.0009
Tanzania	1	0.0006	0.0002	0.0003	0.0014	0.0005
Tunisia	1	0.0007	0.0002	0.0004	0.0019	0.0006
Uganda	1	0.0008	0.0005	0.0004	0.0043	0.0007
				2017		
Botswana	2	0.0006	0.0002	0.0003	0.0017	0.0005
Egypt	5	0.0008	0.0005	0.0003	0.0038	0.0007
Ghana	2	0.0007	0.0002	0.0003	0.0023	0.0007
Mauritius	2	0.0006	0.0003	0.0009	0.0036	0.0006
Morocco	6	0.0006	0.0002	0.0003	0.0026	0.0006
Namibia	2	0.0008	0.0003	0.0004	0.0029	0.0008
Nigeria	8	0.0010	0.0006	0.0003	0.0063	0.0008
South Africa	10	0.0009	0.0004	0.0004	0.0060	0.0008
Tanzania	1	0.0006	0.0004	0.0002	0.0037	0.0005
Tunisia	1	0.0007	0.0003	0.0004	0.0039	0.0007
Uganda	1	0.0006	0.0002	0.0003	0.0014	0.0006[9]

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		Systemic risk index (SRI)				
				2011		
Country	Banks	Mean	SD	Minimum	Maximum	Median
Botswana	2	0.3361	0.0332	0.2729	0.4527	0.3271
Egypt	5	0.3425	0.0376	0.2730	0.4526	0.3324
Ghana	1	0.3403	0.0351	0.2729	0.4525	0.3314
Mauritius	1	0.3401	0.0350	0.2729	0.4525	0.3312
Morocco	6	0.3407	0.0352	0.2729	0.4527	0.3314
Namibia	2	0.3406	0.0353	0.2730	0.4528	0.3312
Nigeria	7	0.3399	0.0350	0.2729	0.4534	0.3294
South Africa	9	0.3403	0.0352	0.2729	0.4529	0.3308
Tanzania	1	0.3397	0.0347	0.2728	0.4525	0.3289
Tunisia	1	0.3412	0.0363	0.2729	0.4527	0.3316
Uganda	1	0.3422	0.0352	0.2851	0.4527	0.3342
				2012		
Botswana	2	0.2798	0.0341	0.2083	0.3622	0.2813
Egypt	5	0.2813	0.0331	0.2083	0.3629	0.2852
Ghana	1	0.2806	0.0334	0.2083	0.3621	0.2821
Mauritius	2	0.2730	0.0357	0.2083	0.3620	0.2717
Morocco	6	0.2814	0.0334	0.2083	0.3624	0.2845
Namibia	2	0.2806	0.0336	0.2085	0.3626	0.2821
Nigeria	8	0.2805	0.0334	0.2083	0.3625	0.2825
South Africa	10	0.2797	0.0336	0.2084	0.3622	0.2813
Tanzania	1	0.2771	0.0339	0.2083	0.3620	0.2799
Tunisia	1	0.2829	0.0336	0.2083	0.3622	0.2867
Uganda	1	0.2831	0.0331	0.2096	0.3620	0.2866
				2013		
Botswana	2	0.2511	0.0221	0.2184	0.3329	0.2461
Egypt	5	0.2529	0.0234	0.2066	0.3330	0.2478
Ghana	2	0.2528	0.0220	0.2066	0.3329	0.2485
Mauritius	2	0.2518	0.0216	0.2195	0.3330	0.2473
Morocco	6	0.2520	0.0222	0.2066	0.3331	0.2478
Namibia	2	0.2514	0.0220	0.2067	0.3334	0.2469
Nigeria	8	0.2515	0.0218	0.2066	0.3341	0.2472
South Africa	10	0.2513	0.0219	0.2066	0.3353	0.2470
Tanzania	1	0.2515	0.0228	0.2067	0.3331	0.2468
Tunisia	1	0.2514	0.0211	0.2067	0.3150	0.2476
Uganda	1	0.2506	0.0207	0.2191	0.3329	0.2479
				2014		
Botswana	2	0.2563	0.0253	0.2038	0.3302	0.2525
Egypt	5	0.2612	0.0271	0.2038	0.3305	0.2578
Ghana	2	0.2602	0.0262	0.2038	0.3302	0.2568
Mauritius	2	0.2590	0.0266	0.2038	0.3302	0.2548
Morocco	6	0.2600	0.0268	0.2038	0.3303	0.2559
Namibia	2	0.2600	0.0266	0.2039	0.3302	0.2554
Nigeria	8	0.2604	0.0267	0.2039	0.3304	0.2563
South Africa	10	0.2598	0.0265	0.2039	0.3303	0.2554
Tanzania	1	0.2618	0.0269	0.2039	0.3303	0.2577
Tunisia	1	0.2600	0.0265	0.2040	0.3302	0.2560
Uganda	1	0.2590	0.0267	0.2040	0.3303	0.2545[10]

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		Systemic risk index (SRI) – continued				
				2015		
Country	Banks	Mean	SD	Minimum	Maximum	Median
Botswana	2	0.2850	0.0254	0.2373	0.3761	0.2812
Egypt	5	0.2843	0.0249	0.2373	0.3718	0.2805
Ghana	2	0.2847	0.0250	0.2373	0.3761	0.2801
Mauritius	2	0.2847	0.0253	0.2374	0.3760	0.2803
Morocco	6	0.2847	0.0251	0.2373	0.3770	0.2809
Namibia	2	0.2853	0.0254	0.2375	0.3777	0.2809
Nigeria	8	0.2848	0.0251	0.2374	0.3772	0.2805
South Africa	10	0.2853	0.0253	0.2375	0.3794	0.2811
Tanzania	1	0.2848	0.0258	0.2375	0.3760	0.2798
Tunisia	1	0.2846	0.0250	0.2374	0.3760	0.2806
Uganda	1	0.2842	0.0259	0.2391	0.3761	0.2795
				2016		
Botswana	2	0.3004	0.0282	0.2357	0.3868	0.2973
Egypt	5	0.2996	0.0280	0.2356	0.3842	0.2969
Ghana	2	0.3014	0.0281	0.2357	0.3868	0.2978
Mauritius	2	0.3004	0.0278	0.2356	0.3868	0.2976
Morocco	6	0.3003	0.0277	0.2356	0.3870	0.2973
Namibia	2	0.3008	0.0278	0.2358	0.3872	0.2975
Nigeria	8	0.3002	0.0279	0.2358	0.3884	0.2971
South Africa	10	0.3005	0.0277	0.2357	0.3871	0.2973
Tanzania	1	0.3010	0.0281	0.2360	0.3869	0.2976
Tunisia	1	0.3014	0.0276	0.2356	0.3839	0.2976
Uganda	1	0.2981	0.0259	0.2359	0.3838	0.2946
				2017		
Botswana	2	0.2472	0.0187	0.1995	0.3057	0.2442
Egypt	5	0.2483	0.0188	0.1994	0.2964	0.2458
Ghana	2	0.2479	0.0186	0.1996	0.3058	0.2459
Mauritius	2	0.2477	0.0182	0.1996	0.3057	0.2453
Morocco	6	0.2479	0.0188	0.1995	0.3058	0.2450
Namibia	2	0.2477	0.0185	0.1997	0.3058	0.2443
Nigeria	8	0.2478	0.0188	0.1996	0.3068	0.2448
South Africa	10	0.2478	0.0186	0.1996	0.3063	0.2443
Tanzania	1	0.2457	0.0179	0.1996	0.3056	0.2429
Tunisia	1	0.2479	0.0189	0.1995	0.3057	0.2446
Uganda	1	0.2480	0.0182	0.2106	0.3058	0.2448[11]