

**European Union: Publication of Financial Sector Assessment Program
Documentation—Technical Note on Stress Testing of Banks**

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STRESS TESTING OF BANKS

TECHNICAL NOTE

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GLOSSARY

AQR	Asset quality reviews
CCA	Contingent claims analysis
CEBS	Committee of European Banking Supervisors
CRD	Capital Requirements Directive
EBA	European Banking Authority
ECB	European Central Bank
ESRB	European Systemic Risk Board
EU	European Union
FMA	Austrian Market Authority
HTM	Held to maturity
IFRS	International Financial Accounting Standards
LCR	Liquidity coverage ratio
LGD	Loss given default
LTRO	Long-Term Refinancing Operations
MTM	Mark-to-market
NPLs	Nonperforming loan
NSAs	National Supervisory Authorities
NSFR	Net Stable Funding Ratio
OeNB	Oesterreichische Nationalbank
PD	Probabilities of default
PIT	Point-in-time
QATF	Quality Assurance Task Force
RAMSI	Risk Assessment Model for Systemic Institutions
RWA	Risk-weighted assets
SRL	Systemic Risk-adjusted Liquidity
SSM	Single Supervisory Mechanism
TTC	Through-the-cycle

EXECUTIVE SUMMARY

The European authorities are strengthening bank stress testing procedures and their application. Following the poor reception of the 2010 exercise, the 2011 solvency stress testing and recapitalization exercises were marked by extensive consistency checks, more transparency about methodology and data, for example, regarding sovereign exposures, and higher hurdle rates. The exercises succeeded in prompting banks to increase the quantity and quality of their capitalization, and contributed to a reduction in uncertainty and an increase in the credibility of the process. However, despite banks raising more than €200 billion as a result of the recapitalization exercise, confidence in European banks is not fully restored, in part because the market suspects some banks of having been insufficiently transparent—including as part of the stress testing exercises—about their losses and exposures to problem sectors.

Lessons from the past stress tests are being used to strengthen and streamline procedures for the planned 2013 exercise. That exercise is likely to involve three-year projections under a baseline and a stressed scenario. Much effort has been, and will be put into ensuring that methodologies are consistently applied while reducing, as far as possible, costs to participating banks. A major objective is to generate detailed analysis relevant to the assessment of banks' capital plans during the gradual transition to Capital Requirement Directive (CRD) IV requirements, rather than pass/fail results based on a single metric.

There remain a number of controversial issues, but experience suggests that the benefits of a bold approach outweigh the risks. A high degree of transparency, including on reference date data and on sensitivity to differences in definitions of input data, strengthens rather than weakens confidence and market functioning. If the 2013 exercise is to focus on supervisory issues such as an assessment of banks' plans to implement the solvency elements of CRD IV, then it should be consistently designed for that purpose, and also presented as such; otherwise, markets are likely to follow past form and be fixated on capital shortfalls and relative weaknesses.

As the acuteness of the crisis diminishes, the identification of other vulnerabilities and issues, such as funding risks and structural weaknesses, will gain in relative importance. Most major banks now seem comparatively well capitalized, but funding remains problematic (for example, because of reliance on official funding and asset encumbrance in some banks), while the sector faces deep structural challenges relating to low profitability and growth and the longer-term impact of regulatory changes.

In light of these considerations, the note elaborates on certain main recommendations, some of which are primarily the responsibility of National Supervisory Authorities (NSAs). In these areas, work is already on-going or can start soon, but often some time will be needed to complete the task:

- Continue development of the efficiency and effectiveness of consistency checks, for example, by facilitating timely communication and agreement on templates.
- Continue to publish a wide range of detailed information on participating banks, and especially on their reference period condition and (sovereign) exposures.
- The practice adopted in the 2011 European Banking Authority (EBA) recapitalization exercise of recognizing the full risks attached to all banks' sovereign securities' exposure, and at a minimum relevant data should be published.
- Move to standardize definitions of nonperforming loans (NPLs), loan classifications, provisioning, etc., while initiating reviews of input asset quality data.¹ Some issues here will take time to be resolved, so the sooner the process starts the better. NSAs are responsible for the provision of consistent and interpretable banking sector data, but the EBA has an important role in coordinating and driving forward activities.
- Implement checks on the sensitivity of the results to model assumptions and bank circumstances, including sensitivity to differences in asset quality and definitions.
- Further refine benchmarks and satellite models, especially regarding pre-impairment income, risk-weighted assets (RWA), and funding costs, in order to ensure more comparability and consistency across banks' bottom-up results.
- Ensure that the 2013 stress testing exercise generates operational recommendations and supporting indicators for supervisors, rather than being reduced to a perception of a pass/fail metric.
- Incorporate as far as possible banks' funding and capitalization plans in the stress test projections, including the effects of the phase out of the Long-Term Refinancing Operations (LTRO) provided by the European Central Bank (ECB); further efforts could be made to assess the sensitivity of results to likely changes in balance sheet composition, rather than assuming that it stays static.
- Ensure full coordination between future EBA and ECB and European Systemic Risk Board (ESRB) stress testing exercises. For the 2013 exercise, the ECB could play a very active role, not only in making macro projections and top-down stress testing, but also, for example, in the review of input asset quality data.
- Continue EBA coordination of the EU-wide stress tests under the new Single Supervisory Mechanism (SSM), working with ECB and NSAs, and ensuring of

¹ The definitions should be as consistent as possible while recognizing real differences, for example, in loss given default rates across countries and across time.

quality control. The ECB should run supervisory stress tests for the banks in the SSM, while ESRB should focus its contributions on macro-prudential issues, such as the identification and calibration of systemic risk factors and the use of stress test results in formulating policy advice. Over the medium term, shift some of EBA's efforts to running tests on hitherto relatively neglected topics such as structural issues and funding vulnerabilities. In this context, stress tests could be designed to incorporate more longer-term and cross-sector factors (for example, using contingent claims analysis and incorporating nonbank financial institutions) that relate to structural and macro-prudential issues, and to calibrate prudential requirements. However, competing EBA, ECB/SSM and ESRB stress tests are to be avoided.

- Following the 2011 internal EBA liquidity risk assessment, develop further liquidity stress testing, including through cash flow-based approaches and making use of the relevant reporting templates being developed in the context of CRD IV. Ensure disclosure and transparency of the reporting templates and overall liquidity stress testing approach, while safeguarding sensitive results.

I. INTRODUCTION²

1. **Stress testing has become an essential and very prominent tool in the analysis of financial sector stability and development of financial sector policy.** Starting with the 2010 test led by the Committee of European Banking Supervisors (CEBS), and reinforced by the 2011 test and the bank recapitalization exercise led by the EBA, the output of EU-wide stress tests has been viewed as essential information on the health of the system. Moreover, the reliability of the results and the efficiency with which they were generated (especially the recapitalization exercise) have greatly influenced the credibility of the European and national authorities involved. This prominence demands that future stress testing exercises be very carefully designed and executed.
2. **Stress testing in itself can have only a limited impact unless it is tied to action.** In current circumstances in much of Europe, stress testing alone would mainly reconfirm the over-leverage of the public, household or corporate sectors, and the structural impediments to faster overall growth, in addition to unfavorable conjunctural conditions. The publication of stress test results with enough supporting material (including on the initial condition of banks) can indeed be helpful in reducing uncertainty; even banks that are revealed to be relatively weak may benefit if the market paralysis engendered by great uncertainty is relieved. But stress tests are of value mainly when they are followed up by concrete and swift actions by the authorities (supervisory and others) and by bank managers that improve the condition of banks and of banks' clients. Therefore, the informational role of stress testing and its link to policy actions are the underlying themes of this note.
3. **This note focuses on bank stress testing led by the EBA, and in particular the forthcoming 2013 exercise and the associated data quality issues.** The NSAs, ECB and ESRB conduct their own tests for various purposes; there will be discussion of those that have more or less Europe-wide relevance. Moreover, consideration will be given to both solvency and liquidity aspects of stress testing, and how priorities are likely to evolve in the post-crisis environment, especially with the introduction of the SSM.

II. BACKGROUND

4. **The 2010 CEBS-led stress testing exercise, which can be viewed as the start of EU-wide stress testing and which was initiated near the start of the financial crisis, was relatively poorly received.** The stress scenario was regarded as too mild in the circumstances, and there was little assurance that banks had not been able to incorporate an optimistic bias into the results. Limited information disclosure did little to relieve the intense uncertainty prevalent at that time. The sample of banks included some that quickly proved to pose systemic risks in certain countries.

² Prepared by Daniel Hardy and Heiko Hesse.

5. **The design of the 2011 EBA-led exercise partly reflected the lessons learnt, notably on the need for quality and consistency controls and on transparency, and was better received.** Even though the final estimated capital shortfall was modest, that result was largely the product of many banks—especially those with relatively weak capital buffers—preemptively increasing their capitalization and what with hindsight appears to be unduly optimistic baseline and stress scenarios, including with regard to the treatment of sovereign risk. Three main quality control mechanisms were: the banks’ own controls; those by NSAs (e.g., supervisory judgment); and the quality assurance process led by EBA. For the latter, EBA formed a Quality Assurance Task Force (QATF) with secondees from NSAs, the ECB and the ESRB, who challenged their peers in other NSAs on the consistency of the banks’ bottom-up assumptions, methodologies and results. Compared to the 2010 stress test, EBA also improved its off-site review by checking bank input data for errors, ensuring the correct adoption and application of the stress testing methodologies, and using statistical benchmarks (mainly cross-sectional) for probabilities of default (PDs), loss given default (LGDs), and default rates by counterparties, country and sector. The top-down stress test performed by the ECB and ESRB played an essential part in order to benchmark the bottom-up results of the banks.

6. **For the 2011 stress test, EBA’s board of supervisors decided not to include market risk haircuts to the banks’ sovereign exposures in the banking book, but did publish relevant data.** Only the banks’ sovereign holdings in the trading book would be subject to mark-to-market (MTM). Given the intensification of the euro area sovereign debt crisis, this assumption was debatable and criticized (including by the IMF), but the enhanced disclosure and transparency of the banks’ sovereign exposures allowed market analysts to calculate their own sovereign haircuts and eventually the capital shortfall of banks in the sample.

7. **The subsequent recapitalization exercise contained some elements common to stress testing, and further enhanced the credibility of the institutions involved (Box 1).** Importantly, all sovereign securities’ holdings were subject to MTM. The recapitalization exercise was not a full stress test since it did not include a macro scenario or capture banks’ ongoing funding strains. Most banks have met the 9 percent core Tier 1 (CT1) capital requirement; the exceptions are banks in unusual circumstances where action is being taken especially where government governments apply (Box). One important implication of this achievement is that banks already more or less have the capital necessary to meet requirements under Basel III or the EU’s Capital Adequacy Directive (CRD) IV, even were the requirements to be applied in full or imposed through market discipline.

Box 1. Capital Outcome of the 2011 Stress Test and Recapitalization Exercises

The EBA stress and recapitalization exercises have helped identify weak banks and increase capital buffers. The second EU-wide stress test (July 2011) identified €25bn of capital shortfall using a single adverse macro scenario. Even though banks raised €50 billion fresh capital in the first four months of 2011, confidence remained tenuous as the sovereign debt crisis intensified in 2011.

In December 2011 the EBA recapitalization exercise recommended the achievement of 9 percent CT1 by end-June 2012, after establishing a sovereign buffer against banks' holdings of government securities based on a market-implied valuation of those holdings. The aggregate capital shortfall after including the sovereign capital buffer amounted to €115 billion for 37 banks including those under restructuring (out of 71 banks in the sample), with the largest shortfall on Greek banks (€30 billion) followed by Spain (€26 billion), Italy (€15 billion) and Germany (€13 billion). Taking out banks under deep restructuring (Dexia, Volksbank and WestLB), the Greek banks as well as Bankia left 27 banks with a capital shortfall totaling €76 billion.

The banks' capitalization plans, in aggregate, more than covered the capital shortfall identified by EBA. Direct capital measures accounted for the majority of the plans, with the remainder comprising changes to bank risk weight models, asset disposals, and reductions in lending, which mostly comprised actions taken under European Union (EU) State Aid rules. EBA explicitly discouraged banks from shedding assets in order to meet the 9 percent capital target, by requiring that banks cover the shortfall mainly through capital measures of the highest quality. EBA subsequently published an overview of the capital plans that banks submitted to regulators and then to EBA at end-January 2011.³

The EBA recapitalization exercise led to an additional €200 billion in capital generation or release by June 2012, while government backstops were provided to the weakest banks. A few banks under restructuring and recapitalization programs did not achieve the target on time.

III. THE 2013 BANK SOLVENCY STRESS TESTING EXERCISE

8. **The authorities have decided to conduct another coordinated bank solvency stress testing exercise, but with more emphasis on supervisory issues and less on a pass/fail metric.** The initial plan envisages that the exercise would be conducted mainly in the second half of 2013, with preparatory work beginning as soon as possible. The main supervisory issue is the assessment of the realism, consistency and robustness of banks' capital plans to meet the phased-in capital requirements under CRD IV, which will affect minimum capitalization levels, the definitions of various sorts of capital, and the definition of RWA.

9. **The lessons from past stress testing exercises will have to be incorporated into the design and execution of the forthcoming exercise, but modified as needed in light of current conditions and the exercise's objectives.** The improvements in efficiency and effectiveness seen since the 2010 CEBS exercise should be extended, and in particular, the 2011 stress testing and recapitalization exercises offer additional lessons. Nonetheless, adjustments need to be made to allow for the fact that the situation of European banks is

³ The banks' capital plans were submitted by national supervisors to EBA at end January 2011.

more diverse (also due to ongoing fragmentation and asset quality pressures) and also less uncertain than in 2010 or 2011—some operate in program countries and others operate in a comparatively benign macroeconomic environment, some are heavily dependent on central bank refinancing and others have ample and excess liquidity (often deposited back at the ECB). Moreover, the tests need to be geared towards generating output and recommendations that are relevant for supervisory purposes, rather than those that are needed in an acute crisis situation. This section concentrates on identifying ways to reconcile these features in various aspects of the design of the exercise.

A. Publication and Transparency

10. **The publication of detailed data on major European banks in the context of the 2011 stress testing and recapitalization exercises contributed to reducing uncertainty markedly and to the credibility of those exercises.** The authorities were praised for providing enough information (over 3,000 series, notably on sovereign exposures) that market analysts could check and run their own projections based on alternative scenarios and assumptions on banks' treatment of their sovereign exposures. It is inevitable that analysts will want to assess the situation of banks assuming the immediate full implementation of CRD IV (partly already happening), and banks may be basing their own planning on this assumption. Were relevant data not provided, the market would look on the exercise with increased skepticism.

11. **The authorities will have to publish data from the forthcoming exercise, in at least as much bank-by-bank detail and also covering the initial situation of individual banks at the reference date, if not necessarily all projections.** To do otherwise would at best miss an opportunity to reduce uncertainty, which has contributed to the fragmentation of funding markets, and could lead to suspicions that the authorities have bad news to hide. There should be a presumption that also test results would be published in detail. Even if the authorities do not highlight certain series such as the projected evolution of banks' profitability, the information is valuable in the context of structural pressures on the sector. For instance, the 2011 stress test did not publish as comprehensive bank-specific data on the banks' starting positions as projections from the adverse scenario. However, there may be scope to keep confidential some details. For example, publication of results from sensitivity analysis may be more confusing than reassuring, in part because the market could take those as benchmark results and penalize banks that do poorly in the sensitivity stress tests. The experience with sensitivity tests performed in the 2011 exercise could be useful here.

12. **Confidentiality will have to be maintained over certain aspects of the supervisory recommendations.** Some recommendations may relate to a bank's confidential business planning, its detailed funding plans, or supervisors' own policies. But a possible negative market impact should not in itself be grounds for non-publication, since such market discipline is desirable. Consistent treatment across banks would be essential, not least to maintain a level playing field for competition.

13. **In this connection, it is worth stressing that full disclosure of banks' sovereign exposures (including that in the banking book) will be essential, and that the tests will need to recognize fully the attendant risks.** Given that the 2011 EBA recapitalization exercise involved marking to market (MTM) banks' sovereign securities' exposure in the banking book (available for sale, AFS, and held to maturity, HTM), the market could be critical of a reversal. Admittedly, the Basel III rules envisage that just the trading and AFS books be marked to market with a gradual phase in period, while the HTM book would not be subject to MTM. While authorities will have to trade off disclosure with the taken MTM approach, at a minimum relevant data should be published. Nonetheless, if current market conditions persist, for most banks sovereign exposures are likely to be a smaller source of losses (or could contribute positively) in the baseline of the 2013 exercise. A relapse at least to recent peak sovereign spreads would be seen as constituting a plausible but not very extreme scenario. Hence a conservative approach would probably not be disruptive. In any case, analysts would be able, based on the disclosed detailed banking data, to calculate each bank's estimated haircut on its total sovereign securities portfolio.

B. Consistency and Quality Control Mechanisms

14. **The authorities are making strong and commendable efforts to improve on the quality control mechanisms that were successfully deployed in the 2011 exercise.** For example, reporting templates will incorporate various checks, and there is expected to be early contact between the authorities and banks to ensure that the methodology, benchmarks, and reporting forms are well understood. The 2011 experience suggests that the ECB top-down macro stress test need to be prepared and used as a cross-check at an earlier stage, but to this end "clean up" data needs to be provided to the EBA earlier on.⁴ In particular, NSAs need to make a quick but thorough check of data as soon as it is received.

15. **The role of the ESRB/ ECB top-down stress test could be further strengthened.** The ECB has indeed indicated an interest in being more closely involved in various aspects of the exercise, including the input data review (see below). Besides the above mentioned importance of the top-down stress test used at an earlier stage in the quality assurance process, such tests could also be used to challenge the banks' bottom-up results by introducing different modeling approaches or including effects that cannot be captured in the bottom-up exercise, such as systemic and feedback effects. Such an expanded role could be especially useful for sensitivity analysis around the adverse scenario.

16. **The efficiency of the quality control process would be enhanced by allowing EBA staff to be in direct contact with banks, rather than channeling communication through NSAs.** Staff from the NSAs should be present in conference calls or physical

⁴ In the 2011 EBA stress test, the ECB contributed the adverse scenario and top-down stress test, besides participating in the stress testing and quality assurance task forces.

meetings with EBA staff and the involved banks so the NSAs remain well-informed. This would help to avoid unnecessary delays encountered in the 2011 stress test in communication among banks, NSAs and the EBA.

17. **As part of this process, the authorities need to continue to build up time series of statistical benchmarks for PDs, LGDs, and default rates by granular counterparties, countries and sectors, as well as ensure consistent application by banks of point-in-time (PIT) estimates of PDs and LGDs.** Those benchmarks should be cross-checked with the estimated PDs and LGDs of the ECB that are also being used to challenge banks and are adopted by banks under the standardized approach. Banks should use their PIT PD and LGD parameters for the bottom-up stress test and not through-the-cycle (TTC) equivalents. The use of PIT parameters is important because results need to be sensitive to the scenarios, and the PIT PDs are relatively forward-looking. Stress tests are meant to say something about the ability of banks to survive bad points in time, so TTC parameters are not fully relevant to an assessment of resilience to conjunctural shocks ⁵

C. Input Data Review

18. **The banking systems of the program countries have been subject to detailed asset quality reviews (AQR), and the question therefore arises of how to ensure consistency of input data.** Elaborate and expensive “deep dive” AQRs have been carried out in individual banking systems in Europe, and have formed a solid base upon which to conduct crisis stress tests. The IMF-Commission-ECB “Troika” very much supported these efforts. Yet, data from some of the non-program countries conceivably may contain important flaws, and merely a lack of consistency will make results difficult to interpret and could interfere with the internal market.

19. **Inconsistencies may arise despite the (almost) universal application of International Financial Accounting Standards (IFRS) and a system of internal and external audits with supervisory oversight.** First, IFRS allows some room for local differences in definition, for example, of a NPL or renegotiated/ restructured loan. Second, interpretation of common definitions may differ across countries or banks. Third, interpretations may differ over time. In current circumstances, a bank may more readily choose to roll over a problem loan and make modest provisions, partly to help its borrower and partly to make its own results look better. It should be noted here, however, that consistency does not imply uniformity, as accounting differences may reflect underlying differences; PDs and LGD rates may genuinely differ, for example, because of large differences in bankruptcy laws and loan work-out arrangements.

⁵ It is possible that, if PDs and LGDs are not sufficiently sensitive to the scenario, and RWAs decline over the scenario due to losses, the positive impact on capital (from lower the RWA—the denominator) may offset the limited impact of losses on capital (the numerator).

20. **Yet, undertaking a full-blown AQR across the EU would be very expensive, time consuming, and possibly counter-productive.** Besides the practical difficulties and expense, announcing a comprehensive AQR would cast doubt on the integrity of past stress testing exercises, national authorities, bank management, and the accounting and audit professions. Furthermore, consideration would have to be also given to undertaking an AQR for the assets of European banks outside the European Union, which enterprise would add greatly to the complexity and cost.

21. **It is recommended that the authorities, coordinated by the EBA, make rapid progress in unifying definitions of NPLs and provisioning criteria.** Efforts in this direction have been under way for some time, but now there should be momentum behind the project. Full implementation of all aspects might take place after the 2013 stress testing exercise, but that would not be a great drawback. There would need to be guidance offered to national authorities and the accounting and audit professions. Overall, the provision of consistent and comparable banking sector data lies in the (national) supervisors' accountability.

22. **On balance, it would be worthwhile to conduct a limited review of input data, especially on asset quality, but with a focus on problem sectors and without greatly impeding the stress testing exercise.** It may be possible identify some sectors—based on expert judgment, statistical analysis, or experience with the program country AQRs—which are worth investigating more closely. EBA is considering choosing one specific asset portfolio (which can be different by countries) for the asset classification review as input for the 2013 stress test, an approach which seems sensible. EBA with the NSAs should conduct a detailed analysis which of the four chosen portfolios commercial real estate, small to medium enterprises, forbore residential mortgages or level 3 trading book assets should apply to each country in the EBA sample. The review of input data would complement the enhanced system of consistency checks built into the stress testing procedures.

23. **Issues of special concern for such a review of input data are likely to include:** lender forbearance, impairment deficiencies, risk weighting, and RWA calculations by banks;⁶ collateral valuations and credit risk mitigation techniques; and treatment of restructured loans. The approach would also need to enhance confidence in the reliability of the internal credit rating systems operated by banks.⁷ The main concern should be to make

⁶ For instance, the recent Bank of England Financial Stability Report (November 2012) shows that banks' RWA calculations for the same hypothetical portfolio can differ vastly, with the most prudent banks calculating over twice the needed capital than the most aggressive banks.

⁷ Depending on the scope and time available, some additional elements are possible for the review of the chosen loan portfolio, such as a review of loan alteration practices, determining the reasonability of the methodology used to estimate TTC risk drivers and cycle-smoothing techniques, or providing an opinion on the overall reliability and integrity of the TTC risk weights and PIT loss estimates. The comprehensive AQRs conducted in Euro area program countries could provide further elements that could be relevant for the review of the input data.

the reference period data as reliable as possible, as judged by the situation at that time: the baseline projection is meant to capture the evolution of impairments going forward. The initial focus should be on banks included in the stress test, but in due course the unified definitions should be used across all banks. Countries that recently underwent third party diagnostics of their banking systems would be exempted from part of the exercise to avoid a mere repetition of effort.

24. **Delaying the stress testing for the sake of undertaking an exhaustive input data review would bring some benefit, but also important costs if the postponement is major or of uncertain length:** the review may end up being very long drawn out, and meanwhile the regulatory framework is changing, so the stress testing hurdle rates and other conditions would alter.⁸ In addition, investors could come to expect the revelation of additional losses in banks' portfolios, so a delay could potentially lead to destabilizing market uncertainty.⁹ One approach would be to define certain limited but valuable objectives (e.g., review of a significant sample of exposures to one problem sector in each country) that could realistically be achieved within six to nine months, and launch the stress testing exercise when these objectives are met. Methodological preparations for the exercise could proceed in parallel. Further refinements to data consistency would be left to later. Costs and benefits of a delay need to take into account also the interest of the ECB in participating in the 2013 stress test in connection with the forthcoming SSM.

25. **Public explanation of the effort will need to be handled with care, and measures taken to ensure that the exercise is recognized to be rigorous but limited.**¹⁰ In the publication stage, EBA could promote the disclosure of granular asset quality information to enhance transparency and reduce market uncertainty about banks' asset quality. However, some data may be highly market sensitive; rules of engagement in such case should be worked out in advance, especially if the ECB is involved in the context of the SSM. Also, evidence of under-provisioning that is unquestionably consistent with IFRS might prompt tougher guidance in the stress testing methodology on the future evolution of losses, rather than being reflected in published stock data at the reference date. The experiences of data disclosure from the external AQRs already conducted could be useful here. The credibility of the exercise would be increased by the involvement of outside evaluators or at least peer reviewers.

⁸ For example, the liquidity coverage ratio (LCR) would come into force.

⁹ It is possible that the exercise will reveal a sizable "hole" in the capitalization of some banks, even before any projections are made. The authorities will need to think in advance of how to handle such a situation, for example, through immediate remedial supervisory action and exclusion of the affected banks from the regular stress test.

¹⁰ Using a term other than "Asset Quality Review" might be one element of the communication strategy that distinguishes this effort from the more comprehensive AQRs undertaken in program countries. "Asset quality data exercise" or "input data review" might be suitable titles.

D. Refinement of Satellite Models

26. **The authorities have collected data and undertaken analysis which allows the plausible projection of many variables of interest in a baseline and an adverse scenario, but certain important series have proven to be especially difficult to model and deserve more research attention.** In the 2011 stress testing exercise, the projections of some series differed greatly across banks for reasons that were at best unintuitive, and these peculiarities may have weakened confidence in the overall results. The following series are important but have proven difficult to forecast:

- *Non-interest, non-trading income*, which is of increasing importance to many banks and which may be disproportionately sensitive to a severe downturn. Banks' projections of their fee income could be subject to some guidance by EBA, especially for the adverse scenario, to avoid banks using fee projections to compensate for loan impairments;
- *Trading income*, which depends on banks' own-account trading activity of both on- and off-balance sheet items. Financial instruments in bank portfolios could be re-valued at the prices prevailing in the scenario, rather than through the use of satellite models, which might not adequately capture banks' trading income;
- *Funding costs*, which depend both on exogenous or macroeconomic conditions such as the sovereign's credit rating and on the bank's own situation (Box 2); and
- *Risk weighted assets*, which may be affected by shifts in risk weights and write-offs even if the overall balance sheet is static.

Box 2. EBA Stress Tests and Bank Funding Costs

EBA incorporated a cost of funding shock in their 2011 solvency stress test, which was linked to sovereign stress. Specifically, EBA assumes that the banks were subject to static balance sheets and faced stable wholesale and retail funding needs. Higher cost of funding in the baseline and adverse scenarios could arise due to: higher short- and long-term interest rates, increased banks' spreads (which depended just on a bank's respective sovereign's spreads), collateral value declines, and more expensive deposits. Funding costs did not depend on the change in a bank's projected situation in the course of the scenario.

An important funding and capital link was not considered in the 2011 exercise: As seen during the financial crisis, the banks' cost of funding is linked to the banks' capital buffers. Banks with lower solvency levels have either seen their funding costs sharply increase, or market funding channels closed entirely. Some recent FSAPs have incorporated this feedback mechanism, albeit somewhat crudely. In this context, a bank benefits from a reversal of this negative feedback when it is recapitalized. Establishing a link between funding costs and capitalization would benefit from panel data (and not only based on a cross section) given the link is possibly dynamic and non-linear. For sensitivity analysis, higher hurdle rates that are compatible with sustainable funding costs could be used. The 2011 exercise benefited from the EBA liquidity risk assessment in 2011 in terms of cost of deposits for different sources and maturities. In light of the ongoing financial fragmentation, the 2013 exercise would benefit from further refining the cost of deposit channel. Ideally, the cost of funding methodology used should take into account banks' applications of their internal pricing mechanisms, which often include hedging of funding cost changes.

Furthermore, the 2011 stress test considered only sovereign assets as collateral for central bank and wholesale funding, and not other securities such as corporate or bank bonds. Hence, the assumption of a drop in the sovereign asset value emanating from the increased sovereign spreads did not cover a wide range of collateral assets. The sovereign asset collateral value also did not include ECB haircuts but only the estimated bond price haircut.

E. Achieving Supervisory Orientation

27. **The forthcoming stress testing exercise is meant to be mainly for supervisory purposes, as opposed to the past emphasis on crisis management and the assessment of bank capitalization.** Translating this intention into the design and practice of the stress test, and transcending the market perception of past tests, will require careful preparation. Market participants and analysts are likely to compare results across banks and try to quantify capitalization needs. If the capital needs are not "enough," analysts may question the rigor of the tests.

28. **To achieve the supervisory purposes, the tests should yield recommendations for supervisors as bank managers, and generate relevant indicators.** Some of these recommendations, which may have to remain confidential, might include indications of the areas on which supervisors should focus their attention during the coming period (e.g., lending practices in especially vulnerable sectors or sustainability of funding). To this end, it may be useful to generate relatively detailed projections, for example, for loan quality by sector and by country, capitalization by country, and profitability measures. Supervisory colleges could then discuss the implementation of these recommendations.

29. **The authorities intend in particular to use the exercise to evaluate banks' plans to comply with the evolving capitalization requirements under CRD IV.** The approach is as follows: each bank will provide its dynamic capital plan, which includes also related planned adjustments among its assets and liabilities (e.g., a shift out of assets with high capital weights or out of short-term market funding). Each will also provide data on its balance sheet positions at the reference period, which will probably be end-2012, and projections of its profit and loss under the given the provided baseline and stress scenarios and satellite model guidance, but with a static balance sheet.¹¹ A three-year projection period is envisaged. The authorities, after checking plausibility and consistency, will substitute the projected losses, etc. from the two scenarios (baseline and adverse) into the bank's capital plan. The authorities would then assess whether the bank's capitalization level falls below, or close to, the CRD IV minimum requirements, such as on the definition of capital and RWA, which are progressively tighter over the projection period due to the gradual phase-in period of CRD IV. If a bank's plan looks precarious or based on implausible assumptions, the relevant supervisor would demand a revision.

30. **The use of a static balance sheet over three years may be justified mainly on the grounds of tractability and the desire to facilitate comparability.** The stress testing exercises are already highly complex, and allowing balance sheets to change would greatly add to the complexity: the methodology and consistency checks would need to be more complex, because they would need to cover the capital plans. Also, peer reviews would be less informative.

31. **Yet, the static balance sheet approach has distinct risks and other drawbacks if the aim is primarily supervisory.** First, precisely because static balance sheets facilitate comparisons (more so than with dynamic balance sheets), market analysts will be better able to interpret the results as a "beauty contest" among banks, as they seek out those that look comparatively or absolutely under-capitalized. Second, there is an inconsistency between the treatment of the considerable number of banks under restructuring plans agreed in the context of EU state aid rules, which will be assumed (as in the 2011 exercise) to implement those plans, and the others. Third, there is an inconsistency between the macro projections, where monetary and financial aggregates change over the envisaged three year stress testing horizon, and the assumption of static balance sheets of monetary financial institutions. Fourth, there may be instances where a static balance sheet is inconsistent with other regulatory changes, such as those prompted by ESRB recommendations on foreign currency lending. Finally and perhaps most importantly, projections using a static balance sheet may not be very relevant for evaluating banks' plans that involve significant balance sheet adjustment. It is possible that a bank has a robust, plausible capital plan, that is consistent

¹¹ The balance sheet is "static" in that it is not managed by the bank, but it will change as loan quality varies and capital is accumulated or depleted. Furthermore, the authorities envisage incorporation of the ending of the ECB's LTRO and the replacement of this financing with more expensive market financing.

with the plans of others and the macroeconomic forecast, but the plan looks inadequate when projections from a static balance sheet are inserted into it. Were the supervisor to raise objections and require action, the bank could argue that its original plan includes all the additional action needed. Relevant in this connection is the fact that many banks are currently being prompted by upcoming regulatory changes (CRD IV, CRR) and the LTRO phase-out to aggressively adjust their balance sheets by de-risking activities and by decisively changing their funding profile. Market analysts also facilitate such a balance sheet adjustment by focusing not on the gradual CRD IV regulatory thresholds but on the fully phased in ones.

32. Furthermore, banks' capital plans are likely to also include funding elements aimed at dealing with LTRO exit and achieving compliance with the prospective Basel III liquidity coverage ratio (LCR), and any supervisory assessment should take account of these elements. Banks with an estimated LCR shortfall have a number of ways in their funding plans to become compliant.¹² There is likely to also be some heterogeneity across European banks depending, for instance, on their funding profile, risk appetite and geographical activities. The need to achieve LCR compliance shortly after the projection period could imply that some European banks will be further forced to cut back on short-term wholesale funding and increase funding maturity, with consequences for their asset side (e.g., deleveraging and sale of non-core business).

33. The possibility of incorporating more "dynamic" elements into the balance sheet projections should therefore be reviewed, and is encouraged, while comparability of the CRD IV definition should be ensured.¹³ It may be reasonably easy to provide banks with guidance on the evolution of major balance sheet components that are consistent with the macroeconomic scenario (for example, aggregate growth in deposits and credit by country or use of loan-to-deposit limits) and indicate that they should avoid strategies that rely on "deus ex machina" (such as the sale of an unprofitable business at a handsome price). Such a differentiation would also allow for the ongoing process of financial fragmentation and de-integration. As in the case of the 2011 recapitalization exercise, banks should not be allowed to optimize their RWAs. Adherence to such guidance would reduce the need to subject plans to preliminary evaluation before the stress test is performed.¹⁴ To ensure comparability across banks and jurisdictions, the stress testing CRD IV definitions and hurdle rates during the phase-in period should allow for no national discretion.

¹² For instance, they can lengthen the maturity of their (unsecured) wholesale funding beyond 30 days, promote deposits, reduce costly uncommitted credit lines or increase their proportion of liquid assets in their balance sheets and deleverage on activities that are low interest yielding but are funded by short-term liquidity.

¹³ Note that the external banking stress test conducted for Spain was based on a dynamic balance sheet assumption and banks' capital plans.

¹⁴ In any case, assumptions need to be made consistent. For example, if the balance sheet is static, a well-capitalized bank cannot be expected to retain any dividends.

34. **More effort in assessing the robustness of results, including to the assumption of static balance sheets, would contribute to their usefulness to supervisors and to their overall credibility.** Sensitivity tests might involve, for example, re-running top-down tests with slight variations in the macro scenario or the satellite models, to see the extent to which results vary (possibly in a non-linear manner). Top-down analysis could be used to quantify the effects of changing balance sheet size and competition to reflect projected aggregate changes (e.g., money supply and credit stock evolution), banks' own plans, and the consistency of these elements. It may also be worthwhile to run tests for sensitivity to variations in input data.

35. **Sensitivity to macroeconomic assumptions and projections needs to be assessed.** Macroeconomic assumptions in the baseline and adverse scenarios play a crucial role in solvency stress tests, and can be key drivers for banks' loan losses.¹⁵ It might be useful to use the ECB/ ESRB top-down stress test for a country-specific sensitivity analysis of the adverse macroeconomic scenario. This could provide a sensitivity of banks' resilience to the severity, or lack, of the adverse macroeconomic scenario, especially since a common scenario might affect banks in specific jurisdictions in very diverse ways.

IV. FUTURE PRIORITIES

A. Solvency and Structural Issues

36. **As the situation of the banking sector changes and supervisory institutions evolve, it is worth considering where best to allocate limited stress testing resources.** There is already a great deal of stress testing and simulations done not only by the EBA but also by the NSAs, for their own stability analysis and supervisory purposes; and by financial institutions themselves for risk management generally, internal capital adequacy assessment process (ICAAP), and recovery planning/living will purposes. Some streamlining would be welcome. EBA could also have some enhanced role on giving guidance to banks on their recovery plan/living will stress testing.

37. **Over the medium term, EBA could shift efforts to running tests on hitherto relatively neglected topics such as structural issues and funding vulnerabilities.** In this connection, competing EBA, ECB/SSM and ESRB stress tests are to be avoided. Under the new SSM architecture, EBA should continue to closely coordinate the EU-wide stress tests with ECB and NSAs, and ensure quality control; the ECB should run supervisory stress tests for the banks in the SSM; while ESRB should focus its contributions on macro-prudential issues, such as the identification and calibration of systemic risk factors and the use of stress test results in formulating policy advice. The EBA regulation gives it a mandate to oversee

¹⁵ For the 2011 EBA stress test, the EC provided the baseline scenario while the adverse scenario was given by the ECB/ ESRB. EBA identified the microprudential risk factors and the ESRB and the ECB mapped them into the macroeconomic scenarios.

stress testing; its comparative advantages lie in such areas as (i) providing benchmarks and satellite models, especially for host country operations;¹⁶ (ii) ensuring that NSAs benefit from the latest techniques and apply them with full rigor;¹⁷ and (iii) exercising its mandate to ensure that best use is made of stress testing by NSAs, e.g., in setting supervisory priorities and in evaluating banks' recovery plans. Consistency in scenario building may sometimes be desirable, but may be of lesser importance for supervisory purposes for many banks. In this light, the EBA may wish to focus in 2014–15 on improving liquidity stress testing and its integration with solvency tests, which is a relatively new area, rather than devoting so much of its limited resources to another comprehensive solvency test during this period (see below). Also, the EBA may have occasion to assess the use of stress testing by NSAs as part of its peer review process.

38. **It would be valuable to run stress tests and related simulations designed to incorporate more long-term factors and generate lessons that relate more to structural issues.** As emphasized above, the European banking system faces a prolonged period of low interest rates, possibly low growth, increased regulatory burden such as Basel III and CRD IV, and demographic change, developments which will put pressure on profitability, the supply of savings, competition, etc. Hence, the stress tests scenarios need to encompass a longer time horizon; incorporate structural shifts (e.g., ongoing deleveraging and changes of bank funding profiles) affecting the balance sheet and income; and emphasize more other metrics, such as profitability, and changes in RWA. It should be noted that stress tests and simulations are only one instrument in the toolkit to examine the structural challenges faced by banks, and complement other quantitative and qualitative approaches. The ESRB would be the leader for efforts in these areas—in addition to its analysis of more conjunctural issues and nonbank sectors—which would be guided by the emerging consensus on best practice in macro-financial stress testing (Box 3).

¹⁶ The EBA is well placed to provide common benchmarks for the hosted operations of banks that come from several home countries.

¹⁷ The EBA is already active in this area, as evidence by its guidance on ICAAP evaluations and review of practices.

Box 3. Principles for Macro-Financial Stress Testing

A recent Fund document has brought together principals that summarize good practices and strategies for macro-financial stress testing (IMF 2012c):

- Define appropriately the institutional perimeter for the tests.
- Identify all relevant channels of risk propagation.
- Include all material risks and buffers.
- Make use of the investors' viewpoint in the design of stress tests.
- Focus on tail risks.
- When communicating stress test results, speak smarter, not just louder.
- Beware of the "black swan."

39. **Stress tests that make full use of market data (such as those based on contingent claims analysis, CCA) need to be developed further and used to complement balance sheet-based tests, at least where such data are available.**¹⁸ These methods, which are already deployed and being further developed by the ECB and some national central banks, are especially suited to capturing cross-sectoral and funding issues, for example, by treating banks, nonbank financial institutions, and nonfinancial corporations on a consistent and integrated basis, and by linking sovereign and bank balance sheets. Furthermore, these models are intrinsically non-linear, and thus differentiate between behavior and pricing in "normal" times and in under stress conditions.

40. **Another area for attention over the medium term is the calibration of prudential requirements.** Many prudential requirements (such as the 8 percent capital adequacy requirement under Basel II) seem to be largely the produce of historical accident rather than a deliberate evaluation of costs versus (stability) benefits. While work in this area is challenging, it would be comforting to know, say, the change in the proportion of banks that failure under a given shock as a capital requirement is varied. A thorough analysis that took into effect structural implications might be suitable for a joint effort by the ESRB and the EBA.

41. **In this connection, stress tests might be used to investigate the stability effects of the growth in "shadow banks."** The shadow banking sector is diverse, and some parts might be of much greater systemic importance (for example, due to linkages to banks, or affects on aggregate credit supply) than others. Even simple stress tests might shed light on how important it might be to tighten the regulatory and supervisory framework for this sector.

¹⁸ See Gray and Jobst (2011) and Gray et al (2007) for details on the CCA approach.

B. Liquidity Stress Testing

42. **The financial crisis has highlighted the need to better integrate solvency and liquidity stress testing.** A sharp rise in their euro and US dollar funding costs, or quantitative rationing, was often the trigger for the failure of banks during the crisis, and for the difficulties that many European banks continue to face. As mentioned above, EBA in their 2011 stress test introduced a cost of funding shock, which, among others, was linked to the sovereign debt spread. The EBA in 2011 conducted a less formal liquidity risk assessment, which indirectly captured fire sales through collateral haircuts.¹⁹ Elsewhere, the ECB in their recent Financial Stability Report has incorporated an explicit funding volume shock and deleveraging path into the ECB macro stress testing framework (see annex for details). The IMF (2012a and d) has been also incorporating a dynamic deleveraging path in their analysis.

43. **In the medium term, EBA could intensify its work on liquidity stress testing, especially in the context of the phasing in of detailed common reporting templates on maturity mismatches, cost of funding, and asset encumbrance, as part of CRD IV.** EBA already has experience with liquidity stress testing especially from their 2011 cash flow based assessment of European banks. Such a liquidity risk assessment would test the resilience of European banks to various funding shocks (deposits, wholesale and off-balance sheet). It would also consider the banks' behavior to more limited liquidity support such as, for instance, the tightening of central banks' collateral requirements, and include risks from asset encumbrance (box). The output could also feed into ESRB's work stream on systemic risk assessments. The starting point for EBA could be lessons learnt from the 2011 internal EBA cash flow based liquidity risk assessment. EBA could provide guidance on liquidity stress testing issues, and ensure some consistency of approaches by NSAs. EBA would likely need to boost its staff resources as well as adjust its medium term work plan to incorporate such additional work on liquidity stress testing. EBA should also ensure the disclosure and transparency of the reporting templates and the overall liquidity stress testing approach, while safeguarding sensitive results.

¹⁹ The exercise was generally well-designed, and some of its features will be a useful in preparation for the introduction of the LCR. Granular cash flow data including by currencies and maturity buckets, for broad sample of European banks (54), was compiled and checked. Multiple scenarios capturing the banks' main liquidity risks and counterbalancing capacities were analyzed. On this basis, recommendations were conveyed to banks through the NSAs.

Box 4. Asset Encumbrance and Liquidity Risk Assessments

Excessive asset encumbrance levels lower the resilience of a bank to further funding shocks by constraining its access to funding backed by suitable collateral, and may undermine investor confidence. It also subordinates other unsecured creditors such as depositors. In such circumstances, a tightening of central bank collateral requirements can reduce a bank's unencumbered eligible collateral to dangerously low levels.

Based on a survey of 53 European banks, the ESRB finds a large dispersion among banks, and significant constraints faced by a subset of banks. Increased ECB liquidity provision has contributed to very high asset encumbrance levels among some banks, especially in the periphery. To deal with excessive asset encumbrance levels, the ESRB proposed action to improve related risk management in banks, enhance supervisory monitoring on asset encumbrance, and market transparency, where the ESRB recommends EBA to develop guidelines. For the longer run, the ESRB will consider whether to have a formal encumbrance framework that may alleviate the pro-cyclicality of excessive asset encumbrance.

44. **A cash flow-based liquidity stress test, such as used by EBA in 2011, offers certain advantages (see Schmieder et al, 2012, and the appendix).** A cash flow-based module along the lines of the 2011 internal EBA liquidity risk assessment or the forthcoming EBA cash flow based maturity mismatch template allows running detailed liquidity analysis, and hence it is well suited to capture a bank's funding resilience and its liquidity risk bearing capacity. Cash flow-based liquidity stress testing allows for detailed maturity buckets and can be also adapted to different currencies. Liquidity risk exposure (net funding gap, cumulated net funding gap) and liquidity risk bearing capacity are clearly separated in the cash flow template. The template incorporates securities flows and ensures consistency between cash-flows and securities flows. This is especially important given the role unsecured and secured wholesale funding play for many large banks. Off-balance sheet activities such as FX swaps or credit and liquidity lines can be easily incorporated as well.

45. **Weaknesses of the cash flow approach include the high data intensity as well as initial set-up costs.** While banks typically use a cash flow-based approach for internal liquidity monitoring and liquidity stress testing, regulatory liquidity ratios are often based on stock accounting data with often less data granularity than the cash flow based templates. The phase-in of EBA cash flow based maturity mismatch templates will provide regulators and banks with standardized templates that would need to be regularly filled out and reported. As with the EBA solvency stress tests, it is suggested that EBA staff have access with NSA colleagues to banks for a consulting/feedback process, and direct interaction with banks' liquidity risk managers, so as to facilitate the roll-out of such cash flow templates.

APPENDIX I. APPROACHES TO LIQUIDITY STRESS TESTING

A. Literature Review

46. **There have been a number of liquidity stress testing approaches in the literature with a few studies attempting to link solvency and funding risk.**

- Schmieder et al. (2012) provide an Excel based framework that allows running liquidity tests informed by banks' solvency conditions, and to simulate the increase in funding costs resulting from a change in solvency. Drawing on this framework, Hesse, Salman and Schmieder (2013, forthcoming) focus on scenario design and building integrated macro-financial scenarios that take into account various dimensions of potential shocks at the same time - solvency and liquidity risks in particular.
- The IMF GFSR (2012a, 2012b) conducts a dynamic deleveraging analysis which includes an assumed funding shock on deposits and wholesale funding for the European banks in the sample.
- The Systemic Risk-adjusted Liquidity (SRL) model of Jobst (2012) combines option pricing with market information and balance sheet data to generate a probabilistic measure of the frequency and severity of multiple entities experiencing a joint liquidity event. It links a firm's maturity mismatch between assets and liabilities impacting the stability of its funding with those characteristics of other firms, subject to individual changes in risk profiles and common changes in market conditions.
- Van den End (2008) at the Dutch Central Bank developed a stress testing model that tries to endogenize market and funding liquidity risk by including feedback effects that capture both behavioral and reputational effects. A number of central banks and bank supervisors have been successfully using the Monte Carlo framework of Van den End (2008).
- Wong & Hui (2009) from the Hong Kong Monetary Authority sought to explicitly capture the link between default risk and deposit outflows. Their framework allows simulating the impact of mark-to-market losses on banks' solvency position leading to deposit outflows; asset fire sales by banks is evaporating and contingent liquidity risk sharply increases.
- Barnhill & Schumacher (2011) developed a more general empirical model, incorporating the previous two approaches that attempts to be more comprehensive in terms of the source of the solvency shocks and compute the longer term impact of funding shocks.

- Another attempt to integrate funding liquidity risks and solvency risk is the Risk Assessment Model for Systemic Institutions (RAMSI) developed by the Bank of England (Aikman et al., 2009). The framework simulates banks' liquidity positions conditional on their capitalization under stress, and other relevant dimensions, such as a decrease in confidence among market participants under stress.
- The current Basel Research Task Force on liquidity stress testing is also looking at the solvency and liquidity link.

B. Integrating Liquidity and Solvency Risks and Bank Reactions in Stress Tests²⁰

47. **Banks have numerous ways to react to credit and funding shocks. High-quality capital and profits are usually the first line of defense, and retained earnings can help buffer banks' capital levels.** Banks have an inherent capacity to generate liquid assets by using high-quality eligible securities as collateral for market or central bank funding if interbank markets freeze. As seen post-Lehman, fire sales of securities are also an option, but at a considerable cost in an environment of sharply declining asset prices. Deleveraging, especially targeted at assets with higher risk weights, is also a way to raise capital adequacy ratios by reducing RWAs. In practice, banks have been using a combination of these, as well as other hybrid measures, ranging from debt-to-equity conversions to issuance of convertible bonds to optimizing risk-weighted assets, to react to shocks.

48. **Incorporating banks' reactions to shocks is a critical input into the design of informative stress tests, especially over longer time horizons.** This, however, requires modeling solvency and liquidity shocks in a coherent manner because first, when banks react to financial stress, the source of the shock (solvency or liquidity) is not always clear; and second, the measures banks take in reaction to these shocks have both capital and liquidity aspects that are not easy to disentangle.

49. **A relatively simple (but somewhat ad hoc) way to integrate solvency and liquidity shocks is to conduct two-round stress tests, with a bottom-up (BU) first round and a top-down (TD) second round.** If, for example, the majority of banks report in the BU first-round test asset sales of particular asset classes in response to the shock, the TD second-round test could impose haircuts on those assets; if banks report that they would discontinue reverse repos, the analysis would incorporate a reduction in repo roll-overs. The quantification of these haircuts or roll-over rates could be based on historical information, cross-country experience, or expert judgment.

²⁰ This section draws on IMF, 2012c.

C. Liquidity Risks Analysis by Authorities

50. **The ECB does not conduct stand-alone liquidity stress tests of European banks.** It indirectly does incorporate funding and liquidity stress via its contribution to the EBA solvency stress tests where a funding cost shock is assumed (see below). Furthermore, in the June 2012 ECB Financial Stability report, an explicit funding volume shock is incorporated into the ECB macro stress testing framework. Specifically, in a contagion and deleveraging scenario originating from non EU/IMF program countries such as Belgium, France, Italy and Spain, it is assumed that European banks can only refinance 50 percent of their wholesale funding which matures in 2012–2013. Deposit withdrawal rates range between 0 percent for countries with an AAA rating to 20 percent for countries below investment grade. The scenario embeds a deleveraging path whereby banks fire sell more liquid assets to cover the wholesale funding gap, and around one third of this gap is covered by loan reductions. Similarly, losses in deposits lead to loan deleveraging. The scenario also includes differential increases in interest rates as well as stock market declines. Banks' solvency positions are calculated by changes in their profits, credit risk parameters and RWAs. The scenario leads to a 0.2 euro area GDP decline in 2012 and of 0.7 in 2013, both relative to baseline of -0.3 and 1 percent, respectively.

51. **Findings for the contagion and deleveraging scenario suggest a sizable drop of banks' capital.** In aggregate, from a baseline average core Tier 1 ratio of 9.3 percent at end–2013 (end–2011 is 8.7 percent) the scenario causes a capital drop to 7 percent. If one adds an additional domestic demand shock, core Tier 1 capital further drops to 6.4 percent. If one adds the EBA mandated temporary sovereign buffer from the recapitalization exercise to the contagion and deleveraging scenario, the core tier capital increases from 7 to 7.4 percent. The macro stress test does not consider the LTRO effect on reducing banks' funding costs which the ECB estimates at between 0.2-0.6 percent of core Tier 1 capital. The ECB mentions that the analysis does not incorporate any second round effects on the banks from the limited bank funding availability.

52. **The ECB approach does not take into consideration its collateral and haircut policies or banks' heterogeneous asset encumbrance levels.** As mentioned above, asset encumbrance levels for peripheral banks have significantly increased during the ongoing financial crisis with many banks also resorting to the ECB LTROs and benefiting from collateral loosening by increasing pledging credit claim type collateral subject to high and conservative ECB haircuts. Banks that already suffer from high asset encumbrance levels have diminished counterbalancing capacity to withstand severe liquidity stress so the design of liquidity stress tests should ideally also include information about banks' asset encumbrance or liquidity from eligible collateral ex post haircuts.

53. **IMF liquidity stress tests for FSAPs have often been based on a stock and not on a cash flow approach.**²¹ FSAP stress testers would then use stock balance sheet information (sometimes not decomposed by maturity buckets) and conduct a bank run type analysis on deposits and wholesale funding whereby banks use liquid assets as their counterbalancing capacity. In some FSAP cases, the Basel III liquidity ratios LCR (which embeds a quasi 30-day cash flow funding run) and the NSFR were simulated. For instance, in the Spain and U.K. FSAPs, implied cash flow tests (sensitivity of banks to outflow of funding over 5 and 30 days) were conducted (IMF, 2011a and 2012b). Both FSAPs also included a simulation of banks' Basel III liquidity measures. The Germany FSAP also included an implied cash flow analysis of funding shocks to consecutive periods (IMF, 2011b), while the France FSAP included a cash flow-based liquidity stress test using maturity buckets (IMF, 2012e). In the U.S. FSAP, the liquidity stress test was based on a basic analysis of the maturity mismatches of major banks (same coverage as the Pillar 1 of solvency analysis) and assumes that banks are unable to refinance maturing loans (IMF, 2010). The forthcoming paper by Hesse, Jobst, Ong and Schmieder (2013) provides an overview of IMF FSAP liquidity stress testing exercises.

54. **The cash flow based liquidity stress tests of the Oesterreichische Nationalbank (OeNB) are relatively advanced.** During the financial crisis in 2008, the Austrian Market Authority (FMA) and OeNB required banks to submit a weekly cash flow based report based on a new liquidity reporting template (see OeNB, 2009, as well as Schmitz and Ittner, 2008, for more details). The cash flow approach is forward-looking by including banks' contractual cash out- and inflows as well as banks' expected counterbalancing capacity. The template also distinguishes between different currencies. The difference between cash flow tests run by banks and those run by the OeNB for monitoring purposes is that the latter requires standardized templates, which then allows simulating the impact of common shocks based on a uniform method. A key prerequisite to carry out cash flow based liquidity tests is access to a wide range of data on contractual cash flows for different maturity buckets and possibly behavioral data based on banks' financial/funding plans.

D. Basel III and Liquidity Stress Testing

55. The Basel III liquidity coverage ratio (LCR) amount to a quasi-liquidity stress test, and its phase in period from 2015 could compel many European banks to close their current funding gaps. The BCBS has published basic principles of liquidity management, essentially guidance on the risk management and supervision of liquidity risks for banks and supervisors (BCBS 2008). Overall, the LCR can be viewed as a 30-day medium shock stress test. With the publication of the final Basel III LCR rules (see BIS, 2013), banks with an estimated

²¹ Jobst, Ong and Schmieder (forthcoming) provide an overview of FSAP solvency stress testing, and Schmieder, Hasan and Pühr (2011) offer a flexible stress testing framework.

LCR shortfall have a number of ways in their funding plans to become compliant.²² The Net Stable Funding Ratio (NSFR) is currently being reviewed by the Basel Committee.

²² For instance, they can lengthen the maturity of their (unsecured) wholesale funding beyond 30 days, promote deposits, reduce costly uncommitted credit lines or increase their proportion of liquid assets in their balance sheets and deleverage on activities that are low interest yielding but are funded by short-term liquidity. There is likely to also be some heterogeneity across European banks depending, for instance, on their funding profile, risk appetite and geographical activities.

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