

INTERNATIONAL MONETARY FUND

Macrofinancial Stress Testing: Principles and Practices—Background Material

Prepared by the Monetary and Capital Markets Department

Approved by José Viñals

August 29, 2012

Contents	Page
Glossary	3
I. Introduction	4
II. Overview of Survey Results	5
A. Definition, Goals, Sectoral Coverage, and Responsibility for Stress Tests	5
B. Banking Sector Stress Testing	5
C. Communication Practices	9
III. Detailed Survey Results	10
A. Definition of Stress Testing	10
B. Banking Sector Stress Testing	10
C. Communication of Stress Test Assumptions and Results	28
D. Other Questions	29
Appendix I. Survey Questionnaire	31
Tables	
1. Process of Bank Solvency Stress Tests	13
2. Bottom-up Solvency Tests: Contributions to the Test Process	14
3. Process of Bank Liquidity Stress Tests	16
4. Bottom-up Liquidity Tests: Contributions to the Test Process	17
5. Ranking of Risk Factors in Stress Tests Before and After the Financial Crisis	20
Figures	
1. Objectives and Focus of Stress Tests	11
2. Types of Surveillance (Macroprudential) Solvency Tests	12
3. Data Used in Top-down Solvency Stress Tests	14
4. Types of Surveillance (Macroprudential) Liquidity Stress Tests	15
5. Data used in Top-down Liquidity Stress Tests	17
6. Solvency Test Time Horizon	18
7. Scenario Selection	19
8. Risks Included in Solvency Stress Tests	19
9. Bank Positions Included in Solvency Stress Tests	21
10. Dimensions of Interconnectedness Included in Stress Tests	22

11. Determining Capital Adequacy in Solvency Tests.....	23
12. Hurdle Rates	23
13. Alternative Approaches Under the Basel Framework in Solvency Tests	24
14. Design of Bank Liquidity Stress Tests	26
15. Calibration of Liquidity Stress Tests	27
16. Hurdle Rates for Liquidity Stress Tests.....	27
17. Communication of Stress Tests Results	28
18. Follow up Actions to Negative Stress Test Results.....	29
19. Stress Testing of Nonbank Financial Sectors	30

GLOSSARY

AIRB	Advanced internal ratings-based approach
BU	Bottom-up
CCAR	Comprehensive Capital Assessment Review
DSGE	Dynamic stochastic general equilibrium
EBA	European Banking Authority
FRB	Federal Reserve Board
FSAP	Financial Sector Assessment Program
IRB	Internal rating based approach
LGD	Loss given default
NPL	Nonperforming loan
PD	Probability of default
RWA	Risk weighted asset
SCAP	Supervisory Capital Assessment Program
TD	Top-down
VAR	Vector auto regressive
VaR	Value at risk

I. INTRODUCTION¹

1. **Staff conducted a survey of stress testing practices among selected national central banks and supervisory authorities.** The online survey was undertaken in November 2011 as part of the preparatory work for the paper on “Macrofinancial Stress Testing: Principles and Practices.” The survey focused on stress testing for banks, which is more widespread and better established—and practices are therefore easier to compare across countries—but also included questions on stress testing for nonbank financial institutions. Questions covered three broad areas (the detailed questionnaire can be found in Appendix I):

- The definition, objectives, coverage, responsibility for, and use of stress tests by national authorities;
- The process, scenario selection, risk identification, and design of banking sector stress tests (with separate questions for solvency and liquidity tests, where applicable).
- The communication of stress test results and any follow-up actions, as well as practices for stress testing nonbank financial institutions.

2. **Central banks and, where relevant, supervisory authorities from 23 jurisdictions participated in the survey.** Central banks and supervisory authorities in 32 advanced economies and major emerging markets, including all G-20 countries, were invited to participate. Rather than aiming at comprehensive coverage, the survey targeted agencies that have an established track record in stress testing of financial institutions, including applying relatively advanced techniques. In cases where more than one institution per country was invited to participate, it was left to the authorities to decide whether to submit separate responses from each institution or a single joint response for the country. In all, there were 26 submissions from institutions in 23 different jurisdictions,² a response rate of over 70 percent. In three cases, different agencies within the same jurisdiction submitted separate responses; in two other cases, multiple agencies coordinated and submitted a single joint response for the jurisdiction. The other 18 jurisdictions submitted a single response from a single agency: 12 were central banks that were also bank supervisors; four were central banks that were not in charge of supervision; and two were non-central bank regulatory agencies. Of the 23 jurisdictions, seven were emerging markets and 16 were advanced economies (following the IMF’s World Economic Outlook definition); and 13 were in Europe, six in Asia, and four in the Western Hemisphere.

¹ This paper was prepared by Hiroko Oura, with assistance from Ryan Scuzzarella. The survey of stress testing practices was designed by Li Lian Ong, Hiroko Oura, and Liliana Schumacher.

² Austria, Belgium, Brazil, Canada, China, France, Germany, Hong Kong SAR, Hungary, India, Ireland, Italy, Japan, Malaysia, Mexico, the Netherlands, Russian Federation, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

3. **This paper is organized as follows.** The next Section presents a summary overview of the survey results; Section III the detailed responses; and Appendix I contains the questionnaire.

II. OVERVIEW OF SURVEY RESULTS

A. Definition, Goals, Sectoral Coverage, and Responsibility for Stress Tests

4. **Definition of stress testing.** All respondents share a broadly similar working definition of stress tests as “what if” exercises aimed at assessing the vulnerability and resilience of individual banks and/or of the system as a whole against extreme but plausible shocks. A bottom-up (BU) test is typically defined as an exercise implemented by individual institutions using their internal data and models, but based on common assumptions provided by a central authority (central bank or supervisory agency). A top-down (TD) test is defined as one implemented by the central authority. TD tests use either confidential supervisory data or publicly available institution-by-institution data or both.

5. **Coverage of financial sectors in stress tests.** About 40 percent of the respondents test only the banking sector. The insurance sector is the second most frequently tested. Some agencies started insurance tests in the 1990s, and several others have started more recently in the context of the E.U.-wide quantitative impact study for Solvency II. A few respondents examine the pension sector, though these tests are not conducted regularly. Tests of financial market infrastructures are organized in a much more ad hoc manner, if at all. Some country authorities also test brokerage houses and key nonbank financial institutions designated by regulation.

6. **Responsibility for stress tests.** Central banks and supervisors—when they are separate—tend to share responsibility or collaborate closely for stress testing the banking sector and, where applicable, financial market infrastructures. The tests of the insurance and pension segments are implemented mainly by the designated supervisors. In banking, about a half of respondents are central banks with supervisory responsibilities, conducting both micro and macroprudential tests. Where the supervisor is not the central bank, the central bank typically focuses on macroprudential tests and the supervisor on microprudential tests. In the insurance and pension sectors, all tests, including macroprudential tests, are conducted by supervisors. In the four cases where financial market infrastructures are tested, central banks play the key role. Inter-agency coordination for stress tests across different segments of the financial system appears to be easier to achieve under an integrated regulator.

B. Banking Sector Stress Testing

7. **Choosing between TD and BU approaches for bank solvency tests.** Most of the authorities conduct macroprudential/surveillance stress tests using both TD and BU approaches, recognizing the complementary strength of each approach. A TD test can impose a more uniform methodology while a BU test can better reflect each bank’s own risk profiles.

Though the majority of BU exercises are implemented using common scenarios, assumptions, key parameters, and data templates, authorities allow banks to use their own internal data and models. Cross-checking of BU results is considered relevant by all respondents, and several authorities use TD results to cross-examine BU results.

8. **Coverage of institutions and test frequency for solvency tests.** Based on the survey responses, banking stress tests cover between 60 and 100 percent of the system by assets, with the median at 85 percent. Where coverage is less than universal, the institutions to be covered are selected based on similar criteria (systemic relevance based on some measures of interconnectedness and size) for both TD and BU exercises. In terms of ownership structure, domestically-owned private commercial banks are the key target of stress tests, followed by foreign subsidiaries and state-owned banks. Several respondents reported also covering other types of deposit-taking institutions. TD tests are conducted relatively more frequently (semi-annual or annual) than BU tests (mostly annual).

9. **Bank liquidity stress test processes.** A somewhat smaller number of countries implement liquidity stress tests, either microprudential or macroprudential, compared to solvency tests. The processes of liquidity stress tests (coverage, uses of TD and BU tests, and frequency) are broadly similar to those for solvency tests. However, liquidity tests tend to rely more on banks' data and methodologies, and banks are given more flexibility regarding the detailed assumptions.

Risk and Scenario Selection for Bank Solvency Tests

10. **Risk factors and exposures.** Credit risk is always incorporated in the tests, followed by market risk, interest risk in the banking book, and funding liquidity risk. Sixty percent of respondents include sovereign risk (typically modeled as a haircut on sovereign securities). The exposures examined in tests include loans, exposures in banking and trading books, and derivatives and other off-balance sheet items. But not all the items on these books seem to be covered: for instance, loans to the public sector, financial institutions, and households, as well as cross-border exposures, are not always covered.

11. **Scenarios, severity of shocks, and time horizon.** Most of the respondents conduct macro scenario tests that involve simultaneous shocks in multiple risk factors. Many also carry out single-factor and multi-factor tests separately. Stress scenarios are formulated on the basis of historical data, as well as by utilizing expert judgment or externally-provided parameters (e.g., market analysis or scenarios given by European Banking Authority). Several authorities target a specific probability of occurrence, mostly in the range from 1 to 5 percent, but others test shocks designed to be in line with or worse than historical worst.³ In a few cases,

³ However, the answers do not provide enough detail on the length of the historical horizon used to calculate the probability, making it difficult to compare the severity of shocks across countries.

authorities do not impose any specific probability of occurrence to the assumed shocks. Most respondents use a one- to three-year horizon for the stress tests, in order to balance the need to fully capture credit losses that materialize gradually over time on one hand, and the larger estimation errors entailed by longer time horizons on the other. The use of reverse stress tests is limited, and they are conducted mostly for supervisory review of individual institutions, rather than for macroprudential purposes.⁴

12. **Systemic risk factors.** Before the global financial crisis, respondents considered credit risk, liquidity and funding risk, and asset prices (including stock and property) as the most important systemic risk factors, followed by macroeconomic and interest rate shocks. After the crisis, the ranking and definition of risk factors changed significantly: respondents are even more focused on liquidity and funding risks, but also concerned about contagion/spillover effects (including through a reversal of capital flows), sovereign risks, low profitability, regulation-related risks, credit crunch, and interconnectedness. Most respondents are trying to integrate the elements of systemic risk and interconnectedness by examining exposures to common macroeconomic risk factors across institutions and/or by introducing interbank contagion models and other additional model features. Because of the technical complexity, these models are sometimes implemented on a stand-alone basis, separately from the macro scenario tests. Many responses emphasize the difficulty in incorporating second-round effects. Improving the existing models to better reflect contagion, second-round effects, and interconnectedness appears to be a high and shared priority among all respondents.

13. **Data, detailed assumptions, and validation of risk parameters.** A number of authorities use both accounting (balance sheet) and market-based data, while many primarily rely on accounting-based information, from published sources, supervisory data, or both. Market data are often used to determine assumptions for stress testing trading book exposures and sovereign risks (e.g., market price-implied haircuts to compute mark-to-market losses); however, they are little used for setting credit risk parameters (e.g., probability of default (PD) and loss given default (LGDs)). Most authorities validate the detailed assumptions chosen by banks by comparing them to historical data or their own TD estimates; comparing them across peers; or scrutinizing them in the context of supervisory reviews. Stress tests typically assume the balance sheet to remain static over the test period, but some respondents assume constant growth or allow portfolio changes as projected by banks. Asset disposals are allowed in a very limited manner, usually reflecting already closed deals. Dividend payout (when there are positive profits) is mostly assumed to be in line with banks' own history, though some tests impose the assumption of no payouts in a stress scenario.

⁴ Reverse stress tests assess the maximum shock—within a risk category such as credit, market, or liquidity risk—that a bank can withstand and remain solvent.

Macrofinancial Linkages in Bank Solvency Tests

13. **Modeling the macroeconomic environment and macrofinancial linkages.** Macro scenario tests typically require two types of quantitative models: a macroeconomic model, and a macro-financial linkage model that establishes the econometric relationship between risk parameters (e.g., PD, LGD, and NPL ratios) and macroeconomic variables. Country authorities rely on various types of macroeconomic models, ranging from simple vector autoregression (VAR) to large structural econometric or dynamic stochastic general equilibrium (DSGE) models. The impact of macroeconomic stress on bank solvency is assessed by estimating econometrically the relationship between macroeconomic variables and balance sheet (such as valuation changes of securities, assets, and derivatives) and income statement items (such as credit losses, trading losses, and interest rate income). In almost all cases, the results of stress tests do not feed back into the macroeconomic scenarios.

Determining Capital Adequacy in Bank Solvency Tests

14. **Capital adequacy and hurdle rates.** All respondents examine the impact of shocks on regulatory capital. In addition, some study economic capital and other capital ratios, such as common Tier 1 ratio. Total, Tier 1, and core Tier 1 capital ratios are all used as the basis for hurdle rates. Typically, core Tier 1 hurdle rates range from 4 to 7 percent, Tier 1 hurdle rates range from 4 to 8 percent, and total capital hurdle rates range from 8 to 11 percent. Most authorities use the Basel II capital framework, while about 40 percent of them also use the Basel III framework. Reconciliation of test results across banks with different risk management and capital framework (ranging from Base II standardized approach to internal rating based (IRB) and advanced IRB (AIRB) approaches) is rare, owing to its complexity.

15. **Methods to map portfolio loss and profits to solvency ratio in stress scenarios.** Practices vary widely in this area, especially as regards the impact on risk weighted assets (RWA). Nine respondents indicate that stressed RWA are modeled to increase in line with the deterioration of risk parameters (such as PD and LGD), in line with the Basel II framework. Three indicate that stressed RWA are modeled to decline, as impaired assets (those that are provisioned) are taken out from exposures and hence RWA. One mentioned that RWA is kept constant, and another indicated that they apply a fixed percentage change. Other respondents did not explain their treatment of RWA, but most seem to assume some change under stress.

Design of Bank Liquidity Tests

16. **Overall design of liquidity stress tests.** Liquidity tests focus primarily on individual bank liquidity conditions, but a number of authorities also examine disruptions in market funding and, to a lesser extent, systemic liquidity. All respondents analyze deposit withdrawals, and most of them also consider disruptions in interbank positions and declines in liquid asset values. The majority also assess shocks to repo and loan positions. In addition, a few consider liquidity needs from off-balance sheet positions. About half of the respondents examine domestic and foreign exchange liquidity risks separately. About two-thirds of the respondents use scenario tests, and therefore link market and funding liquidity in the tests by assuming

liability withdrawals (shock to funding liquidity) and declines in liquid asset values captured by larger haircuts (shock to market liquidity) simultaneously. Most of the liquidity stress tests are implemented independently of the solvency tests. The majority of respondents judge the liquidity conditions of a bank based on current or prospective (Basel III) regulatory requirements, but some also rely on other economic measures in setting hurdle rates, such as the ability to survive without relying on central bank funding.

17. **Formulation of the liquidity stress scenarios.** The country's own experience is the most frequently used source in establishing liquidity stress scenarios and assumptions. Liability run-off rate assumptions are also often based on banks' own estimates, expert judgment, or in some cases as prescribed by liquidity regulations. Most tests incorporate shocks to market liquidity by applying haircuts to the value of liquid assets. Haircut values are chosen following the country's own history, international experience, expert judgment, banks' own estimates, or following haircuts applied by the central bank for its refinancing operations.

C. Communication Practices

18. **Communication practices.** Communication practices vary between liquidity and solvency tests: over 80 percent of the respondents communicate the solvency test results outside their institutions, but only 50 percent of the respondents do the same for the liquidity tests. Only a few of the respondents indicated that they are *required* to communicate the test results to the general public. Nevertheless, many do so voluntarily. Solvency results are mostly reported on annual or semi-annual basis, and the majority of the reported liquidity tests are on a semi-annual basis. Results are shown using system aggregates, possibly with some measures of distribution, so that they do not reveal the identity of individual institutions.⁵ For both solvency and liquidity tests, the majority of the public communication is channeled using the authorities' periodicals (e.g., Financial Stability Review). Solvency tests results are also sometimes communicated through special, comprehensive documents, such as those issued by the EBA or the U.S. Federal Reserve Board.

19. **Experience with public communication.** The main objectives of communication are reported to be (i) raising public awareness on financial stability, (ii) achieving transparency, and (iii) providing information to market participants. Overall, public communication seems to have provided positive experiences in terms of transparency and reinforcing confidence. However, several respondents voiced concerns, such as that public communication could create unrealistic expectations for stress tests; that mass media tend to interpret the results inconsistently; or that the communication process is too burdensome (as banks focus too much on communication aspects) and could undermine the effectiveness of stress tests as a supervisory tool.

⁵ Exceptions include the EBA tests and U.S. Supervisory Capital Assessment Program (SCAP) and Comprehensive Capital Assessment Review (CCAR).

III. DETAILED SURVEY RESULTS

A. Definition of Stress Testing

20. **Working definition of stress testing.** Twenty-one respondents have an established working definition of stress tests. These definitions are broadly similar: stress tests are “what if” exercises assessing the vulnerability and resilience of individual banks or the system using “extreme but plausible” shocks.

21. **Working definition of bottom-up (BU) stress testing.** Seventeen respondents have a working definition of BU stress tests. The majority of them define the tests as exercises implemented by individual institutions using their internal data and models but using common assumptions provided by a central authority (the central bank or supervisory institution). However, a few define the term differently, and include tests implemented with bank-specific assumptions (similar to stress tests banks conduct for their own internal risk management purposes) or tests implemented by the supervisor using bank-by-bank data available to the authority. The latter is defined as a top-down exercise by most respondents (see below).

22. **Working definition of top-down (TD) stress testing.** Eighteen respondents have a working definition of TD stress tests as exercises implemented by a central authority using (supervisory and/or public) bank-by-bank data and common assumptions and methodologies. A few consider TD exercises as those using aggregate data, rather than bank-by-bank data.

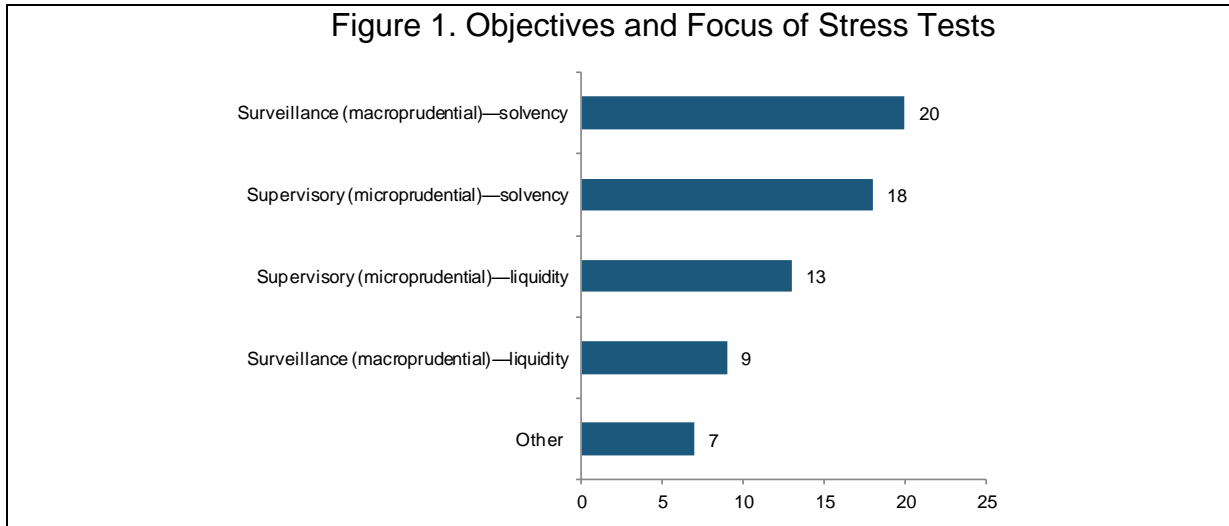
B. Banking Sector Stress Testing

Process

23. **Coverage.** Forty percent of respondents include, in addition to commercial banks, other deposit-taking institutions, such as credit cooperatives, nonbank finance companies, investment firms, and saving banks. When financial conglomerates (with an entity operating under banking license) are stress tested, some nonbank entities’ operations could be covered as well.

24. **Incidence of stress testing.** The formal use of stress tests has increased in two waves, one in the 2002–03 period, and another one in the 2008–10 period. About a half of the respondents were regularly using stress tests by 2003. In some cases, the Financial Sector Assessment Program (FSAP) provided the first opportunity to conduct stress tests.

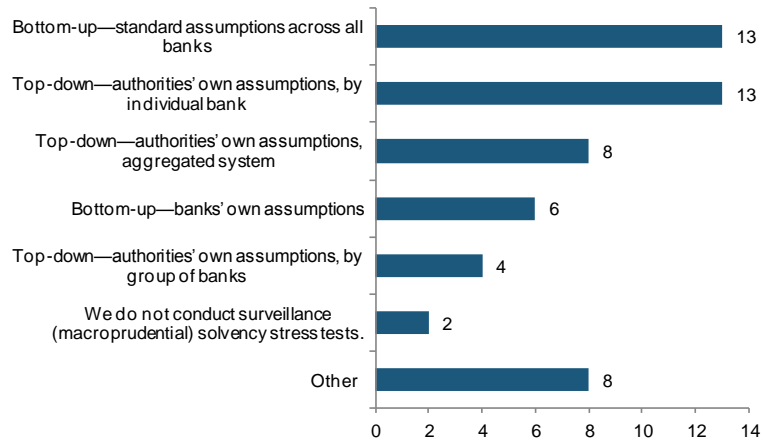
25. **Focus of stress tests.** Almost all respondents (25 out of 26) conduct solvency stress tests, while a lower number (16) also cover liquidity tests. This pattern is particularly apparent for surveillance (macroprudential) stress testing (Figure 1).



26. **Follow up.** Follow up to macroprudential stress tests varies among respondents for both solvency and liquidity tests. In both cases, about a half of respondents take action vis-à-vis the financial system or individual banks based on their macroprudential stress test findings. Responses suggest a wide variety of follow-up actions, ranging from using stress test results to inform on- and off-site examinations to requesting additional information or a detailed action plan for improving performance, including possible recapitalization.

Process for Solvency Stress Tests

27. **Types of solvency tests.** Most authorities carry out macroprudential stress tests using both TD and BU approaches. Two-thirds of the respondents implement bottom-up exercise using standard assumptions across banks, while another third allow adjusting assumptions in line with banks' risk profiles (Figure 2). The majority of the TD exercises are implemented using bank-by-bank data, though many authorities look at results from multiple levels of aggregation. The relative strength of each approach is the main criterion for choosing between TD and BU exercises: TD tests can impose uniform methodology while, by using banks' internal data, BU tests can better reflect each bank's risk profile. Only one respondent indicated they chose TD because they lacked confidence in the banks' capacity. Many authorities use both TD and BU, and emphasize the importance of running their own TD in order to cross-check BU results. When a country has a supervisory agency different from the central bank, there typically is a division of labor, with the supervisory agency focusing on BU and the central bank focusing on TD stress tests.

Figure 2. Types of Surveillance (Macroprudential) Solvency Tests¹

¹ Multiple answers were allowed.

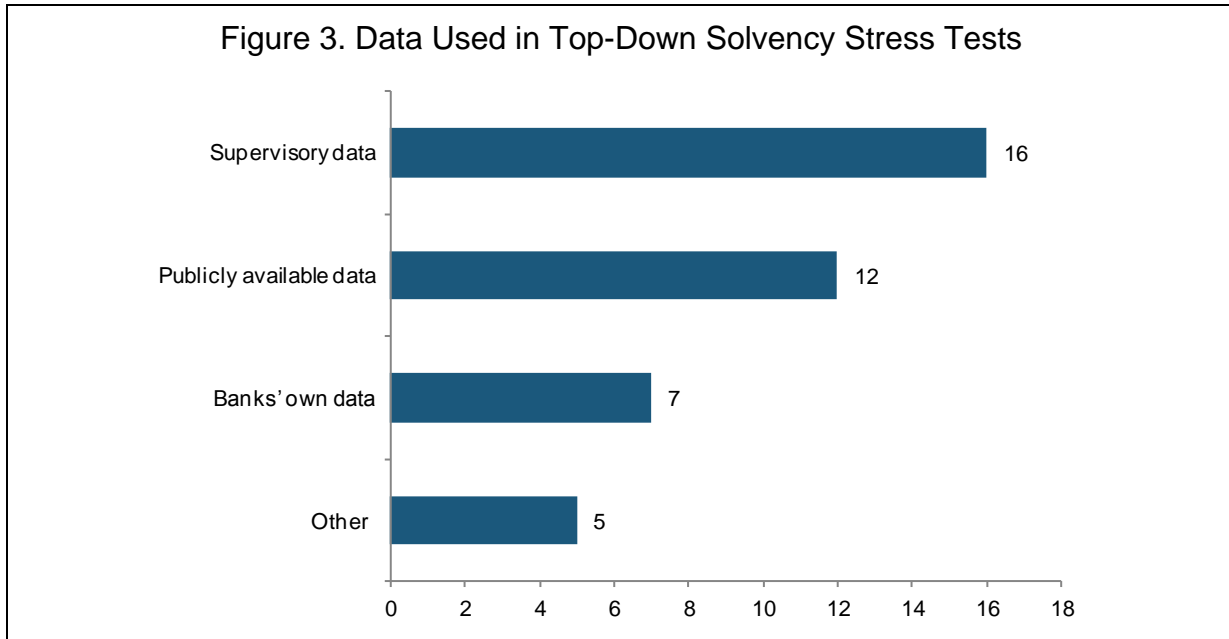
28. **Institutions included in solvency tests and test frequency.** Both TD and BU exercises cover similar samples, based on broadly shared criteria, ranging from 60 to 100 percent of the system by assets (the median is 85 percent for TD and 79 percent for BU tests). Private domestically-owned commercial banks are the main targets, followed by foreign subsidiaries and state-owned banks. Several countries cover other types of deposit-taking institutions. When coverage is not universal, covered institutions are chosen mainly based on their systemic relevance, using various measures of size and interconnectedness. Other criteria used to select covered institutions include the type of banking license, those with substantial local retail activities (in the case of international financial centers), or the sample defined by legislation. TD tests are conducted relatively more frequently (semi-annual or annual) than BU tests (mostly annual) (Table 1).

29. **Data used in TD solvency tests.** The majority of the authorities use supervisory or banks' own data for TD tests (Figure 3). Typically, multiple sources of data, including publicly available data, are used.

Table 1. Process of Bank Solvency Stress Tests*

	Top-down		Bottom-up	
	<i>Number</i>	<i>Percent</i>	<i>Number</i>	<i>Percent</i>
Types of banks included in the solvency tests				
Private sector commercial banks: domestically-owned	20	100	19	83
Private sector commercial banks: foreign subsidiaries	12	60	11	48
Building societies and mutuals	2	10	2	9
Savings banks	6	30	6	26
Cooperatives	5	25	6	26
State-owned banks	8	40	9	39
Not applicable	...	...	4	17
Total respondents	20	100	23	100
How to determine which institutions to include in the tests				
Based on your definition of systemic relevance (e.g., size, interconnectedness)	12	57	13	57
Based on collaboration with other agencies	2	10	1	4
Other	10	48	8	35
Not applicable	1	5	4	17
Total respondents	21	100	23	100
Frequency of the tests				
Quarterly	2	9	1	4
Semi-annually	8	36	2	9
Annually	5	23	10	43
No particular schedule, as and when needed	3	14	2	9
Not applicable	...	...	4	17
Other	4	18	4	17
Total respondents	22	100	23	100

* Multiple answers were allowed.



30. **Roles for central authority and financial institutions in BU solvency tests.** When managing BU exercises, the central authority (central bank or supervisory agency) typically takes the initiative to establish common assumptions, issue guidance, determine reporting templates, and selecting stress scenarios, mostly leaving the model selection to banks (Table 2). Other relevant parameters are also typically determined by individual banks, though nearly half of the authorities provide some guidance on these. Generally, the authorities seem to manage BU exercises in close collaboration with participating institutions.

Table 2. Bottom-up Solvency Tests: Contributions to the Test Process

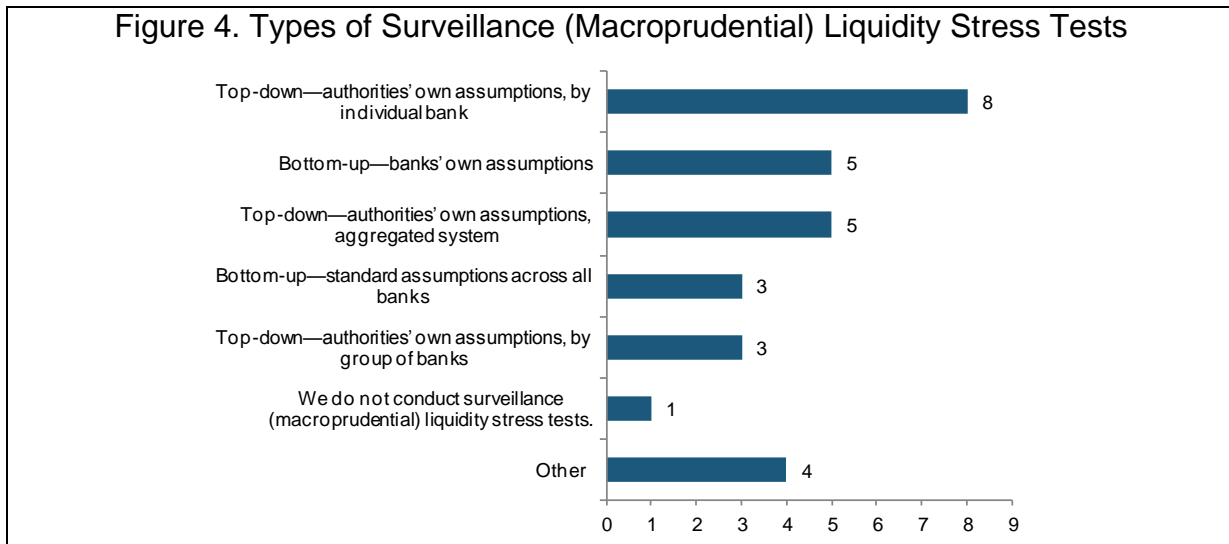
	Financial institutions		Authorities	
	Percent	Number	Percent	Number
Data	94.7	18	26.3	5
Model(s)	89.5	17	31.6	6
Assumptions/guidelines/prescriptions	26.3	5	100.0	19
Templates reporting output	21.1	4	94.7	18
Templates submitting inputs	27.8	5	77.8	14
Determination of stress scenarios	21.1	4	100.0	19
Calculation of parameters such as the probabilities of default	73.7	14	47.4	9

31. **Validation of BU solvency tests.** All 17 respondents that implement BU tests validate their results in some way. The primary means for validation are standard supervisory tools, including comparisons of reported stress test results to supervisory reports and on-site inspection results, examining the methodology used, comparing to previous results, and comparing to results in peer countries. Six out of the 17 respondents cross-check the BU results with TD outcomes.

Process for Liquidity Stress Tests

32. **Relatively fewer country authorities carry out regular liquidity stress tests, either for microprudential or macroprudential purposes, compared to solvency tests.** The processes of liquidity stress tests (coverage, uses of TD and BU tests, and frequency) are broadly similar to those for solvency tests. One difference is that liquidity tests rely more on banks' data and methodologies and provide greater flexibility to banks on detailed assumptions, especially in BU exercises. This could reflect the greater importance of institution-specific liquidity factors.

33. **Types of surveillance (macroprudential) liquidity stress tests.** Most of the respondents conduct macroprudential stress test using both TD and BU approaches. As in the case of solvency tests, the majority of the TD exercises use bank-by-bank data, though many authorities look at results of multiple levels of aggregation. On the other hand, unlike in solvency stress tests, the authorities use the banks' own assumptions for BU liquidity tests (Figure 4).



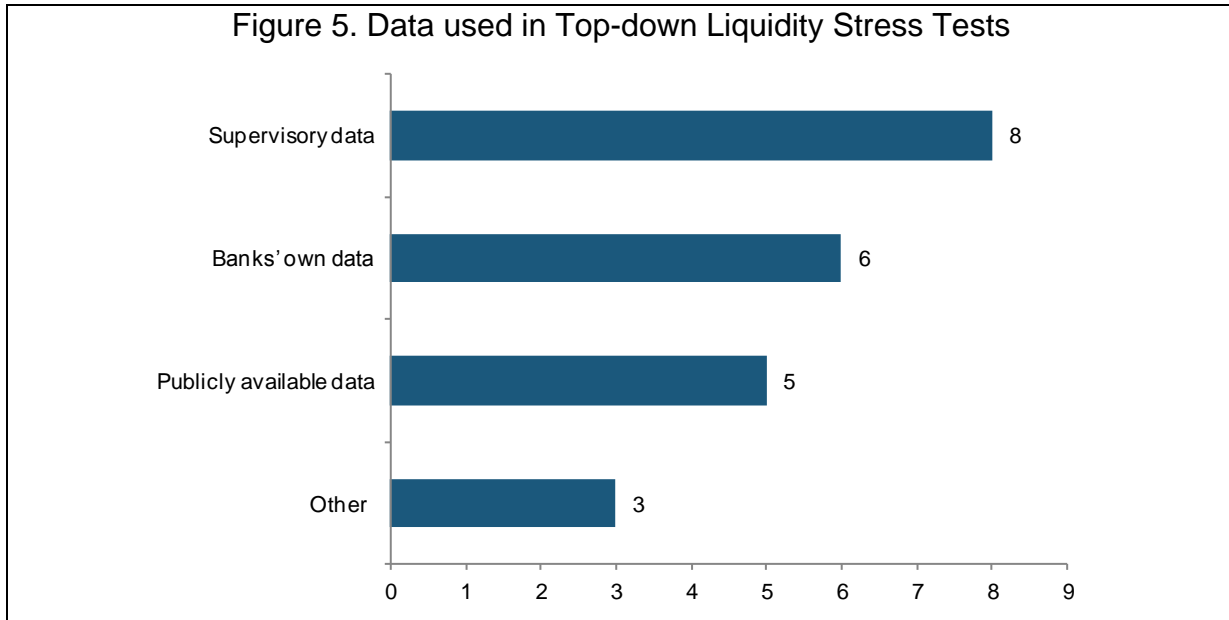
34. **Institutions covered in liquidity tests and test frequency.** Where liquidity stress tests are undertaken, the coverage and—when coverage is not universal—the sample selection criteria are the same as with the solvency stress tests: coverage ranges between 60–100 percent, with the at 85 percent of the system by assets for TD tests and 75 percent of the system for BU tests. Covered institutions are usually chosen mainly based on their systemic relevance, using some measures for size and interconnectedness. Private domestically-owned commercial banks are the key targets, followed by foreign subsidiaries and state-owned banks (Table 3). TD tests are conducted relatively more frequently (semi-annual or annual basis) than BU tests (mostly annual).

Table 3. Process of Bank Liquidity Stress Tests*

	Top-down		Bottom-up	
	Number	Percent	Number	Percent
Types of banks included in the liquidity tests				
Private sector commercial banks: domestic-owned	12	92	13	87
Private sector commercial banks: foreign subsidiaries	11	85	10	67
Building societies and mutual	3	23	2	13
Saving banks	5	38	5	33
Cooperatives	5	38	3	20
State-owned banks	9	69	10	67
Not applicable	...	...	2	13
Total respondents	13	100	15	100
How to determine which institutions to include in the tests				
Based on your definition of systemic relevance (e.g., size, interconnectedness)	5	33	3	20
Based on collaboration with other agencies	1	7	3	20
Other	9	60	1	7
Not applicable	2	13	10	67
Total respondents	15	100	15	100
Frequency of the tests				
Quarterly	1	6	1	7
Semi-annually	3	19	0	0
Annually	4	25	4	27
No particular schedule, as and when needed	2	13	3	20
Not applicable	...	...	3	20
Other	6	38	4	27
Total respondents	16	100	15	100

* Multiple answers were allowed.

35. **Data used in TD liquidity tests.** The majority of authorities that conduct liquidity stress tests use supervisory or banks' own data for the tests. Typically, multiple sources of data, including publicly available data, are used. Compared to solvency tests, the role of publicly available data is smaller, reflecting the limited use of publicly available data to analyze liquidity conditions (Figure 5).



36. Roles for central authority and financial institutions in BU liquidity tests.

Compared to BU solvency tests, authorities tend to give more room to individual institutions to manage BU liquidity tests. While the central authority retains a strong grip on scenarios and reporting templates, they rely almost 100 percent on banks for data and model selection, and banks provide more input on the assumptions and prescriptions of the exercise. Other relevant parameters are also mostly calculated by banks, with relatively little input from the central authority (Table 4).

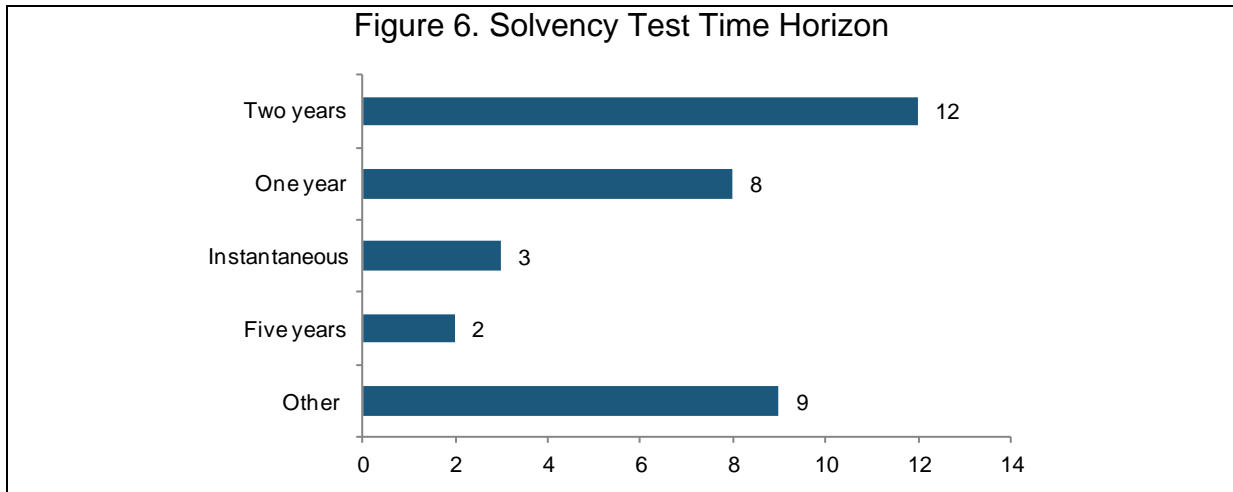
Table 4. Bottom-up Liquidity Tests: Contributions to the Test Process

	Financial institutions		Authorities	
	Percent	Number	Percent	Number
Data	100.0	12	0.0	0
Model(s)	100.0	11	9.1	1
Assumptions/guidelines/prescriptions	58.3	7	66.7	8
Templates reporting output	16.7	2	83.3	10
Templates submitting inputs	58.3	7	41.7	5
Determination of stress scenarios	27.3	3	72.7	8
Calculation of parameters such as the probabilities of default	100.0	8	12.5	1

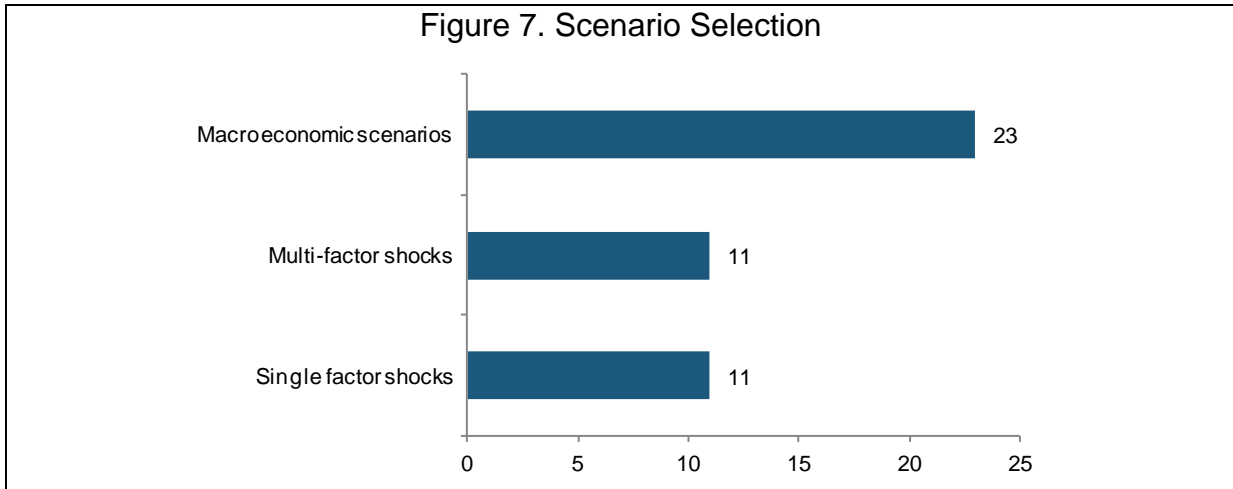
37. Validation of BU liquidity tests. Compared to BU solvency tests, a smaller share of authorities (8 out of 11) validates BU liquidity test results. In those cases, as with solvency tests, the primary means for validation are standard supervisory tools, including comparisons of reported stress test results to supervisory reports and on-site inspection results, examining the methodology used, comparing to previous results, and comparing to results in peer countries. Half of the respondents cross-examine the BU liquidity test results with TD outcomes.

Solvency Stress Tests: Risk and Scenario Selection

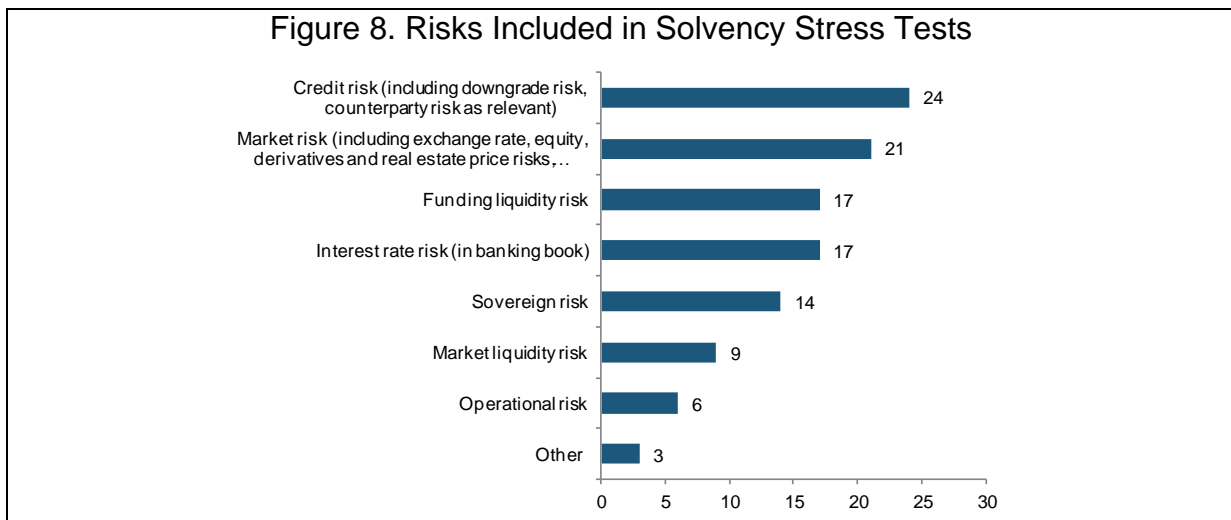
38. **Time horizon of solvency tests.** The majority of solvency tests have a horizon of two years. Instantaneous tests are used in only a handful of cases (Figure 6). Capturing the full extent of credit risk, which would require a horizon of at least one year, is the main reason for choosing longer horizons. Many authorities indicated that exercises with horizons longer than three years involve too much uncertainty and a large margin of error, even though longer horizons may be needed to capture fully the effects of Basel III implementation.



39. **Scenario and shock selection.** Most respondents apply macroeconomic scenarios, and many apply separately additional single- and multi-factor shocks (Figure 7). Baseline scenarios are usually taken from macroeconomic forecasts by other departments in the same agency, external agencies (IMF and ECB, among others), or market consensus forecasts, or are produced by internal models. Stress scenarios are generated by reference to historical data (e.g., “historical worst,” multiples of the worst, standard deviations, percentiles) or to expert or external judgment or prescription (market analysis and EBA scenarios, among others). Six respondents indicated that they target a specific likelihood for the assumed shocks, ranging from 1 to 5 percent; four indicated they tailor the assumed shocks to historical worst or recent recession episodes; and another four indicated they use worse than historical worst. Several said they do not impose any specific probability of occurrence. However, the answers do not clarify the length of historical period used to calculate the likelihood.



40. **Risk factors included in solvency tests.** All respondents include credit risk, and the majority of them also include market, banking book interest rate, and funding liquidity risks (Figure 8). About 60 percent also include own and sovereign risk.⁶ Credit risk is most commonly modeled by linking PD and LGD to macroeconomic variables, while some work with credit ratings frameworks. A few respondents consider additional aspects of credit risk, such as counterparty risk using credit valuation adjustment (CVA) sensitivities, and incremental default rate models. There is some variety in the extent that market risks are incorporated: methodologies range from Value at Risk (VaR) to revaluation methods, and sensitivity analysis. The range of market risk parameters incorporated in the test varies as well: one respondent indicated assessing 90 parameters, but most others indicated smaller numbers. Sovereign risk is modeled by applying haircuts for calculating mark-to-market losses on sovereign securities.



⁶ The questionnaire did not distinguish between own and foreign sovereign risk.

41. **The evolution of risk factors included in solvency stress tests over time.** Before the global financial crisis, credit risk, funding/liquidity risk, and asset prices (including property and stocks) were the main risk factors examined by stress tests, followed by macroeconomic factors (growth, inflation, fiscal deficit, unemployment) and interest rate risks. After the crisis, the relevance of liquidity/funding and contagion and cross-border spillover effects (especially those from European sovereign crisis) increased dramatically. In addition, new risk factors—such as sovereign risk, low profitability, regulation-related risks, and credit crunch—have gained relevance (Table 5).

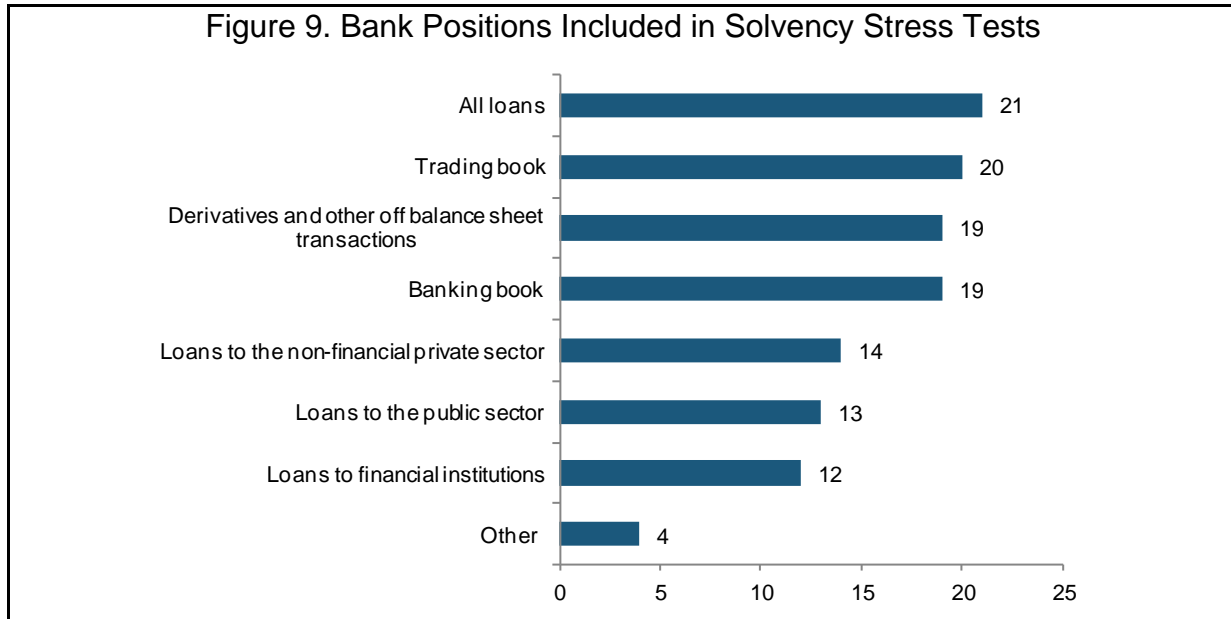
42. **Modeling the co-movement of multiple risk factors.** Over 70 percent of respondents include scenarios with joint movement of multiple risk factors. Most implement this by formulating macro-financial scenarios that affect credit and market risk parameters simultaneously (see next sub-section). But only a few try to model explicitly the interaction between credit and market risks with counterparty risk.

Table 5. Ranking of Risk Factors in Stress Tests Before and After the Financial Crisis

	<i>Pre crisis</i>		<i>Post crisis</i>	
	Rank	Number of responses	Rank	Number of responses
Liquidity and funding	2	11	1	18
Contagion and spillovers (incl., capital flows)	6	6	2	14
Asset prices (incl., properties and stocks)	2	11	3	9
Credit risk	1	12	4	8
Sovereign risk	...	0	5	6
Interest rate risk	5	8	6	5
Macroeconomic risk	4	9	7	4
Market risk	8	4	7	4
Foreign exchange rate risk	8	4	7	4
Low profitability risk	...	0	7	4
High leverage in non-financial sectors	7	5	11	3
Risks from debt securities (incl., structured products)	11	3	11	3
Regulation-related risks	13	1	11	3
Credit crunch	...	0	11	3
Interconnectedness	...	0	15	2
Excessive growth and risk-taking	8	4	16	1
Operational risk	12	2	16	1
Concentration risk	12	2	...	0

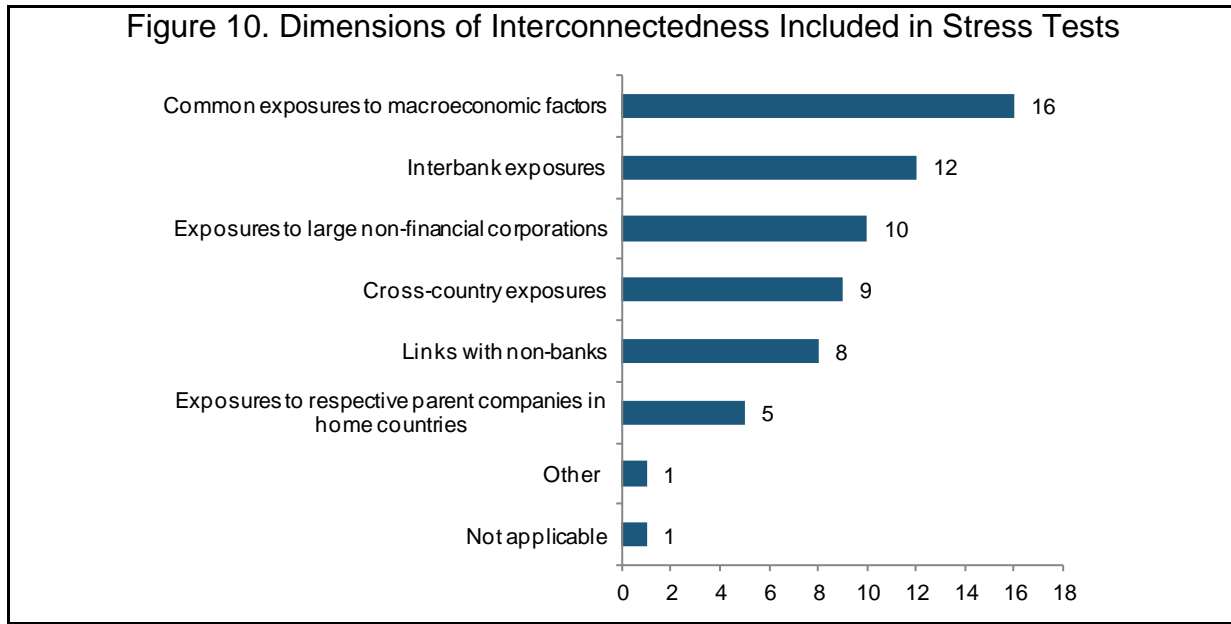
43. **Validation and consistency check of risk parameters.** Over 90 percent of respondents cross-check the risk parameters by comparing to historical data and to peers, but also by follow-up supervisory review.

44. **Exposures examined in the exercises.** Most respondents indicate that the entire loan book is subject to shocks, but some include only some components of loan exposures. Others exclude specific exposures (e.g., cross-border loan exposures through subsidiaries, household loans). About 80 percent of the respondents examine potential losses from off-balance sheet items and banking and trading book exposures.



45. **Data sources.** As already indicated, the majority of respondents use both accounting data and market data sources. Eight out of 24 respondents use “primarily” accounting data (including confidential supervisory data), while the rest indicate using both sources. Market data are often used to stress trading book exposures and sovereign risk (i.e., market-price implied haircuts on securities). However, they are only marginally used in estimating credit risk parameters (e.g., PD and LGDs of loans).

46. **Elements of systemic risk and interconnectedness incorporated in solvency tests.** Systemic risk is mostly modeled by assuming distress on exposures to systemic factors (such as macroeconomic shocks and sovereign exposures) and/or by using interbank contagion models. Most respondents reported difficulties with incorporating second-round effects that capture feedback from the financial sector to the rest of the economy. Respondents also struggle with accounting for interconnectedness. Some elements of interconnectedness are occasionally covered by introducing additional model features to the base model (in 11 out of 23 responses) or by prescribing additional assumptions (5 out of 23 respondents). Several respondents run separate sensitivity tests for interconnectedness (Figure 10).



47. **Other assumptions.** Bank balance sheets are typically assumed to be static with the same portfolio structures and size during the test horizon (10 out of 23 respondents). A few respondents, however, assume that the balance sheet evolves as projected by banks (five responses) or grows at a constant rate (two responses). Asset disposals are occasionally allowed, as agreed with the authority on a case-by-case basis (typically, when they reflect already closed deals). Dividend payout (when there are positive profits) is mostly assumed to be in line with the banks' own history, though some stress tests assume no payouts. In some tests (including instantaneous tests), profits during the test periods are not considered at all.

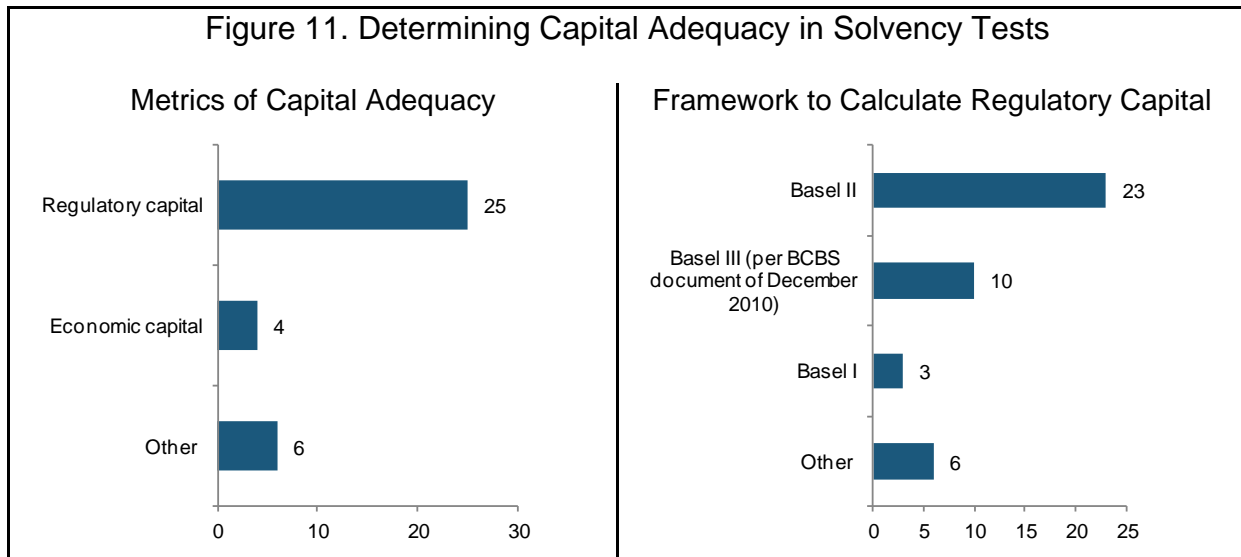
Solvency Stress Tests: Macrofinancial Linkages

48. **Macroeconomic modeling.** The large majority of respondents use macroeconomic models to set out macro stress testing scenarios, including those developed by other departments of the agency conducting the tests or other agencies (e.g., the research department of a central bank, or models used for monetary policy decision purposes). Models range from simple VAR and other structural econometric models to DSGE models. However, these macro models usually do not include the financial sector, and therefore, it is necessary to estimate additional macrofinancial linkage models that describe the relationship between bank performance (such as PD, LGD, and NPL ratios) to macroeconomic indicators (such as GDP growth rate).

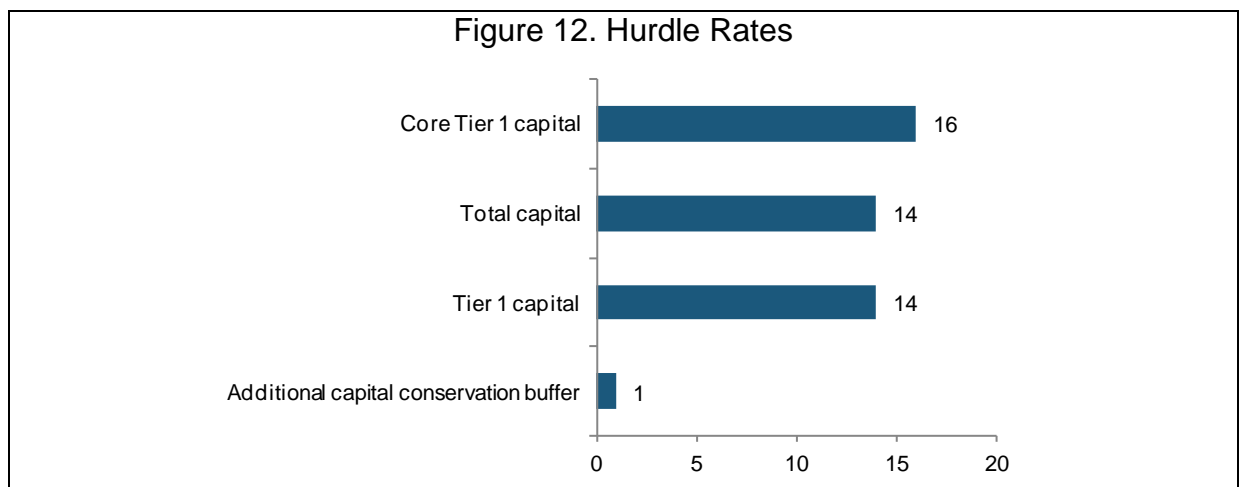
49. **Modeling macrofinancial linkages.** In most cases, macroeconomic shocks in stress tests affect bank solvency through their impact on certain balance sheet items (e.g., valuation losses) and income statement items (e.g., provisioning expenses for credit losses, trading losses, and interest income). On the other hand, only a couple of respondents map the results of stress tests back into the macroeconomic scenarios in order to capture feedback effects from the financial sector to the macroeconomy. Only one has an established macroeconometric model including the financial sector.

Solvency Stress Tests: Determining Capital Adequacy

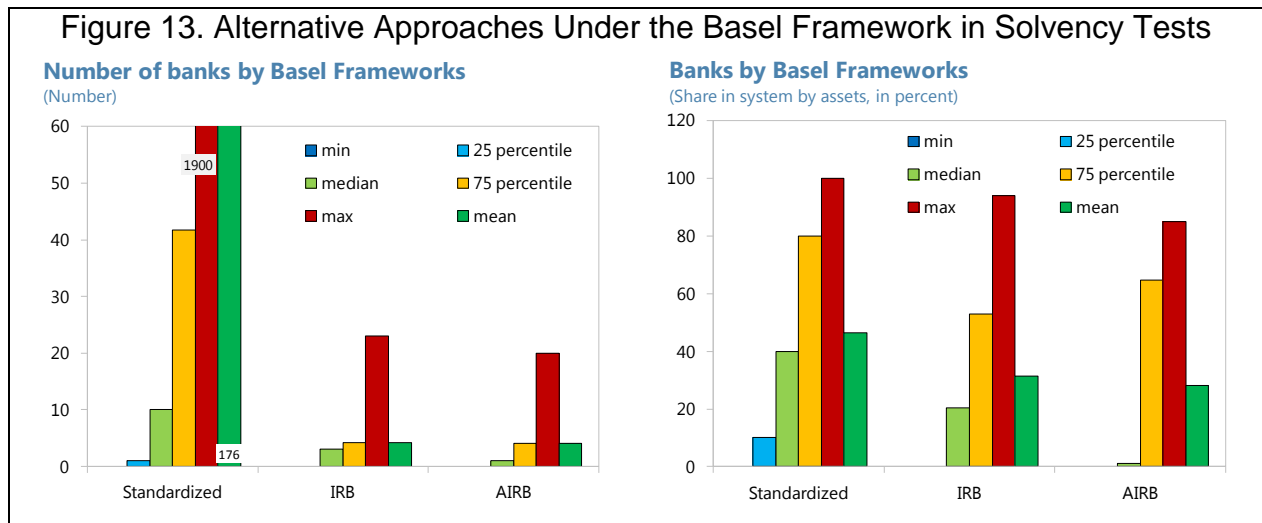
50. **Definition of capital for stress test purposes.** All respondents examine the impact of shocks on regulatory capital. In addition, some study economic capital and other capital ratios, such as common Tier 1. Most authorities use the Basel II framework, but 40 percent of respondents also use Basel III framework (Figure 11). Some European respondents adopted the capital definition used in EBA stress tests. Use of the Basel I definition is limited, as most of the sample countries have already adopted the Basel II capital requirement framework.



51. **Hurdle rates.** In setting hurdle rates to judge the resilience of banks, the total, Tier 1, and core Tier 1 capital ratios are equally used (Figure 12). So far, none of the respondents are using additional capital conservation buffers or charges specific to systemically important financial institutions (SIFI) in the context of Basel III in setting hurdle rates. For most authorities, the core Tier 1 ratio hurdle rate ranges from 4 to 7 percent, the Tier 1 ratio hurdle rate ranges from 4 to 8, and total capital hurdle rate ranges from 8 to 11 percent.



52. **Alternative approaches within the Basel framework.** The majority of the jurisdictions participating in the survey include banks operating under different risk management approaches recognized in the Basel framework. Most banks use standardized approaches, though their share in the system (by assets) tends to be smaller. A smaller number of banks use IRB and AIRB approaches, and these tend to be the larger and more systemically important institutions (Figure 13). When a stress test is applied to a system including banks subject to different approaches, nearly half of the respondents do not attempt to reconcile potential gaps, as it would be too difficult. Others compare results among peer groups using the same approach: cross-check the results with TD calculation using standardized or IRB approaches, and cross-check the results of standardized approach banks with the average results of IRB banks.



53. **Methods to map portfolio losses and profits to solvency ratio.** The solvency ratio is capital over RWA, and both numerator and denominator could potentially change in a stress scenario. The approaches differ widely regarding the impact of assumed shocks on RWA.

- The impact of assumed shocks on the numerator is calculated in a more or less similar way across jurisdictions: credit costs and net losses from various portfolios are subtracted from capital (adjusted for current year profits, dividend, and tax). While the method of calculating credit losses differs depending on the model (some work with the nonperforming loan (NPL) ratio and provisioning rate, while others work with changes in expected losses using PD and LGD framework), once credit losses are estimated, their impact on the solvency ratio is computed in more or less the same manner.
- In contrast, the impact on RWA is calculated very differently across jurisdictions. Nine out of 24 respondents indicate stressed RWA would increase in line with deterioration of risk parameters (such as PD and LGD) in line with the Basel II framework. Three respondents replied that stressed RWA would decline as impaired assets (those that are provisioned) are taken out from exposures and hence RWA. One keeps RWA constant,

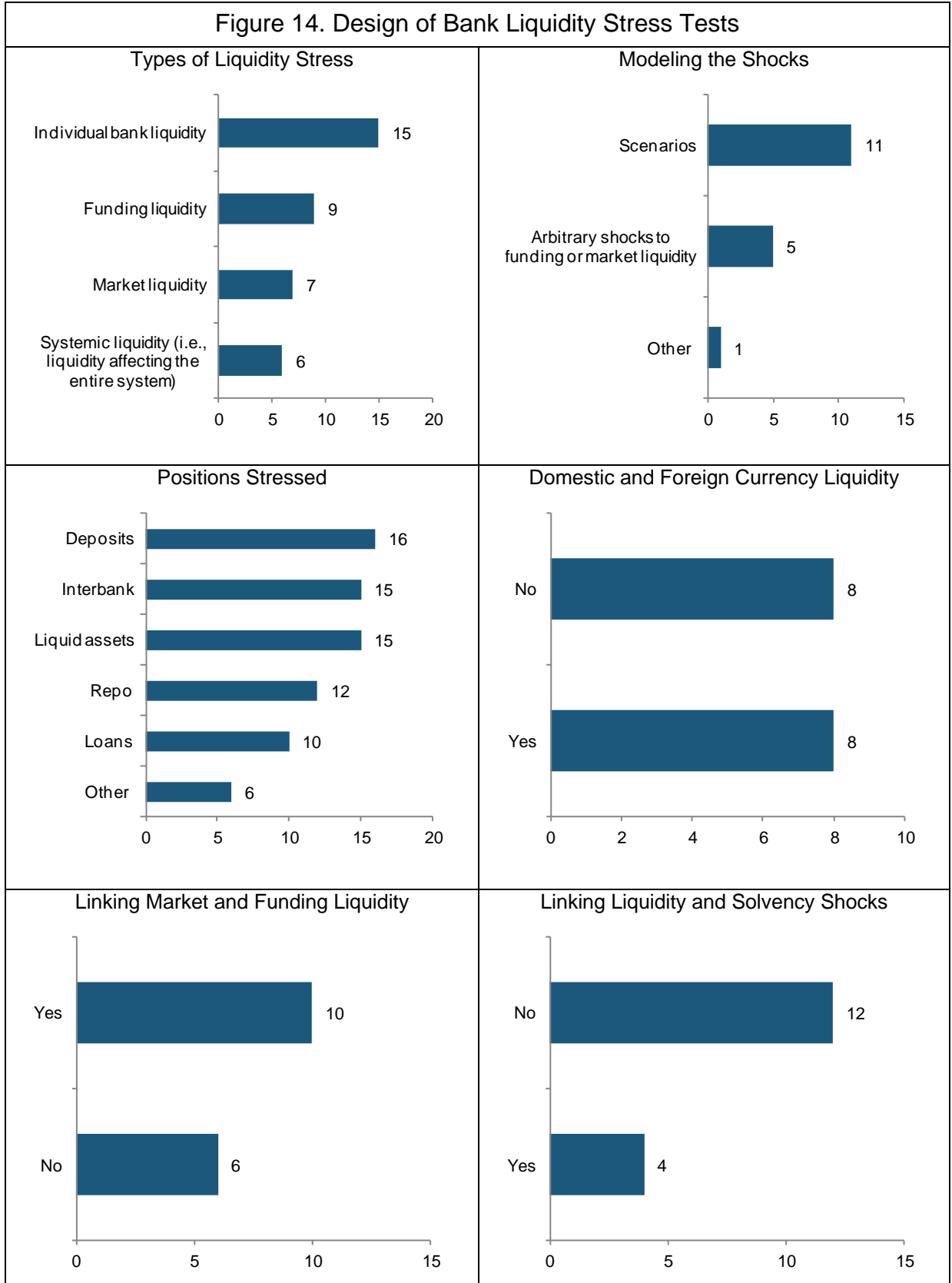
and another indicated it applies a fixed percentage change. The other respondents did not specify how they treat RWA in stress tests.

Liquidity Stress Tests

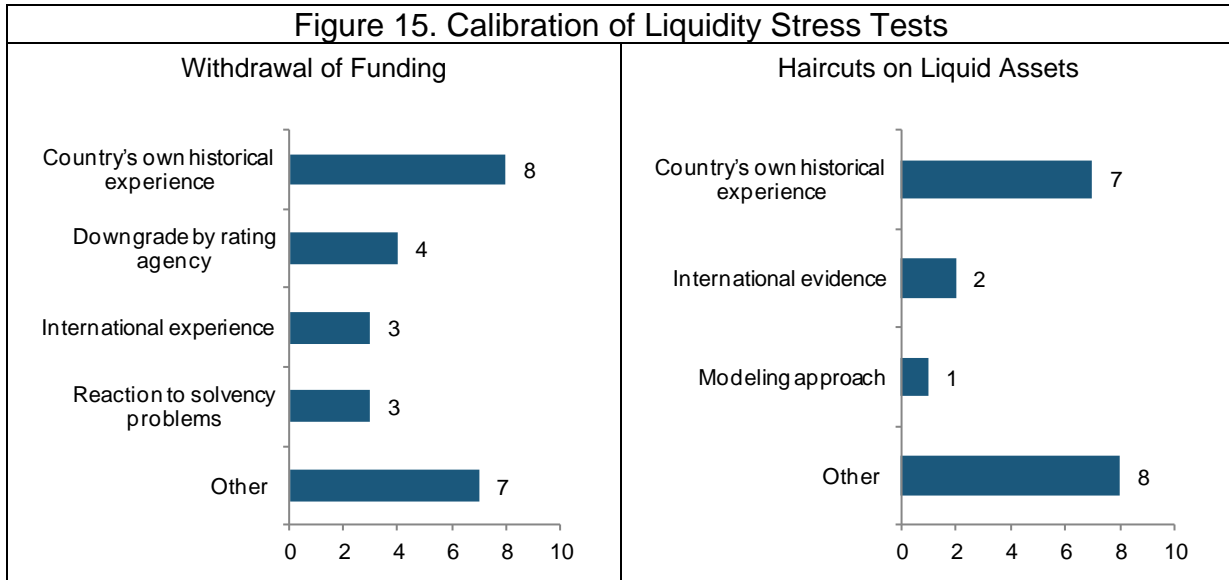
54. **Scenario and shock selection, risk factors, and exposures covered.** Liquidity stress tests primarily focus on individual bank liquidity, although a number of authorities also examine disruptions in market, funding and, to a lesser extent, systemic liquidity (Figure 14). All respondents analyze deposit withdrawals, and most of them consider disruptions in interbank positions and declines in liquid asset values. The majority of them also assess shocks to repo and loan positions. In addition, a few consider liquidity needs from off-balance sheet positions under stress, as well as from disruption of wholesale funding channels (both secured and unsecured). In about half of the cases, domestic and foreign exchange liquidity is stressed separately. About two-thirds of the respondents link market and funding liquidity in the tests, often by considering a liquidity stress scenario that assumes liability withdrawal (a funding liquidity shock) and a reduction in liquid assets' value (a market liquidity shock) simultaneously.

55. **Integration with solvency stress tests.** Most of the liquidity stress tests are implemented independently of solvency tests. Among the few respondents linking the two, two integrate liquidity stress into solvency stress by explicitly accounting for the impact of higher funding costs due to liquidity stress in profits; and another incorporates solvency and liquidity stress by assuming higher funding costs as a result of lower solvency ratio under stress and reduced cash flow due to loan losses and reduction in repayments.

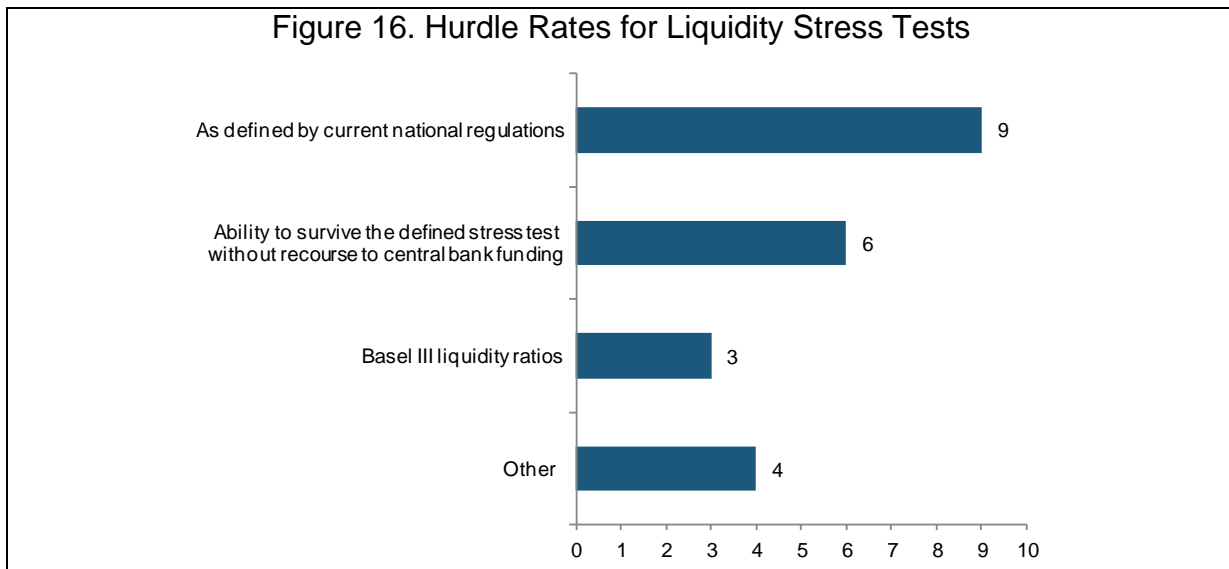
Figure 14. Design of Bank Liquidity Stress Tests



56. **Calibration of liquidity stress tests.** The country's own experience is the most frequently used source in establishing liquidity stress parameters. In establishing liability run-off rate assumptions, alternative approaches include using banks' own estimate, reviewed by supervisors; expert judgment; or regulatory guidance. Most respondents indicate that liquidity stress scenarios also include haircuts on liquid assets. To establish the extent of the assumed haircuts, in addition to the country's own history, respondents rely on international experience, expert judgment, banks' own estimate, arbitrary shocks, or the haircuts applied by the central bank for its refinancing operations (Figure 15).

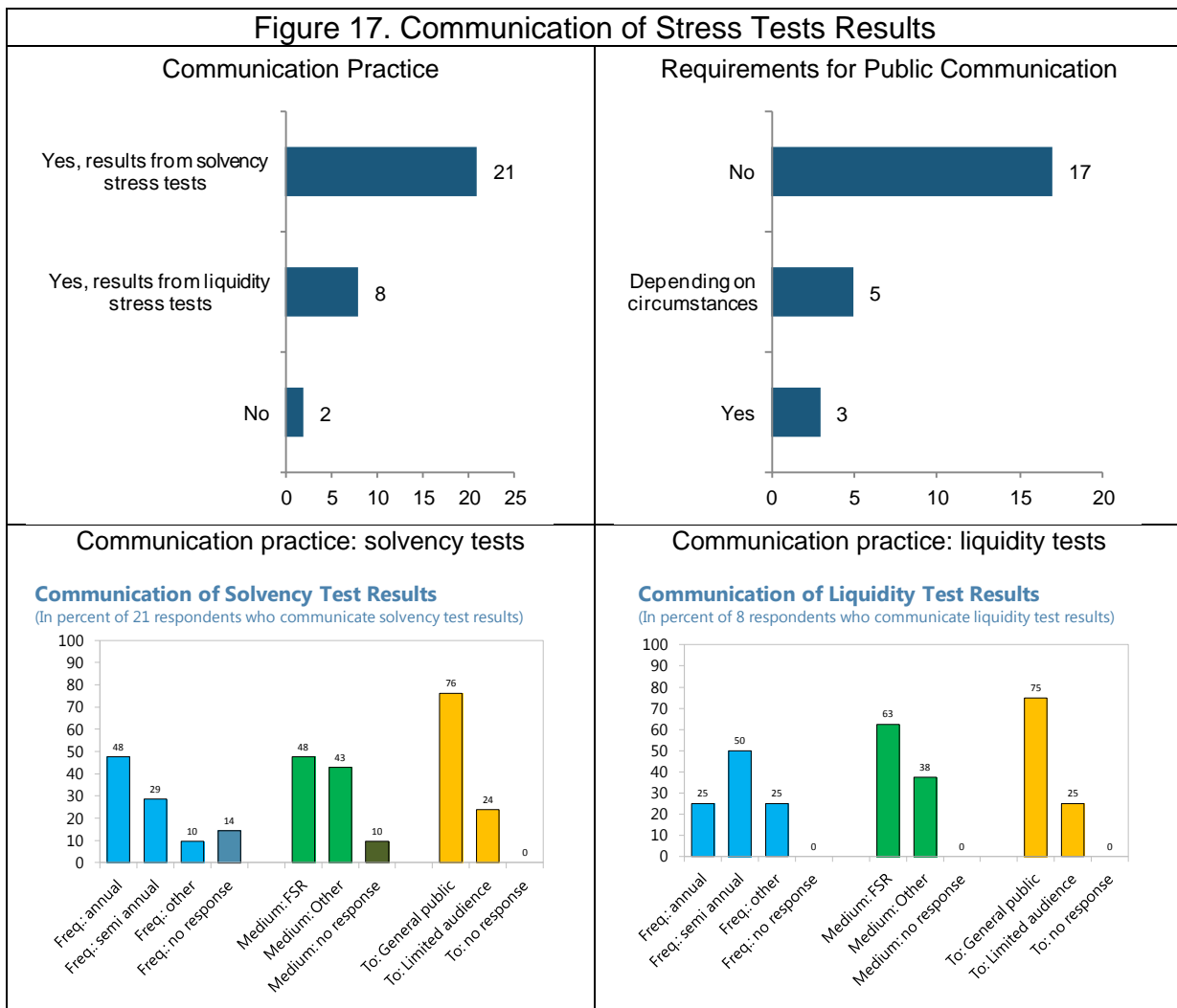


57. **Hurdle rates.** While the majority of the authorities judge the liquidity conditions of a bank based on current or prospective (Basel III) regulatory requirements, some also rely on other economic measures, such as the ability to survive without relying on central bank funding (Figure 16).



C. Communication of Stress Test Assumptions and Results

58. **Communication practices and requirements.** Communication practices vary between liquidity and solvency tests: 84 percent of respondents (21 out of 25 institutions that conduct solvency tests) communicate the results of these tests outside of their institutions, while 50 percent of the respondents (8 out of 16 institutions that conduct liquidity tests) communicate liquidity tests (Figure 17). Most of the authorities are not *required* to communicate the test results publicly, but some are (e.g., those bound by EBA policies or the Dodd-Frank Act in the U.S.). When communicated, solvency stress test results are mostly communicated on an annual or semi-annual basis, while liquidity tests are communicated more frequently. In both cases, the majority of the communication is aimed at the general public using the authorities’ regular publications (notably Financial Stability Reviews). In some cases, solvency stress test results are also communicated in special, comprehensive documents, such as those issued by the EBA or the U.S. Federal Reserve. For both liquidity and solvency tests, public communications in most cases use system aggregates, possibly with some distribution measures, so that the results do not disclose the identity of individual institutions. There are, however, exceptions to this, notably for the recent EU-wide stress testing exercises or the U.S. SCAP and CCAR exercises.

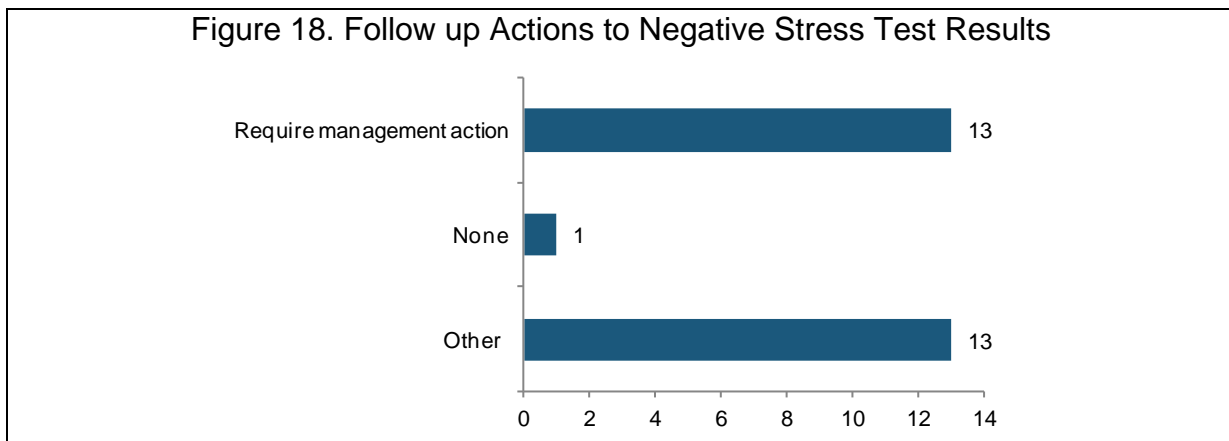


59. **Objectives of communication.** Raising public awareness of financial stability, achieving transparency, and providing information to market participants are reported as the main goals of public communication (12 out of 23 respondents). Eight respondents also mention the goal of influencing the financial institutions' risk management.

60. **Experiences with public communication.** Overall, public communication seems to have provided positive experiences in terms of transparency and reinforcing confidence. However, several respondents voiced concerns, such as that public communication could create unrealistic expectations for stress tests; that mass media tend to interpret the results inconsistently; or that the communication process is too burdensome (as banks focus too much on communication aspects) and could undermine the effectiveness of stress tests as a supervisory tool.

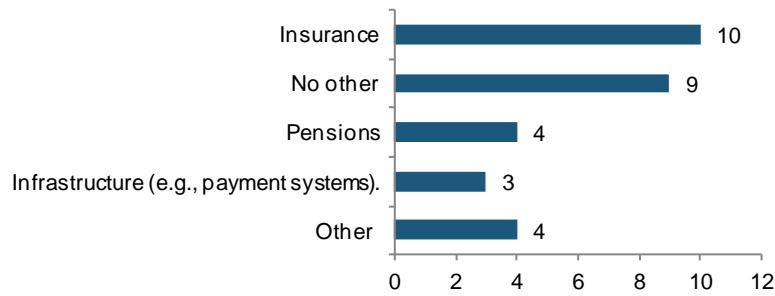
D. Other Questions

61. **Follow up actions.** If stress test results are negative (individual financial institutions fail to meet the hurdle rate), about half of the respondents reported that they routinely follow up with supervisory action, such as informing on-site inspection officers, collecting more information from specific institutions, discussing results with other relevant agencies, and conducting targeted examinations. An equal number also follow up by requiring bank management to undertake specific actions, such as raising additional capital, reviewing business strategies, reducing certain exposures, capping dividend payouts, and updating resolution plans (Figure 18).



62. **Stress testing the nonbank financial sector.** About 40 percent of the respondents test only the banking sector. Stress tests of the insurance sector are a distant second (Figure 19). Three respondents started insurance stress tests in the 1990s, and several others have started exercises more recently in the context of EU-wide exercises to prepare for Solvency II. Four respondents conduct pension sector stress tests, though not all of them do the exercise regularly. Tests of financial market infrastructure are organized in a much more ad hoc manner, if at all. Other types of institutions that are stress tested include brokerage houses, and key nonbank financial institutions designated by regulation.

Figure 19. Stress Testing of Nonbank Financial Sectors



63. **Responsibility for conducting stress tests.** Central banks and supervisory authorities tend to share responsibility or collaborate closely for stress testing the banking sector. The tests of the insurance and pension segments are implemented mainly by the respective supervisors. For banking sector stress tests, 8 out of the 19 respondents are central banks with supervisory responsibilities, conducting both micro- and macroprudential stress tests. When the supervisory agency is separate from the central bank, the former tends to focus on microprudential stress tests and the central bank on macroprudential tests. Insurance and pension stress tests are conducted by the respective supervisors. In the four cases where respondents indicated that financial market infrastructures are tested, central banks play the key role.

64. **Inter-agency coordination for stress tests across different financial sectors.** Three-quarters of respondents, including those in jurisdictions with a unified supervisory framework, indicate that there are efforts to coordinate stress testing exercises across departments in the same agency or across agencies. While the extent of this effort is not clear from the responses, the typical forms of coordination include creating working groups; meeting regularly to discuss scenarios, assumptions, and results; and holding discussions in high-level Financial Stability Councils.

65. **Reverse stress tests.** The use of reverse stress tests is limited: only 6 out of 25 respondents require banks to run reverse stress tests. Most of these cases are part of the internal capital adequacy assessment processes, not for macroprudential purposes. One respondent, however, indicates that the requirement for reverse stress tests also extends to other major nonbank financial institutions.

66. **Plans to develop stress test models/frameworks.** Most respondents are striving to upgrade their existing stress testing framework and models. The highest reported priorities are incorporating contagion, second-round effects, and interconnectedness among major financial institutions. Other respondents highlight the importance of extending the exercise to cover nonbank financial institutions; introducing full-fledged macro scenario test framework (in cases where it has not yet been introduced); strengthening liquidity tests; and enhancing or introducing better TD tests that could function as cross-checks for BU tests and help improve the consistency of BU exercises across financial institutions.

APPENDIX I. SURVEY QUESTIONNAIRE

Introduction

Does your institution have a working definition of “stress testing”?

- Yes. Please define _____.
- No.

Does your institution have a working definition of “bottom-up” stress testing?

- Yes. Please define _____.
- No.

Does your institution have a working definition of “top-down” stress testing?

- Yes. Please define _____.
- No.

Banking Sector

A. Process

Do your stress tests of the “banking sector” also cover other deposit-taking institutions (e.g., building societies, mutuals)?

- Yes. Please define _____.
- No.

In what year did your institution begin formally running stress tests, i.e., the results were formally used in policy discussions/implementation? _____.

What is your key focus when conducting stress tests? (Must select at least one in order to continue with the questionnaire.)

- Solvency.
- Liquidity.

What objective(s) guides your stress tests?

- Surveillance (macroprudential)—solvency.
- Surveillance (macroprudential)—liquidity.
- Supervisory (microprudential)—solvency.
- Supervisory (microprudential)—liquidity.
- Other. Please specify _____.

A.1. Solvency Stress Tests

What type(s) of **surveillance (macroprudential) solvency** stress test(s) do you conduct?

- Top-down—authorities' own assumptions, by individual bank.
- Top-down—authorities' own assumptions, by group of banks.
- Top-down—authorities' own assumptions, aggregated system.
- Bottom-up—standard assumptions across all banks.
- Bottom-up—banks' own assumptions.
- We do not conduct **surveillance (macroprudential) solvency** stress tests. This question is not relevant.
- Other. Please specify _____.

What drives your decision on whether to run **bottom-up** or **top-down solvency** stress tests?

- We choose top-down stress tests because we lack confidence in the capacity of banks to run bottom-up stress tests.
- We choose bottom-up stress tests because banks have better information on their own risk profiles.
- Top-down stress tests have the advantage of applying a more uniform methodology
- Other. Please specify _____.

What types of banks are included in your **top-down solvency** stress test sample?

- Private sector commercial banks—domestic-owned.
- Private sector commercial banks—foreign subsidiaries.
- Building societies/mutuals.
- Savings banks.
- Cooperatives.
- State-owned banks.

How many banks participate in your **top-down solvency** stress testing exercise and what proportion of total banking sector assets do they represent?

Number of banks: _____.

Proportion of total banking sector assets: _____.

How do you determine which institutions to include in the **top-down solvency** exercise?

- Based on your definition of systemic relevance (e.g., size, interconnectedness, etc.), which is _____.
- Based on collaboration with other agencies. Please specify _____.
- Other. Please specify _____.
- Not applicable.

How often do you conduct your **top-down solvency** stress testing exercises?

- Quarterly.
- Semi-annually.

- Annually.
- No particular schedule, as and when needed.
- Other. Please specify _____.

What data do you use in your **top-down solvency** stress tests?

- Supervisory data.
- Banks' own data.
- Publicly available data.
- Other. Please specify _____.

What types of banks are included in your **bottom-up solvency** stress test sample, if applicable?

- Private sector commercial banks—domestic-owned.
- Private sector commercial banks—foreign subsidiaries.
- Building societies/mutuals.
- Savings banks.
- Cooperatives.
- State-owned banks.
- Not applicable.

How many banks participate in your **bottom-up solvency** stress testing exercise and what proportion of total banking sector assets do they represent, if applicable?

Number of banks _____.

Proportion of total banking sector assets _____.

How do you determine which institutions to include in the **bottom-up solvency** exercise, if applicable?

- Based on your definition of systemic relevance (e.g., size, interconnectedness, etc.), which is _____.
- Based on collaboration with supervisors.
- Other. Please specify _____.
- Not applicable.

How often do you conduct your **bottom-up solvency** stress testing exercises, if applicable?

- Quarterly.
- Semi-annually.
- Annually.
- No particular schedule, as and when needed.
- Not applicable.
- Other. Please specify _____.

For **bottom-up solvency** stress tests, who (either financial institutions or authorities) contributes the following items to the process, if applicable?

	Financial institutions	Authorities
Data	<input type="checkbox"/>	<input type="checkbox"/>
Model(s).	<input type="checkbox"/>	<input type="checkbox"/>
Assumptions/guidelines/prescriptions.	<input type="checkbox"/>	<input type="checkbox"/>
Templates reporting output	<input type="checkbox"/>	<input type="checkbox"/>
Templates submitting inputs	<input type="checkbox"/>	<input type="checkbox"/>
Determination of stress scenarios.	<input type="checkbox"/>	<input type="checkbox"/>
Calculation of parameters such as the probabilities of default	<input type="checkbox"/>	<input type="checkbox"/>
Not applicable	<input type="checkbox"/>	<input type="checkbox"/>
Other. Please specify _____.		

If **bottom up solvency** stress tests are conducted, do you validate the results for quality assurance purposes?

- Yes. Please specify _____.
- No.
- Not applicable.

Are you required to take any action with respect to the financial system or individual banks based on your **surveillance (macroprudential) solvency stress test** findings?

- Yes. Please specify _____.
- No.
- Not applicable.

A.2. Liquidity Stress Tests

What type(s) of **surveillance (macroprudential) liquidity** stress test(s) do you conduct?

- Top-down—authorities' own assumptions, by individual bank.
- Top-down—authorities' own assumptions, by group of banks.
- Top-down—authorities' own assumptions, aggregated system.
- Bottom-up—standard assumptions across all banks.
- Bottom-up—banks' own assumptions.
- We do not conduct **surveillance (macroprudential) liquidity** stress tests. This question is not relevant.
- Other. Please specify _____.

What drives your decision on whether to run bottom-up or top-down **liquidity** stress tests?

- We choose top-down stress tests because we lack confidence in the capacity of banks to run bottom-up stress tests.
- We choose bottom-up stress tests because banks have better information on their own risk profiles.
- Top-down stress tests have the advantage of applying a more uniform methodology
- Other. Please specify _____.

What types of banks are included in your **top-down liquidity** stress test sample?

- Private sector commercial banks—domestic-owned.
- Private sector commercial banks—foreign subsidiaries.
- Building societies/mutuals.
- Savings banks.
- Cooperatives.
- State-owned banks.

How many banks participate in your **top-down liquidity** stress testing exercise and what proportion of total banking sector assets do they represent?

Number of banks _____.

Proportion of total banking sector assets _____.

How do you determine which institutions to include in the **top-down liquidity** exercise?

- Based on your definition of systemic relevance (e.g., size, interconnectedness, etc.), which is _____.
- Based on collaboration with other agencies. Please specify _____.
- Other. Please specify _____.
- Not applicable

How often do you conduct your **top-down liquidity** stress testing exercises?

- Quarterly.
- Semi-annually.
- Annually.
- No particular schedule, as and when needed.
- Other. Please specify _____.

What data do you use in your **top-down liquidity** stress tests?

- Supervisory data.
- Banks' own data.
- Publicly available data.
- Other. Please specify _____.

What types of banks are included in your **bottom-up liquidity** stress test sample, if applicable?

- Private sector commercial banks—domestic-owned.
- Private sector commercial banks—foreign subsidiaries.
- Building societies/mutuals.
- Savings banks.
- Cooperatives.
- State-owned banks.
- Not applicable.

How many banks participate in your **bottom-up liquidity** stress testing exercise and what proportion of total banking sector assets do they represent, if applicable?

Number of banks _____.

Proportion of total banking sector assets _____.

How do you determine which institutions to include in the **bottom-up liquidity** exercise, if applicable?

- Based on your definition of systemic relevance (e.g., size, interconnectedness, etc.), which is _____.
- Based on collaboration with supervisors.
- Other. Please specify _____.
- Not applicable.

How often do you conduct your **bottom-up liquidity** stress testing exercises, if applicable?

- Quarterly.
- Semi-annually.
- Annually.
- No particular schedule, as and when needed.
- Not applicable.
- Other. Please specify _____.

For **bottom-up liquidity** stress tests, who (either financial institutions or authorities) contributes the following items to the process, if applicable?

	Financial institutions	Authorities
Data	<input type="checkbox"/>	<input type="checkbox"/>
Model(s).	<input type="checkbox"/>	<input type="checkbox"/>
Assumptions/guidelines/prescriptions.	<input type="checkbox"/>	<input type="checkbox"/>
Templates reporting output	<input type="checkbox"/>	<input type="checkbox"/>
Templates submitting inputs	<input type="checkbox"/>	<input type="checkbox"/>
Determination of stress scenarios.	<input type="checkbox"/>	<input type="checkbox"/>
Calculation of parameters such as the probabilities of default	<input type="checkbox"/>	<input type="checkbox"/>
Not applicable	<input type="checkbox"/>	<input type="checkbox"/>
Other. Please specify _____.		

If **bottom up liquidity** stress tests are conducted, do you validate the results for quality assurance purposes?

- Yes. Please specify _____.
- No.
- Not applicable.

Are you required to take any action with respect to the financial system or individual banks based on your **surveillance (macroprudential) solvency stress test** findings?

- Yes. Please specify _____.
- No.
- Not applicable.

B. Risk/Scenario Selection (Applies only to Solvency Stress Tests)

What is your stress test risk horizon?

- Instantaneous.
- One year.
- Two years.
- Five years.
- Other. Please specify _____.

What drives your decision on the risk horizon?

- Basel III implementation calendar.
- Limitations of our models.
- Other. Please specify _____.

Do you apply comprehensive macroeconomic scenarios or single factor shocks in your stress tests?

- Macroeconomic scenarios.
- Single factor shocks.
- Multi-factor shocks.

Please specify the criteria for selecting baseline and stress scenarios/shocks (e.g., based on historical standard deviations; historical maximum, etc.). _____.

How severe (e.g., a defined probably of occurrence; worst historical outcome) do you require the scenarios to be and why? _____.

What risks are included in your stress tests? Please provide a brief explanation of how you model each risk (e.g., interest rate risk is modeled using duration/value-at-risk etc.)

- Credit risk (including downgrade risk, counterparty risk as relevant). Please specify _____.
- Interest rate risk (in banking book). Please specify _____.
- Sovereign risk. Please specify _____.
- Market risk (including exchange rate, equity, derivatives and real estate price risks, interest rate risk in trading books). Please specify _____.
- Funding liquidity risk. Please specify _____.
- Market liquidity risk. Please specify _____.

- Operational risk. Please specify _____.
- Other. Please specify _____.

Do you have stress scenarios that involve joint-movements of multiple factors (e.g., credit and market risks)? What are they and how have you designed them?

- Yes. Please specify _____.
- No.

Do you check/validate the risk parameters (e.g., against historical evidence) and for consistency across banks with regard to internal models and reporting? How is the validation done and how are differences reconciled for comparability of results?

- Yes. Please specify _____.
- No.

Please rank the five key systemic risk factors for your financial system/institution, PRE-global financial crisis, starting with the most important:

Please rank the five key systemic risk factors for your financial system/institution, POST-global financial crisis, starting with the most important:

Which bank positions are included?

- Loans to the non-financial private sector.
- Loans to financial institutions.
- Loans to the public sector.
- All loans.
- Trading book.
- Banking book.
- Derivatives and other off balance sheet transactions.
- Other. Please specify _____.

What is the role of accounting versus market-based information (e.g., PDs inferred from market prices) in your stress tests? _____.

What aspect of systemic risk is incorporated into your stress tests (e.g., spillover effects)?
_____.

What dimensions of interconnectedness are important for your stress tests?

- Interbank exposures.
- Cross-country exposures.
- Links with non-banks.
- Common exposures to macroeconomic factors.
- Exposures to respective parent companies in home countries.

- Exposures to large non-financial corporations.
- Not applicable.
- Other. Please specify _____.

How do you assess the dimensions included above?

- Sensitivity stress tests.
- Additional assumptions.
- Specific model features.
- Other. Please specify _____.

Which of the variables in the above question do you stress?

- Interbank exposures.
- Cross-country exposures.
- Links with non-banks.
- Common exposures to macroeconomic factors.
- Exposures to respective parent companies in home countries.
- Exposures to large non-financial corporations.
- Other. Please specify _____.
- Not applicable.

What factors management control do you include in your stress tests?

- Balance sheet growth (e.g., static, constant growth)? Please specify _____.
- Dividend payout? Please specify _____.
- Asset disposal? Please specify _____.
- Lending standards? Please specify _____.
- Portfolio allocation? _____.
- Zero profits or otherwise? Please specify _____.
- Other. Please specify _____.

C. Macrofinancial Linkages (Applies only to Solvency Stress Tests)

Do you have a model of the macroeconomic environment in which your financial institutions of interest operate? What type of model?

- Yes. Please specify _____.
- No.

What macrofinancial linkages (channels) are key in your stress testing framework and how do you map the impact of changes in macroeconomic variables onto banks?:

- Income statement items (e.g., credit losses, net interest income, operating expenses, etc.)? Please specify _____.
- Balance sheets (e.g., credit growth, changes in asset values)? Please specify _____.

Do you map the results of your stress tests back into the macroeconomic scenario(s)? How is this done?

- Yes. Please specify _____.
- No.

D. Determining Capital Adequacy (Applies only to Solvency Stress Tests)

What metric(s) do you use to measure capital adequacy?

- Regulatory capital.
- Economic capital.
- Other. Please specify _____.

Which framework do you use to calculate regulatory capital?

- Basel I.
- Basel II.
- Basel III (per BCBS document of December 2010).
- Other. Please specify _____.

What hurdle rates do you use?

- Core Tier 1 capital. _____ percent.
- Tier 1 capital. _____ percent.
- Total capital. _____ percent.
- Additional capital conservation buffer. _____ percent.
- Additional cushion for G-SIBs.

If Basel II or III, how many banks use the standardized approach, IRB or AIRB?

- Standardized approach. Number of banks _____; percentage of total banking sector assets _____.
- IRB. Number of banks _____; percentage of total banking sector assets _____.
- AIRB. Number of banks _____; percentage of total banking sector assets _____.

Please explain how you map changes in banks' balance sheets and profitability under stress into a measure of bank solvency (e.g., how do you calculate capital and RWA post shock?).

_____.

How do you compare results across banks that use different approaches (e.g. standardized vs. IRB)? _____.

E. Design of Liquidity Stress Tests

(Answer this section only if you have indicated that you undertake liquidity stress tests)

What type(s) of liquidity stress do you conduct?

- Individual bank liquidity.
- Systemic liquidity (i.e., liquidity affecting the entire system).
- Funding liquidity.
- Market liquidity.

How do you model the shock(s)?

- Scenarios.
- Arbitrary shocks to funding or market liquidity.
- Other. Please specify _____.

Do you link market liquidity and funding liquidity risks in the stress tests?

- Yes. Please specify _____.
- No.

What positions do you include?

- Deposits
- Loans
- Liquid assets.
- Interbank.
- Repo.
- Other. Please specify _____.

Do you differentiate between local and foreign currency liquidity risks?

- Yes.
- No.

How do you calibrate the withdrawal of funding?

- Reaction to solvency problems.
- Downgrade by rating agency.
- International experience.
- Country's own historical experience.
- Other. Please specify _____.

How do you calibrate haircuts to assets under a liquidity shock?

- Modeling approach. Please explain _____.
- International evidence.
- Country's own historical experience.
- Other. Please specify _____.

What is your hurdle rate?

- As defined by current national regulations.
- Ability to survive the defined stress test without recourse to central bank funding.
- Basel III liquidity ratios.

- Other. Please specify _____.

Do you link solvency and liquidity risks in your stress testing exercise and what is the feedback mechanism?

- Yes. Please specify _____.
- No.

F. Communication Strategy

Do you communicate the results of the stress tests outside your institution?

- No.
- Yes, results from solvency stress tests;
To whom _____.
- How was it communicated _____.
- How regularly _____.
- To what degree of detail _____.
- Yes, results from liquidity stress tests;
To whom _____.
- How was it communicated _____.
- How regularly _____.
- To what degree of detail _____.

What is your primary objective of communicating the stress tests results? _____.

Are you required to communicate stress test results to the public?

- No.
- Yes.
- Depending on circumstances. Please specify _____.

Did you have occasion in the past to publicly communicate stress test results?

- No.
- Yes. What did you learn from the experience _____.

Other

What actions do you typically take following negative results from stress tests?

- None.
- Require management action. Please specify _____.
- Other. Please specify _____.

What other sectors do you stress test or require to undertake stress tests and in which year did you begin formally running stress tests?

- Insurance. Please specify _____.
- Pensions. Please specify _____.
- Infrastructure (e.g., payment systems). Please specify _____.
- Other. Please specify _____.
- No other.

Which agency is responsible for conducting stress tests for each sector, and for what purpose (i.e., surveillance, supervisory)?

- Banks. Please specify _____.
- Other deposit-taking institutions. Please specify _____.
- Insurance. Please specify _____.
- Pensions. Please specify _____.
- Infrastructure. Please specify _____.
- Other. Please specify _____.

Please elaborate on the extent of inter-agency coordination where stress tests across different financial sectors are conducted. _____.

Do you require financial institutions to run reverse stress tests? Which sector? Please provide a brief description of the exercise.

- Yes. Please specify _____.
- No.

If you have immediate plans to develop your stress test models/frameworks, what would be your main objectives? _____.

If you have immediate plans to develop your stress test models/frameworks, what would you do to improve your existing framework? _____.

Please discuss other key issues or considerations that may not have been captured in this survey. _____.