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# SPAIN

## FINANCIAL SECTOR ASSESSMENT PROGRAM

November 2017

## TECHNICAL NOTE—STRESS TESTING BANKING SYSTEM RESILIENCE

This Technical Note on Stress Testing Banking System Resilience for Spain was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed in October 2017.

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## FINANCIAL SECTOR ASSESSMENT PROGRAM

October 31, 2017

# TECHNICAL NOTE

## STRESS TESTING BANKING SYSTEM RESILIENCE

**Monetary and Capital Markets Department**

This Technical Note was prepared by IMF staff in the context of the Financial Sector Assessment Program in Spain. It contains technical analysis and detailed information underpinning the FSAP's findings and recommendations. Please also see the Financial System Stability Assessment at http://www.imf.org/~/media/Files/Publications/CR/2017/cr17321.ashx
Further information on the FSAP can be found at http://www.imf.org/external/np/fsap/fssa.aspx

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# Glossary

| | |
|---|---|
| AFS | Available For Sale |
| CCP | Central Clearing Counterparty |
| CDS | Credit Default Swap |
| CET1 | Common Equity Tier1 |
| COREP | Common Reporting Framework |
| CRD | Capital Requirement Directive |
| CRR | Capital Requirements Regulation |
| CVA | Credit Valuation Adjustment |
| EBA | European Banking Authority |
| ECB | European Central Bank |
| EDF | Expected Default Frequency |
| EL | Expected Losses |
| ELA | Emergency Liquidity Assistance |
| EU | European Union |
| FDI | Foreign Direct Investment |
| Bank of Spain | Spain's Financial Supervision Authority |
| FINREP | Financial reporting |
| FSGM | Flexible System of Global Models |
| FSSA | Financial System Stability Assessment |
| GBP | Pound Sterling |
| HFCS | Household Finance and Consumption Survey |
| HFT | Held For Trading |
| IBB | Consolidated Banking Statistics on Immediate Borrower Basis |
| ICAAP | Internal Capital Adequacy Assessment Process |
| IMF | International Monetary Fund |
| NFC | Nonfinancial Corporations |
| OLS | Ordinary Least Squares |
| OTC | Over-the-Counter |
| O-SII | Other Systemically Important Institution |
| PIT | Point-in-time |
| RAM | Risk Assessment Matrix |
| RWA | Risk Weighted Assets |
| STA | Standardized Approach |
| STeM | Stress Test Matrix (for FSAP stress tests) |
| TN | Technical Note |
| TTC | Through-the-Cycle |
| U.K. | United Kingdom |
| U.S. | United States |
| USD | United States Dollar |
| VAR | Vector AutoRegression |
| VIX | Chicago Board Options Exchange Volatility Index |

# EXECUTIVE SUMMARY[1]

**Low profitability and large exposure to fixed income securities are the key vulnerabilities of the Spanish banking sector.** FSAP stress test results indicate that some banks may have difficulty enduring additional pressures on their profitability. In addition, some banks are vulnerable to market losses arising from a rapid increase in interest rates, given their significant exposures to fixed income securities**.**

**Near term funding and liquidity risks seem limited, but funding challenges are likely to amplify. Several banks are heavily reliant on central bank funding.** Funding from the Eurosystem makes up 6 percent of banks' total funding, a significant share which would expose Spanish banks to liquidity risks if the ECB decided to normalize its monetary policy. The systemic liquidity stress tests reveal that every bank in the FSAP sample meets the standard Liquidity Coverage Ratio (LCR) hurdle rate of 100 percent. Funding risks in foreign currencies are limited, as are maturity mismatches at the one-year horizon based on the NSFR results. However, Spanish banks could face liquidity shortfalls in a potential extreme event characterized by large retail deposit withdrawals and a significant reduction in central bank funding over a month, as well as in a very severe wholesale funding shock scenario. The cash-flow-based analysis suggests that Spanish banks would be able to cope with significant net liquidity outflows, up to a year, by using their liquidity buffers, but this scenario might translate into trading losses.

**Based on these findings the authorities are encouraged to continue to monitor closely interest rate and government bond market risks in their stress testing exercises.** The post crisis period has seen some Spanish banks become highly exposed to sovereign and interest rate risks. In order to boost profitability in an environment where credit to the private sector continues to shrink, many Spanish banks have used long-term ECB funding to buy government bonds in carry-trade operations. Solvency stress test results suggest that these exposures could lead to large losses as monetary policy normalizes. The authorities are encouraged to continue to monitor sovereign exposures and the interest rate risk associated with them.

**Furthermore, supervisors should ensure that Pillar II requirements adequately reflect banks' vulnerability to a further compression in NIMs.** Some banks show less ability to absorb any additional stresses on profitability. While the NIMs are already compressed and the likely scenario is an improvement as interest rates increase, the banks should be able to withstand the potential for continued compressed margins or even their further tightening. In this regard, the ECB's 2017 stress test dedicated to interest rate risk on the banking book is welcome.

**Reliance on CET1 elements that will be deducted on a fully-loaded basis, should be reduced in line, and if possible ahead of, transitional arrangements in CRD IV**. Spanish banks rely heavily on

[1] The authors of this note are Cyril Pouvelle and Maral Shamloo (both IMF), part of the Spain FSAP 2017 team led by Udaibir Das. The analysis has benefitted from discussions with the staff of the Bank of Spain, the Spanish Treasury, the European Central Bank, the Spain FSAP team, and reviewers at the IMF. The collaboration of Mr. Felipe Nierhoff (IMF) is highly appreciated.

CET1 elements that will be deducted from CET1 as CRD-IV is implemented, showing one of the largest discrepancies between transitional and fully-loaded measurements of capital in Europe. The banks will need to replace the capital that will be phased out, roughly 160 bps, in the next three years.

**The authorities are also encouraged to ramp-up their monitoring of liquidity, funding and derivatives related risks.** Liquidity stress test results call for a carefully designed exit strategy from the ECB unconventional monetary policy and the search for alternative stable sources of funding. Moreover, the European authorities should improve their liquidity monitoring by performing liquidity stress tests at various maturities, and close liquidity reporting gaps on a permanent basis with an expanded harmonized EU bank reporting.

**The authorities are also encouraged to ramp-up their monitoring of liquidity, funding and derivatives related risks.** Liquidity stress test results call for a carefully designed exit strategy from the ECB unconventional monetary policy and the search for alternative stable sources of funding. Moreover, the European authorities should improve their liquidity monitoring by performing liquidity stress tests at various maturities, and close liquidity reporting gaps on a permanent basis with an expanded harmonized EU bank reporting.

| Table 1. Recommendations on Risk Analysis | Time[1] | Responsibility |
|---|---|---|
| ***Risk analysis*** | | |
| Ensure that Pillar II requirements adequately reflect banks' vulnerability to a further compression in NIMs (¶30). | NT | ECB/BdE |
| Ensure that banks' Pillar II requirements adequately reflect their ability to withstand interest rate hikes (¶30). | NT | ECB/BdE |
| Ensure that CET1 deductions are replaced in line, and preferably ahead of, transitional arrangements in CRD IV (¶30). | NT | ECB/BdE |
| Ensure the banks improve their overall capital adequacy ratio, via issuance of Tier II and Tier 1 instruments (¶30). | I | ECB/BdE |
| Intensify monitoring of risks other than credit for the SIs (¶30). | NT | BdE |
| Perform liquidity stress tests for various time horizons and take supervisory action if imbalances emerge (¶48) | NT | ECB/BdE |
| Regularly review banks' plans for ECB unconventional monetary policy exit (see ¶ 48). | NT | ECB/BdE |
| Improve liquidity monitoring by closing liquidity reporting gaps on a permanent basis with an expanded harmonized EU bank reporting (maturity ladder) (see ¶ 48). | NT | ECB/ European Commission |

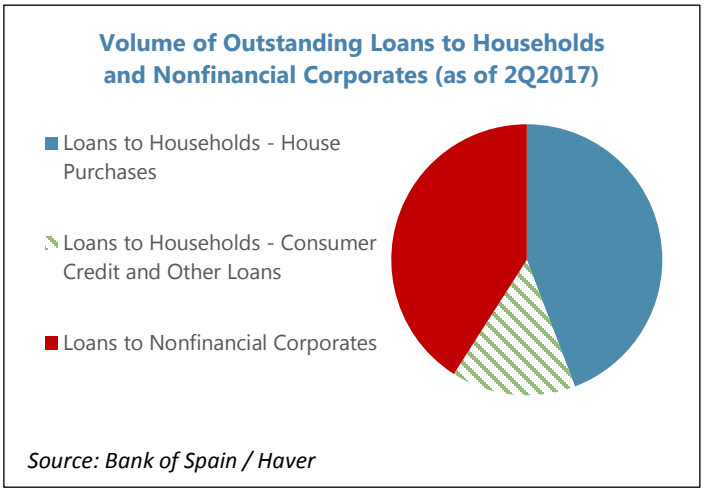
[1] I-Immediate" is within one year; "NT-near-term" is 1–3 years; "MT-medium-term" is 3–5 years.

# INTRODUCTION

## A. The Structure of the Financial System

**1. Despite sharp contraction following the crisis, the banking sector remains large as a share of GDP.** As of December 2015, financial system assets were 14 percent lower than in 2007, largely due to the deleveraging of bank assets; the number of institutions fell to 220 from 336 following bank mergers and acquisitions that mainly involved savings banks; and the contribution of the financial sector to employment and GDP declined by 5 and 33 percent respectively. Nevertheless, at 360 percent of GDP, the Spanish financial sector assets are large. Furthermore, the Spanish financial system remains bank-dominated, with over two thirds of the system assets belonging to banks.[2] The 14 Significant Institutions (SIs) account for more than 90 percent of banking sector assets.

**2. Spanish banks operate a universal model with a strong retail orientation, both on the asset and funding sides.** Mortgages make up the largest component of loans (44 percent), followed by loans to non-financial corporates (NFCs) (41 percent) and consumer credit and other loans (15 percent) (see text chart). The two largest banks, Santander and BBVA, have considerable international operations and their subsidiaries abroad are systemically important in several countries.[3] A third bank, Sabadell, has operations in the United Kingdom. The other SIs focus primarily domestically. Less Significant Institutions (LSIs) are mainly represented by 38 groups of credit cooperatives that operate regionally.




**3. The Spanish banking system has recovered significantly since the crisis but legacy from the crisis endures (Figure 1).** Since the height of the crisis in 2012, Spanish banks have increased their capital, benefited from the ECB long-term funding operations and have gone through a large-scale restructuring and consolidation within the sector. Nevertheless, legacy assets continue to weigh on banks' asset quality, profitability remains below the cost of capital, exposure to government bonds is among the highest in Europe in terms of asset share. As a result, some institutions remain vulnerable.

[2] The rest of the financial sector includes insurance companies, pension funds, investment funds and financial vehicle corporations, most of which are part of bank-led conglomerates.

[3] The two most international banks are: Santander and BBVA. Santander is a G-SIB.

## B. Stress Testing Under FSAP

**4. The FSAP approach to stress testing is macroprudential.** As such, it focuses on the resilience of the broader financial system to adverse macrofinancial conditions and the identification of financial system vulnerabilities. This is different from the focus of micro-prudential stress tests, e.g., those conducted by the European Banking Authority (EBA), that assess capital adequacy in individual institutions. The FSAP stress test analysis is intended to help country authorities identify key sources of systemic risk in the banking sector and inform macroprudential policies. FSAP stress tests can also help identify informational and methodological gaps and priorities for policy actions, such as those aimed at reducing specific exposures or building capital and liquidity buffers.

## C. Approach in Spain

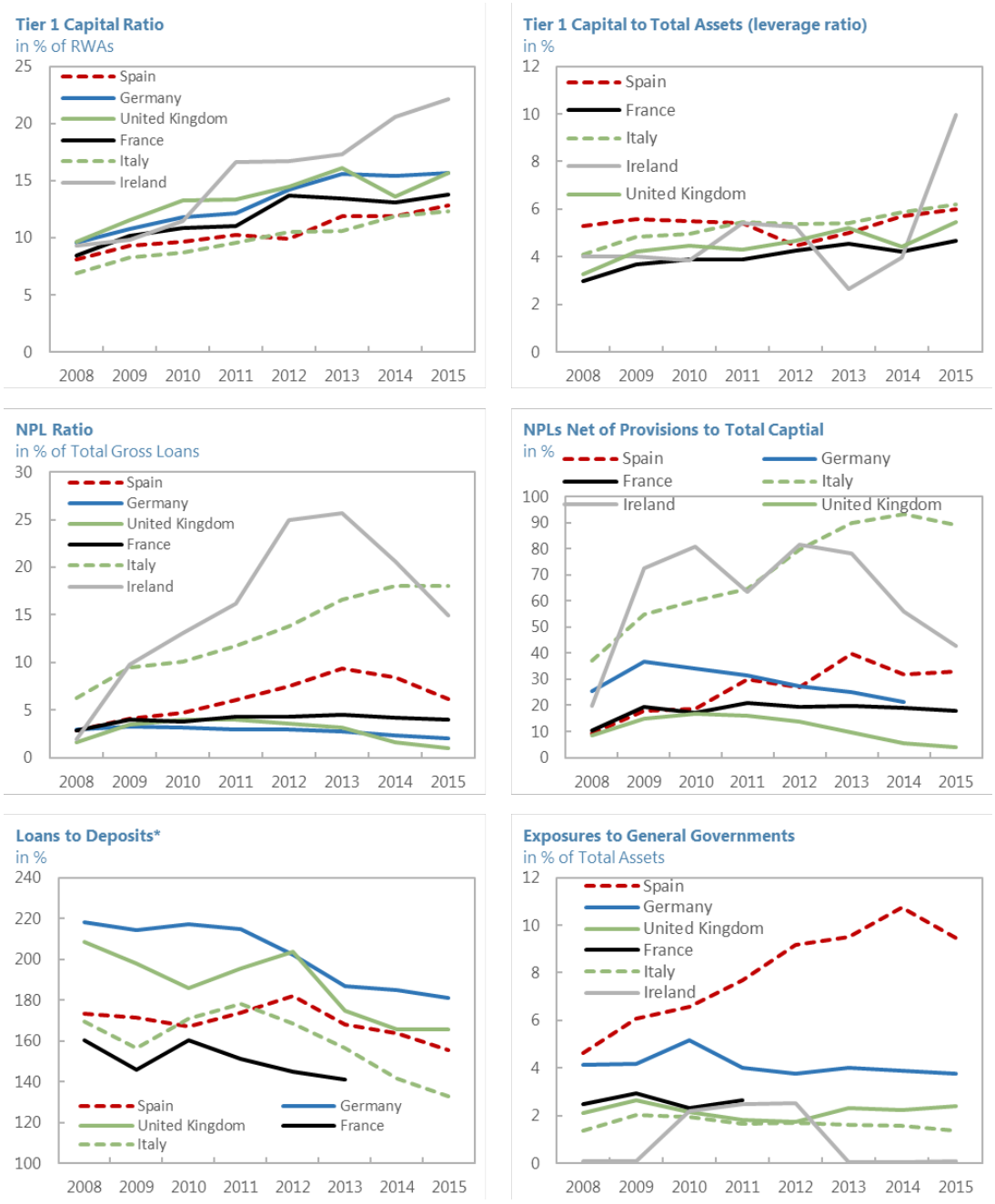
**5. The stress tests examined the resilience of the banking system to *solvency* and *liquidity* risks (Figure 2).** The stress tests included a Top-Down (TD) exercise based on macroeconomic scenarios and sensitivity analyses. The tests based on macroeconomic scenarios assessed the impact of combined external and domestic shocks on the economy over a three-year horizon (2017–2019). The reference date for the test was December 2016. The effects of these shocks on individual banks' profitability and capitalization were assessed using satellite models and methodologies developed by Fund staff; credit risk benchmarks from the ECB were also used. The TD liquidity tests assessed the capacity of banks to withstand large withdrawals of funding. It used a maturity ladder analysis, i.e., a cash flow-based analysis with different maturity buckets, and supervisory information.

**6. The IMF stress tests covered the 14 Significant Institutions (SIs).** The solvency tests for the SIs were conducted by the FSAP team based on the IMF methodology discussed in detail in this note. The scenario-based solvency stress test was complemented by a range of sensitivity tests.

**7. The BdE conducted the solvency and liquidity stress tests for the Less Significant Institutions (LSIs).** These covered over 95 percent of less significant institutions (LSIs), including credit cooperatives and was based on the BdE's own methodology. LSI liquidity tests included LCR analyses. Both exercises were based on the same scenarios developed by the IMF staff.

**8. The remainder of this technical note (TN) is structured as follows.** The second section presents the key risk factors. The third section discusses the different components of the solvency stress tests based both on macroeconomic scenarios and sensitivity analysis: scenario design, methodology, and results. The fourth section presents the stress tests of liquidity risk.

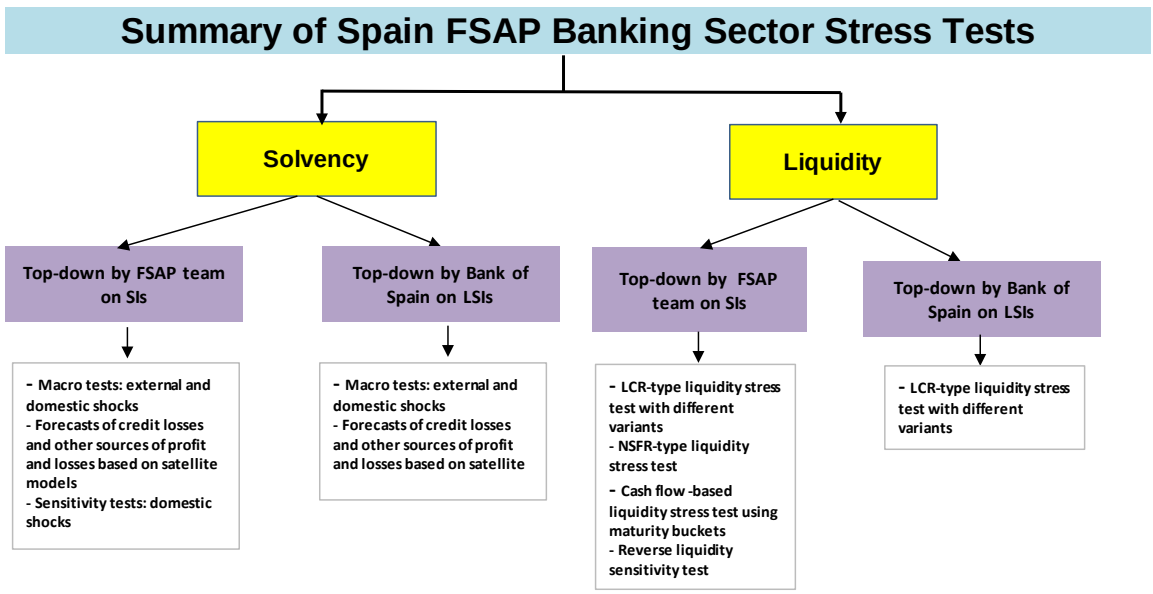
## Figure 1. Spanish Banks' Financial Soundness Indicators vs. European Peers




* Loan to Deposit Data Unavailable for Ireland in FSI Database

Source: IMF Staff Calculations, IMF Financial Soundness Indicators Database

**Figure 2. Summary of Spain FSAP Stress Tests**




Source: IMF staff

# KEY VULNERABILTIES

**9. Certain features of the Spanish banking system may increase its vulnerability to external shocks.** The stress tests and sensitivity analyses were designed to assess the resilience of the Spanish banking sector to external shocks. The main vulnerabilities assessed in our solvency and liquidity stress tests are as follows:

- *Spanish banks remain heavily exposed to the sovereign.* Exposures to own sovereign as a share of assets is the second largest in the Euro-Area, after Italy and stands at 8 percent of total assets (compared to 5 percent for the Euro Area average) (see Figure 3).
- *Profitability is low by historical standards, albeit has evolved more favorably compared to other European banks.* ROE stood at 5.6 percent in consolidated terms at end-2015, and at 4.4 percent for domestic banking. Spanish banks' profitability is negatively affected particularly by the relatively higher provisioning ratios compared to their European peers (Figure 3). The internationally-oriented Spanish banks enjoy higher net interest margins compared to the domestically oriented ones, mainly due to income from their subsidiaries abroad, in particular in Latin America. Even so, the consolidated profitability of the two international banks remains slightly below the average for Global Systemically Important Banks (G-SIBs). Overall, bank profitability remains below the cost of capital—estimated to be 6.8 percent for Spanish banks by the Bank of Spain.[4]

[4] Bank of Spain (2016), *Financial Stability Report*, May 2016. See also ECB (2015), "Bank Profitability Challenges in Euro Area Banks: The Role of Cyclical and Structural Factors," *Financial Stability Review,* and GFSR (April 2016), Potent Policies for a Successful Normalization, Chapter 1, *Global Financial Stability Report*, IMF.

- *Banks continue to hold sizeable nonperforming loans (NPLs) and foreclosed real estate assets.* Non-earning assets still amount to roughly 7 percent of bank assets as of June 2016, and close to 25 percent of total capital, net of provisions, despite significant progress and continued efforts by the authorities and the banks. Financial system's problem assets are higher when those in SAREB's[5] portfolio is included.
- *Spanish banks' continued reliance on ECB funding (about 6 percent of total funding) raises questions about their ability to secure stable funding in a stress environment.* The ECB long-term refinancing operations have allowed Spanish banks to lengthen the maturity of their liabilities (four years on average) and to improve their profitability as they used this cheap funding to buy Spanish government bonds in "carry trade" operations (operations which have been reduced currently). In that context, the replacement of ECB funding with short-term unsecured wholesale funding would be detrimental to the Spanish banks' stability. Despite the low credit demand and the negative credit growth, most banks display loan-to-deposit ratios largely above 1, including a few banks having a ratio exceeding 120 percent, and ECB funding making up 17 percent of total funding in one case. Therefore, the attention of the supervisors should be focused on these banks as they might face liquidity tensions if the ECB started reducing its support.

**10. Laying bare these vulnerabilities is the Spanish banks' moderate capacity to absorb shocks.** While aggregate solvency has been improving steadily since 2012 (CET1 ratio stood (transitional) at 12.8 percent as of end-2016 compared to 9.2 percent in December 2012), Spanish banks lag their European peers in terms of their CET1 capital ratio, particularly on a Fully Loaded basis. The difference between fully-loaded and transitional CET1 capital is large for Spanish banks, due to their reliance on goodwill and DTAs.

**11. Mitigating the impact of these vulnerabilities, Spanish banks benefit from a number of strengths:**

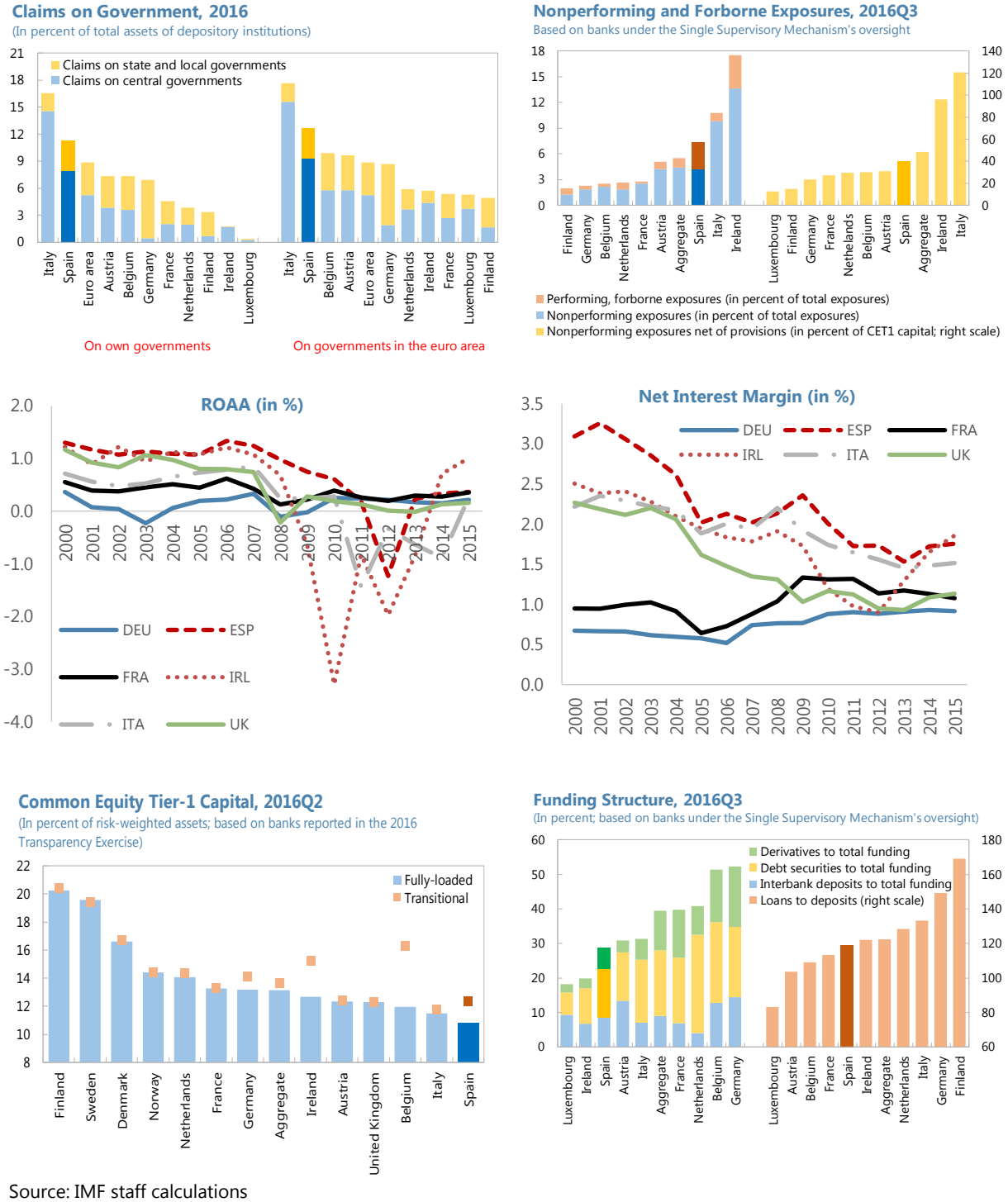
- *The risk weight density of Spanish banks is above average of EU banks* due to a larger fraction of assets under the standardized approach and higher risk weights in the IRB portfolio (Table 2).[6] This increases the shock-absorption capacity of Spanish banks' balance sheets.
- *NPLs seem to be adequately provisioned on average, with a provisioning ratio of 58 percent, albeit with significant dispersion.* Furthermore, the 2014 ECB Asset Quality Review assigned the smallest adjustment to the Spanish banking system CET1 capital among euro area countries, with the amount of provisions and the valuation of collateral deemed to be broadly appropriate. Nevertheless, there is some heterogeneity across banks with five banks displaying a provisioning ratio around 40 percent.
- *Overall funding conditions have improved with banks seeing a decline in the loan to deposit ratio to 108 percent in 2016 from 145 percent in 2011.* Spanish banks have been able to tap funding from capital markets—with increased issuances of covered bonds—in the past two

[5] Sociedad de Gestión de Activos Procedentes de la Reestructuración Bancaria (Sareb) is an asset management company created in 2012 to deal with the management of €50 billion of non-performing assets in bank portfolios.

[6] Turk, Rima (2017) How Heterogeneous are Bank Risk Weights across Europe. IMF Working Paper, forthcoming.

years. Spanish banks were complying with the phased-in requirement of 70 percent for the liquidity coverage ratio in 2016 and should be on time with the fully-loaded requirement in 2018.

## Figure 3. Selected Advanced Economies: Balance Sheet Characteristic




Source: IMF staff calculations

| Table 2. Average Risk Weights Across IRB portfolios: Spain vs. European Average<br>June 2016 (in percent) | | |
|---|---|---|
| | Spanish banks | European banks |
| Corporate Exposures | 66 | 51.8 |
| Retail Exposures | 46 | 27 |
| Mortgage Exposures | 14 | 15.5 |

Sources: EBA; and R. A. Turk "How Heterogeneous are Bank Risk Weights across Europe?", IMF Working Paper (forthcoming)

# SOLVENCY STRESS TESTS

## A. Macrofinancial Risks and Scenarios

**12. The banking sector's resilience was assessed against two extreme but plausible adverse scenarios.** The scenarios were based on the risks described in the IMF GRAM and Spain-specific risks summarized in the country RAM, and with a view of the vulnerabilities described above. The baseline reflects the January 2017 WEO projections. Both adverse scenarios are designed using the IMF's GFM model. The shocks and their magnitudes are described in Tables 3 and 4. The narratives for the two adverse scenarios are as follows:

- **Scenario 1—Financial Stress in Europe.** This scenario assumes the realization of financial stability risks in the Euro Area with spillovers worldwide, in particular, a reemergence of financial stress in high spread euro area economies, represented by an increase (and divergence) in long-term government bond yields and stock-market sell-off. Fragile euro area growth also puts downward pressure on external demand for Spain. The strong government bond market-bank nexus will be the main transmission channels to the banks and the financial sector, through funding costs; NPLs are also affected by lower GDP growth and higher unemployment rate.

- **Under this stress test scenario, the Euro Area and Spain experience a deep balance sheet recession (Figures 4 and 5 and Table 4)**. The recession in the EA is concentrated in high spread economies, EA output is 6.8 percent lower relative to the baseline at end-2019. At the end of the horizon, the cumulative output shortfall relative to the baseline is 9.6 percent for Spain. Unemployment rises by 2.5 percent relative to the baseline at the end of the horizon.[7] Long-term government bond yields increase 195 bps relative to the baseline at the peak and equity prices fall by 23 percent relative to the baseline at their trough.

- **Scenario 2—De-globalization and Stagnation in Advanced Economies.** The narrative is driven by political developments in Europe and the United States. These de-globalization initiatives, including the post-Brexit arrangements, limit or reverse international trade and financial integration (in the medium-term). Anticipating these effects, stock markets experience a

[7] In Spain, the unemployment rate is very sensitive to deviations of output from potential whereas the GFM does not predict a large negative beta coefficient of the unemployment rate with respect to the output gap. As such, the model underestimates unemployment rate in Spain, partly compensating for the GDP impact, to the extent that unemployment rate is important for calculation of credit losses.

sell-off in the near-term on profitability concerns and reduced risk appetite, with sharp drops in the euro area, the United Kingdom and the United States over two years. Furthermore, there would be large capital outflows from Turkey and Latin America, motivated by political uncertainty, and a significant growth slow-down in the United Kingdom as the terms of Brexit become more clear. The scenario affects Spanish banks due to their large exposures to these countries. In addition, consumption and investment would become weaker due to increased political uncertainty

- **For Spain, the output decline over the stress horizon is roughly similar** (see Figures 4 and 5 and Table 5). In this scenario, the end-of-horizon cumulative output shortfall with respect to the baseline is 8.8 percent. Long term government bond yields rise by 185 basis points compared to the baseline at their peak whereas unemployment is 2.4 percentage points higher relative to the baseline (at its peak also).

**Table 3. Scenario 1 Exogenous Shocks**

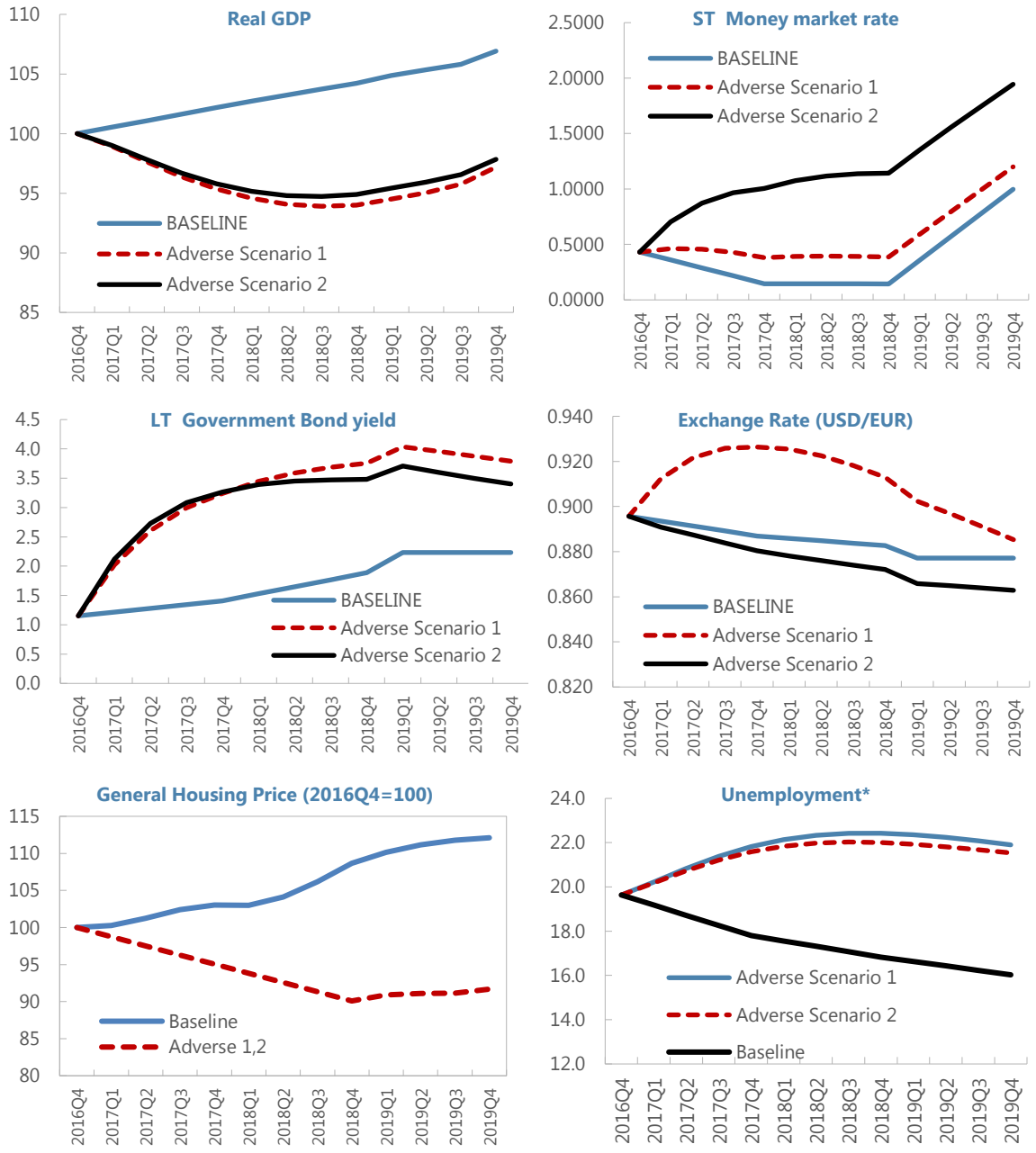
| Description | Magnitude at Peak |
|---|---|
| **Layer 1: Tightening financial conditions in systemic economies, 2017Q1-2018Q2** | |
| Real equity price, Equity risk premium shocks | |
| China, Euro area, Japan, United Kingdom, United States | -20 percent |
| Money market interest rate spread, Credit risk premium shocks | |
| China | +100 basis points |
| Euro Area, Japan, United Kingdom, United States | +25 basis points |
| Long-term government bond yield, Duration risk premium shocks | |
| High spread euro area economies | +200 basis points |
| Japan, United Kingdom, United States | +100 basis points |
| Low spread euro area economies | +50 basis points |
| Real bilateral exchange rate, Currency risk premium shocks | |
| Euro area | +5 percent |
| **Layer 2: Fiscal consolidation in the euro area, 2017Q1-2019Q2** | |
| Primary fiscal balance ratio, Fiscal expenditure shocks | |
| High spread euro area economies | +2 percentage points |
| Low spread euro area economies | +1 percentage point |
| **Layer 3: Credit cycle downturns in emerging market economies, 2017Q1-2019Q2** | |
| Loan default rate, Loan default shocks | 0 to +6.4 percentage points |
| **Layer 4: Suppressed economic risk taking worldwide, 2017-21** | |
| Private investment, Investment demand shocks | -4 percent |
| Private consumption, Consumption demand shocks | -1 percent |
| **Layer 6: Suppressed economic risk taking in Spain, 2017-18** | |
| Private investment, Investment demand shocks | -4 percent |
| Private consumption, Consumption demand shocks | -1 percent |

[1] High spread euro area economies include Greece, Ireland, Italy, Portugal, and Spain.
[2] Low spread euro area economies include Austria, Belgium, Finland, France, Germany, and the Netherlands.

| Table 4. Scenario 2 Exogenous Shocks | |
|---|---|
| Description of exogenous shocks to variables | Magnitude of the shock at peak |
| **Layer 1: Risk-off reactions in Europe and the United States, 2017-18** | |
| Real equity price, Equity risk premium shocks | |
| Euro area, United Kingdom, United States | -20 percent |
| Money market interest rate spread, Credit risk premium shocks | |
| High spread euro area economies, United Kingdom | +100 basis points |
| Low spread euro area economies, United States | +50 basis points |
| Long-term government bond yield, Duration risk premium shocks | |
| High spread euro area economies | +100 basis points |
| Exposed emerging market economies | +50 basis points |
| Low spread euro area economies, United Kingdom, United States | -25 basis points |
| **Layer 2: Heightened uncertainty in Europe and the United States, 2017-19** | |
| Private investment, Investment demand shocks | |
| United Kingdom | -2 percent |
| Euro area, United States | -1 percent |
| Private consumption, Consumption demand shocks | |
| United Kingdom | -0.5 percent |
| Euro area, United States | -0.25 percent |
| **Layer 3: Balance sheet vulnerabilities in emerging market economies, 2017-19** | |
| Loan default rate, in emerging economies | +0.0 to +3.2 percentage points |
| **Layer 4: De-globalization in Europe and the United States, 2017-21** | |
| Private investment, Investment demand shocks | |
| Euro area, United Kingdom, United States | -6 percent |
| Rest of the World | -3 percent |
| Private consumption, Consumption demand shocks | |
| Euro area, United Kingdom, United States | -2 percent |
| Rest of the World | -1 percent |
| Exports and imports, Exports and import demand shocks | |
| Euro area, United Kingdom, United States | -20 percent |
| Rest of the World | -10 percent |
| Productivity, Productivity shocks | |
| Euro area, United Kingdom, United States | -1 percent |
| Rest of the World | -0.5 percent |
| **Layer 5 Pressures on public finance in Spain, 2017-18** | |
| Long-term government bond yield, Duration risk premium shocks | +100 basis points |
| Primary fiscal balance ratio, fiscal expenditure shocks | +1 percentage points |
| **Layer 6: Suppressed economic risk taking in Spain, 2017-18** | |
| Private investment, Investment demand shocks | -4 percent |
| Private consumption, Consumption demand shocks | -1 percent |
| **Layer 7: Large capital outflows in Latin America and Turkey, 2017** | |
| Real equity price, Equity risk premium shocks | -10 percent |
| Long-term government bond yield, Duration risk premium shocks | +100 basis points |
| Real bilateral exchange rate, Currency risk premium shocks | +20 percent |
| **Layer 8: Suppressed economic risk taking in "selected economies", 2017-18** | |

| Table 4. Scenario 2 Exogenous shocks (concluded) | |
|---|---|
| Private investment, Investment demand shocks | -8 percent |
| Private consumption, Consumption demand shocks | -2 percent |
| Layer 9: Structurally weak growth in Spain, 2019-21 | |
| [1] High spread euro area economies include Greece, Ireland, Italy, Portugal, and Spain. | |
| [2] Low spread euro area economies include Austria, Belgium, Finland, France, Germany, and the Netherlands. | |
| [3] Selected economies in Layer 8 include Latin America (Argentina, Brazil, Chile, Colombia, and Mexico), Turkey, the United Kingdom, and the United States. | |

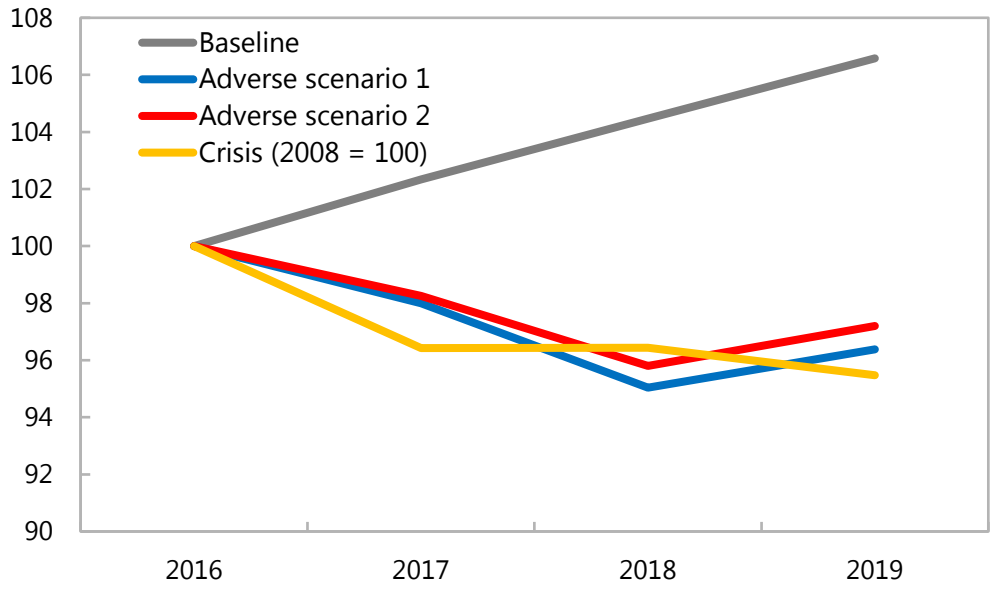
## Figure 4. Macroeconomic Baseline and Stress Scenarios



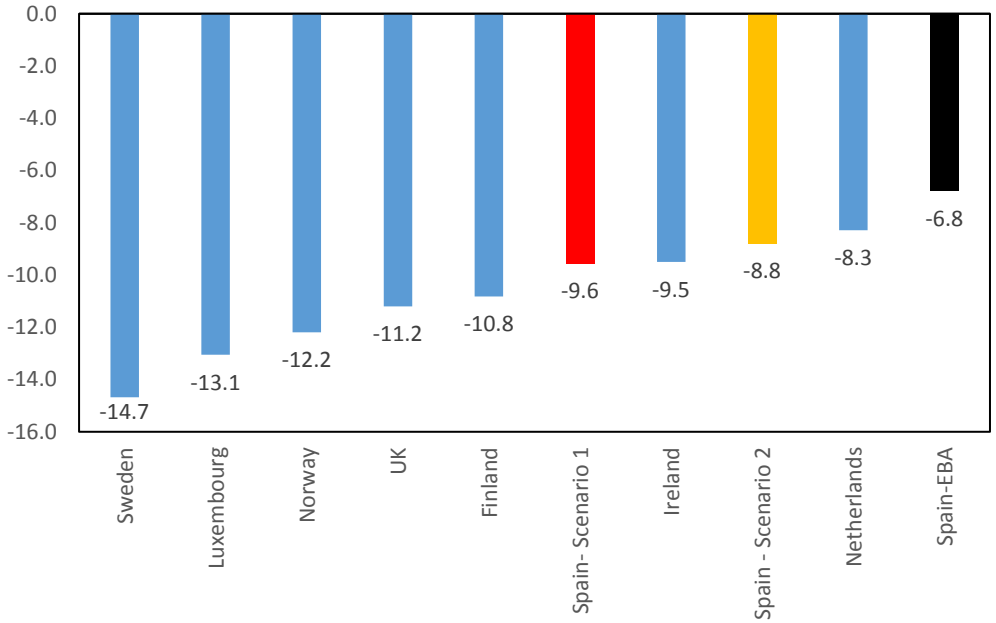

Source: IMF staff calculations

**Figure 5. Scenario severity from a historic perspective**

**Real GDP under Stress Scenarios, 2016-19**
(2016 = 100)




**Total deviation of GDP level from baseline**
**(Percent, cumulative)**



## Table 5. Macroeconomic Scenarios for Stress Tests

**In Percent (Unless otherwise specified)**

| | Adverse Scenario-1 | | | Adverse Scenario-2 | | | Baseline (from WEO) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| Real GDP (2016=100) | 98.1 | 95.2 | 96.5 | 98.3 | 95.9 | 97.3 | 102.4 | 104.6 | 106.7 |
| Short-term money market rate | 0.4 | 0.5 | 1.4 | 0.8 | 1.3 | 2.2 | 0.1 | 0.1 | 1.0 |
| Long-term government bond yield | 3.6 | 4.6 | 4.8 | 3.7 | 4.4 | 4.4 | 2.2 | 2.7 | 3.1 |
| Exchange rate (EUR/USD) | 0.98 | 0.99 | 0.97 | 0.94 | 0.94 | 0.94 | 0.95 | 0.95 | 0.95 |
| Equity price growth | -17.8 | -8.8 | -1.2 | -16.8 | -10.5 | -4.0 | 13.9 | 0.0 | 0.0 |
| Inflation rate (CPI) | 1.7 | -1.3 | -2.0 | 1.5 | -1.5 | -1.8 | 2.4 | 1.4 | 1.5 |
| Unemployment rate | 21.0 | 22.3 | 22.1 | 20.9 | 21.9 | 21.7 | 17.8 | 16.8 | 16.0 |
| Nominal GDP growth | -1.1 | -4.6 | -0.8 | -1.0 | -4.1 | -0.5 | 4.0 | 3.6 | 3.7 |
| Commodity price - Energy (Index 2005=100) | 88 | 64 | 57 | 88 | 67 | 59 | 103 | 102 | 100 |
| Commodity price - Non-energy (Index 2005=100) | 132 | 113 | 106 | 131 | 115 | 107 | 143 | 141 | 139 |
| Real Estate Price Growth | -2.0 | -5.1 | -0.8 | -2.0 | -5.1 | -0.8 | 2.9 | 3.7 | 5.5 |
| *Memo:* | | | | | | | | | |
| *Spread of short-term money market rate* | 0.2 | 0.2 | 0.2 | 0.6 | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 |
| *Real GDP growth (in percent)* | -1.9 | -3.0 | 1.4 | -1.7 | -2.4 | 1.5 | 2.4 | 2.1 | 2.0 |

## B. Stress Test Design and Modeling Approach

**13. The solvency stress test covered credit, market and interest rate risk on the banking book, as well as shocks to the profitability of the banks.** To complement the scenario-based stress test, a range of single factor sensitivity tests were carried out to explore sensitivities around the calibration of key risk factors.[8]

**14. Stress tests were based on the applicable international and national regulatory frameworks.** The hurdle rates for the total capital adequacy, Tier 1 capital, and Common Equity Tier1 capital ratios were set according to the Basel III fully-loaded definitions of capital requirements, plus any applicable institution-specific hurdles (see Table 6). While noting that leverage ratio becomes effective starting January 2018, the banks were assessed against this metric as set out by Basel III standards.

**Table 6. Hurdle Rates for Solvency Stress Tests**

(in percent)

| | **Total Capital ratio** (share of RWA) | **Tier I Capital ratio** (share of RWA) | **CET1 Capital ratio** (share of RWA) | **Leverage ratio** (Tier 1 capital to total assets) |
|---|---|---|---|---|
| | | | | |
| As of Dec. 2016 (Fully Loaded ratios) | 13.6 | 11.8 | 10.9 | 5.6 |
| Hurdle rate | 8.0 + G-SIB/OSII buffer | 6.0+ G-SIB/OSII buffer | 4.5 + G-SIB/OSII buffer | 3.0 |

| **G-SIB/OSII buffers (in percent)** | | |
|---|---|---|
| | **Capital Buffer in 2017** | **Capital Buffer in 2019** |
| Santander | 0.50 | 1.00 |
| BBVA | 0.375 | 0.75 |
| Caixabank | 0.125 | 0.25 |
| Bankia | 0.125 | 0.25 |
| Sabadell | 0.125 | 0.25 |
| Popular | 0.125 | 0.25 |

### Credit Risk

**15. Credit risk accounts for the largest regulatory capital requirement of Spanish banks**. In December 2016, credit risk RWAs of 14 SIs accounted for 88 percent of total RWA. RWAs for market

[8] This is in line with the 2009 BIS principles for sound stress testing practices and supervision.

risk and operational risk are far less material, accounting for around 3 percent, and 9 percent of risk weighted assets, respectively.

**16. Most Spanish banks' portfolios are under the Standardized Basel II framework (see Figure 6).** Seven of the 14 SIs, accounting for 10 percent of the banking sector assets, use standardized approach only whereas the remaining seven institutions use a combination of IRB and STA approaches. Nevertheless, 61 percent of system-wide RWAs for credit risk was treated under the STA approach as of December 2016.

**17. Credit risk projections were obtained separately for STA and IRB portfolios:**

- **For exposures under the STA approach the stock of NPLs were projected for each scenario.** To do so, we used bank by bank NPL data provided by the BdE. The NPL rates were regressed on a range of explanatory factors in a panel regression with bank fixed effects. In particular, lagged NPLs, housing price, unemployment rate, and long interest rates, as well as bank-specific fixed effects, were significant for projection of NPLs (see Appendix III for details).
- **For IRB exposures probabilities of default (PDs) were estimated based on EDFs and the ECB's credit risk models.** The team did not have access to historical PDs (neither TTC nor PiT). As such, we relied on Moody's Expected Default Frequency (EDF) data, as well as the ECB's credit risk models.[9] The ECB model estimates rely on historical default rate series obtained from national competent authorities across the EU countries, and Moody's KMV model and Kamakura-based indicators of expected default rates for financial corporations and sovereigns respectively. For projection of PDs for corporate and institutions portfolios, we relied on EDF data. For mortgages, household consumer credit and sovereign default probabilities, we relied on projections provided by the ECB. Given the significance of lagged PDs for our estimates, the starting point PDs matter for the maximum stress reached in the stress scenario. This is not the case however for the sovereign, where estimates provided by the ECB were scenario dependent only (see Appendix III for details).

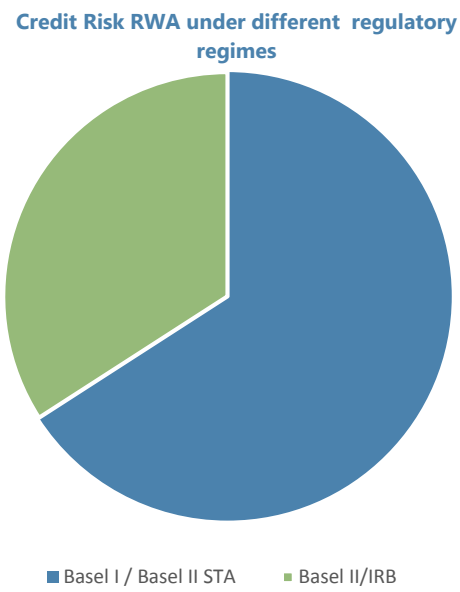
**18. Projections of Loss Given Default (LGD) were based on ECB models.** The ECB has developed a country-specific structural model for LGDs associated with the housing-related loan portfolios. LGD is derived as a function of loan to value (LTV) ratio and costs associated with liquidation. For the non-real estate segments (corporate and consumer credit), a fixed multiplier relative to the starting point LGD is used (implying an increase of 13 to 18 percent for various portfolios). For sovereign banking book exposures, a fixed LGD of 40 percent is employed.

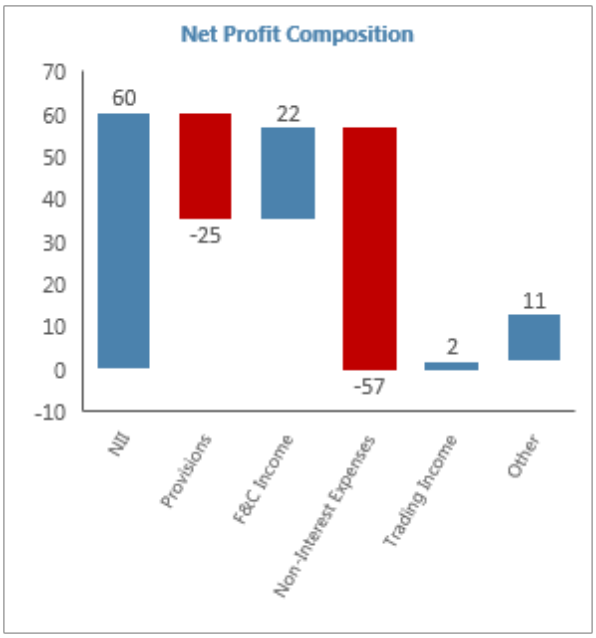
**19. The stock of non-accrual loans almost double during the stress test horizon.** Most of this increase is due to exposures in Spain. NPLs were also estimated for three countries where Spanish banks have significant exposures, namely Brazil, and the United Kingdom. These estimates

[9] These models are described in detail in the ECB's published approach to macroprudential stress testing: https://www.ecb.europa.eu/pub/pdf/other/stampe201702.en.pdf

were at aggregate level as bank-specific historical data was not available. The increase in NPL ratios was applied to STA exposures for those countries.

**Figure 6. Bank Balance Sheets and Business Models**




Source: IMF staff calculations

**20. Estimates from the credit risk models suggest that PDs would rise sharply in the adverse scenario (Figure 7 and Table 7).** In the adverse scenario, system-wide point-in-time PDs increase multiplier is 2.1 times the starting level, but with significant variation across exposure types. The increase in weighted average LGD is smaller: Point-in-time LGDs increase from a weighted-average of 28 percent to 33 percent.[10]

**Table 7. Median PDs Across Banks (in percent)**

| | Initial (median) PD | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|---|
| | | Y1 | Y2 | Y3 | Y1 | Y2 | Y3 |
| Retail SME | 3.3 | 5.9 | 7.8 | 7.0 | 5.9 | 7.8 | 6.6 |
| Mortgages | 1.3 | 2.1 | 3.1 | 2.7 | 2.1 | 3.0 | 2.6 |
| Other Retail | 2.0 | 2.6 | 3.1 | 3.1 | 2.6 | 3.2 | 2.9 |
| Corporate | 2.1 | 3.1 | 3.6 | 3.5 | 3.1 | 3.7 | 3.3 |

Source: IMF staff calculations

[10] The PD and LGD averages are very close under the two adverse scenarios. This is due to the fact that IRB portfolios are almost all domestic (where the impact of the two scenarios on the Spanish economy is very similar), whereas the foreign exposures (where the scenarios differ significantly) are mostly standardized.

### Net Interest Income

**21. Shocks to interest income and rates on liabilities were modeled based on historical correlations.** A Panel Vector Auto Regression (P-VAR) model was used to find the relationship between funding costs, sovereign borrowing costs and Euribor. The exact specification is as follows:

$$\boldsymbol{V}_t = \boldsymbol{A} + \boldsymbol{B}\boldsymbol{V}_{t-1} + cy_t + \epsilon_t$$

where $\boldsymbol{V}_t$ is a vector of three variables: a bank's average funding cost, the growth in funding and the long-term interest rates measures by 10-year sovereign yield $y_t$ is short-term Euribor. We find that sovereign yields have a positive and significant impact on bank funding rates. We use the estimated coefficients to calibrate the increase in funding costs given the increase in Euribor and sovereign rates produced by the scenario.

Furthermore, the lending rates were linked to the 12-month Euribor. The deviation from the baseline of overnight money market rates, the proxy for Euribor, are projected using the model. Using the Euro swap curve, we obtain projections of 12 month Euribor throughout the stress test horizon under the baseline, which combined with the deviations produced by the model allow us to project lending rates in the adverse scenario.

**22. Interest rate risk on the banking book was assessed using time-to-repricing buckets.** The impact of interest rate risk on net interest income is estimated by measuring the gap between assets and liabilities in several maturity buckets (less than one month, until greater than one year)**.** Spanish banks carry a large positive interest rate risk, implying lost net interest despite an increase in market interest rates.

### Market Losses

**23. Market valuation losses corresponding to holdings of debt securities were split into two components:**

- **Interest-rate risk was measured using a modified duration approach.** Specifically, for each year in the stress test horizon sovereign yield curves were constructed by linear interpolation of short- and long-term interest rates for the risk-free government bonds (German bunds). The change in yield for each country exposure in this synthetic portfolio is constructed similarly to the Spanish exposures. Finally, changes in yields are obtained based the (modified) duration of the Spanish and foreign exposures of each bank to calculate interest-risk component of the haircuts applied to bond portfolios in HFT, AFS, and FV accounts, according to the following formula:

$$\frac{\partial \text{Valuation}}{\text{Valuation}} = -MD \cdot \partial y_{MD}$$

  where MD is the modified duration of the portfolio, and $\partial y_{MD}$ is the change in the yield caused by the shift in the yield curve (vis-à-vis the value prevailing in the previous year), and measured at a point in time that matches the modified duration of the portfolio.

- **Credit risk associated with these exposures was measured using the PD-LGD approach.** The same sovereign PD and LGDs as described in the credit risk section were applied to Spanish securities exposures.

**24. The direct effects of exchange rate risks were assessed based on banks' net open FX positions.** The banks open net FX positions against four currencies (USD, GBP, Mexican peso, and Turkish lira) and losses arising due to these open positions were taken into account. The negative net foreign exchange position at the banking system level means that the banking system experiences direct market losses in the case of a euro depreciation. Nevertheless, these losses are quite small as the open positions are limited.

**25. Losses on foreclosed assets due to a drop-in house prices are also taken into account.** Banks foreclosed assets are directly exposed to a fall in house prices. The indirect impact is accounted for through higher loss rates and thus larger credit losses. This channel contributes to 90 bps reduction in Tier 1 capital ratio.

## C. Results

**26. While the Spanish banking system appears fairly resilient, some banks show vulnerabilities in the face of risks considered.** Stress tests of solvency risk suggest that banks are affected significantly by the realization of the shocks captured by the scenarios. Results in terms of the regulatory minima (capital levels and leverage ratios) were mixed. The overall results of the tests indicate the following (see Figures 7 and 8 and Table 8):

- *The shocks have a significant negative impact on (risk-weighted) capital ratios,* and the capital adequacy ratio (CAR) under the adverse scenario declines from an intial level of 13.6 percent of RWA in 2016 to 11.0 percent (10.0 percent) in scenario 1 (2) . The common equity tier 1 capital ratio (CET1) for the 14 SIs considered declines from 10.9 at end-2016 to 8.5 (7.4) percent in 2019 in the adverse scenario 1 (2).

- *Spanish banks hold the majority of their capital in terms of CET1 instruments and as such, they face more difficulty meeting 8 percent CAR requirement.* In particular, several banks are unable to meet the 8 percent CAR in both scenarios. In terms of CET1, a few banks fall short in meeting the 4.5 Basel III, and any application systemic buffers in scenario 1 (2. The overall capital shortfall amounts to 10.9bn Euros (10.4bn), or 1.0 percent of GDP in adverse scenario 1 (2).

- *The results in terms of the leverage ratio indicate that some banks could fall below the minimum 3 percent hurdle.* In particular, in the adverse scenario 1 (2), the leverage ratio in the system (14 largest banks) would decline from 5.6 percent to 4.7 (4.1) percent, and the ratio for several banks would fall below the minimum 3 percent hurdle. This outcome implies a capital shortage of Tier 1 capital in the adverse scenario (equivalent to 9.4 billion euros in both scenarios).

**27. The three main factors contributing to the results above are a decline in profitability, market losses due to sovereign exposures and credit losses.** Under both scenarios net interest margins (NIMs) tighten. This has a particularly strong impact on net profits of the banks and consequently on their capitalization. The second important negative factor, are mark-to-market losses arising from exposures to (mainly) sovereign securities. Credit losses remain the largest negative contributor to the capitalization ratio, yet the increase in credit losses in the system relative to 2016 is rather muted, mainly due to a large base effect, as Spanish banks booked significant levels of provisions in 2016, as they prepare for the implementation of IFRS9. Finally, losses on foreclosed assets due to a fall in real estate prices (via other comprehensive income account) and an increase in RWA contribute to lower capital ratios.

**28. More specifically, the stress tests results reveal the following (see Figure 8)**:

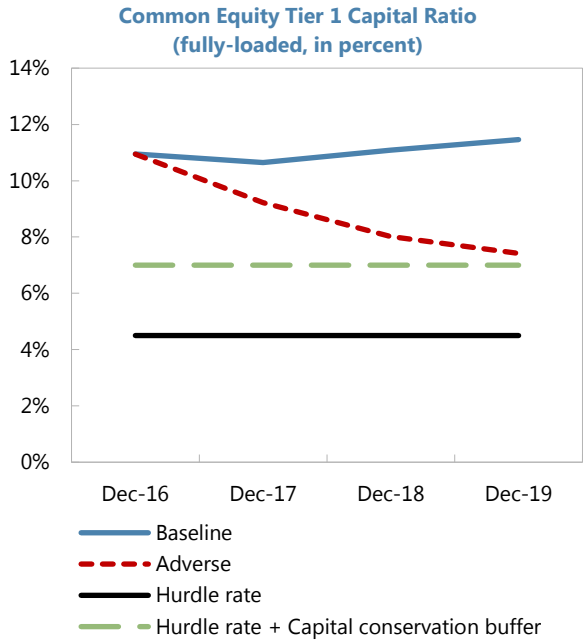
- *Overall profitability declines from 0.8 percent of RWAs in 2016 to an average of-0.6 percent in 2017–19 in scenario 2,* with significant cumulative impact on capitalization levels. In scenario 1, final profitability falls to -0.9 percent.

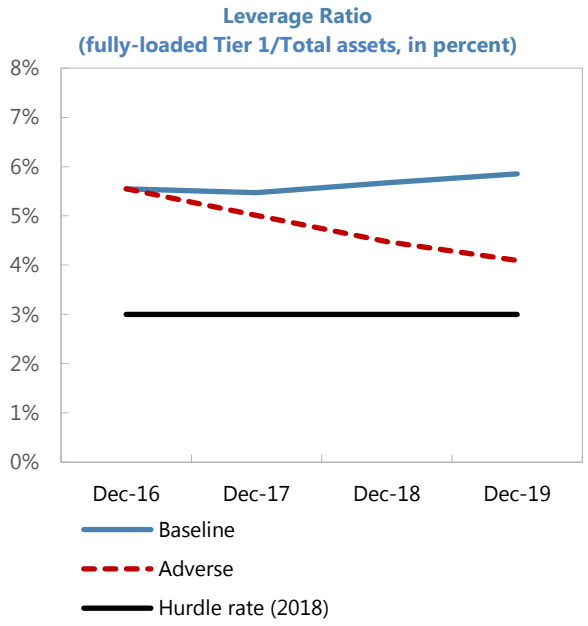
- *Net interest income declines from 3.9 percent of RWAs in 2016 to 2.4 (2.5) percent in 2019 respectively in scenarios 1 and 2.* Two factors contribute to this decline, simultaneously adversely affecting income. First, the net interest margin (NIM) is adversely affected due to a rise in funding costs, whereas lending rates barely increase as policy rates are kept constant. Further, the banks have significant positive interest risk, which exposes them to losses as Euribor increases slightly throughout the stress test horizon, due to money market stresses.

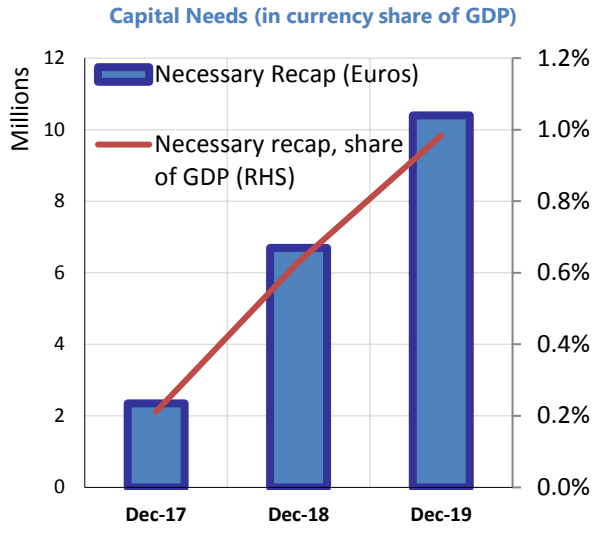
- *Banks are exposed to potential losses from market risk on government bond holdings.* In the adverse scenario, banks suffer from declining valuations in their trading book as sovereign spreads rise significantly and the shift upwards in the yield curves. Banks are particularly affected as the overwhelming majority of their sovereign exposure is due to Spanish government bonds, which are stressed heavily in the scenario. As a result, market gains of 0.1 percent of RWA in 2016 turns to a market loss of 0.7 percent in 2017 in scenario 2. It is important to note that the large securities portfolio exposure causes vulnerabilities even in the baseline scenario, where interest rates rise as economic environment improves, leading to significant repricing losses associated with marked-to-market portfolios.

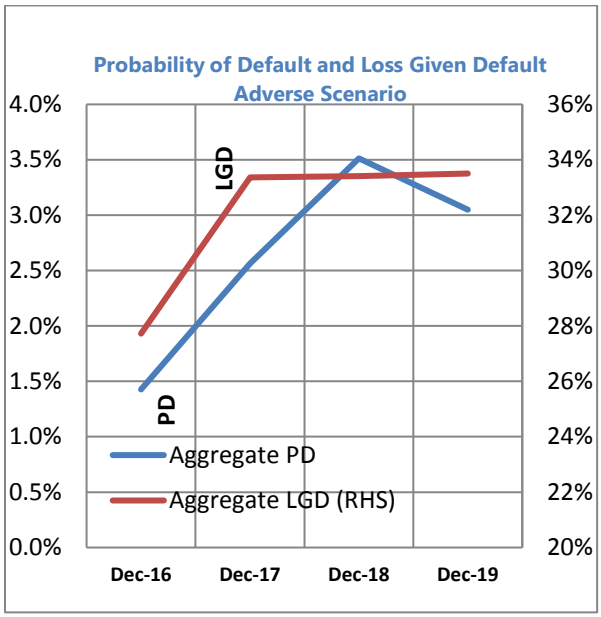
- *Credit risk is a significant driver of overall losses.* Credit loss impairments increase in absolute terms by 7 percent from 2016 to 2018, which is the peak in terms of provisioning. However, as a share of RWA, they remain more or less constant at 2 percent of RWAs. It is important to note that provisioning in 2016 was particularly high due to a one-off booking of losses by one bank and preparation for implementation of IFRS 9, leading to significant increases in general provisions. Thus, the increase would be even more significant if one were to compare credit losses in the stress test horizon to those in 2014–2016 average (see Figure 8).

## Figure 7. Stress Test Results (1)



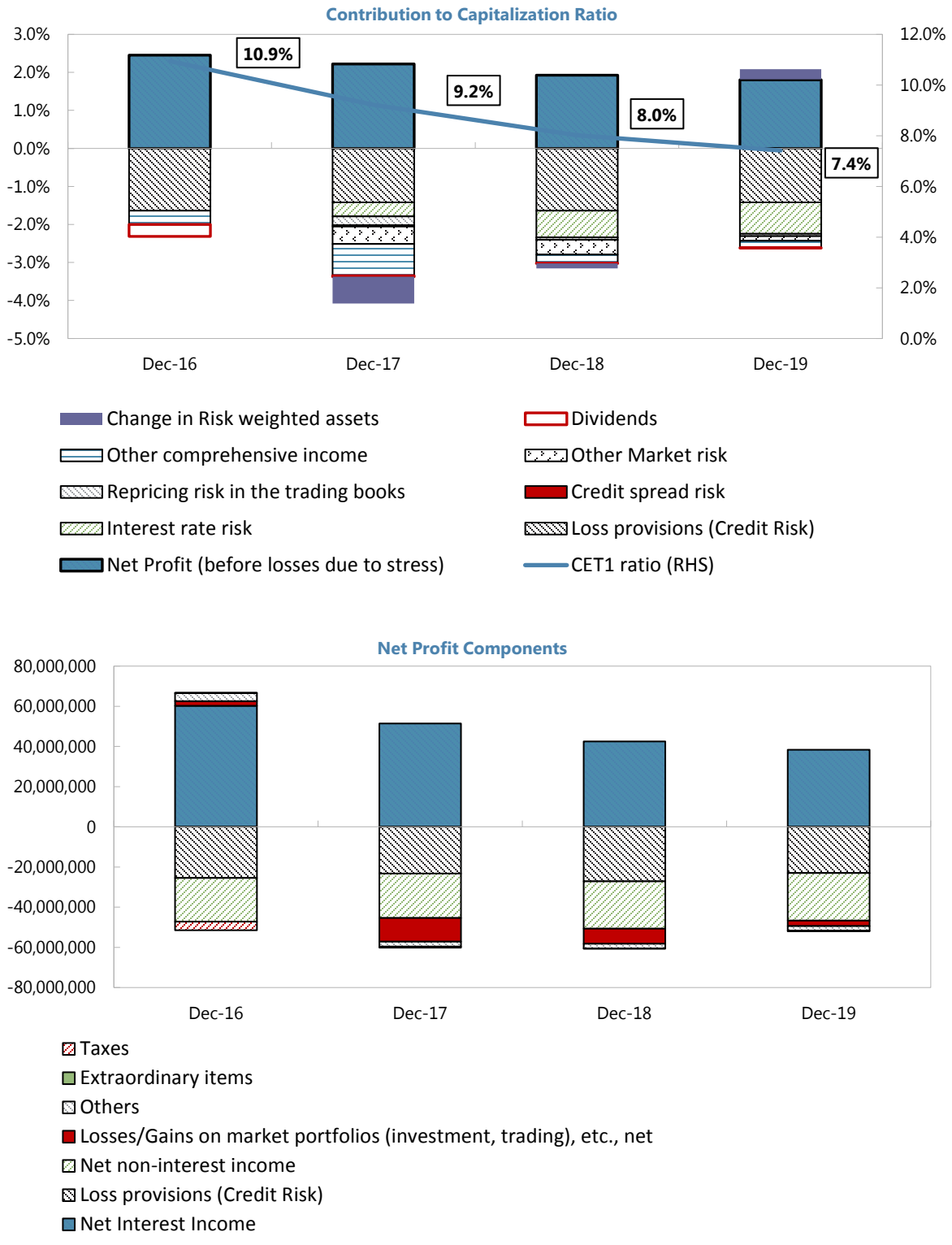




Source: ECB, and IMF staff calculations

## Figure 8. Stress Test Results (2)




Source: IMF Staff Calculations

**Figure 9. Sensitivity Analyses**

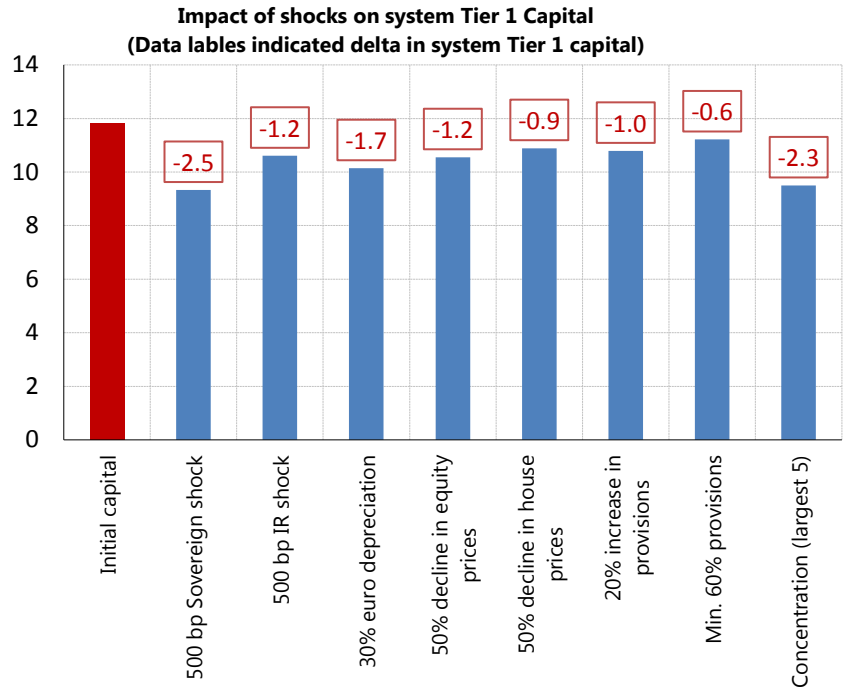



**Table 8. Results of the TD Solvency Stress Test for SIs: Adverse Scenario**

| | Aggregate CET1 ratio | Leverage ratio | Max. capital shortfall (% of GDP) |
|---|---|---|---|
| **Before stress** | 10.9% | 5.6% | 0.0% |
| **Baseline scenario** | 11.5% | 5.9% | 0.2% |
| **Adverse scenario** | 7.4% | 4.1% | 1.0% |

Source: IMF staff calculations

## D. Sensitivity Analysis

**29. In addition to stress scenario analysis, sensitivity stress tests assessed vulnerabilities of the banking system to key individual shocks (see Figure 9).** These included an assessment of concentration risk via default of the largest exposures, a sovereign yield shock, an increase in interest rates that affects banks' net interest income, a 30 percent depreciation of euro against all major currencies, a 50 percent decline in equity prices, a 50 percent decline in house prices that affects the stock of foreclosed assets, a 20 percent increase in provisions in each bank, and a minimum 60 percent provisioning rate on nonperforming exposures. The latter two sensitivity tests are motivated by IFRS 9, which will come into effect in January 2018 and requires bank to provision for unexpected losses. The results are as follows:

- *Name concentration risk (i.e., exposure to a single borrower) was tested by assessing the impact of the simultaneous default of the largest nonfinancial corporate exposures.* Supervisory data on the large bank exposures were used to perform this sensitivity analysis, which included exposures to groups of nonfinancial interconnected clients, but excluded sovereign exposures and credit institutions (as these were addressed in a different technical note on interconnectedness and contagion risks). Spanish banks' credit risk mitigation techniques are mostly comprised of financial collateral and third party financial guarantees. The test assessed the impact of the simultaneous hypothetical default of up to ten of the largest borrowers, and computes the implied losses for various assumptions on the recovery rate. In our first scenario, the recovery rate calculated by banks within the national regulation framework was used, but alternative assumptions were also made to assess the sensitivity of banks' solvency to a change in recovery rates, as done in other FSAPs.

- *Spanish banks would be able to cope with the simultaneous default of up to five of their largest exposures.* Yet some banks would be vulnerable beyond this number. These results are based on net exposures as they take into account the collateral received and other credit risk mitigation measures. Banks hold most of their credit risk mitigation measures in the form of financial collateral, debt instruments and third party financial guarantees. On average, the size of the single gross largest exposure reaches 15.5 percent of Tier 1 capital, whereas the size of the net largest exposure (without off-balance sheet contingent liabilities and after consideration of cash collateral and the application of other credit risk mitigation) is considerably smaller (5.4 percent). Under the European regulation regarding collateral valuation, the default of up to five of the largest net exposures of each of the fourteen banks would not cause any undercapitalization. A simultaneous default of the ten largest net exposures would cause several banks to be undercapitalized in terms of Tier 1 capital, translating into a capital shortfall to 0.3 percent of GDP or 0.6 percent of the RWAs of this group of banks.

- *A large drop in real estate collateral value would not lead to additional capital shortfalls***.** A haircut of 30 percent additional to the regulatory haircut already embedded in the national framework was applied to the valuation of the real estate collateral held by Spanish banks against their large exposures. The result of this analysis compares to the previous one and reflects the fact that banks do not hold most of their credit risk mitigation measures in the form of real estate against their large non-financial corporate exposures.

- *Capital shortfalls would be significantly larger if exempted corporate exposures were reintegrated* and if a zero-recovery rate was assumed on credit risk mitigation measures. Exempted exposures refer to nonfinancial corporates benefiting from an explicit state guarantee. The number of undercapitalized banks following the default of the largest, five largest and ten largest gross exposures would increase to two, two, and five, respectively. This would imply capital shortfalls of 1.1 percent, 1.5 percent, and 2.4 percent of GDP respectively, or comprised between 4.5 percent and 16 percent of the RWAs. The differences with the previous tests reflect the fact that banks hold most of their credit risk mitigation

measures in the form of financial collateral, debt instruments, and third party financial guarantees. However, it is important to acknowledge that this sensitivity analysis is based on extremely severe assumptions as it would require the occurrence of a "double default" of the borrower and the financial guarantor for the credit loss risk to materialize for the bank. These stress test results assume no credit risk mitigant, and should be interpreted as such.

- *Banks proved to be highly sensitive to a government bond yield shock, with a majority of them holding a significant exposure to sovereign bonds*. A 500 bps increase in sovereign yields decreasing the system Tier I capital by 250 bps. The impact can be significantly larger for certain banks (up to 890 bps in capital) who hold particularly large exposures to the sovereign. Overall, several banks would fall short of the 6 percent Tier I capital ratio as a result of such a shock and one bank would be essentially at the threshold

- *Banks also show some sensitivity to interest rate risk on their banking books, with a majority of them holding a positive interest rate risk exposure*. A 500 bps increase in interest rates reduces the system Tier 1 ratio by 120 bps, with the impact larger in certain banks (a maximum impact of 260 bps). No bank fails to meet the regulatory minima as a result of this shock.

- *A significant euro depreciation would have a similar impact on the system's capitalization ratio*. A 30 percent depreciation of euro (assumed against all major currencies) would impact the banks through their FX net open positions and lead to a 170 basis point reduction in total Tier 1 capital. The maximum impact on an indivual bank is 530 bps, as a result of which the bank would fail to meet the 6 percent Tier 1 capital minimum.

- *A 50 percent drop in equity prices is manageable*, with a impact on the system-wide capitalization ratio of 120 bps. No bank failes the Tier 1 capital ratio as a result and the maximum impact is 360 bps for one bank.

- *A decline in house prices and their impact on the stock of foreclosed assets is rather mild at the system level*. The impact on the system-wide capitalization is 90 basis points, however, one bank with significant foreclosed assets will see its Tier I capital ratio fall below the regulatory 6 percent, with an overall impact of 500 bps on its capital to RWA ratio.

- *A proxy for the impact of IFRS9 implementation shows that the new regulation will be manageable for the Spanish banks*. Finally, we present two sensitivity tests that are motivated by the need to increase provisions as IFRS9 is implemented in January 2018. The first test assumes a 20 percent increase in each banks existing provisions. The 20 percent increase is in line with the banks' own assessment. The impact of this scenario on system-wide Tier 1 capital ratio is -100 bps, and the maximum impact is 300 bps for one bank. Imposing a minimum 60 percent provisioning level has a milder system-wide impact of -60 bps, but implies a 350bps drop in one case.. Neither scenario causes any bank to fall short of its regulatory minima.

## E. Policy Recommendations

**30. The vulnerability analysis highlights several areas in which Spanish SIs could be made more resilient:**

- Adverse scenarios would bring additional decline in profitability. Supervisors should ensure that Pillar II requirements adequately reflect banks' vulnerability to a further compression in NIMs. Banks show sensitivity to any additional stresses on profitability. While the NIMs are already compressed and the likely scenario is an improvement as interest rates increase, the banks should be able to withstand the potential for continued compressed margins or even their further tightening

- The impact of adverse scenarios on profitability is highly determined by its current low levels, which in turn are driven by large non-interest earning legacy assets. Building on the recent measures, and ensuring adequate loan classification would make banks' interest income more resilient to future shocks by freeing up resources to respond to credit demand. A desirable time-horizon is three years, based on the remaining maturity of ECB liquidity lines. Supervisory action should be concentrated in the most vulnerable banks.

- While a focus on credit risk and legacy assets is welcome, this should not be at the expense of neglecting other forms of risk, such as interest rate, and sovereign risks. Holdings of government bonds have helped banks boost their profits, however, their large durations expose banks to losses due to changes in the monetary policy or in market sentiment regarding the credit worthiness of the Spanish sovereign. We recognize that the ECB includes these risks in their SREP assessment and that the BdE included them in their TD assessment during the FSAP. We encourage a continuous monitoring of these elements going forward.

- Large deductions from CET1 should be replaced in line, and if possible ahead of, transitional arrangements in CRD IV. Spanish banks rely heavily on non-eligible elements that will be phased out as CRD-IV is implemented, showing one of the largest discrepancies between transitional and fully-loaded measurements of capital in Europe. The banks will need to replace the capital that will be phased out, roughly 160 bps, in the next three years.

- The Spanish banks' capital is almost entirely in CET1 instruments. While this reflects high quality of capital (notwithstanding the debate regarding DTCs), it also makes the banks vulnerable to the 8 percent CAR threshold. Thus the banks should continue to strengthen their overal capital adequacy ratio, via issuance of Tier II and Tier 1 instruments.

# LIQUIDITY STRESS TESTS

**31. Three types of liquidity stress tests were performed in order to get a holistic assessment of bank liquidity risks.** The first test was based on the national transposition of the Liquidity Coverage Ratio (LCR). The LCR measures bank's ability to meet its liquidity needs in a 30-day stress scenario by using a stock of unencumbered high-quality liquid assets (HQLA).[11] The implementation of the LCR follows a gradual approach. When the LCR came into effect in 2015, banks had to meet a ratio of 60 percent. The phase-in level in 2016 was 70 percent and will converge to 100 percent by January 2018. The second test was based on the Net Stable Funding Ratio (NSFR). While banks are not yet required to meet the NSFR—it will be effective from January 2018 onwards—it provides a useful complementary view of banks' funding profile in relation to the composition of their assets and off-balance sheet activities at a one-year horizon.[12] The third liquidity test is a cash flow based analysis by maturity buckets. It allows for a more granular analysis of bank's liquidity buffers taking into account cash flows generated by different assets and liabilities with different maturities ranging from 1 day to more than a year.

**32. Top-down liquidity stress tests were conducted by the FSAP team.** Cash-flow based liquidity stress tests were implemented through a Top-Down approach, using supervisory information on maturity structures of assets and liabilities at December 2016. They included the same sample of fourteen banks covered in the solvency stress test. The tests were carried out at the aggregate level, i.e., combining every currency including the euro, and with separate tests on U.S. dollar, and British pound. Foreign currency-denominated liabilities make up 92 percent of total liabilities, but with only three banks having significant foreign currencies in their balance sheets. This high share of foreign currency-denominated liabilities results from the international activity of these three banks which have large subsidiaries in the United Kingdom, United States, Turkey, and Latin America. However, these subsidiaries operate on a standalone basis—i.e., they are locally funded and do not depend on their parent company for their funding. These tests assessed banks' resilience to strong shocks characterized by run-off rates on funding sources calibrated by type, and liquidation of assets subject to valuation haircuts. Specifically, the exercise captured (i) a bank's liquidity need derived from outflows, (ii) its available standby liquidity from inflows, and (iii) its buffers available to counterbalance liquidity gaps. The liquidity stress tests were calibrated to meet very severe stress test conditions, such as those experienced by some financial institutions during the 2008/2009 global financial crisis. It should be noted that common practice in FSAPs is to implement the liquidity tests assuming an underlying environment in which funding pressures are sizeable but limited to a number of banks (not systemic).[13]

[11] See Basel Committee on Banking Supervision (2013), "Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools", January.

[12] See Basel Committee on Banking Supervision (2014), "Basel III: The Net Stable Funding Ratio", October.

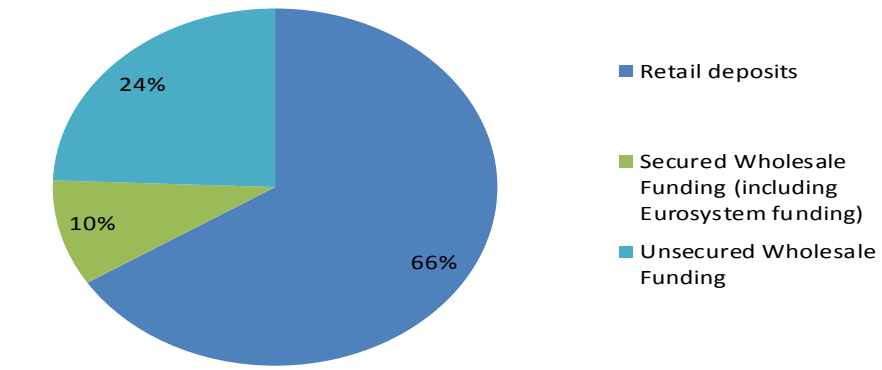
[13] The underlying environment in which a bank's resilience to liquidity shocks is tested should affect the calibration of deposit run-off rates and asset haircuts. Under generalized banking panics (bank runs affecting many banks,

(continued)

**33. The funding structure of the banking system (excluding capital and undrawn credit and liquidity facilities) as of December 2016, can be described as follows** (Figure 9):

- 66 percent of funding comes from retail sight and time deposits;
- 9.6 percent comes from secured wholesale funding, including funding from the Eurosystem (8.6 percent) and covered bonds. The share of Eurosystem funding in total funding is very high, with seven banks having a share above 10 percent and a peak of 17 percent at one bank. This raises the question of these banks' dependence on central bank funding and their ability to attract stable funding when the ECB starts normalizing its monetary policy;
- 24.4 percent is unsecured wholesale funding, coming in particular from non-financial corporates (13 percent), and operational deposits generated by clearing, custody, and cash management activities.

**Figure 10. Spanish Banks' Funding Structure—December 2016**




Source: ECB

## A. LCR-Based Stress Test

**34. To assess the short-term resilience of banks to an abrupt withdrawal of funding, the LCR stress tests included scenarios that are more severe than those prescribed by the Basel III LCR (Table 9).** The LCR liquidity stress tests covers three scenarios, including two scenarios tailored to stresses based on characteristics of liquidity practices of Spanish banks:

- *A standard LCR scenario applying the same parameters as set out by 2013 Basel III LCR.* It is carried out at the aggregate currency level, i.e. combining the bank's positions in every currency.

including important ones), the scramble for liquidity usually results in fire sales of assets, and hence, larger haircuts. Similarly, run-off rates on deposits should be higher when a panic sets in and triggers widespread bank runs.

- *A secured funding and retail stress scenario aimed at replicating a deposit run and a reduction in central bank funding.* The key assumption raises run-off rates to 10 percent for stable and 15 percent for unstable retail and wholesale deposits, and a 20 percent reduction in central bank funding.

- *A wholesale funding stress scenario.* This scenario assumes a complete freeze of wholesale funding on the interbank market. Key assumptions include: (i) run-off rates of up to 100 percent for wholesale funding from other legal entity customers; (ii) rates of 50 percent for operational deposits generated by clearing, custody, and cash management activities; and (iii) outflows by non-financial corporates, central banks and multilateral development banks of up to 50 percent.

These three scenarios were carried out aggregating banks liquidity positions across every currency. To assess currency-specific liquidity risk, IMF staff also applied a separate LCR stress tests based on major foreign currencies (USD, GBP) applying the same assumptions as under the standard LCR scenario.

**35. The LCR-based stress test was based on three scenarios, with various parameters in terms of deposit run-off rates, roll-off rates for cash inflows and asset haircuts.** These rates, together with the assumed asset haircuts, are presented in Table 9. The national transposition of the LCR under the European Commission Delegated Act differs from the Basel III LCR on three main points: (i) covered bonds are included in level 1 assets in the EU legislation; (ii) the latter includes a larger range of high quality liquid assets, but subjects them to high haircuts (e.g., equity is assigned a haircut of 50 percent); and (iii) the granularity of deposits is higher under the Commission Regulation. It has also an accelerated phase-in timetable relative to the Basel III LCR reaching the 100 percent hurdle in 2018 rather than 2019. The test was first carried out at the aggregate currency level, i.e., combining the bank's positions in every currency. Potential sources of funding pressures for banks consist mainly of deposits from individuals, businesses and large corporations and secured central bank and market funding. Cash outflows are generated by the need to pay contracted and contingent liabilities under specific assumptions regarding the capacity of banks to re-issue liabilities in adverse conditions.

**36. Funding pressures were captured through specific time profiles of run-off rates for different funding sources.** A set of general principles guided the choice of run-off rates for the computation of the LCR. First, more informed and sophisticated depositors withdraw funding more rapidly than less informed ones. That is why run-off rates applied to wholesale funding sources are higher than those applied to retail funding sources. Second, run-off rates on secured funding sources are lower than those applied to unsecured funding sources.

**37. Banks' standby liquidity inflows stem mostly from maturing loans, deposits and credit facilities.** Assets that can generate cash inflows over one month mostly include maturing loans from retail counterparties (17.4 percent), from nonfinancial wholesale counterparties (16.6 percent) and from financial institutions and central banks (11.6 percent).

**38. For different assets and maturity buckets, specific roll-off rates were applied to convert the maturing amounts into cash inflows.** Specifically, 50 percent rates were applied to inflows from retail and nonfinancial wholesale counterparties, i.e., to performing loans to non-financial customers, and 100 percent rates were applied to maturing loans to financial institutions. This means that cash inflows from performing loans to non-financial customers were assumed to decline by 50 percent in a month, and cash inflows from maturing loans to financial institutions to dry up completely.

**39. Banks can counterbalance negative funding gaps by using their cash holdings and standard operations of the Eurosystem.** In the tests, banks were allowed to cover negative balances of cash inflows relative to cash outflows by using their sovereign securities as collateral to obtain liquidity through the standard ECB lending facilities—weekly repo operations or the more expensive overnight loans. At the banking system level, liquid assets make up 12 percent of total assets (including both on- and off-balance sheet items).

**40. Results based on the standard LCR show that Spanish banks have ample liquidity buffers (Table 10, Figures 10 and 11).** Liquidity stress test results suggest that the aggregate LCR is equal to 159 percent in December 2016. Under this standard scenario, each of the 14 banks composing our sample passes the 80 percent ratio imposed by national regulators in 2017 according to the LCR phase-in agenda, and even the 100 percent hurdle rate, which will be binding in 2018. This resilience can be explained by the large retail deposit base of Spanish banks.

**41. However, some banks in the system would be exposed to liquidity risks in the event of large deposit withdrawals and a sharp reduction in ECB funding.** Under this adverse scenario, banks lose 10 to 15percent of their retail and small business deposits, including sight and term deposits, in a month. Moreover, banks would experience an (unlikely) 20 percent reduction in their secured funding, including from the central bank, as monetary policy is assumed to normalize.[14] Finally, a haircut of 7 percent, consistent with the one assumed in the solvency stress test adverse scenario, is applied to the five-year Spanish government bond value. Four out of 14 banks would fall below the LCR hurdle rate of 100 percent but they would all continue to meet the rate of 80 percent. The aggregate LCR would fall to 99 percent, translating into a liquidity shortfall of €35 billion, equivalent to 1 percent of banks' assets and to 3.1 percent of GDP. The severity of this scenario is in line with the most severe episode of deposit withdrawal at a Spanish bank, namely Banesco, which lost 8 percent of its customer deposits in a week in 1994. No LSI would experience a liquidity shortfall.

[14] Admittedly, a 20 percent drop in ECB funding over a 30 day-horizon is a highly unlikely scenario given the maturity of the ECB funding (four years) but this assumption is aimed at correcting the distortion created in the ratio calculation by Spanish bank's overreliance on ECB funding.

## Table 9. LCR-Based Stress Test Assumptions on Run-off Rates (in percent)

**Outflows of liquid assets (over 30 days)**

| | LCR | Outflow scenario 2 | Outflow scenario 3 |
|---|---|---|---|
| **Retail Deposits** | | | |
| Demand deposits | | | |
| *Stable deposits* | 5% | **10%** | 5% |
| *Less stable retail deposits* | 10% | **15%** | 10% |
| Term deposits, residual maturity > 30d | 0% | 0% | 0% |
| **Unsecured Wholesale Funding** | | | |
| Demand and term deposits, residual maturity < 30d, small business | | | |
| *Stable deposits* | 5% | **10%** | 5% |
| *Less stable deposits* | 10% | **15%** | 10% |
| Operational deposits generated by clearing, custody, and cash management activities | 25% | 25% | **100%** |
| *Portion covered by deposit insurance* | 5% | 5% | **50%** |
| Cooperative banks in an institutional network | 25% | 25% | 100% |
| Nonfinancial corporates, sovereigns, central banks, multilat development banks, PSEs | | | |
| *Fully covered by deposit insurance* | 20% | 20% | **50%** |
| *Not fully covered by deposit insurance* | 40% | 40% | **100%** |
| Other legal entity customers | 100% | 100% | 100% |
| **Secured Funding** | | | |
| Secured funding with a central bank, or backed by Level 1 assets | 0% | **20%** | 0% |
| Secured funding backed by Level 2A assets | 15% | **25%** | 15% |
| Secured funding backed by non-Level 1 or non-Level 2a asset, with domestic sovereign, multilat dev banks, or domestic PSEs as a counterparty | 25% | **50%** | 25% |
| Fundign backed by RMBS eligible for Level 2B | 25% | **50%** | 25% |
| Funding backed by other Level 2B assets | 50% | 50% | 50% |
| Other secured funding transactions | 100% | 100% | 100% |
| **Additional Requirements** | | | |
| Valuation changes on non-Level 1 posted collateral securing derivatives | 20% | 20% | 20% |
| Excess collateral held by bank related to derivate transactions that could be called anytim | 100% | 100% | 100% |
| Liquidity needs related to collateral contractually due on derivatives transactions | 100% | 100% | 100% |
| Increased liquidity needs related to derivative transactions allowing collateral substitutio | 100% | 100% | 100% |
| ABCP, SIVs, conduits, SPVs, or similar | | | |
| *Liabilities from maturing* | 100% | 100% | 100% |
| *Asset backed securities* | 100% | 100% | 100% |
| Undrawn but committed credit and liquidity facilities | | | |
| *Retail and small business* | 5% | **10%** | 5% |
| *Nonfinancial corporates, sovereigns, central banks, multilat dev. banks, PSEs* | | | |
| *Credit facilities* | 10% | **50%** | 10% |
| *Liquidity facilities* | 30% | **50%** | 30% |
| *Supervised banks* | 40% | **50%** | 40% |
| *Other financial institutions* | | | |
| *Credit facilities* | 40% | **50%** | 40% |
| *Liquidity facilities* | 100% | 100% | 100% |
| *Other legal entity customers, credit and liquidity facilities* | 100% | 100% | 100% |
| Other contingent funding liabilities | | | |
| *Trade finance* | 5% | **10%** | 5% |
| *Customer short positions covered by customers' collateral* | 50% | **75%** | 50% |
| Additional contractual outflows | 100% | 100% | 100% |
| Net derivate cash outflows | 100% | 100% | 100% |
| Any other contractual cash outflows (not listed above) | 100% | 100% | 100% |

Sources: BCBS (2013) and IMF proposals

**42. The third scenario including a dry-up of unsecured wholesale funding provides similar results.** In the case of a loss of wholesale funding by 70 percent most banks would be able to find alternative sources and would not suffer. However, in the case of a complete freeze of funding markets banks would be clearly affected. Under the latter scenario, banks were assumed to face 100 percent run-off rates on unsecured wholesale funding, including corporate deposits other than from SMEs. Admittedly, this scenario might be considered to be extreme but given the short-term nature of wholesale funding of Spanish banks, the analysis was deemed to be worth conducting. resolution, might be considered as an illustration of this scenario. The results show that the aggregate LCR would fall to 89 percent. The total liquidity shortfall would amount to EUR 76 billion, equivalent to 2.1 percent of banks' assets and 6.8 percent of GDP. The liquidity shortfall for LSIs would be very limited.

**43. Separate LCR-liquidity stress tests carried out on foreign currency positions did not reveal large shortfalls.** Banks are not required to meet LCR in foreign currencies but this test was carried out for robustness reasons. It used the same assumptions as noted under the standard scenario but separated balance sheet items based on the following foreign currencies: U.S. dollar, and British pound. Results did not show material liquidity shortfalls, with a very small EUR 127 million shortfall in U.S. dollars on aggregate. This result reflects the liquidity structure of Spanish banking groups in which foreign subsidiaries are funded on a standalone basis, with the currency denomination of liabilities matching the currency denomination of assets.

**44. In a reverse liquidity stress test, the withdrawal rates of retail deposits alone would need to be very high to lead the system-wide liquidity ratio to fall below 100 percent.** Leaving the other parameters unchanged compared to the standard LCR test, the withdrawals rates of the retail deposits covered by the deposit guarantee scheme and of the uncovered retail deposits would have to reach 20 percent and 30 percent, respectively in a month, to bring the aggregate liquidity ratio below 100 percent. As regards secured funding from the central bank, the reduction would have to reach 50 percent to see the first bank display a LCR falling below 100 percent.

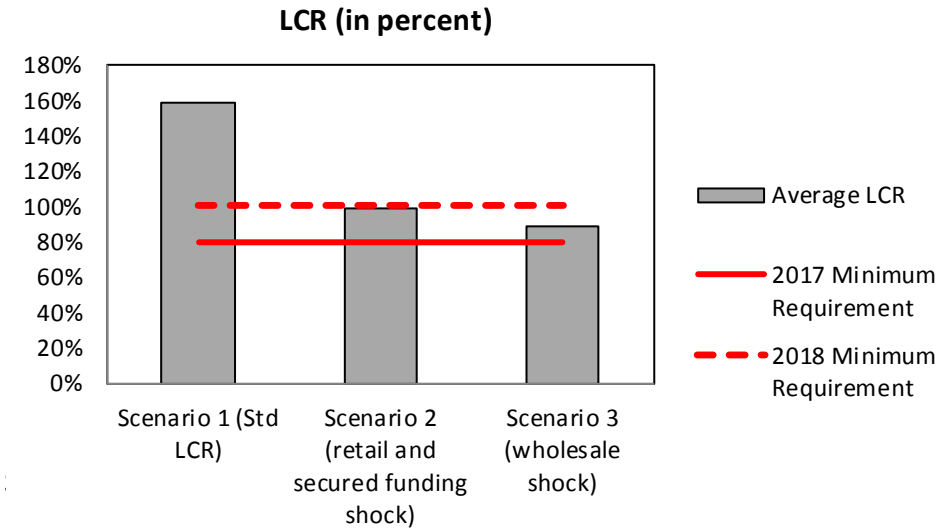
**Table 10. Summary of the SIs' Liquidity Stress Test Results**

| | LCR Stress Test Scenarios | | | | | NSFR Scenar. | Cash Flow Stress Test | |
|---|---|---|---|---|---|---|---|---|
| | LCR Standard | LCR Retail | LCR Wholesale | LCR FX (USD) | LCR FX (GBP) | NSFR | Outflows (before CC 2/) | Outflows (after CC 2/) |
| System-wide Liq. ratio (in percent) | 159% | 99% | 89% | 146% | 141% | 111% | - | - |
| Liquidity shortfall 1/ | | | | | | | | |
| *as a percent of GDP* | 0.0 | 3.1 | 6.8 | 0.0 | 0.0 | 0.2 | 6.9 | 0.0 |

Sources: Banco de Espana and IMF staff calculations

Note: 1/ Liquidity shortfall is the amount required so that the Liq. Ratio in each bank in the sytem be equal to or above 100 percent.
2/ Counterbalancing Capacity

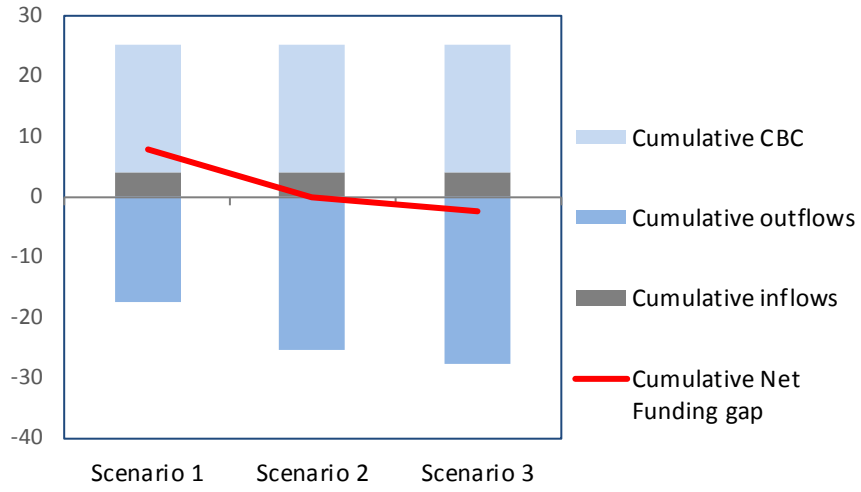
**Figure 11. LCR-Based Stress Test Results**




Sources: ECB and BdE

**Figure 12. Bank Liquidity Coverage Ratio Results, Cumulative Inflows, Outflows, Net Funding Gap, and Use of Counterbalancing Capacity**

(in percent of outstanding non-equity liabilities)




Sources: ECB, BdE and IMF staff calculations

Notes: Scenario 1: LCR - Delegated Act
Scenario 2: Scenario with larger deposit withdrawals and reduction in ECB funding
Scenario 3: Dry-up of unsecured wholesale funding

## B. NSFR-Based Stress Test

**45. The liquidity stress test results based on the NSFR do not suggest large maturity transformation at the aggregate level, although one bank stands out with a lower ratio.** Under the NSFR methodology, available stable funding for the fourteen largest banks amounts to EUR 2,287 billion in December 2016 and the required stable funding to EUR 2,060 billion, resulting in an aggregate NSFR of 111 percent, comfortably above the minimum requirement of 100 percent which will be binding in 2018. Nevertheless, at the individual level, one bank would be experiencing a liquidity shortfall, resulting from maturity transformation. The liquidity mismatch at the one-year horizon would amount to EUR 2.1 billion, equivalent to 0.2 percent of GDP. This mild result reflects the large reliance of Spanish banks on stable retail deposits. It should be noted that Spanish banks' NSFR positions might be distorted by their extensive use of long-tern ECB funding and could become less favorable if this funding, considered as very stable as part of the NSFR calculation, had to be replaced by short-term unsecured wholesale funding. Based on supervisory data, the aggregate NSFR would fall in such an event to 97 percent, translating into a shortfall equal to EUR 54 billion and equivalent to 4.8 percent of GDP. The NSFR of the weakest bank would drop to 77.5 percent, with a EUR 25 billion liquidity shortfall.

## C. Outflow Analysis Stress Test

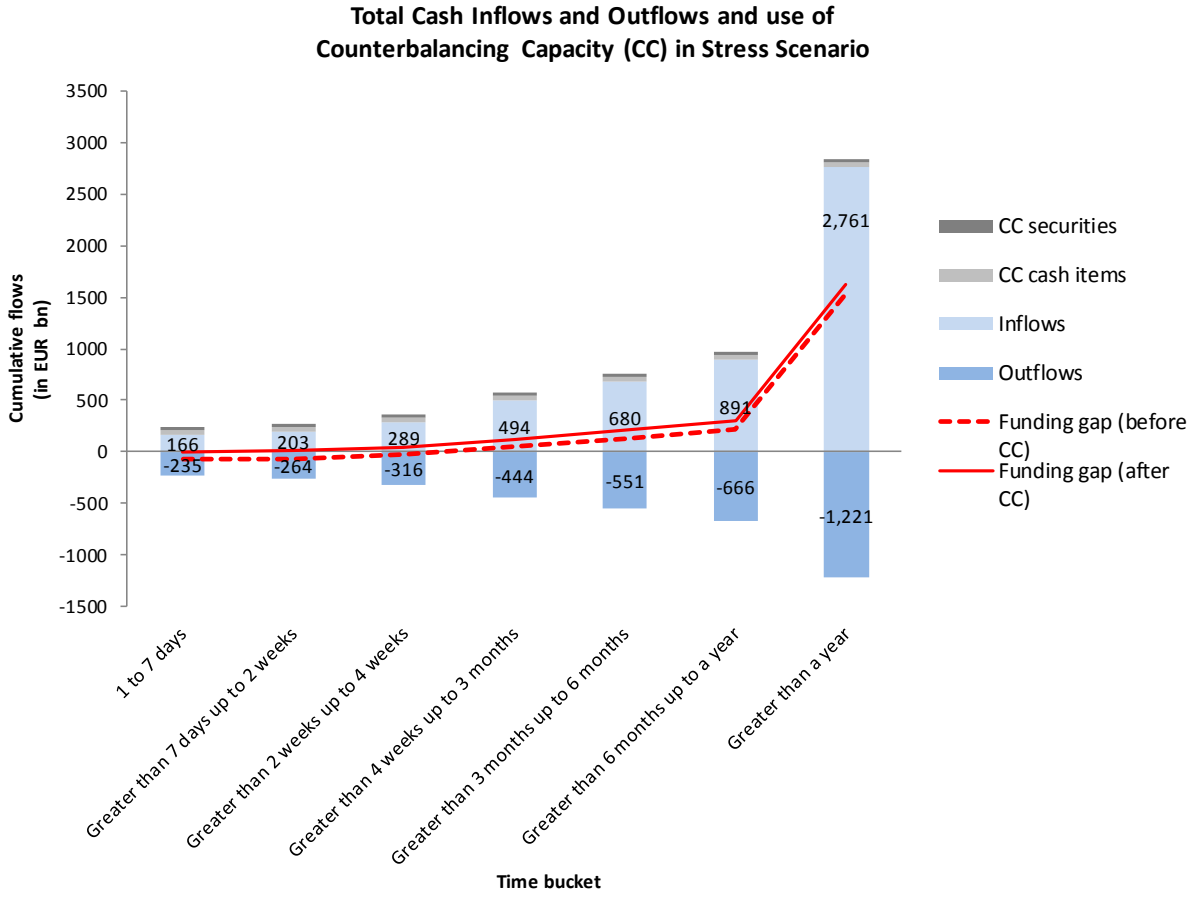
**46. The outflow analysis was based on seven maturity buckets aimed at capturing the comprehensive time structure of banks' cash in- and outflows.** The maturity ladder was composed of the following buckets: 1 to 7 days, 8 to 15 days, 16 to 30 days, 31 to 90 days, 91 to 180 days, 180 to 365 days, and more than 365 days. These tests assessed banks' resilience to severe shocks characterized by run-off rates on funding sources calibrated by type, and liquidation of assets subject to valuation haircuts. Specifically, the exercise captured (i) banks' liquidity needs derived from outflows, (ii) available standby liquidity from inflows, and (iii) buffers available to counterbalance liquidity gaps. The pace of deposit outflows was assumed to slowdown as the time horizon increases (Table 11). For each bucket, the number of net outflows was compared to the amount of liquid assets available for sale to counterbalance funding gaps in the so called "counterbalancing capacity," with liquid assets eligible as central bank collateral subject to a 20 percent haircut and non-central bank eligible assets subject to a 40 percent haircut.

**47. The results of the outflow analysis suggest that Spanish banks would be resilient to significant funding gaps in the short term but would have to sell a large amount of securities.** All fourteen banks would be able to meet substantial funding gaps at different maturity buckets from 1 day to 1 year by using their cash (EUR 45 billion) and selling liquid assets for an amount of EUR 32 billion, equivalent to 2.6 percent of the total assets of banks experiencing a gap (Table 11 and Figure 12). The sale of securities would be mostly taking place during the first seven days of the scenario (EUR 28.5 billion) and would end after three months. This result suggests a solid liquidity position of Spanish banks. However, the reliance on securities to fund short term gaps could become a source of vulnerability in times of distress when banks might have to recourse to fire sales and register trading losses. This factor can cause a negative feedback loop between liquidity and solvency risks in a crisis.

## Table 11. Outflow Analysis Stress Test Assumptions on Run-off, Roll-off Rates and Haircuts (in percent)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| | 1 to 7 days | Greater than 7 days up to 2 weeks | Greater than 2 weeks up to 4 weeks | Greater than 4 weeks up to 3 months | Greater than 3 months up to 6 months | Greater than 6 months up to a year | Greater than a year |
| **Run-off rates on potential outflows** | | | | | | | |
| Retail funding: sight deposits | | | | | | | |
| Stable | 2% | 4% | 4% | 4% | 0% | 0% | 0% |
| Unstable | 8% | 6% | 6% | 3% | 0% | 0% | 0% |
| Retail funding: term deposits | 5% | 5% | 5% | 15% | 10% | 10% | 10% |
| Other deposits | 10% | 10% | 10% | 10% | 10% | 10% | 10% |
| Secured wholesale funding from other financial institutions | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| Unsecured wholesale funding from other financial institutions | 60% | 60% | 60% | 60% | 60% | 60% | 60% |
| Outflows from derivatives | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Other obligations | 50% | 50% | 50% | 50% | 50% | 50% | 50% |
| **Roll-off rates on cash inflows** | | | | | | | |
| Securities in trading book | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Available for sale securities | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Held to maturity securities | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Inflows from derivatives | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Loans maturing | 60% | 60% | 60% | 60% | 60% | 60% | 60% |
| Other | 80% | 80% | 80% | 80% | 80% | 80% | 80% |
| **Haircuts on liquid assets** | | | | | | | |
| Cash items | 0% | | | | | | |
| Securities in trading book | 20% | | | | | | |
| Available for sale securities | 40% | | | | | | |
| Held to maturity securities | 20% | | | | | | |

**Figure 13. Outflow Analysis-Based Stress Test Results**




Note: A positive number indicates a liquidity surplus. Sources: ECB, and IMF staff calcultions

## D. Policy Recommendations

**48. The liquidity stress test results confirm the strong liquidity buffers of Spanish banks but also their heavy reliance on central bank funding.** Therefore, they call for a carefully designed exit strategy from the ECB unconventional monetary policy and the search for alternative stable sources of funding. The replacement of ECB funding with short-term unsecured wholesale funding would be detrimental to the Spanish banks' stability. Moreover, as many banks used the long-term ECB funding to buy government bond rates in carry-trade operations, their profitability will be reduced when the banks start repaying the ECB. This requires the search for alternative income sources. Another issue was related to the fact that data for the cash-flow based analysis relied on information obtained through the Short-Term Exercise (STE) as carried out by the ECB, which is a one-off exercise. The European authorities should improve their liquidity monitoring by performing liquidity stress tests, using the structure of cash flows at various maturities, and closing liquidity reporting gaps on a permanent basis with an expanded harmonized EU bank reporting. In that regard, the data needed to compute the maturity ladder should be collected on a regular and permanent basis.

# CONCLUSION

**49. While stress test results suggest that the Spanish banking system is fairly resilient, several banks show vulnerabilities in the face of risks considered.** Under the adverse scenario, several banks would fail to meet minimum requirements for total capital adequacy ratio (CAR). The common equity tier 1 capital ratio (CET1) for the 14 SIs considered declines from 10.9 at end-2016 to 8.1 (7.2) percent in 2019 in the adverse scenario 1 (adverse scenario 2). The results in terms of the leverage ratio indicate that some banks could fall below the minimum 3 percent hurdle. In particular, in the adverse scenario 1 (2), the leverage ratio in the system (14 largest banks) would decline from 5.5 percent to 4.1 (3.8) percent, and the ratio for several banks would fall below the minimum 3 percent hurdle. This outcome implies a capital shortage of Tier 1 capital in the adverse scenario (equivalent to 9.4 and 10.5 billion euros respectively in scenarios 1 and 2).

**50. A range of sensitivity tests suggest that banks are relatively exposed to large shocks to market risk and government bond yields.** The two single factor sensitivity tests with the largest impact on Tier 1 Capital included a government bond yield shock and a failure of the 5 largest counterparties. A 500bps increase in sovereign yields decreasing the system Tier I capital by 250 bps. The impact can be significantly larger for certain banks who hold particularly large exposures to the sovereign. Overall, several banks would fall short of the 6 percent Tier I capital ratio as a result of such a shock and in one case would be essentially at the threshold. The impact on the overall Tier I capital ratio as a result of simultaneous failure of the largest 5 counterparties is a drop of 230 bps.

**51. By contrast, funding and liquidity risks seem limited but Spanish banks are heavily reliant on central bank funding.** Funding from the Eurosystem makes up 9 percent of banks' total funding, a significant share which would exposed Spanish banks to liquidity risks if the ECB decided to normalize its monetary policy. The global liquidity stress tests reveal that every bank in our sample meets the standard Liquidity Coverage Ratio hurdle rate of 100 percent. Funding risks in foreign currencies seem to be very limited, as are maturity mismatches at the one-year horizon based on the NSFR results. However, Spanish banks would face liquidity shortfalls in an extreme event characterized by large retail deposit withdrawals and a significant reduction in central bank funding over a month. The cash-flow-based analysis suggests that Spanish banks would be able to cope with significant net liquidity outflows up to a year by using their liquid buffers, but this scenario might translate into trading losses.

**52. The authorities are encouraged to continue reinforcing their monitoring of interest rate, government bond yield, liquidity, funding and derivatives related risks.** Solvency results suggest that large government bond exposures could expose the banks to interest rate risks, or stresses in the government bond markets. Liquidity stress test results call for a carefully designed exit strategy from the ECB unconventional monetary policy and the search for alternative stable sources of funding. Moreover, the European authorities should improve their liquidity monitoring by performing liquidity stress tests at various maturities, and close liquidity reporting gaps on a permanent basis with an expanded harmonized EU bank reporting.

# Appendix I. Risk Assessment Matrix

| Source of Risks | Relative Likelihood | Impact and Transmission Channels |
|---|---|---|
| **Weak economic growth due to internal and external factors**<br><br>This risk could materialize due to:<br>• Weak demand in the euro area;<br>• Weak implementation of domestic fiscal commitments and structural reforms or reversal of past policy achievements | **High**<br><br>**High**<br><br>**Medium** | **Medium/ High**<br><br>These factors could cause a significant deviation of domestic GDP growth relative to baseline, leading to:<br>• Prolongation of low interest rates environment and slowing external demand, affecting net interest income (NII).<br>• Weakening of confidence, consumption and investment, which could adversely impact public debt dynamics, asset prices (collateral and foreclosed assets valuations) NPLs and provisions.<br>• Lower demand for new credit, affecting NII. |
| **Tighter and more volatile global financial conditions**<br><br>This risk could materialize due to:<br>• Reemergence of financial stresses in Euro Area.<br>• Financial markets front-loading the impact of retreat from cross-border integration initiatives in the US and Europe. | **Medium/High**<br><br>**Medium**<br><br>**High** | **Medium**<br><br>These factors could cause a sharp rise in risk premia, and Spanish bond spreads, leading to:<br>• Losses due to bond valuation.<br>• Increase in funding costs, and subsequent lower credit growth.<br>• Impact on confidence: access to market funding for weaker banks; slow pace of recovery of real estate prices. |
| **Significant growth deterioration in countries with a large presence of Spanish banks**<br><br>This risk could materialize due to:<br>• Capital outflows from large EMs.<br>• Slowdown of the U.K. economy, as the terms of Brexit become clearer. | **Medium** | **Medium**<br><br>• Direct impact on banks with significant interests in these countries via low profitability, asset quality and exchange rate depreciation which could weaken contributions to parents' capital buffers.<br>• Reduction in external demand from the United Kingdom and euro area. |

# Appendix II. Stress Test Matrix (STeM) for the Banking Sector: Solvency, Liquidity

| Stress Test Matrix: Solvency and Liquidity (Using December 2016 Data) | | | |
|---|---|---|---|
| **BANKING SECTOR: SOLVENCY RISK** | | | |
| **Domain** | | **Assumptions** | |
| | | Top-down by FSAP Team | Top-down by the BdE |
| | Institutions included. | • 14 SIs. | • 44 LSIs. |
| 1. Institutional Perimeter | Market share | • 93 percent of total banking sector assets. | • 7 percent of total banking sector assets. |
| | Data and baseline date | • European reporting templates (FINREP and COREP).<br>• Publicly available data from the 2016 EBA Transparency Exercise, and the 2016 EBA Stress Test.<br>• Supervisory data from the BdE.<br>• Other public data sources such as SNL and market data.<br>• December 2016 data.<br>• Consolidated. | • Publicly-available data.<br>• Supervisory data, based on national reporting templates.<br>• December 2016 data.<br>• Individual and consolidated data. |
| 2. Channels of Risk Propagation | Methodology | • Detailed balance sheet stress test, covering key risk-sensitive exposures.<br>• Based on satellite models developed by the FSAP team.<br>• For SIs, the stress test was conducted at the group/holding level, considering both domestic and foreign exposures. | • To the extent possible methodology was aligned with that of the larger banks.<br>• The level of details on the stress test depended on data availability and relevance (e.g., certain market risks were not covered, and some foreign exposures were irrelevant). |
| | Satellite Models for Macro-Financial linkages | • For banks under Basel II standardized approach, the nonperforming loan ratios were projected by sector. For Internal Ratings-Based banks, the sensitivity of Probability of default (PDs) for various | • To the extent possible, satellite models were aligned with those used for SIs.<br>• For the small banks, the nonperforming loan ratios were projected by sector.<br>• BDE methodology. |

| Stress Test Matrix: Solvency and Liquidity (Using December 2016 Data) | | | |
|---|---|---|---|
| **BANKING SECTOR: SOLVENCY RISK** | | | |
| **Domain** | | **Assumptions** | |
| | | Top-down by FSAP Team | Top-down by the BdE |
| | | portfolios to macroeconomic cycles was calculated based on historical experience.<br>• Lending rate and funding costs were estimated and projected based on various macro and financial factors such as Euribor, changes in sovereign yields, and changes in the VIX index.<br>• NPLs assumed to not provide any accrued interest.<br>• Expert judgment super-imposed. | |
| | Stress test horizon | • Three-year horizon: 2017–2019. | |
| 3. Tail shocks | Scenario analysis | • Same scenario was used for SIs and LSIs.<br>• "Baseline Scenario" based on the IMF October 2016 or January 2017 Update World Economic Outlook.<br><u>Scenario 1: Financial stress in Europe</u><br>• Assumes the realization of financial stability risks in the Euro Area with spillovers worldwide.<br>• Includes an abrupt unwinding of financial risk taking and low secondary market liquidity in systemic advanced economies.<br>• Assumes a reemergence of financial stress in high spread Euro Area economies, represented by an increase (and divergence) in long-term government bond yields and stock-market sell-off.<br>Shocks include:<br>• A tightening of financial conditions in systemic economies, represented by risk premium shocks and increases in long-term yields. | |

| Stress Test Matrix: Solvency and Liquidity (Using December 2016 Data) | | | |
|---|---|---|---|
| **BANKING SECTOR: SOLVENCY RISK** | | | |
| **Domain** | | **Assumptions** | |
| | | Top-down by FSAP Team | Top-down by the BdE |
| | | • A credit cycle downturn in all emerging market economies and a disorderly deleveraging in China, represented by an increase in default rate on bank loans.<br>• Suppressed economic risk taking worldwide, with private investment and private consumption declining in all economies.<br>• Additional contraction in consumption and investment in Spain.<br><u>Scenario 2: De-globalization and Stagnation in Advanced Economies:</u><br>• Triggered by financial markets reactions to de-globalization initiatives in the short-term, and their dampening effect on growth in the medium-term.<br>Sources of shocks:<br>• Stock-market sell-off and heightened uncertainty regarding international trade and financial arrangements in the short-term.<br>• Secular stagnation in the medium-term due to protectionist measures in Europe and the United States.<br>• Large capital outflows from emerging markets.<br>• Additional demand shocks in those countries with a significant Spanish bank presence.<br>• Political uncertainty and roll back of reforms hit confidence and affect bond yields in Spain. Spain suffers additional pressure on public finances and an aggregate demand shock. | |
| | Sensitivity analysis | • For SIs, sensitivity tests evaluated direct and indirect effects of exchange rate shocks; direct and indirect effects of interest rate shocks; a decline in the prices of sovereign bonds and real estate; and failure of the largest to 10 largest corporate exposures | |
| 4. Risks and Buffers | Risks/factors assessed | • Risks assessed include: credit (domestic and foreign exposures), market (equity risks, exchange and interest rates), sovereign, and interest rate risk in the banking book. | • Certain risks may not be applicable for the LSIs (certain market risks for example), or feasible to quantify given data limitations. |
| | Behavioral adjustments | • Balance sheet grows in line with nominal GDP with a floor set at 0. | • Balance sheet grows in line with nominal GDP with a floor set at 0. |

| Stress Test Matrix: Solvency and Liquidity (Using December 2016 Data) | | | |
|---|---|---|---|
| **BANKING SECTOR: SOLVENCY RISK** | | | |
| **Domain** | | **Assumptions** | |
| | | Top-down by FSAP Team | Top-down by the BdE |
| | | • Dividends are paid out by banks that remain adequately capitalized throughout the stress.<br>• Invariant asset allocation, i.e., no change in business models, lending standards, or investment pattern in response to shocks (over three years). | • Cooperatives' remuneration is paid out throughout the stress.<br>• Invariant asset allocation, i.e., no change in business models, lending standards, or investment pattern in response to shocks (over three years). |
| 5. Regulatory and Market-Based Standards and Parameters | Calibration of risk parameters | • Where they exist, point-in-time PDs and loss given default (LGDs) are taken from supervisory data. Otherwise, proxies are used (such as Moody's KMV Expected default frequencies or supervisory TTC PDs transformed into PIT PDs after application of a conversion factor). | • For small institutions, point-in-time PDs and LGD estimates were used. |
| | Regulatory/ Accounting and Market-Based Standards | • CRD IV / CRR [fully loaded/phased-in] levels for CET1.<br>• Capital shortfalls to be measured in terms of CET1, T1, total capital and the leverage ratio. | • CRD IV / CRR [fully loaded/phased-in] levels for CET1.<br>• Capital shortfalls to be measured in terms of CET1, T1, total capital and the leverage ratio. |
| 6. Reporting Format for Results | Output presentation | • System-wide capital shortfall<br>• Number of banks and percentage of banking assets in the system that fall below certain ratios. | |

| Stress Test Matrix: Solvency and Liquidity (Using December 2016 Data) | | | |
|---|---|---|---|
| **BANKING SECTOR: LIQUIDITY RISK** | | | |
| Domain | | Assumptions | |
| | | Top-down by the FSAP team | Top-down by the BdE |
| 1. Institutional Perimeter | Institutions included | • 14 SIs | • 44 LSIs |
| | Market share | • 93 percent of total banking sector assets | • Nearly 7 percent of total banking sector assets |
| | Data and baseline date | • Latest data: December 2016.<br>• Source: supervisory data (COREP/FINREP).<br>• Scope of consolidation: perimeter of individual banks. | • Latest data: December 2016.<br>• Source: supervisory data (BdE).<br>• Scope of consolidation: perimeter of individual banks. |
| 2. Channels of Risk Propagation | Methodology | • An extended Basel III LCR scenario with variants (retail/wholesale shock).<br>• A Basel III NSFR scenario.<br>• A cash-flow based scenario analyzing different maturity buckets. | • An extended Basel III LCR scenario with variants (retail/wholesale shock). |
| 3. Risks and Buffers | Risks | • Funding liquidity (liquidity outflows).<br>• Market liquidity (price shocks). | • Funding liquidity (liquidity outflows) |
| | Buffers | • Counterbalancing capacity.<br>• Central bank facilities. | • Counterbalancing capacity.<br>• Central bank facilities. |
| 4. Tail shocks | Shocks | • For LCR, see: BCBS (2013), The Liquidity Coverage Ratio and liquidity risk monitoring tools, Basel, January 2013.<br>• For NSFR, see: BCBS (2014), Basel III: The Net Stable Funding Ratio—Consultative Document, Basel, April 2014. | |
| 5. Regulatory and Market-Based Standards and Parameters | Regulatory standards | • Basel III liquidity standards for LCR and NSFR | |
| 6. Reporting | Output presentation | • Liquidity ratios, disaggregated by type and size of bank<br>• Counterbalancing capacity | |

# Appendix III. Satellite Models for Credit Risk—Technical Details

The NPL projection model was specified using the following panel auto-regressive regression:

$$NPL_{i,t} = g + \sum_{s=1}^{l} \alpha_s NPL_{i,t-s} + \sum_{s=1}^{P} \beta_s X_{i,t} + \gamma_i + \varepsilon_{i,t}$$

In the above equations, the indexes $i$ and $t$ indicate, respectively, the bank and the time period. NPL denotes the logistic transformation of the NPL ratio, where the measure of NPL is the adjusted overall NPL ratio provided by the BdE for each bank:

$$NPL_{i,t} = ln\left(\frac{NPL^{o}_{i,t}}{1 - NPL^{o}_{i,t}}\right)$$

$\gamma_i$ denotes bank-specific fixed effects and $X = (HP, U, LT)$ is a vector of macroeconomic variables, where HP denotes the housing price growth; U denotes the unemployment rate and LT denotes the long-term interest rates. The model was estimated using quarterly data for the period 2006:Q2 through 2016:Q4.

The estimated coefficients (except for the bank-specific fixed effects) are presented in the following table:

| **NPL Projections** | |
|---|---|
| Explanatory Variable | Coefficient |
| Lag NPL | 0.29 |
| Housing | -3.35 |
| Unemployment | 0.11 |
| LT rates | -0.22 |
| Constant | -2.88 |
| R Squared (percent) | 89.6 |

A similar approach to NPL projections was taken for projection of sectoral PDs. A regression of EDFs (log transformed as above) on macro variables was conducted on a quarterly basis, including quarterly dummies. The regression form is as follows:

$$PD_t^j = g + \sum_{s=1}^{l} \alpha_s PD_{t-s}^j + \sum_{s=1}^{P} \beta_s X_t + \sum_{s=1}^{4} \gamma_s + \varepsilon_{i,t}$$

where $PD_t^j$ denotes EDF at time $t$ in sector $j$ (corporate or financial institutions), $X$ is a vector of explanatory variables and $\gamma_s$ denote quarter-specific dummies. The model was estimated using quarterly data for the period 2005:Q1 through 2016:Q4. The estimated coefficients and the explanatory variables with statistically significant coefficients are produced below (except for quarterly dummies).

**Corporate EDFs**

| Explanatory Variable | Coefficient |
|---|---|
| Lag EDF | 0.74 |
| Real GDP growth | -0.05 |
| Euribor | 0.07 |
| Constant | -0.02 |

**Financial Institutions EDFs**

| Explanatory Variable | Coefficient |
|---|---|
| Lag EDF | 0.76 |
| Real GDP growth | -0.02 |
| Euribor | 0.03 |
| VIX | 0.31 |
| Constant | 0.00 |

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