

**Nigeria: Publication of Financial Sector Assessment Program Documentation—
Technical Note on Stress Testing**

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GLOSSARY

BU	Bottom-up
CAR	Capital Adequacy Ratio
CBN	Central Bank of Nigeria
FSAP	Financial Sector Assessment Program
FX	Foreign exchange
GDP	Gross Domestic Product
HTM	Hold to Maturity
IMF	International Monetary Fund
LCR	Liquidity Coverage Ratio
LOLR	Lender of Last Resort
LTV	Loan to Value
₦	Naira
NDIC	Nigeria Deposit Insurance Corporation
NPL	Nonperforming loan
NOP	Net Open Position
NSFR	Net Stable Funding Ratio
P&L	Profit and Loss
ROA	Return on assets
ROE	Return on equity
TA	Technical Assistance
TD	Top-down
US\$	U.S. dollar
WEO	World Economic Outlook

I. INTRODUCTION, KEY FINDINGS, AND RECOMMENDATIONS¹

- 1. Stress tests were undertaken jointly by the Nigerian authorities and the Financial Sector Assessment Program (FSAP) team.** The exercise covered all 20 commercial banks (100 percent of the Nigerian banking sector) and included several methodological components. Most of the actual calculations were carried out jointly by staff of the Central Bank of Nigeria (CBN) and the FSAP team. An important goal of the exercise was to provide an opportunity for a two-way exchange of experiences and technical expertise on solvency and liquidity stress testing, as well as network and contagion analysis. The aim was to see the results on the banks of the various stress tests and analytic processes, as a key element for assessing financial stability in Nigeria.
- 2. The stress tests were built around four complementary pillars:** (i) top-down sensitivity analysis for solvency risk (credit, interest, and FX) carried out jointly by the CBN and FSAP teams, using data for the overall banking system; (ii) top-down calculations for liquidity risk carried out jointly by the CBN and FSAP teams for the same set of banks; (iii) bottom-up sensitivity analysis conducted by eight large commercial banks (about 70 percent of the overall banking system); and (iv) network analysis and assessment of contagion risks. The FSAP team collaborated closely with the CBN on the methodology of the stress testing. The authorities shared supervisory data on individual banks with the FSAP team, subject to confidentiality. Going forward, the authorities are encouraged to include all 20 commercial banks in the bottom-up stress testing exercise and conduct it on a regular basis.
- 3. The exercise included macroeconomic scenario analysis and its transmission into a range of factor shocks, as well as other tests.** It included medium and high risk macroeconomic scenarios for aggregate credit risk and a range of tests for liquidity and solvency risks, based on agreed assumptions and scenarios (Section III). The shock sizes took into account recent (2009 domestic banking crisis) experience from, recent global crisis experience, as well as past FSAP practice. The scenario design was informed by the recent World Economic Outlook (WEO) update (April 2012 and September 2012) as well as by several discussions with the Nigerian authorities.
- 4. The stress tests did not derive from the use of econometric time series analysis (so called macro stress tests) because of lack of data over a sufficient time period and structural breaks within the data.** The banking sector time series (including that for the nonperforming loans (NPLs)) have very recent and fundamental structural breaks due to the

¹ This note is the results of work conducted in close collaboration between the FSAP team and the dedicated stress-testing teams of the CBN. The main authors of the note are Moses Kitonga and Elena Loukoianova. The paper benefited from inputs from and numerous discussions with Christian Schmieder on integrated liquidity stress testing frameworks and inputs, as well as valuable comments from the FSAP team.

major consolidation of the banking sector that took place since 2005–06, and the significant changes in the structures of the banks' balance sheets during the 2009 Nigerian banking crisis. Amongst the effects, the aggregate NPLs were reduced from about 35 to about 5 percent in the year 2011, as part of the adopted crisis resolution framework.² Overall, the number of banks fell from 89 in 2009 to 20 in 2011.

5. **With these caveats in mind, the exercise suggests that the Nigerian commercial banking system as a whole can absorb credit and market risk shocks, withstand liquidity pressures, absorb moderate potential losses, but is exposed to credit concentration risk.**³ This reflects the high capitalization and currently low NPL ratios of commercial banks,⁴ which in turn reflects the banking system restructuring and recapitalization after the 2009 domestic banking crisis. However, while the banking system as a whole is quite robust, some individual banking institutions appear vulnerable, and one is insolvent even before any stress test.⁵ Equally important, the Nigerian economic situation can quickly deteriorate due to a global oil price shock or increasing security concerns in the Northern regions, generating the possibility of large multi-factor shocks on the banking system. The single-factor sensitivity calculations described above suggest that the system would be able to withstand a range of sector-specific and risk-specific shocks occurring in isolation. The shock with the most severe impact on the banking system is credit concentration risk, since a default of five single-name or group borrowers would result in a failure of several banks. The banking system seems to be well positioned to withstand liquidity pressures from funding and market side. Going forward, the authorities may consider conducting liquidity tests for Basel 3 liquidity ratios to monitor preparedness of banks to Basel 3 requirements.

6. **The network and contagion analysis indicates that the interbank market is segmented and, in part as a consequence, contagion effects would have relatively little**

² As part of the banking sector restructuring, a newly created government asset management company (AMCON) bought most of the bad assets (including NPLs) from the banks.

³ Rather severe liquidity pressures can be withstood due to excess liquidity in the banking system.

⁴ In 2011, the CBN introduced a regulatory limit on the banks' NPL ratio of five percent of the gross total loans.

⁵ There has been a large increase of capital in a few banks from June to August 2012. Hence, some banks that were very vulnerable based on end-June 2012 data seem much more stable based on end-August 2012 data. Such a rapid capital increase might be reflection of the choice of assets included within the definition of capital as some capital increase at least in one former bridge bank is due to a swap of government T-bills to the AMCON bonds. A bridge bank is defined as a temporary bank organized by the regulators (CBN and NDIC) to administer the deposits and liabilities of a failed bank. Under the arrangement, the Nigeria Deposit Insurance Corporation (NDIC) is authorized to operate a failed bank for a period until a buyer can be found for its operations. However, a subsidiary of an international banking group seems to have increased its capital in this period through the raising of external finance.

impact. The Nigerian banking system is a tiered system, with some banks being net lenders and others net borrowers on the interbank market. The interbank market appears quite resilient to contagion from the failure of large net borrowing banks. In the situation of market segmentation (or clustering), the simulated failure of major net borrowers or net lenders may have a significant negative effect on either credit or funding of banking institutions; however the propagation of contagion beyond the first stage would be limited.

7. **While the current system of stress testing is quite developed, the authorities are encouraged to conduct integrated stress tests on a regular annual or semi-annual basis and close related data gaps.** This note, in addition to presenting the methodology and the results of the stress testing exercise, identifies the key data and analytical gaps, and makes recommendations for further improvements in stress testing (Box 1).

Box 1. Stress Testing—Key Recommendations

As part of their broader efforts to strengthen measurement of systemic risks, the authorities are encouraged to take the following key steps in the stress testing area.

- Conduct integrated stress tests with the participation of the major banks on an annual basis.
- Work further with banks to ensure building of their risk management institutional capacity, appropriateness of their modeling capacity, including credit, market, and liquidity stress tests, and in particular in relation to modeling impacts of macro-economic scenarios.
- Continue working toward integrating the various exercises for credit, market, liquidity, and contagion risks into a comprehensive framework.
- Incorporate into the analysis more granular data on banks' loan portfolios, by economic sectors, regions, types of counterparty, as well as the specific sectors in which banks concentrate most of their operations.
- Closely monitor large and/or rapidly growing sectors (such as oil and gas, manufacturing, and communications), sectors with rapidly growing NPLs, and single and group borrower concentration, and improve data reporting systems to enable carrying out a stress test with differentiated shock sizes in different regions of the country.
- Moving toward Basel III, the CBN should consider collecting data for liquidity coverage ratio (LCR) and net stable funding ratio (NSFR) and conduct stress tests on the preparedness of banks to adopt liquidity requirements of Basel III; and improve quality of the underlying data on stress testing, including more granular data.
- To ensure no liquidity disruption in the interbank market and the banking sector as a whole, transferring federal government deposits to the CBN from commercial banks, as is proposed, should be done gradually and with continuous monitoring of the liquidity situation in the banking sector.
- Continue efforts on collecting comprehensive data on bilateral interbank exposures and cross-sectoral exposures for individual banks and other financial institutions, to carry out network analysis modeling for assessment of contagion risk for domestic interbank market and cross-border flows on regular basis.
- Start collecting more granular data on banks' exposure (assets and liabilities) to non-financial counterparts (households, corporate and others) to assess interconnectivities and potential contagion.
- Ensure that the CBN remain current on the latest techniques as these evolve, while ensuring also that adopted techniques are appropriate for the Nigerian financial system at its current level of development.
- Continue improving the CBN institutional capacity for stress testing.

8. **The structure of the note is as follows:** Section II presents the overall design and methodology of the exercise. Section III provides a brief overview of the macroeconomic

scenarios and their links to the shocks and combination of shocks for the sensitivity analysis. Section IV discusses results of the sensitivity analysis; Sections V is devoted to liquidity risk. Section VI analyzes bottom-up (BU) sensitivity analysis results and compares them with the top-down results. Section VII is devoted to discussion of network analysis and contagion stress tests. Finally, Section VIII summarizes and concludes.

II. GENERAL METHODOLOGY

9. **The stress test exercise was a collaborative effort of the FSAP and the CBN stress testing teams.** The sincerity and high technical capabilities of the CBN stress testing team ensured high quality and timeliness of the results of the exercise. The joint nature of the exercise ensured that the work (i) captured the special features of the Nigerian economy and financial system; (ii) built on relevant analytical work and the stress testing framework of the CBN; and (iii) provided suggestions on ways to improve the existing framework further, for the CBN to adopt for the future.

10. **The tests covered the entire Nigerian banking system (20 commercial banks) and looked at the short-term (immediate shocks) horizon, in part because of data constraints.**⁶ The stress tests did not cover insurance companies and some other non-bank financial institutions. All the top down (TD) tests for solvency and liquidity risks were carried out on the most recent end–August 2012 data from banks’ financial statements (annualized where appropriate) and macroeconomic data.⁷ The interbank contagion analysis was carried out based on June 2012 data. The bottom up (BU) tests were carried out based on June 2012 data, as the requests to individual banks were sent out in July 2012. The stress tests were single immediate shocks for sensitivity analysis for credit, interest rate, foreign exchange (FX), and equity price risks, with the horizon of their effect being one year, as well as five and 30 days for liquidity risk, to demonstrate how single- and multi-factor shocks transmit in the short term.

11. **The stress test for the commercial banks was built on four pillars: a bottom-up exercise and three top-down exercises.** These pillars complement each other, as they look at different aspects of the Nigerian banking system, including aggregate impact of risks, impact on individual banks, and contagion risks across banks through the interbank market. Also, various pillars focus on different risks, such as aggregate credit risk, single-factor credit risk shocks, liquidity risk, market risks, and contagion risks. Specifically, these exercises consisted of the following: (i) top-down sensitivity analysis for solvency risk (credit, interest,

⁶ See paragraph 4 above on the explanation of structural breaks in the data series and recent crisis events.

⁷ For robustness check, the FSAP team has run the same stress tests based on the data for end–June 2012. Both data reports for June and August 2012 are unaudited. The latest available audited bank statements are for end–December 2011.

FX, and equity price) carried out jointly by the CBN and FSAP teams, using data for the overall banking system; (ii) top-down calculations for liquidity risk carried out jointly by the CBN and FSAP teams for the same set of banks; (iii) bottom-up sensitivity analysis conducted by eight large commercial banks (about 70 percent of the overall banking system);⁸ and (iv) network analysis and assessment of contagion risks.

Table 1. Nigeria: Banks Participating in the Bottom-Up Stress Testing

Domestic Banks	Foreign Owned Banks
Skye Bank	Stanbic IBTC Bank
Guaranty Trust Bank	
Access Bank	
Diamond Bank	
Ecobank	
First Bank of Nigeria (FBN)	
United Bank of Africa (UBA)	

- The FSAP and the CBN stress testing teams implemented sensitivity analysis for various single and multi-factor shocks, using supervisory data and applying agreed shocks. The results were discussed not only at the aggregate level, but also with granularity, to express results in terms of the number of banks that fall below regulatory requirements and their relative share in the overall banking system's total assets.
- The CBN together with the FSAP team carried out top-down calculations for integrated liquidity risks, using supervisory data and applying a methodology provided by the FSAP team. The results were discussed at the aggregate and bank-by-bank levels, so that the results could be presented in terms of the number of banks that fall below regulatory requirements and their share in the total banking system's assets.
- The bottom-up part of the exercise was implemented by the eight large banks selected by the CBN for the exercise (Table 1). To ensure comparability of results, they all used the same sizes of shocks as in the top-down approach. Banks calculated their own risk exposures, potential losses, and the impact on profits and capital using their internal risk management systems. They submitted the results to the CBN team, which then shared them with the FSAP team. The results were shared in similar format, but separate from the results of the top down exercises. Selected banks also discussed with the FSAP team their risk methods used in estimating the impact of the shocks.

⁸ The request for the bottom-up stress testing exercise was sent out to 10 largest banks, only eight banks sent back the results.

- The FSAP team carried out network and contagion analysis, which is used to assess interlinkages and contagion risk in the interbank market. This test uses network modeling to assess the impact of the failure of one or several banks on the interbank market. The results and methodology were discussed with the CBN team.

12. The results of all the approaches were compared, analyzed, and cross checked.

The results showed consistent results—that the banking system is overall well capitalized, stable, and very liquid,⁹ although some banks appear very vulnerable to specific shocks, with one being insolvent even before any stress test. As one would expect, there were nonetheless some differences across the approaches. Banks use diverse risk management systems in their own stress tests, and the granularity of data also differs. Going forward, there is scope for collecting more granular data, including liquidity data for assessing Basel III preparedness in terms of LCR and NSFR ratios, cross-border bilateral exposures, and for improving analysis based on additional data.

13. The stress testing framework of the CBN has been enhanced as a result of a technical assistance (TA) mission in April 2012 and the FSAP Update.

The CBN has a financial stability unit, which is responsible for stress testing. Prior to the FSAP Update, MCM provided a TA mission on banking sector stability analysis and stress testing. As a result of this TA, the CBN improved its stress testing capacity, building upon the liquidity framework that the TA mission shared with the authorities,¹⁰ as well as enhanced the sensitivity analysis for credit and market risks. The macro stress testing is not yet performed in Nigeria for the reasons identified above, including structural breaks in the data time series.

III. MACROECONOMIC SCENARIOS AND THEIR TRANSMISSION INTO SHOCKS

14. To approximate the impact of several macroeconomic shocks materializing at the same time, the stress testing exercise included a set of macroeconomic scenarios and translated them into a series of single and multi-factor shocks.¹¹ Due to data constraints, the proposed macro scenarios are based on expert judgment and historical qualitative and quantitative information where applicable. The following scenarios have been analyzed within the sensitivity stress testing exercise:

- A slowdown in global economy is expected to result in a sharp oil price drop (put at about US\$50 per barrel). This scenario would result in (i) aggregate NPLs increasing

⁹ Currently, commercial banks have excess liquidity due to fiscal expenditure and low growth of credit to the private sector.

¹⁰ Liquidity framework is based on Schmieder et al, 2012.

¹¹ In general, macroeconomic shocks (in terms of GDP decline in standard deviation terms) cannot be easily translated into shocks in the sensitivity analysis. Thus, expert judgment is used here to create single- and multifactor shocks based on more general macroeconomic shocks.

by 200 percent; and (ii) an increase of NPLs of the same magnitude in the major sectors financed by the banking sector: oil and gas, general commerce, real estate and construction, and general loans.¹² In addition, the rate of the Naira vis-à-vis the U.S. dollar would depreciate by 30 percent and the stock market index would decline by 30 percent.

- Continuing terrorism attacks would result in an overall shock to the economy (by at least two or three standard deviations of GDP). This scenario is expected to result in an increase in aggregate NPLs by 100 percent, a depreciation of the Naira vis-à-vis the U.S. dollar (and other major foreign currencies) by 30 percent and a sharp decline of the local stock market index by 50 percent.
- Economic deterioration in other African countries with Nigerian banks subsidiaries and branches would result in a structural deterioration of the Nigerian banking sector. This scenario is put as resulting in an increase of NPLs by 200 percent, a sharp decline of the local stock market index by 30 percent and a sharp decline in the banks face value by 350 percent.
- Decline in value of the AMCON bonds and increased contingent fiscal liabilities of the government. This scenario will result in the deterioration of bank capital, and in banks' liquid assets and thus liquidity ratios.

IV. SENSITIVITY ANALYSIS

15. **Sensitivity stress tests estimated the impact of changes in individual variables on banks' portfolios.** In a sensitivity analysis, shocks are assumed to stem from a single risk factor, holding other risk factors constant. Shocks are assumed to occur instantaneously, unless indicated otherwise. The sensitivity analysis covers all positions sensitive to risk factor changes. Ideally, these should include all long (buy) and short (sell) positions, both on- and off-balance sheet, to the extent possible. In the Nigeria FSAP stress testing exercise, data constraints prohibited an explicit analysis of these positions and operations, except for those relating to the direct exchange rate risk.¹³

16. **Before conducting the stress testing, the data for reported capital and risk weighted assets for two banks were adjusted for their under-provisioning, to meet regulatory requirements, at end–August 2012.**¹⁴ The under-provisioning charge was

¹² Definitions of some of the sectoral classification are as follows (i) general commerce—domestic trade, automotive loans, and food processing; and (ii) general—personal loans and retail loans.

¹³ In addition, the size of off-balance sheet positions is negligible, thus the analysis of on-balance sheet positions, both banking and trading books reflects risks quite well.

¹⁴ For end–June 2012, five banks were slightly under-provisioned.

initially treated as income losses and deducted from operating profit. The residual, if any was then deducted from capital. Since the operating profit fully absorbed the under-provisioning expense, the resulting adjusted capital remained the same for both under-provisioned banks.

17. **Credit risk was a key area of focus.** As per international experience, especially in emerging and frontier market economies, rapid credit expansion in select key sectors exacerbates vulnerabilities in these sectors and may prompt the build-up of potential bubbles. In the case of Nigeria, rapid credit growth in some sectors may potentially constitute a source of risk over the medium term. Thus, going forward it is important to be aware of potentially vulnerable sectors and concentration to single name and group borrowers.¹⁵

18. **The sensitivity analysis for credit risk included aggregate shocks on asset quality and a set of separate shocks, each aiming to examine a different aspect of credit risk concentration.** The aggregate test assumes an overall deterioration in asset quality. In addition, given that potential risks are differentiated, based on the economic sectors to which banks lend, parts of this exercise were carried out along these dimensions. In light of this, a set of separate shocks, each run separately, covered: (i) aggregate NPL shocks; (ii) sectoral exposures for selected sectors; and (iii) largest individual exposures (for groups and single names). In all these tests, banks' balance sheet shocks were applied directly to NPLs with assumptions of provisioning.¹⁶ All the tests assessed the impact of an increase in bank provisioning on the back of loan quality deterioration.

19. **To calculate the impact of the new NPLs on bank losses, the following assumptions were made:** (i) The additional NPLs were categorized as loss and therefore provisioned at 100 percent; (ii) the provisioning expense was treated as income losses; (iii) the income losses were adjusted with profits; and (iv) the residual loss, if any, was deducted from the capital (Total qualifying capital), as well as from the RWAs. The revised CAR was derived from reduced capital and revised RWA and was measured against 10 percent regulatory minimum.

20. **Shock sizes were determined based on Nigeria's historical record as well as experience in other FSAPs.** The shock were in line with historical data for Nigeria, not only on the aggregate level but on level for some banks, based on recently conducted informal survey and discussion with selected banks. The proposed shocks were in the low percentile of the shocks applied in previous FSAP practice in emerging market economies. Some FSAPs assumed higher increases in NPLs, while others, mostly in advanced countries, assumed lower NPL increases.

¹⁵ Currently, the regulatory limit for related-party lending is 20 percent of unimpaired shareholders' funds (which is equivalent to Tier 1 capital).

¹⁶ The types and sizes of all the shocks are presented in Appendix 1.

A. Aggregate Credit Risk Sensitivity Analysis

21. **The results of the aggregate credit risk TD sensitivity analysis, as measured by increase in NPLs, demonstrate that the banking system is quite resilient to the single-factor credit risk shocks occurred in isolation (Appendix Table 1.1).** With an NPL increase of 100 percent, the average total CAR for the system goes down from 18.5 to 17.3 percent, with only one bank (constituting 2.0 percent of the total assets of the banking system) falling below the regulatory CAR requirement of 10 percent.¹⁷ The total system's gross losses would be 8.8 percent of total (Tier I and Tier II) capital. With an NPL increase by 200 percent, the average CAR declines by 3.3 points to 15.2 percent, with three banks (9.7 percent of the total assets) falling below the regulatory CAR requirement and the total system's losses would amount to 26.7 percent of the total capital. With a very severe 300 percent NPL increase (close to the historic high), seven banks (21.6 percent of the total assets) fall below the regulatory requirement, while the average CAR falls to 12.9 percent, and the total losses would be 33.9 percent of the total capital (Appendix Table 1.1).¹⁸ Moreover, two banks would become insolvent in the last test (in addition to one already insolvent bank).

22. **The results of the aggregate credit risk BU sensitivity analysis confirm the TD results (Appendix Table 1.2).** Out of eight large banks participating in the BU exercise, only two would experience total CAR lower than 10 percent with 300 percent increase in NPLs, while the average total CAR (for the eight banks) would decline from the average of 17.6 to 13.8 percent.

B. Sectoral Credit Risk Analysis

23. **The exercise examined the credit risk of exposure to six major sectors for both TD and BU exercises.**¹⁹ Based on the discussions with the authorities, an additional test for the TD exercise also examined the impact of the combined shock for three sectors: oil and gas; general; and general commerce simultaneously, based on recent experience of the direct effect the oil price shock had on these three sectors.²⁰ The assumed shock, for both the single and combined shock was an increase in NPLs of 100, 200, and 300 percent. Given the

¹⁷ The results for June 2012 indicated that the total Car for the banking system would go downs from 17.7 to 16.5 percent, with three banks falling below the regulatory CAR requirement of 10 percent

¹⁸ The same shock based on June 2012 data found that nine banks would fall below regulatory capital requirement.

¹⁹ The sectors included agriculture, oil and gas, telecom, real estate, general, and general commerce.

²⁰ Some trade financing related to refined oil and gas products is booked in the general and general commerce categories.

importance of oil and gas sector for Nigeria, an oil price shock could adversely affect profits in these sectors.

24. **The results of this analysis reveal that the combined shock would significantly increase NPLs, while the single sector shock would have only marginal effect.** For the combined shock (three sectors simultaneously), the most severe test (300 percent increase in NPLs) would result in CAR for the banking sector falling from 18.5 to 15.9 percent. While the CAR remains high, the system accumulates gross total losses of 20 percent of the total capital, and four banks (12.5 percent of the total assets) would fall below the regulatory requirement. (Appendix Table 1.1).²¹

25. **The BU exercise did not include the new test (three sectors simultaneously) however, the single sector tests confirm similar TD results.** The single sector shock had a marginal effect for the eight banks that participated. The average CAR for the banks reduced to 15.6 percent for a shock of 300 percent (Appendix Table 1.2).

26. **Even though the effects of a single sector shock are not severe, an incremental increase of NPLs in the general sector by 300 percent would result in three banks CAR falling below the regulatory requirement.** However, the system CAR would only slightly decrease, by less than 0.4 percentage points (Table 2).

Table 2. Nigeria: Bank Exposure to Selected Sectors, August 2012
(System average, percent, unless otherwise specified)

	NPL Ratio (Sectoral)	Share in Total Loans	Share in Total Assets	Total Capital to Loans to the Sector Ratio
Agriculture	2.2	0.1	0.04	810.0
Oil and Gas	15.5	0.66	0.27	126.0
Telecommunication	10.6	0.5	0.19	298.0
Real Estate	5.3	0.2	0.09	562.0
General	17.9	0.76	0.32	225.0
General Commerce	19.1	0.8	0.34	267.0
Combined three Sectors: Oil and gas, General, and General Commerce	52.2	2.3	0.93	62.0

Source: CBN.

²¹ Based on June 2012 data, the average CAR would decline from 17.7 to 14.6 percent; the system would accumulate gross total losses of 25.5 percent of the total capital; and five banks would fall below the regulatory capital requirement.

C. Concentration Risk Analysis

27. **The Nigerian banking system is highly concentrated. Banks lend to large multinationals mostly in the oil and gas and oil-related sectors.** There has been limited progress in officials' attempts to increase lending more broadly, for instance, lending is reportedly inhibited to SMEs and consumers as banks have tightened their underwriting standards since the 2009 banking crisis.²² As a result, the banking sector is highly exposed to concentration risk. It should be noted, however, given the dependence on oil, a major oil shock would pose a significant risk to the banking sector, although one might note that multinationals have traditionally had resources to meet their obligations.

28. **To assess concentration of exposures among the largest borrowers, two tests were performed.** The first test focused on the effect of one or several largest single-name borrowers defaulting at the same time. The second test focused on large connected parties or group borrowers defaulting. The tests considered a simultaneous default of the top one, three, and five single-name and group borrowers.

29. **The concentration of loans in the system as a whole appears somewhat attenuated, while it could be quite high in an individual bank.** The largest group exposure on the system level is only 5.9 percent of total loans or 11.3 percent of the total capital, while the highest group exposure for an individual bank is 16.6 percent of total loans and 26.1 percent of the total capital.

30. **The results indicate that for the mild test (single large borrower default), most of the banks are resilient.** The results of the calculations (Appendix Table 1.1) suggest that the default of the top five individual borrowers would have the largest effect on the entire system in the TD exercise, with the total average CAR declining to 11.3 percent, and nine banks becoming undercapitalized (with the share of the total system's assets of 52.6 percent) and one insolvent.²³ For the BU test, the average CAR for the banks would fall from 17.6 to 13.5 percent, with the capital of three banks falling below the regulatory requirement.²⁴ While this shock maybe considered severe, it should be recalled that the fact that the Nigeria banking system is centered on the oils and gas sector and as such a number of the large exposures are either directly or indirectly linked to this sector. Therefore, in an environment of weakening oil demand, it is plausible for multiple large borrowers (single-name or groups) to default.

²² This may also be an effect of the recently introduced 5 percent regulatory limit on NPL ratio for the banking sector.

²³ Based on June 2012 data, the total average CAR would decline by 7.7 percentage points to 10.4 percent; and 10 banks would fall below regulatory requirement.

²⁴ The results for BU exercise are based on June 2012 data.

31. **The results of group exposure test as expected were more severe for the TD exercise.**²⁵ In a test of the default of the five largest groups, the banking sector would become undercapitalized, with the average CAR for the sector falling to 5.5 percent for the TD test, and 13 banks' total capital (73.1 percent of the total assets) falling below regulatory requirement.²⁶

D. Direct Interest Rate Risk

32. **A range of calculations were carried out to examine direct interest rate risk, which reflects re-pricing mismatches of interest bearing assets and liabilities.** The examined shocks included parallel shifts in the Naira yield curve and the steeping of the domestic yield curve. All the tests were TD and run for the banking book using the GAP analysis.²⁷ Each maturity bucket was tested separately for each single shock (Appendix 1). The calculated total (net) impact on the banking book was calculated by adding income losses. The resultant losses were used to derive the impacted CAR by evaluating the effect on banks' operations, profits, and capital of all interest rate shocks. The impact on the CAR is taken for one year, to reflect the impact on the profit and loss (P&L) and income statement.

33. **In reviewing the BU tests conducted for market risk, it became apparent that, probably due to capacity constraints, the results of the interest rate stress tests in several banks were unreliable and therefore not referenced in this note.** The authorities are well aware of the capacity constraints in some banks and informed the mission that they are planning several workshops with banks to further develop their capacity in stress testing.

34. **Direct interest rate risk on the banking book appears manageable.** Shocks to the yield curve were examined in the analysis, and their impacts were evaluated in terms of the implied changes in the CAR and the total gross losses (in percent of the total capital). The shocks investigated—above 500 bps—would be considered severe in advanced countries, but reflect movements that have been experienced in Nigeria. The shocks were discussed and agreed with the CBN and confirmed during the team's meetings with banks that have a well developed stress test framework. The most severe shock—a 1500 bps parallel shift—resulted only in one bank (two percent of the total system's assets) falling well below the regulatory capital requirement with its capital being close to zero after the shock. The overall resilience to the interest rate risk comes from limited maturity mismatch for all time buckets and flexible interest rates for the vast majority of loans.

²⁵ The BU results for this particular shock were inconsistent and therefore not referenced in the note.

²⁶ Based on June 2012 data, the CAR for the sector would fall to 4.4 percent, with 16 banks' total capital falling below regulatory requirement.

²⁷ GAP is the difference between interest sensitive assets and interest sensitive liabilities. The interest rate shock is applied to the GAP exposure for each maturity buckets to assess the portfolios exposure interest rate movements.

35. **The steepening of the Naira curve appeared to have more impact on the banks' capital compared with parallel shifts, though the overall impact is still limited.** A steepening of the Naira curve from 0 to 1000 bps would cause two banks (4.7 percent of the total assets) to fall below regulatory requirement, and the average CAR for the banking sector would decline to 16.6 percent. None of the banks would become severely undercapitalized (Appendix Table 1.3).²⁸

36. **The exercise did not cover the indirect interest rate risk, that is, the impact of interest rate changes on banks' economic position via the soundness of their counterparts.** A major increase in nominal interest rates would lead or at least imply an increase in real interest rates, likely leading to deterioration in asset quality (increasing NPLs). Also, the interest rate shock would likely have broader macroeconomic impacts, including an impact on the GDP growth rate, with a second-round impact on the banking sector. These broader macroeconomic impacts are not captured in this exercise, but are examined as part of macroeconomic scenario analysis (Section IV above).

E. Direct Foreign Exchange Risk

37. **Foreign exchange (FX) risk stems from exchange rate changes that affect the local currency value of financial institutions' assets, liabilities, and off-balance sheet positions.** The tests examined banks' direct exchange rate risk exposures, covering all exchange-rate sensitive positions. (Appendix Table 1.4). The potential impact of the shock was evaluated against banks' individual net open bilateral currency positions. The stress testing team and participating banks ran these shocks on banks' individual foreign currency net positions, and reported the results both for individual banks and for the overall banking system, expressing potential losses against the CAR.

38. **The results suggest that the direct impact of exchange rate movements on the banking system would be extremely limited.** This is due to the fact that the net-open-position (NOP) limit set by the CBN is currently one percent of shareholder unimpaired funds (essentially Tier I capital). As such, the results of the test (Appendix Table 1.4) suggest that under the severe stress scenario (in which the Naira exchange rate vis-à-vis the US\$ is assumed to depreciate by 40 percent), the CAR for the overall system would remain unchanged, well exceeding the 10 percent minimum regulatory requirement. This virtually negligible direct impact reflects a number of factors, including (i) very low FX exposure (foreign denominated loans are 8.2 percent of the total assets for the overall banking system); and (ii) closely monitored net open position limit sets for each individual bank.

²⁸ Based on June 2012 data, the results of this should seem more severe, compared with those for August 2012 data: The capital of two banks would fall below regulatory requirement, and the average CAR for the banking sector would decline to 15.9 percent. The capital of only one bank would fall below 8 percent CAR and its Tier I—to 1.9 percent, which would be considered severely under-capitalized.

39. **The exercise does not cover the indirect FX risk, that is, the impact of exchange rate changes on banks' economic position via the soundness of banks' counterparts.**

There is a lack of solid system-level data on FX exposures of banks' counterparts. A major currency fluctuation would have broader macroeconomic impacts, including an adverse impact on the GDP growth rate. To that extent, the macroeconomic scenario analysis (Section IV) attempts to capture the broader impacts from macroeconomic shocks to credit position of the banks.

F. Equity Price Analysis

40. **The equity price risk examined a shock of a fall in the equity price index on NPL level and bank capital.** In particular shocks of 40 and 70 percent drops in the equity price index were examined. This test assumes a one-to-one effect on the equity investments of banks in an attempt to assess the resiliency of the banks' balance sheet to adverse movements in the stock market. It would also assess whether there has been a change in banks' vulnerability in this regard, given the magnitude of the impact on them of the recent stock market crash.

41. **The results suggest that the impact of the equity price index drop is extremely limited for the overall system due to banks low level of equity holdings (Appendix Table 1.5).** While the system wide CAR would decline by 0.6 percentage points to 17.8 percent, if the stock market drops by 70 percent, the total system losses would be only 5.1 percent of total capital. None of the banks would be undercapitalized.²⁹ The low levels of equity holding is attributed to new the implementation of the regulation on the new banking model in Nigeria, which among others, requires the banks to divest their interest in non-permitted subsidiaries, dispose non-permitted equity investments, and dispose of non-permitted real estate investments. Relicensing and penalties were employed to ensure banks' compliance.

G. Multi-Factor Analysis

42. **A multi-factor test is used to assess the impact of several risks run simultaneously, amplifying the impact of stress on the banking system.** To evaluate such scenario, three risk factors—credit risk, interest rate risk, and foreign exchange risk—were analyzed incrementally as follows: 50 percent increase in NPLs, a 15 percent depreciation of the Naira, and a 500 bps parallel shift in the Naira yield curve.

43. **The results suggest that the impact of the multi-factor shocks on the banking system is limited for a mild shock, but more pronounced for a severe shock**

²⁹ The results are more reassuring than those based on June 2012 data: while in this shock the system wide CAR would decline only by 0.2 percent, one bank would become severely undercapitalized with a CAR dropping to 2.2 percent.

(Appendix Table 1.6). A more severe test which has the highest impact for the overall system comes from the shock of a 40 percent depreciation of the Naira, a simultaneous 1500 bps upward shift of the Naira yield curve, and an aggregate increase in NPLs of 200 percent. With this scenario, the total CAR for the banking sector would decline to 14.8 percent (30.3 percent of the total capital), four banks (11.6 percent of the assets) would have the total capital below 10 percent requirement, and two banks would be insolvent (in addition to the bank that is already insolvent).³⁰

V. LIQUIDITY RISK

44. **The FSAP stress test covered liquidity risk—an important source of risk as highlighted during the global financial crisis.** The liquidity stress tests assumed funding or market liquidity stresses, modeled as shocks to individual banks' deposit and wholesale funding base. As in other FSAPs, the results of the stress tests are analyzed in terms of changes to liquidity ratios and liquidity gaps in a particular period (specifically, the testing periods were five and 30 days). The assumed shock sizes are shown in the table below (Table 3), and took into consideration a sudden reversal of capital flows.³¹ Assumptions of the tests and the stress scenario were calibrated jointly by the FSAP and the CBN teams.

45. **The liquidity stress test followed the next-generation integrated liquidity risk stress testing framework (see Figure 5 for an overview of the liquidity framework).**³² The framework is based on three sub-modules to allow for a comprehensive view on the liquidity position of single banks and the banking system as a whole under adverse conditions: (i) implied cash flow tests to simulate a sudden, substantial withdrawal of funding; (ii) tests to assess maturity mismatch and roll-over risk; and (iii) a framework to link liquidity risk and solvency risk, which examines the impact of changes of solvency and funding concentration risks on banks' funding situation and vice versa. Due to the lack of data, it was impossible to utilize this framework in full to simulate how banks would cope with the upcoming regulatory changes under the Basel III, test for preparedness for the introduction of a liquidity coverage ratio (LCR) and a net stable funding ratio (NSFR). Going forward, it would be important to start collecting necessary data for monitoring LCR and NSFR.

³⁰ For June 2012 data, in this scenario the total CAR for the banking sector declines by 4.7 points and eight banks (3 percent of the total assets) would have the total capital fall below 10 percent requirement.

³¹ In Schmieder, Pühr, and Hasan (2011) this scenario is called a mild stress scenario, as it was quite mild in the recent financial crisis and in the recent FSAP stress testing exercises. In reality, the shocks in this scenario are quite severe.

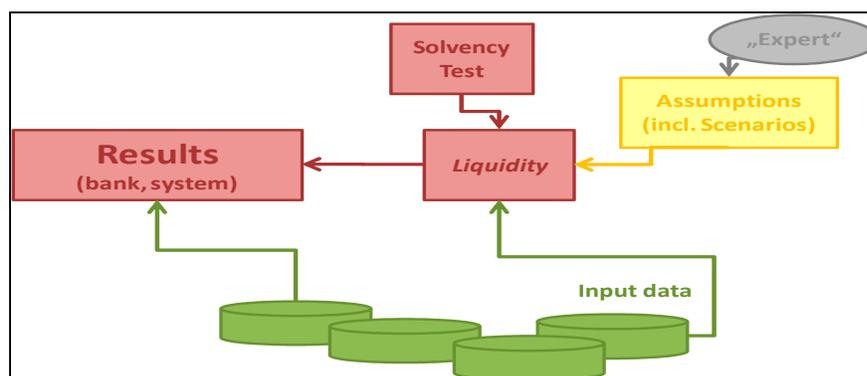
³² For the full methodology of this type of stress tests see Schmieder and others (2011).

Table 3. Nigeria: Liquidity Risk Scenario

Liquidity Outflows	Severe Stress Scenario (adjusted to Nigeria)
<i>Deposits (5-day withdrawal)</i>	
Demand deposits	5 percent
Resident	5 percent
Non-resident	5 percent
Electronic Purse	5 percent
Term deposits	3 percent
of which: FX deposits	3 percent
Wholesale (corporate, pension funds, other non-banks)	
Government deposits	6 percent
Banks and other financial institutions	6 percent
Other companies	6 percent
Liquidity Outflows	Mild Stress Scenario (adjusted to Nigeria)
<i>Deposits (30-day withdrawal)</i>	
Demand deposits	
Resident	30 percent
Non-resident	30 percent
Electronic Purse	30 percent
Term deposits	10 percent
of which: FX deposits	10 percent
Wholesale (corporate, pension funds, other non-banks)	
Government deposits	30 percent
Banks and other financial institutions	30 percent
Other companies	30 percent
<i>Short-term funding¹</i>	
Government deposits	10 (30)* percent
Non-government deposits	20 (30)* percent
Money at call	20 (30)* percent
Interbank takings	20 (30)* percent
Bank deposits (due to)	20 (30)* percent
Other funding liabilities	20 (30)* percent
<i>Liquidity Inflows</i>	
Definition of liquid assets and haircuts	All securities are liquid, haircuts in line with Basel II/III for solvency purposes; as well as in line with RBI regulations.
Percent of assets unencumbered	100 percent or actual figures (if available)
*Figures in brackets correspond to a 30-day withdrawal.	

Source: Schmieder and others (2011).

Figure 1. Nigeria: Overview of Liquidity Risk Framework



Source: Schmieder et al. (2011).

46. **The results of the liquidity stress tests suggest that the banking system will be able to withstand relatively severe funding (deposit withdrawal) and market liquidity shocks, as well as the closing of funding markets.** The success rate of banks passing liquidity stress tests is relatively high, but only three banks passed all five tests.

47. **Under the severe test of five-day deposit withdrawal,³³ 12 out of 20 banks (72 percent of the total assets) failed an implied cash flow stress test through five-day period, though their aggregate (theoretical) liquidity shortfall would be only 2.9 percent of the total assets (Table 6).** Such relative resilience is mainly a result of excess liquidity currently present in the banking system. This is a reverse stress test with severe assumptions for deposit runs and specific assumptions on asset fire sales. With these caveats in mind, the results should be treated with caution.

Table 4. Nigeria: Implied Cash Flow Test (5 days)

Minimum number of days of survival	Number of Banks illiquid	Survival - Percent of Banks	Survival - Percent of Assets
0	0	100.0%	100.0%
1	0	100.0%	100.0%
2	0	100.0%	100.0%
3	4	80.0%	81.8%
4	9	55.0%	49.7%
5	12	40.0%	27.7%

Source: CBN and IMF calculations.

³³ Withdrawal of deposits by 5 percent within 5-day period is extreme but possible. The assumptions for withdrawal of funding have been chosen based on the recent FSAP experience in various countries and discussions with the authorities.

48. **The implied cash flow 30-day stress test³⁴ shows that 14 out of 20 banks would become illiquid³⁵ (Table 5).** A liquidity shortfall seems to be small, as in the previous test, only around 2.4 percent of the total assets.³⁶ As before, this is an illustration of excess liquidity in the banking system at present. However, as mentioned above, the results should be treated with caution.

Table 5. Nigeria: Implied Cash Flow Test (30 days)

Survival	Number of Banks	Percent of Banks	Percent of Assets
No	14	70.0%	84.8%
Yes	6	30.0%	15.2%

Source: CBN and IMF calculations.

49. **A complete withdrawal of the federal government deposits within 30-day period (other things being equal) would result in quite illiquid banking system (Table 6).** This in part is due to concentration of federal government deposits in ten banks out of 20. The results indicate that six out of ten banks that have federal government deposits on their balance sheets would become illiquid (47 percent of the total assets of ten banks with federal government deposits). Such outflow of deposits would destabilize the banking system in a very short term. Hence, transferring federal government deposits to the CBN from commercial banks, as is proposed, should be done gradually and with continuous monitoring of the liquidity situation in the banking sector.

Table 6. Nigeria: Implied Cash Flow Test—Withdrawal of Federal Government Deposits (30 days)

Survival	Number of Banks	Percent of Banks	Percent of Assets
No	6	30.0%	36.8%
Yes	14	70.0%	63.2%

Source: CBN and IMF calculations.

³⁴ Again, this rate of deposit withdrawal is extreme but possible.

³⁵ Survival of more banks in 30-day deposit withdrawal, compared with that for 5-day withdrawal implies that the total rate of withdrawals is higher for the 5-day period exercise than for the 30-day withdrawal.

³⁶ The exercise assumed that haircuts on T-bill and AMCON bonds would be 30 and 50 percent respectively.

50. **The maturity mismatch liquidity tests suggest that quite a large number of banks would have maturity mismatches in the longer term buckets (Table 7).** However, banks seem to match their assets and liabilities on demand (less than 30 days), and only a third of the banking system (as a share of total assets) seems to have an asset-liability mismatch from one to six months. The longer bucket maturity mismatch reflects the structural characteristics of the Nigerian banking system that most loans seem to have shorter maturity due to general lack of confidence by banks in their customers.

Table 7. Nigeria: Maturity Mismatch and Roll-Over Test

Bucket	Cumulative no. of banks with shortfall	Shortfall (Percent of total Assets)	Cumulative no. of banks with shortfall	Shortfall (Percent of total Assets)	Cumulative no. of banks with shortfall	Shortfall (Percent of total Assets)
Less than 30 days	0	0.0%	2	6.0%	2	6.0%
31-90 days	7	33.1%	15	66.2%	2	6.0%
3 to 6 months	7	33.1%	18	82.0%	2	6.0%
6 months to 1 year	9	37.9%	18	82.0%	5	18.3%
1-3 years	14	68.3%	19	96.0%	7	24.7%
above 3 years	18	91.2%	19	96.0%	18	89.0%
Not assigned	18	91.2%	19	96.0%	18	89.0%
Not assigned	18	91.2%	19	96.0%	18	89.0%
Not assigned	18	91.2%	19	96.0%	18	89.0%
Not assigned	18	91.2%	19	96.0%	18	89.0%

Source: CBN and IMF staff calculations.

VI. NETWORK ANALYSIS AND CONTAGION RISK

51. **Contagion risk and network analysis were included as part of the top-down exercise.** The FSAP team used the methodology developed in the IMF³⁷ for analyzing contagion risk and interlinkages in the interbank market. The network analysis was enhanced through studying interlinkages among different subsectors within the broader financial sector in Nigeria, cross-border bilateral exposures between the parent banks and their subsidiaries, as well as various sectors of the Nigerian economy. The exercise used the bilateral interbank exposures for end–December 2011 and end–June 2012.

A. The Interbank Network Analysis

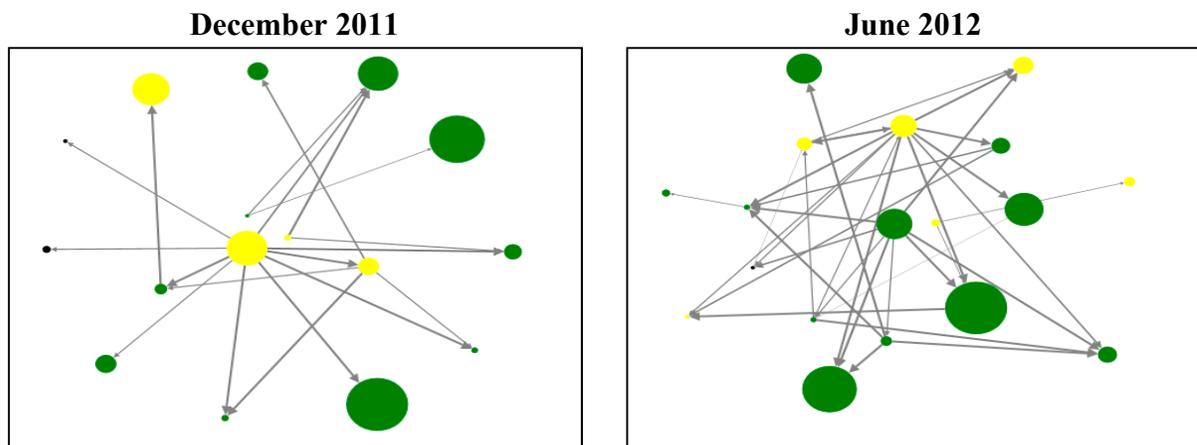
52. **The interbank network analysis revealed that the Nigerian banking system is quite connected and clustered.** There are a few banks that appear to be lenders only, some banks are lenders and borrowers, and some are borrowers only. These are represented (Figure 2) by a tiered structure of the banking system, with lender banks being in the inner circle, borrowing only banks in the out circle, and banks that lend and borrowing the middle. Three to six banks did not participate in the interbank market on the analyzed dates.

53. **The analysis reveals that this type of the tiered structure of the Nigerian banking system has been persistent within the six months under consideration.** Lending only

³⁷ Espinoza and Sole (2010).

banks in large remain lenders, and borrowing banks remain borrowers. At the end of December 2011 only 14 banks participated in the interbank market, while at the end of June 2012 17 banks were present. This may be a reflection of the increasing excess liquidity in the banking system, as well as increasing banking sector stability. Among participating banks, Bank 1 (see Table 8) was the most active player on the interbank market on both dates, and in June 2012 one of the lending only banks. Besides this bank, three other banks lend on the interbank market, with most of the others being mostly borrowers. Importantly, the three banks found to be weakest according to solvency risk stress tests are active in the interbank market. Moreover, the weakest bank from the capitalization prospective even lends to another weakest bank, presenting potential vulnerability on the interbank market.

Figure 2. Nigeria: Tiered Structure of the Banking System³⁸



B. Contagion Analysis—Interbank Market

54. **A network analysis is performed to assess the robustness of the interbank market to idiosyncratic shocks.** The interbank market was modeled as a network whereby each bank's financial exposures vis-à-vis other banks can serve as a potential channel of contagion through which solvency risk can spread across banks. The spillover analysis examines whether the interbank market has the potential to accelerate a shock's initial impact by propagating it throughout the system. The two-step spillover analysis comprises:

- *An initial shock.* The analysis simulates the individual failing of each of the commercial banks. The model assumes that the bank exposed to a failing

³⁸ The green nodes represent banks with the CAR equal or higher than 15 percent; yellow – banks with the CAR between 10 and 15 percent; and black – banks with the CAR less or equal to 10 percent. The links in the charts are weighted and thicker the links, the larger the size of the obligations between the banks connected by the links. The links are not color coded. The size of the nodes reflects the share of the bank's assets in the total assets of the banking system (the size is scaled for better visual representation).

counterparty loses all its balances. In addition, there are no additional risk transfers, as the banks do not hedge their interbank-market exposures with third parties.

- *A contagion phase.* The exercise tracks the lender's capacity to absorb the shock by verifying whether it has enough loss absorbing capital to cover the losses. If the generated loss is greater than its capital base, the lender will default on its own creditor counterparties, potentially unleashing a wave of defaults through a domino effect along the credit chain.³⁹ The number of defaults in the default cascade provides a measure of the interconnectedness of the interbank market.

55. **The results of the analysis suggest that contagion risk through interbank exposures is very small.** The analysis focuses on the transmission of a joint credit and funding shock,⁴⁰ assuming that the borrowing counterparties of a defaulting institution are unable to roll over their funding elsewhere and may need to resort to fire sales of assets. Since Nigerian banks do not hedge their positions on the interbank market, there are no risk transfers; hence a risk transfer risk currently is not present. A hypothetical default of Banks 6 and 8 would lead to capital losses, after all contagion rounds, of 17.2 and 10.2 percent of the total aggregate Tier I capital (Table 8). The number of induced failures through interbank linkages triggered by each hypothetical default is zero for all the banks except Bank 6. The failure of Bank 6 would unleash a failure of one bank (second column) in one round of contagion (fourth column). This makes Bank 6 the most systemic institution through interbank market exposures.

56. **The analysis also identifies that there is only one vulnerable bank, and there are no systemic failures.** Bank 13 appears the most vulnerable, exhibiting the highest hazard rate of one, which means that this bank would fail after one simulation. In fact, in the contagion matrix Bank 13 fails as a result of a failure of Bank 6. The analysis also reveals that the amount of impaired capital even with a domino effect does not lead to systemic failures (Appendix Table 1.7). For example, the default of Bank 1 would produce a capital loss to Bank 2 of 42.3 percent of its pre-shock capital.

57. **Overall, the analysis reveals the limited interconnectedness of the Nigerian interbank market.** The spread of contagion depends crucially on a pattern of linkages among banks, and those are limited, as the interbank market is segmented (Figure 2). The network of interbank exposures in Nigeria is tiered, where most of the exposures are among established pairs of counterparties for both lending and borrowing transactions. The

³⁹ The simulation stops when the set of surviving institutions enters a new steady state in which there are no further aftershocks.

⁴⁰ The analysis of a pure credit shock produces very similar results to the joint credit-funding shock. Therefore, only the latter is reported in this Technical Note.

maximum number of contagion rounds triggered by any defaulting bank is one (Table 8). This implies that the only transmission channel of default risk is through direct exposures rather than through cascading effects. In addition, the number of institutions with capital impairment adds up to maximum of eight banks. For example, if Bank 12 defaults, then the capital of only eight institutions would be affected (though as highlighted above, those banks would not default, and their capital would remain positive).

Table 8. Nigeria: Results of Simulation for Credit and Funding Channels

Institutions	Induced Failures	% Failed Capital	Contagion Rounds	Hazard ^d	Index of Contagion ²	Index of Vulnerability ³
Bank 1	0	8.9	0	0	6	1
Bank 2	0	1.3	0	0	1	7
Bank 3	0	5.5	0	0	0	1
Bank 4	0	4.1	0	0	1	1
Bank 5	0	7.2	0	0	0	0
Bank 6	1	17.2	1	0	6	0
Bank 7	0	6.3	0	0	3	1
Bank 8	0	10.2	0	0	0	0
Bank 9	0	3.9	0	0	3	1
Bank 10	0	1.9	0	0	0	0
Bank 11	0	1.8	0	0	1	1
Bank 12	0	5.6	0	0	8	1
Bank 13	0	0.5	0	1	0	9
Bank 14	0	3.0	0	0	0	0
Bank 15	0	2.1	0	0	0	0
Bank 16	0	4.4	0	0	1	1
Bank 17	0	8.4	0	0	0	0
Bank 18	0	2.3	0	0	0	0
Bank 19	0	0.6	0	0	0	4
Bank 20	0	5.5	0	0	0	1

Source: CBN data and IMF calculations.

¹ The absolute number of times a specific bank would have hypothetically failed in a given simulation.

² The index of contagion is the sum of all the capital losses (in dollars) of all banks (except the trigger bank) divided by the sum of the capital of all banks (except the capital of the trigger bank). This amount to summing along the rows of the capital impairment matrix (in dollars) and dividing this total by the total capital in the system minus the capital of the trigger bank.

³ Index of vulnerability computes a simple average of percentage of losses suffered by a country in all the simulations.

58. **The network frameworks presented in this Note provide a powerful tool for continuous regular monitoring of the interconnectivities in the banking system** to identify build up of risks and excesses in the system and to guide policy action to address potential risks and vulnerabilities. The analysis could be extended to identify build up of risks in the broader financial sector in Nigeria (among banks, insurance companies, pension funds, asset-management companies, and other non-bank financial institutions). The CBN

should develop capacity to carry on the network and contagion analysis for the interbank market and broader financial sector, which would also be helpful in determining domestic systemically important banks and financial institutions.

VII. CONCLUSIONS

59. **The stress testing exercise provided important insights into the overall resilience of the Nigeria banking system, though with some weak banking institutions.** The single- and multi-factor sensitivity calculations suggest that the overall system would be able to withstand a range of risk specific and sector specific shocks occurring in isolation, and the exercise provides some more precise quantification of these impacts. However, there are a number of weak banks that should be monitored extensively and remedial actions are likely to be needed. Integrated liquidity stress test results indicate that the system can withstand a quite severe deposit run, although a number of institutions risk becoming illiquid. The contagion analysis of the interbank market revealed that the banking system is clustered and thus can withstand some credit and funding shocks, with only one round of contagion affecting one bank only.

60. **The stress tests provided a useful learning experience.** The exercise was done in close cooperation with the CBN. An important aspect of the exercise was a two-way exchange of experiences and technical expertise relating to integrated liquidity and solvency tests, as well as network analysis and contagion risk analysis.

61. **Going forward, the authorities are encouraged to conduct integrated stress testing exercise with the participation of major or even all banks on regular basis, perhaps annually.** The stress testing framework should feed into the authorities' broader macroprudential framework. Currently, the macro stress tests are already being conducted on quarterly basis. These tests should be supplemented by other stress tests, and the work in this direction has already started this year.

62. **The stress testing work also helped identify some important data gaps.** More granular data on banks' loan portfolios by sector, including write-offs and provisions will be helpful in identifying vulnerable sectors. More granular data on sectoral NPLs, write-offs, losses, and CAR would further enhance monitoring potential risks emerging from various economic sectors. Data on liquidity that is necessary for constructing LCR and NSFR would help assess preparedness to Basel III liquidity requirements. Finally, more data on non-financial sector exposures to the financial sector are needed to assess contagion risk across sectors within the Nigerian economy.

Appendix I. Sensitivity Analysis—Shock Assumptions and Results

Credit Risk: Aggregate Shocks

- **Shock 1:** NPL (gross of write-offs) increase by 100, 200, and 300 percent, combined with simultaneous increase in provisioning to 1 percent for standard loans; 20 percent for substandard loans; 50 percent for doubtful and 100 percent for loss loans.

Credit Risk: Sectoral Exposure

- **Shock 2:** Increase in sectoral NPLs (gross of write-offs) in the following sectors: Oil and Gas, Agriculture, Telecom, Real Estate and Construction, General, and General Commerce by 100, 200, and 300 percent.
- **Shock 3:** Deterioration of performing sectoral loans (for the above sectors) by 10 (mild), 20 (medium), and 40 (severe) percent.

Credit Risk: Concentration

- **Shock 1:** The largest single borrower (top one) defaults on its loans.
- **Shock 2:** Top three single borrowers default on their loans.
- **Shock 3:** Top five single borrowers default on their loans.
- **Shock 4:** Top 10 single borrowers default on their loans.
- **Shock 5:** The largest single group defaults on their loans.
- **Shock 6:** The largest three groups default.
- **Shock 7:** The top largest group five groups default on its loans.

Reverse Stress Testing

- **Shock 1:** Haircut on performing loans that cause the banking sector CAR average to fall below 10 percent regulatory requirement.
- **Shock 2:** Haircut on performing loans that cause 50 percent of the system to fall below 10 percent minimum capital.

Direct Interest Rate Risk

The shocks for the banking book:

- **Shock 1:** Parallel upward shift of the Naira yield curve by 500 bps.
- **Shock 2:** Parallel upward shift of the Naira yield curve by 1000 bps.
- **Shock 3:** Parallel upward shift of the Naira yield curve by 1500 bps.
- **Shock 4:** Parallel downward shift of the Naira yield curve by 250 bps.
- **Shock 5:** Parallel downward shift of the Naira yield curve by 500 bps.
- **Shock 6:** Parallel downward shift of the Naira yield curve by 1000 bps.

- **Shock 7:** Steepening of Naira yield curve from 0 to 1000 bps.
- **Shock 8:** Parallel shift of the USD yield curve by 100 bps.

For interest rate risk on the banking book (also referred to as non-traded interest rate risk) a number of shocks are applied to the Naira yield curve. Banks reported all interest rate sensitive asset and liabilities by maturity buckets, on a contractual basis, and where the maturity is defined on time to repricing.

Foreign Exchange Risk

The shocks refer to the impact of the Naira depreciation against all key currency exposure:

- **Shock 1:** 15 percent depreciation of Naira.
- **Shock 2:** 30 percent depreciation of Naira.
- **Shock 3:** 40 percent depreciation of Naira.

Equity Price Risk

- **Shock 1:** Equity price index drops by 40 percent.
- **Shock 2:** Equity price index drops by 70 percent.

Multi-factor Shocks

- **Shock 1 (mild):** Aggregate NPL increase by 50 percent, combined with 15 percent depreciation of ₦ over 30-day period and 500 basis points upward parallel shift of the ₦ yield curve.
- **Shock 2 (medium):** Aggregate NPL increase by 100 percent, combined with 30 percent depreciation of ₦ over 30-day period and 1000 basis points upward parallel shift of the ₦ yield curve.
- **Shock 3 (severe):** Aggregate NPL increase by 200 percent, combined with 40 percent depreciation of ₦ over 30-day period and upward parallel shift of the ₦ yield curve to the historic highs.

Details of Assessment of the Direct Interest Rate Shocks

For Interest rate, the simplified gap analysis approach was considered to assess the impact of bank earnings as a result of a shift in the Naira yield curve. The income losses, on interest bearing exposure gap (assets – liabilities), are calculated for one year for each time bucket separately. The calculations of income losses are done as follows:

1 to 28 days	Net Exposure Gap * Interest Shock * (365-15) / 365
29 days to 3 months	Net Exposure Gap * Interest Shock * (365-60) / 365
3 to 6 months	Net Exposure Gap * Interest Shock * (365-135) / 365
6 months to 1 year	Net Exposure Gap * Interest Shock * (365-270) / 365
1 to 3 year	Net Exposure Gap * Interest Shock * (365-0) / 365
Over 3 years	Net Exposure Gap * Interest Shock * (365-0) / 365

The income losses are adjusted with profits. The residual loss, if any, deducted from the capital (Tier I + II) as well as from RWA. The revised CAR is derived from reduced capital and revised RWA. In order to see the impact of Tier I separately, the residual losses are deducted from Tier I. The impact on the CAR is taken for one-year only, to reflect the impact on the P&L and income statement.

Appendix Table 1.1. Nigeria: Credit Risk Sensitivity Analysis

		Top Down Stress Test for 20 Banks								
		System Level			Outlier Banks (CAR < 10%) ¹		Outlier Banks (Tier I CAR < 6%) ²		Insolvent Banks	
		CAR	Tier I/ RWA	NPL Ratio	Losses	Number of Outlier Banks	Share in Total Assets	Number of Outlier Banks	Shares in Total Assets	Number of Outlier Banks
					(% of Total Capital)					
Baseline:		18.5	18.4	4.5		1.4		1.4	1	
	System Level									
Shock 1:	NPLs increase by 100%	17.3	17.2	8.7	8.8	1	2.0	1.0	2.0	1
Shock 2:	NPLs increase by 200%	15.2	15.1	13.0	26.7	3	9.7	3.0	6.9	1
Shock 3:	NPLs increase by 300% (Historical)	12.9	12.8	17.3	53.9	7	21.6	7.0	12.5	3
	Sectoral Loans									
Shock 1:	Increases in Agricultural NPLs by 100%	18.5	18.4	4.4	0.2	0	0.0	0.0	0.0	1
	Increases in Agricultural NPLs by 200%	18.4	18.4	4.5	0.3	0	0.0	0.1	2.0	1
	Increases in Agricultural NPLs by 300%	18.4	18.3	4.6	0.5	1	2.0	0.0	2.0	1
Shock 2:	Increases in Oil and Gas NPLs by 100%	18.3	18.3	5.0	1.0	0	0.0	0.0	0.0	1
	Increases in Oil and Gas NPLs by 200%	18.1	18.0	5.7	2.7	0	0.0	0.0	0.0	1
	Increases in Oil and Gas NPLs by 300%	17.8	17.8	6.3	4.4	0	0.0	0.0	0.0	1
Shock 3:	Increases in Telecom NPLs by 100%	18.4	18.4	4.8	0.3	0	0.0	0.0	0.0	1
	Increases in Telecom NPLs by 200%	18.4	18.4	5.2	0.4	0	0.0	0.0	0.0	1
	Increases in Telecom NPLs by 300%	18.4	18.3	5.7	0.8	0	0.0	1.0	2.0	1
Shock 4:	Increases in Real Estate and Const. NPLs by 100%	18.4	18.3	4.6	0.3	0	0.0	0.0	0.0	1
	Increases in Real Estate and Const. NPLs by 200%	18.4	18.3	4.8	0.5	0	0.0	0.0	0.0	1
	Increases in Real Estate and Const. NPLs by 300%	18.4	18.3	5.0	0.9	0	0.0	0.0	0.0	1
Shock 5:	Increases in General NPLs by 100%	18.4	18.3	5.1	0.8	0	0.0	1.0	2.0	1
	Increases in General NPLs by 200%	18.1	18.0	5.9	2.4	0	0.0	1.0	2.0	1
	Increases in General NPLs by 300%	17.8	17.7	6.6	4.6	1	2.0	1.0	2.0	1
Shock 6:	Increases in General Commerce NPLs by 100%	18.3	18.2	5.2	1.0	0	0.0	0.0	0.0	1
	Increases in General Commerce NPLs by 200%	18.2	18.1	6.0	2.2	0	0.0	0.0	0.0	1
	Increases in General Commerce NPLs by 300%	19.9	17.8	6.8	4.0	0	0.0	0.0	0.0	1
Shock 7:	Combined Shock (Oil and Gas, General and General Commerce) by 300%	15.9	15.8	11.1	20.0	4	12.5	2.0	6.9	1

¹Excluding the bank that is insolvent even before the stress tests.

²Including the bank that is insolvent before tests. Other banks that become insolvent are included in the other outlier banks.

Source: Top Down: CBN and IMF staff calculations.

Table 1.1. Nigeria: Credit Risk Sensitivity Analysis (concluded)

		Top Down Stress Test for 20 Banks								
		System Level				Outlier Banks (CAR < 10%) ¹		Outlier Banks (CAR < 10%) ²		Insolvent Banks
		CAR	Tier I/ RWA	NPL Ratio	Losses	Number of Outlier Banks	Share in Total Assets	Number of Outlier Banks	Shares in Total Assets	Number of Outlier Banks
					(% of Total Capital)					
Deterioration of Standard Loans										
Shock 1:	Increase in Agricultural NPLs by 10%	18.5	18.4	4.7	0.2	0	0.0	0.0	0.0	1
	Increase in Agricultural NPLs by 20%	18.4	18.4	5.0	0.3	0	0.0	1.0	2.0	1
	Increase in Agricultural NPLs by 40%	18.4	18.3	5.7	0.9	1	2.0	1.0	2.0	1
Shock 2:	Increase in Oil and Gas NPLs by 10%	18.1	18.0	6.5	2.9	0	0.0	0.0	0.0	1
	Increase in Oil and Gas NPLs by 20%	17.3	17.2	8.6	8.5	1	2.8	0.0	0.0	1
	Increase in Oil and Gas NPLs by 40%	15.5	15.4	12.9	23.5	2	16.6	2.0	4.9	1
Shock 3:	Increase in Telecom NPLs by 10%	18.4	18.3	5.2	0.5	0	0.0	0.0	0.0	1
	Increase in Telecom NPLs by 20%	18.3	18.2	6.1	1.3	0	0.0	0.0	0.0	1
	Increase in Telecom NPLs by 40%	17.9	17.9	7.9	3.8	0	0.0	0.0	0.0	1
Shock 4:	Increase in Real Estate and Const NPLs by 10%	18.4	18.3	4.8	0.4	0	0.0	0.0	0.0	1
	Increase in Real Estate and Const NPLs by 20%	18.3	18.3	5.3	1.0	0	0.0	0.0	0.0	1
	Increase in Real Estate and Const NPLs by 40%	18.1	18.0	6.2	2.7	0	0.0	0.0	0.0	1
Shock 5:	Increase in General NPLs by 10%	18.4	18.3	5.3	0.8	0	0.0	0.0	0.0	1
	Increase in General NPLs by 20%	18.2	18.1	6.3	1.9	0	0.0	0.0	0.0	1
	Increase in General NPLs by 40%	17.5	17.4	8.2	6.7	1	2.8	0.0	0.0	1
Shock 6:	Increase in General Commerce NPLs by 10%	18.3	18.2	5.5	1.3	0	0.0	1.0	2.0	1
	Increase in General Commerce NPLs by 20%	18.0	17.9	6.6	3.7	1	2.0	1.0	2.0	1
	Increase in General Commerce NPLs by 40%	17.1	17.0	9.0	10.2	1	2.0	1.0	2.0	1
Concentration Risk										
Shock 1:	The top single borrower defaults	17.5	17.4	8.5	6.9	0	0.0	0.0	0.0	1
Shock 2:	The top group borrower defaults	16.9	16.8	10.2	11.7	0	0.0	1.0	2.0	1
Shock 3:	The top three single borrowers default	14.2	14.1	14.9	37.4	2	4.5	1.0	2.8	1
Shock 4:	The top three group borrowers default	12.7	12.6	17.9	55.7	6	30.2	2.0	4.9	1
Shock 5:	The top five single borrowers default	11.3	11.2	19.5	77.9	9	52.6	3.0	10.6	1
Shock 6:	The top three group borrowers default	5.5	5.4	28.7	293.1	13	73.1	9.0	47.5	2
Reverse Testing										
Shock 1:	The haircut on standard loans causing 50% of sector to fall below 10% CAR (Haircut 20%)	8.5	8.4	24.3	143.9	11	69.6	6.0	37.6	2
Shock 2:	The haircut on standard loans causing sector to fall below 10% CAR (haircut 16%)	11.0	10.9	20.6	84.2	7	40.5	5.0	23.8	1

¹Excluding the bank that is insolvent even before the stress tests.

²Including the bank that is insolvent before tests. Other banks that become insolvent are included in the other outlier banks.

Appendix Table 1.2. Nigeria: Bottom up Sensitivity Analysis

Bottom Up Stress Test for 8 banks	System Level CAR	Outlier Banks
System Level		
Shock 1: NPLs increase by 100%	16.9	0
Shock 2: NPLs increase by 200%	15.1	2
Shock 3: NPLs increase by 300% (Historical)	13.8	2
Sectoral Loans		
Shock 1: Combined Shock (Oil and Gas, General and General Commerce, real estate, Agriculture) by 100%	17.1	0
Shock 2: Combined Shock (Oil and Gas, General and General Commerce) by 200%	15.8	1
Shock 3: Combined Shock (Oil and Gas, General and General Commerce) by 300%	15.6	1
Shock 4: Combined Haircut on Standard Loans (Oil and Gas, General and General Commerce) by 10%	16.4	2
Shock 5: Combined Haircut on Standard Loans (Oil and Gas, General and General Commerce) by 20%	14.8	2
Shock 6: General and General Commerce) by 40%	10.5	2
Concentration Risk		
Shock 1: The top largest performing borrower default	16.7	1
Shock 2: The top 3 largest performing borrowers default	14.3	2
Shock 3: The top 5 largest performing borrowers default	13.5	3
Shock 4: The top 10 largest performing borrowers default	10.1	4
Shock 5: The largest member of the group default	17.3	0
Shock 6: The largest three members of the group default	16.3	1
Shock 7: The largest five members of the group default	15.6	1

Source: Individual bank calculations; assumptions provided by the CBN.

Appendix Table 1.3. Nigeria: Interest Rate Risk Sensitivity Analysis (Banking Book)

		Top Down Stress Test						
		System Level			Outlier Banks (CAR < 10%)		Outlier Banks (Core CAR < 6%)	
		CAR	Core CAR	Losses (% of Total Capital)	Number of Outlier Banks	Shares in Total Assets	Number of Outlier Banks	Share in Total Assets
Baseline:		18.5	18.4		1	1.4	1	1.4
Shock 1:	Parallel upward shift of the Naira yield curve by 500 bps	18.4	18.3	0.4	0	0.0	0	0
Shock 2:	Parallel upward shift of the Naira yield curve by 1000 bps	18.3	18.2	1.3	1	1.9	0	0
Shock 3:	Parallel upward shift of the Naira yield curve by 1500 bps	18.1	18.0	2.5	1	1.9	0	2
Shock 4:	Parallel downward shift of the Naira yield curve by 250 bps	18.5	18.4	0.2	0	0.0	0	0
Shock 5:	Parallel downward shift of the Naira yield curve by 500 bps	18.5	18.4	0.2	0	0.0	0	0
Shock 6:	Parallel downward shift of the Naira yield curve by 1000 bps	18.4	18.4	0.3	0	0.0	1	0
Shock 7:	Steepening of the Naira yield curve from 0–1000 bps	16.6	16.5	13.7	2	4.7	1	2
Shock 8:	Parallel upward shift of USD yield curve by 100 bps	18.5	18.4	0.2	0	0.0	0	0

Source: Top Down: CBN and IMF staff calculations.

Appendix Table 1.4. Nigeria: Foreign Exchange Risk Sensitivity Analysis

		Top Down Stress Test						
		System Level			Outlier Banks (CAR < 10%)		Outlier Banks (Core CAR < 6%)	
		CAR	Core CAR	Losses (% of Total Capital)	Number of Outlier Banks	Shares in Total Assets	Number of Outlier Banks	Share in Total Assets
Baseline:		18.5	18.4		1	1.4	1	1.4
Shock 1:	Naira depreciates against all currencies by 15 percent	18.5	18.4	0.000001	-	0.0	-	0
Shock 2:	Naira depreciates against all currencies by 15 percent	18.5	18.4	0.000023	-	0.0	-	0
Shock 3:	Naira depreciates against all currencies by 15 percent	18.5	18.4	0.000031	-	0.0	-	0

Source: Top Down: CBN and IMF staff calculations.

Appendix Table 1.5. Nigeria: Equity Price Risk Sensitivity Analysis

	Top Down Stress Test						
	System Level			Outlier Banks (CAR < 10%)		Outlier Banks (Core CAR < 6%)	
	CAR	Core CAR	Losses (% of Total Capital)	Number of Outlier Banks	Shares in Total Assets	Number of Outlier Banks	Share in Total Assets
Baseline:	18.5	18.4		1	1.4	1	1.4
The Equity Price Index drops by 30 percent	18.2	18.2	1.7	0	0.0	0	0.0
The Equity Price Index drops by 70 percent	17.8	17.7	5.1	0	0.0	1	2.0

Source: Top Down: CBN and IMF staff calculations.

Appendix Table 1.6. Nigeria: Sensitivity Analysis—Multi-Factor Shocks

	Top Down Stress Test							
	System Level			Outlier Banks (CAR < 10%)		Outlier Banks (Core CAR < 6%)		Insolvent Banks
	CAR	Core CAR	Losses (% of Total Capital)	Number of Outlier Banks	Shares in Total Assets	Number of Outlier Banks	Share in Total Assets	Number of Outlier Banks
Baseline:	18.5	18.4		1		1		1
Shock 1: Aggregate NPLs increases 50 percent, Naira depreciates against all currencies by 15 percent and parallel upward shift of the Naira yield curve by 500 bps	17.9	17.8	3.8	0	0.0	1	0.0	1
Shock 2: Aggregate NPLs increases 100 percent, Naira depreciates against all currencies by 30 percent and parallel upward shift of the Naira yield curve by 1000 bps	17.0	16.9	10.9	2	3.9	1	3.9	1
Shock 3: Aggregate NPLs increases 200 percent, Naira depreciates against all currencies by 40 percent and parallel upward shift of the Naira yield curve by 1500 bps	14.8	14.7	30.3	4	11.6	3	11.6	2

Source: Top Down: CBN and IMF staff calculations.

Appendix Table 1.7. Nigeria: Credit and Funding Channels of Contagion—Capital Impairment in Percent of Pre-shock Capital

Institutions	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6	Bank 7	Bank 8	Bank 9	Bank 10	Bank 11	Bank 12	Bank 13	Bank 14	Bank 15	Bank 16	Bank 17	Bank 18	Bank 19	Bank 20
Bank 1	--	42.3	14.4	0.0	0.0	1.6	0.0	0.0	3.4	0.0	7.9	0.0	0.0	0.0	0.0	6.0	0.0	0.0	33.4	9.5
Bank 2	2.2	--	0.0	0.0	0.0	0.0	1.2	0.0	4.8	0.0	0.0	3.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0
Bank 3	3.1	0.0	--	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank 4	0.0	0.0	2.9	--	0.0	0.0	0.0	0.0	0.0	0.0	3.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0
Bank 5	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank 6	1.0	0.0	0.0	0.0	0.0	--	1.0	0.0	3.8	0.0	0.0	2.8	--	0.0	0.0	0.0	0.0	1.3	0.0	0.0
Bank 7	0.0	16.1	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	2.6	36.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank 9	0.5	40.3	0.0	0.0	0.0	2.5	0.0	6.3	--	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	5.7
Bank 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank 11	0.6	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	--	2.0	0.0	0.0	0.0	6.0	0.7	0.0	0.0	0.0
Bank 12	0.0	36.3	5.8	13.2	0.0	1.7	6.7	0.0	0.0	0.0	6.0	--	31.5	0.0	0.0	4.8	6.2	0.0	32.5	4.7
Bank 13	0.0	0.0	0.0	0.0	0.0	1.1	1.0	0.0	0.0	0.0	0.0	1.0	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank 14	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0
Bank 15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0	0.0	1.3	0.0	0.0
Bank 16	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	5.1	1.3	0.0	0.0	0.0	--	0.0	0.0	0.0	0.0
Bank 17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.3	0.0	0.0	0.0	0.0	--	0.0	0.0	0.0
Bank 18	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	--	0.0	0.0
Bank 19	0.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0
Bank 20	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--

Source: CBN data and IMF staff calculations.

Appendix II. Stress Test Matrix

Appendix Table 2.1. Nigeria: Solvency Risk Stress Tests

Scope	Assumptions	
	Bottom-Up by Banks	Top-Down by FSAP and CBN Team
<i>Institutions included</i>	Ten largest banks (eight reported results)	All 20 commercial banks
<i>Market share</i>	Around 77 percent of total assets	100 percent
<i>Data and baseline date</i>	Audited, June 2012	Supervisory, August 2012
<i>Methodology</i>	Internal Models	Sensitivity analysis and reverse stress tests
<i>Stress test horizon</i>	Static (point in time)	Static (point in time)
<i>Shocks</i>	Sensitivity Analysis	
	Credit Risk	
	Deterioration of asset quality (aggregate)	same
	Concentration risk (large borrowers, sectoral shocks)	same
	N/A	Reverse stress on asset quality—haircut on aggregate standard loans
	Market Risk	
	Exchange rate risk—shock to Net open position	same
Interest rate risk—shift to local currency yield curve	same	
Equity Risk—shock to equity price index	same	
Multi-factor Assessment		
Simultaneous credit and market risk shocks	same	
<i>Risks/factors assessed</i>	Credit losses, earning losses and solvency	
<i>Calibration of risk parameters</i>	Based on actual point in time (historical highs) or proxies. Expert judgment due to data limitation for a macro modeling	
<i>Regulatory standards</i>	Basel I (accompanied by local regulatory standards)	
<i>Results</i>	CAR/shortfall, group-wide and by bank.	CAR/shortfall, system-wide and by bank.
	Pass or fail; number of banks and percentage of assets that fail.	Pass or fail; number of banks and percentage of assets that fail; number of insolvent banks post-shock.
	Distribution of capital ratios across the system by bank group/type.	Distribution of capital ratios across the system by bank group/type.

Appendix Table 2.2. Nigeria: Liquidity Risk Stress Tests

Scope	Assumptions	
	Bottom-Up by Banks	Top-Down by FSAP and CBN Team
Institutions included	N/A	All 20 commercial banks
Market share	N/A	100 percent
Data and baseline date	N/A	Supervisory, June 2012
Methodology	N/A	Schmieder, Puhr, and Hasan (2011) Integrated Liquidity framework—bank run test and funding risks
Risks/factors assessed	N/A	Deposit run Short term funding risk Funding liquidity & market liquidity Maturity mismatch/rollover risk Concentration of funding
Regulatory standards	N/A	Basel 1 and local regulatory standards.
Results	N/A	Liquid asset ratios/shortfall; number of failed banks.

Appendix Table 2.3. Nigeria: Interest and Exchange Rate Risk Stress Tests

Scope	Assumptions	
	Bottom-Up by Banks	Top-Down by FSAP and CBN Team
Institutions included	Ten largest banks (eight reported results)	All 20 commercial banks
Market share	Around 77 percent of the total assets	100 percent
Data and baseline date	Audited, June 2012	Supervisory, June 2012
Methodology	Internal Models	Sensitivity analysis and reverse stress tests
Risks/factors assessed	Same as top-down	Shifts in yield curve Depreciation of the Naira
Regulatory standards	Same as top-down	Basel 1 and local regulatory standards
Results	CAR/shortfall, system-wide and by bank. Pass or fail; number of banks and percentage of assets that fail. Distribution of capital ratios across the system by bank group/type.	CAR/shortfall, system-wide and by bank. Pass or fail; number of banks and percentage of assets that fail. Distribution of capital ratios across the system by bank group/type.

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