



Impact analysis of stress tests in the financial system

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Photographs

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Introduction



Since the end of 2007, when several financial institutions collapsed, stress tests on institutions have increasingly been used in different countries with the aim of assessing their robustness and identifying the source of potential weaknesses that could result in new adverse events capable of leading to financial system contagion.

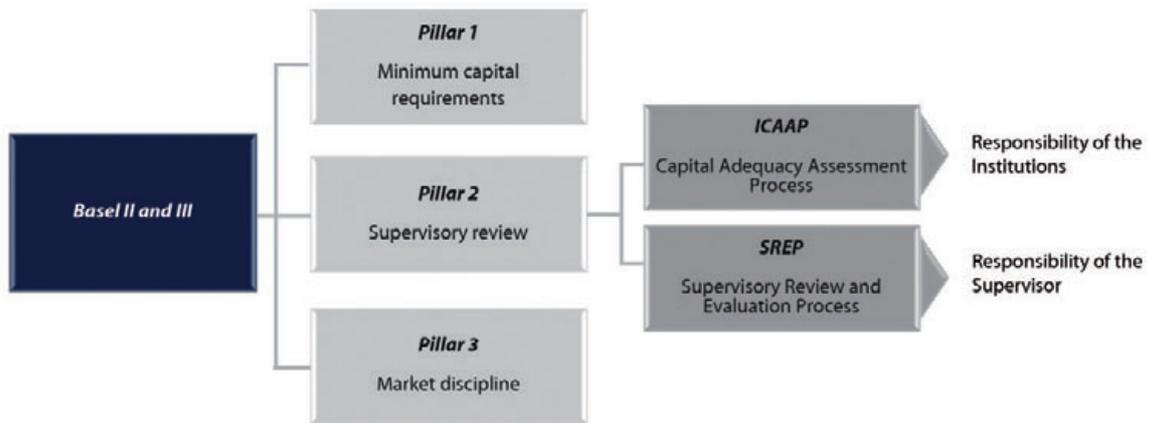
Stress testing is a series of techniques that attempt to measure portfolio, individual bank or financial system sensitivity to changes in certain risk factors. Broadly defined, this includes tools as diverse as strategic what-if analysis, portfolio assessment under different scenarios and analysis of the solvency and liquidity of financial institutions, among others.

Stress testing has been used by banks for decades as an internal management tool that was closely linked to risk management, planning and budgeting. However, as a result of

the international economic situation in the last few years, what was once an internal screening exercise has become a monitoring tool to assess the capital adequacy of institutions in the medium term, and a public instrument of renowned importance. Thus, stress testing is usually conducted as a regulatory requirement aimed at ensuring that institutions have adequate solvency to survive a number of adverse but likely scenarios.

Therefore, it can be said that the financial crisis has contributed to the spread and, in many countries, the regulation of the practice of these exercises. This trend responds both to an alignment with international best

Figure 1. Capital assessment and review processes in Basel II and III



Source: adapted from the Bank of Spain.

practices and to prudent behavior in anticipation of potential future crisis scenarios similar to those that have occurred in the more developed economies.

From a regulatory point of view, stress testing was strongly promoted (Figure 1) by the Basel Committee on Banking Supervision under Pillar 2 of the Capital Accord known as Basel

II, which maintains its structure in Basel III. Under Pillar 2, an Internal Capital Adequacy Assessment Process (ICAAP¹) and a Supervisory Review and Evaluation Process (SREP²) are required to be carried out by the institutions and the supervisor respectively on a regular basis.

This regulatory difference is reflected in financial stress tests; thus, two categories or types of stress tests must be distinguished (Figure 2):

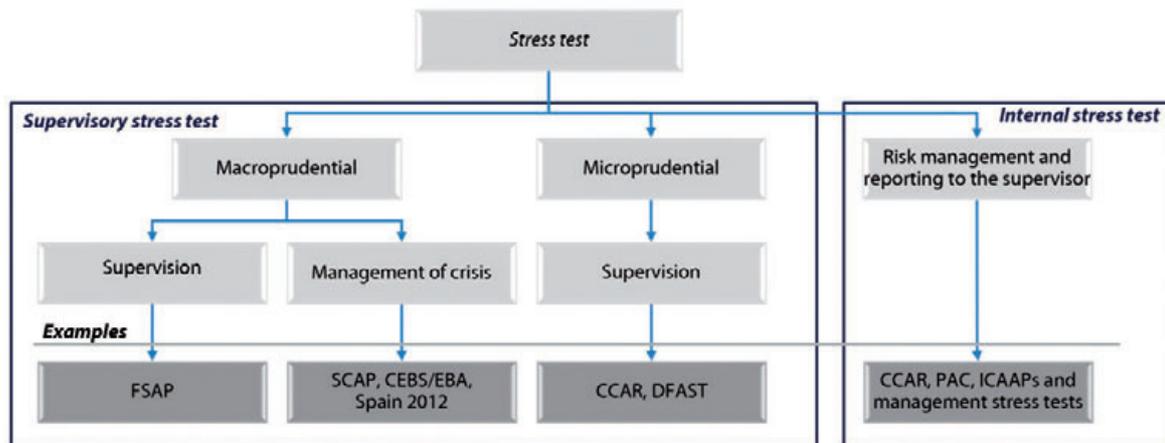
- ▶ Internal stress tests, carried out by each institution, which are governed by the ICAAP provisions in terms of their periodic implementation, but only by some guidelines or principles in terms of their specific execution methodology. Their goal is twofold: to provide a forward-looking approach to be integrated in strategic and business decision making, and to inform the supervisor about capital planning under different scenarios.
- ▶ Supervisory stress tests, conducted by supervisory authorities, national and international regulators and



¹Internal Capital Adequacy Assessment Process, laid down in Basel's Pillar 2.

²Supervisory Review and Evaluation Process, also laid down in Basel's Pillar 2.

Figure 2. Stress test classification



Source: adapted from *A Framework for Macroprudential Bank Solvency Stress Testing: Application to S-25 and Other G-20 Country FSAPs*, FMI, 2013.

banking associations; regulated in part by the provisions of the SREP (Supervisory Review And Evaluation Process); focused on specific aspects of the solvency and liquidity position of institutions and the financial system as a whole. Their aim is to diagnose and occasionally strengthen the stability of the system by taking measures such as the recapitalization or winding-up of institutions whose results are not satisfactory.

Basel’s regulatory requirements regarding both types of stress tests have rapidly been adopted by many national supervisory and regulatory authorities and supranational bodies (such as the EBA³ or the IMF⁴). In every case, these bodies have gone beyond the established minimum requirements and have set their own standards towards establishing best practices in the financial industry.

Concerning the internal stress tests, it is evident that beyond regulatory requirements stress testing as a management tool offers a broad range of uses that more and more institutions are incorporating into their decision-making process, especially in regards to risk appetite definition and monitoring. This management approach, which in many institutions preceded the regulatory approach, is being enhanced by the stress tests required by the ICAAP, and in many institutions it is in line with them.

As for the supervisory stress tests, despite the growing regulation and beyond the seriousness of the macroeconomic scenarios used and the assessments received from organizations which try to unify practices, neither an international standard nor a benchmark of the different exercises have been observed yet. Moreover, analysis on the degree of accuracy of their predictions⁵ has barely been

observed, neither in terms of the macroeconomic projections nor of the profit and loss accounts and solvency of the institutions under stress scenarios.

In this context, this study aims to provide an overview of stress tests, their nature and their implications for financial institutions. To do so, this paper has three basic goals which are developed over three sections as follows:

- ▶ Description of internal stress testing by financial institutions, its regulation in several representative countries, main uses in management and key methodological aspects.
- ▶ Analysis of supervisory stress testing by some of the main supranational and national bodies, looking into the description, the impacts and the implications of several tests carried out on financial institutions in recent years, as well as the challenges and unresolved issues that remain.
- ▶ Retrospective analysis of a supervisory exercise through a quantitative empirical exercise (a backtest of the stress test), towards assessing the degree of accuracy both in the macroeconomic scenarios used and in the losses and capital expected. The exercise carried out by the EBA in 2011 and, more specifically, the homogeneous analysis sample composed of the 22 participating Spanish institutions, was selected for this purpose.

³European Banking Authority.

⁴International Monetary Fund

⁵Apart from the study published by the Bank of Spain in 2013 within the Financial Stability Report, where compliance with the 2012 stress test was partially analyzed, and some private initiatives that regularly compare the predictions of macroeconomic variables with their later value; to see an example, please visit “Diana ESADE” at <http://www.esade.edu/sites-esade/esp/diana>.



Executive summary



This section summarizes the main conclusions obtained through the exercises described in this document on the performance and impact of stress tests in financial institutions. These conclusions are developed in the corresponding sections.

Internal stress test

Regulatory background

1. Advanced development of internal stress tests in financial institutions in most countries has come hand in hand with the implementation of Basel's ICAAP and has followed, more or less strictly, the guidelines provided by supranational bodies. These guidelines have left individual institutions some discretion as to the specifics of stress testing.
2. The ICAAP regulation, which was drawn up by Basel II (2004) and materialized to a varying degree of detail in the different countries, requires banks to conduct internal stress tests and provides guidelines as to their general execution methodology, but there is not a unified, agreed and precise practice across countries or institutions. This study analyzes the cases of Spain (and of Europe, when appropriate), the United States and Brazil, thus trying to use specific cases from three different regions (though there may be substantial differences between regulators in various aspects).
3. In Spain and since 2008, the Bank of Spain requires institutions to provide an annual Capital Adequacy Self-Assessment Report, which in practice imposes the ICAAP, as part of which institutions are required to submit a three-year capital plan under different stress scenarios (at the discretion of the institution), and to quantify capital for the various material risks.

4. In the United States, supervisory agencies⁶ jointly approved the implementation of certain aspects of Basel in 2008, including the ICAAP (later instrumented in part through the CCAR⁷), and in 2009 the Dodd-Frank Act added the requirement that institutions with over USD 10 billion in assets should execute and report internal stress tests on an annual basis, while systemic institutions should do it every six months. This led the supervisory agencies to publish two final rules in 2012, requiring a five-year projection of financial statements and a comprehensive and public report.
5. In Latin America, all countries are promoting regulations requiring institutions to conduct internal stress tests, despite the fact that the degree of implementation of the Basel II regulations varies greatly from one country to another.
6. For instance, in Brazil, the Central Bank of Brazil (BACEN) adopted Basel II in 2007, but it wasn't until 2011 when it first⁸ regulated the ICAAP for financial institutions with over BRL 100 billion in assets, to be implemented in 2013 and requiring specific reporting⁹. The ICAAP report model was published¹⁰ in 2012 and consists of a report template institutions will have to fill in with the quantitative (capital, methodology, validation) and qualitative (description of governance, auditing, risk appetite, etc.) aspects from their capital adequacy assessment, as well as a three-year capital plan and action plans in the event of capital insufficiency.
7. Therefore, internal stress test regulations continue to be developed, and it is expected that requirements for financial institutions will increase. Some countries are taking steps that increase requirements to up to two exercises per year, which entails a substantial effort for institutions, especially in terms of availability, data quality and consistency, as well as in the technological infrastructure this involves.
8. In sum, regulations show uneven progress across countries, especially in regards to specifying requirements and to the need to publish results; in this sense, the expected trend is for steady progress towards standardization, robustness and transparency in internal stress testing in the near future.

Stress test in management

9. In parallel with regulations and driven in part by the ICAAP, institutions have developed their own internal stress testing frameworks aiming to introduce a prospective element in the strategic and business decision making process.
10. These stress testing frameworks are being used for different management purposes within institutions, including the definition and monitoring of risk appetite, which is receiving increased attention by regulators, supervisors and the market.
11. However, the full integration of stress testing in management systems is expensive and requires a continuous effort in all areas: organizational, procedural, methodological and technological, with significant implications for the institution's corporate culture.
12. As a result, achieving this full integration entails many challenges: involving senior management and experts from all areas, linking goals to the stress test results, monitoring that risk appetite is adhered to in stress situations and any necessary corrective action is applied, the balance between severity and plausibility of scenarios or the binding nature of results in management decisions, among others.
13. An added difficulty with stress testing is that it should comprehensively and consistently include the interdependence between all risks (credit, market, liquidity, operational, etc.). Though the most advanced institutions already have stress testing frameworks that include several risks and their interrelationships, achieving a comprehensive approach is still a challenge for most of them.
14. Summing up, financial institutions are quickly developing their internal stress testing frameworks, giving a varying degree of attention to the different risks and showing differences as to their level of centralization; also, their level of integration in the management process is increasing.

⁶ Board of Governors of the Federal Reserve System (Board), Office of the Comptroller of the Currency (OCC) and Federal Deposit Insurance Corporation (FDIC).

⁷ *Comprehensive Capital Analysis and Review*.

⁸ *Resolução 3.988* of the Central Bank of Brazil.

⁹ *Circular 3.565* of the Central Bank of Brazil.

¹⁰ *Circular 3.565* of the Central Bank of Brazil.

Methodological aspects

15. Stress testing exercises usually follow certain stages: definition of scenarios, impact of scenarios on risk factors through econometric models, projection of financial statements and of the loss-absorbing capacity, and final opinion on whether the institution is robust enough to absorb the impact of the described scenario and, if not, immediate action or contingency plans to solve it.
16. Though these aspects tend to be common to all institutions, each stress test is adapted differently to the reality of each individual firm, the nature of its risks and portfolios, the limitations on the availability of historical data, etc.; which together determine the methodology chosen and the application of expert criteria where necessary.
17. Thus, a unified and homogeneous stress testing methodology is not yet in place across institutions; partly because there are many open issues, such as selecting which risks should be stressed and how to deal with some of them; setting the final goal of the stress test (the profit and loss account vs. the capital recalculated under each scenario); the consistency and reliability of scenarios; modeling portfolio growth and profit generation; the difficulty in keeping coherence with the institution's IRB parameters or the difficulty in carrying out a reliable backtest of the results.
18. Stress test results are very sensitive to the hypothesis assumed. In many cases, this hypothesis is constructed in the absence of reliable information and is frequently adjusted by expert judgments that have a direct impact on final results.



Supervisory stress test

Regulatory background

19. In recent years, supervisors have increasingly performed stress tests on the financial system as a whole and on institutions individually, frequently under the SREP framework of Basel's Pillar II.
20. Supervisory stress testing regulations (similar to those on internal stress testing) originated in Basel's Pillar II, although several countries (especially the United States) have gone further and have developed their own regulations, frequently specifying the guidelines of international bodies.
21. In Spain, the SREP process is based on the Capital Adequacy Assessment Report that institutions submit to the Bank of Spain on an annual basis; the Bank then analyzes the current and projected solvency of institutions through its review, but it does not perform an independent and regular supervisory stress test, unlike other countries. However, Spanish institutions have been subject to several stress tests carried out by the EBA between 2010 and 2011 and by the Bank of Spain and the Spanish Ministry of Economic Affairs in 2012.
22. In the United States, the Dodd-Frank Act required institutions considered to be systemically important to carry out supervisory stress tests annually, starting in 2009. As a result, the SCAP¹¹ (2009) and the CCAR¹² (2011 onwards) and other supervisory stress tests were carried out. In 2012, the Federal Reserve published an advanced and comprehensive regulation implementing the Dodd-Frank Act requirements through a test called DFAST¹³, which must be conducted annually on systemic institutions.
23. In Latin American countries, the SREP process focuses on the supervisory review. For instance, in Brazil, the Central Bank of Brazil (BACEN) analyzes the capital adequacy assessment reports issued by institutions and, additionally, carries out a biannual supervisory stress test which was first conducted prior to 2002 (therefore, previous to the SREP), the results of which are published as an aggregate in the Financial Stability Report. This stress test has become increasingly sophisticated over time and has explicitly included a separate liquidity stress test since 2009.
24. In sum, the regulation governing the SREP and the supervisory stress test exercises generally evolves parallel to that of the ICAAP, with the notable exception of the United States, which took a big step forward in this regard in 2012. However, the specific regulation on this issue still appears to have a low degree of maturity and, therefore, it is expected to develop further and acquire greater depth over the coming years, possibly inspired in the United States' DFAST exercises (as the 2009 SCAP influenced on the stress test carried out by the EBA in 2010).

Challenges and open issues

25. Supervisory stress testing exercises are not without criticisms and pose certain challenges and open questions, such as: defining capital (which is not always homogeneous); publishing the methodology; justifying the assumptions and their uniformity across countries; the reasonableness of the economic macroscenario; or the absence of critical analysis of previous exercises determining whether stress tests are effectively highly trustworthy and, therefore, whether relying on them to take actions such as the recapitalization, intervention or winding-up of institutions is reasonable.

Description and impacts of the main exercises

26. A number of stress tests were analyzed in order to present a comparative overview: the EBA exercise of 2010-11; the test conducted in Spain by the Spanish Ministry of Economic Affairs and the Bank of Spain in 2012; the 2009-2013 SCAP, CCAR and DFAST exercises in the United States, and the stress test carried out in several Latin American countries under the FSAP¹⁴ program (in particular, that of Brazil in 2012). The background, goals, participants, main methodological aspects and results, as well as their impact on institutions and on the financial system within their respective geographical scope of application are analyzed for each individual exercise.

27. All these tests are serving as exercises in transparency toward the market, and so it is stated in their goals, focused on restoring confidence. In line with this trend, institutions which together represent between 50% and 90% of the total amount of financial assets in a geography are analyzed, and very detailed results are published (however, the level of detail varies across countries).

28. Regarding results, two out of the four exercises analyzed (Spain and the United States) were binding, in that the institutions that “failed” were required to recapitalize. In Spain, seven out of 14 institutions analyzed in 2012 were in this same situation, with a total capital deficit of EUR 26 billion which was covered with capital increases, sale of portfolios and aid from the FROB¹⁵. In the United States, the pioneering exercise in 2009 “failed” 10 out of the 19 institutions analyzed and showed a capital deficit of USD 185 billion; this required those 10 institutions to recapitalize for that total amount¹⁶.

29. In short, supervisory stress tests are a growing and evolving practice which is expanding rapidly but which still has room to attain a good level of maturity, mainly in terms of scope (risks considered) and methodology.

¹¹ Supervisory Capital Assessment Program.

¹² The CCAR includes a bottom-up internal stress test by the institution and a top-down supervisory exercise.

¹³ Dodd-Frank Act Stress Test.

¹⁴ Financial Sector Assessment Program, by the IMF and the World Bank.

¹⁵ Fund for Orderly Bank Restructuring, whose aim is to manage Spanish credit institution restructuring and resolution processes

¹⁶ This stress test progressed until becoming the DFAST in 2013; in it, only one out of 18 institutions analyzed had a capital deficit.



Retrospective analysis of an exercise: backtesting a stress test

30. A relevant and not very studied aspect of supervisory stress tests in the financial sector is the degree of accuracy of their predictions, both regarding the macroeconomic scenarios used in their definition and the loss and capital projections that form their final result. Despite the fact that these exercises are being used to determine the need to recapitalize or even to liquidate institutions, national and supranational bodies do not publish retrospective analysis on their reliability in statistical terms.
31. For this reason, a backtest was carried out on a supervisory and public stress test: that performed by the EBA on Spanish financial institutions in 2011. To perform the backtest, the degree of accuracy has been assessed for each of the stages of the stress test's methodological process: foreseen macroeconomic scenarios, losses predicted and capital projected. A qualitative analysis has also been performed to conclude whether the overall goal of the exercise was achieved.
32. Regarding the proposed scenarios, the reality was better than predicted in the adverse scenario in 2011, except in terms of inflation. On the contrary, in 2012 the reality was significantly worse than the adverse scenario and the trends of several key variables (GDP, housing prices, Euribor) reversed in respect of what was expected. Thus, the reality observed was worse than the adverse scenario predictions by 2.7 points in terms of unemployment, 6 points in the fall of land prices or 0.3 points in the case of GDP, to name three representative variables. As a result, capital and loss estimations carried forward an error derived from the divergence between the scenarios and the macroeconomic reality.
33. Partly as a consequence of what has just been stated, the stress test exercise could not predict the losses correctly: there were relevant deviations between the values predicted and those observed for 75% of the institutions in 2011, a figure that was increased in 2012. Also, the analysis of the trend reveals that the EBA overestimated the losses by 37.5% on average in 2011, despite the macroeconomic reality being aligned with that predicted for that year, and underestimated them by 45% on average in 2012. This deviation in the degree of accuracy raises the question of the sensitivity of models to macroeconomic factors, as well as the capacity of the exercises to foresee and include inorganic transactions (such as the sale of portfolios) and regulatory changes occurred during the prediction horizon.
34. When comparing the capital predicted by the EBA with the reality observed, ratios were 1% better on average than those foreseen in the adverse scenario in 2011, which increased significantly until they outweighed the predictions of the adverse scenario by 3% on average in 2012. Despite this capital underestimation, one needs to take into account that the EBA exercise could not consider the regulatory changes nor any modifications in the assumptions made during the prediction horizon, so the results were inevitably biased. This is not necessarily the result of errors in the mathematical stress test model, but does question the capacity of the exercise as a whole to predict capital levels in institutions.
35. From a qualitative point of view, the EBA stress test made it possible to rank institutions in a way that showed a correlation with the capital injections, takeovers or even interventions that later occurred; indeed, four out of the five institutions "failed" by the EBA finally underwent restructuring and merger processes involving other institutions, and the fifth was nationalized. However, it is likely that the publication of these results deteriorated the perception of the institutions with the worst results, which resulted in a loss of confidence that contributed to trigger the actions for their bailout.
36. In conclusion, beyond any concrete numeric results, the EBA stress test was an exercise in transparency of great relevance to which most Spanish financial institutions adhered at the request of the Bank of Spain. This transparency played a key role in the financial system restructuring process that framed the implementation of the exercise and, as it has already been said, is a common feature and the clearest trend in all supervisory stress tests.



Internal stress test



Even though the most advanced institutions have been using stress tests as a management tool for decades, this practice was partial or even absent in others, which in recent years has led several national and supranational bodies to regulate the need for institutions to carry out these exercises, towards ensuring that their risk profile and their level of capitalization are properly related.

Partly driven by the ICAAP, institutions have at the same time gradually strengthened their internal stress testing frameworks with a management objective, which is transforming towards even greater integration of prospective tools when taking strategic decisions, both in risks and other financial fields.

Following a summary containing the main observations, this section recalls the regulatory background in which the internal stress test originates, describes its uses in management and briefly introduces its methodology and the challenges and related open issues.

Main observations

Internal stress tests have been observed to be gaining substantial momentum in financial institutions, both towards regulatory compliance with the ICAAP and for management purposes. This development has implications across the board: greater involvement of governing bodies, adaptation of organizational structures, development of advanced methodology and the consequent need for qualified profiles, as well as a requirement for greater efforts in terms of data quality, consistency and completeness, taking into account the investment in technological infrastructure this involves.

However, there is still room for improvement in several key aspects, including the unification of methodological criteria, the full integration of stress testing in the management process, and the publication of hypotheses and results.

Therefore, the expected trend is for continuous progress towards greater robustness and transparency of internal stress testing by the institutions.

Regulatory background

The ICAAP

Even though the internal stress test as a management tool is not specifically regulated, it is indeed regulated as far as the internal capital adequacy assessment process is concerned, a fact that frequently provides institutions with a framework within which the stress test is developed in its different forms and for the various risks, so the regulatory and management processes often converge.

Thus, the first relevant reference to this respect appears in Basel's Pillar II¹⁷, which states that banks shall have a process to assess the capital adequacy depending on their risk profile, and with a strategy to maintain their capital levels.

These principles and in particular the ICAAP (task assigned to the institution) and the SREP (task assigned to the supervisor, which will be seen in the next section), have been implemented across countries at a different pace and to different degrees of completion.

In Europe, Basel's Pillar II (and, therefore, the ICAAP) was adopted by the European Commission in the form of Directives¹⁸, then approved by the European Parliament in 2006 and finally transposed to local regulations. As the process took

several years, some countries, such as Spain, did not pass their local regulation until 2008, four years after the final version of Basel II. In the United States, Basel's adoption was also delayed until 2008, this time due to the dispute within the industry as to what its implications would be in terms of capital requirements and the possible competitive disadvantages it could entail.

Regarding the internal stress test, local regulations address it differently. Analyzing three countries chosen as the sample, the following factors can be observed:

- ▶ Spain (Figure 3): Since 2008, the Bank of Spain requires institutions to submit an annual capital adequacy assessment report, in which a three-year capital plan under different stress scenarios (at the institution's discretion) and a quantification of capital for material risks must be reported.
- ▶ United States (Figure 4): In 2008, supervisory agencies¹⁹ jointly approved the implementation of certain aspects of

¹⁷ Adapted from "Internal Capital Adequacy Assessment Process", presented by J. Serrano (Bank of Spain). Febraban, 2011.

¹⁸ And, in the case of Basel III, the combination of a Directive (known as CRDIV) and a Regulation (CRR IV), approved in April 2013.

¹⁹ Board of Governors of the Federal Reserve System (Board), Office of the Comptroller of the Currency (OCC) and Federal Deposit Insurance Corporation (FDIC).

Figure 3. Main Pillar 2 and internal stress testing milestones in Spain

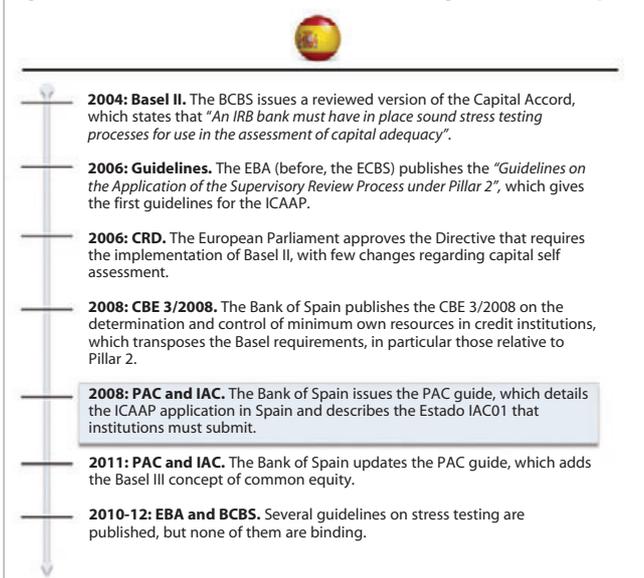
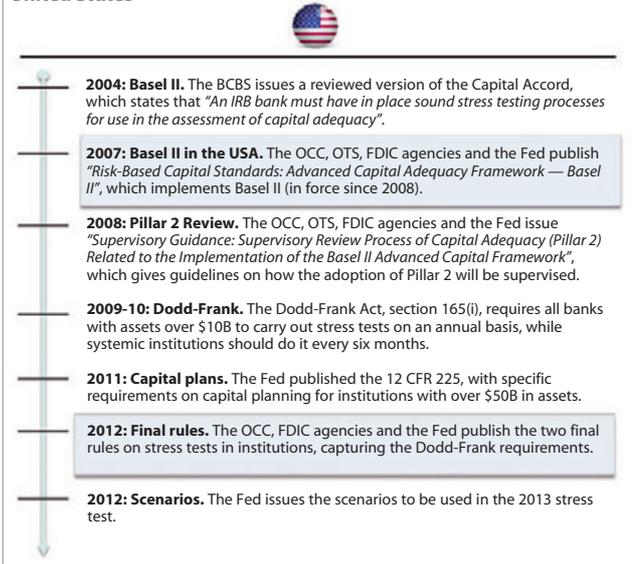


Figure 4. Main Pillar 2 and internal stress testing milestones in the United States



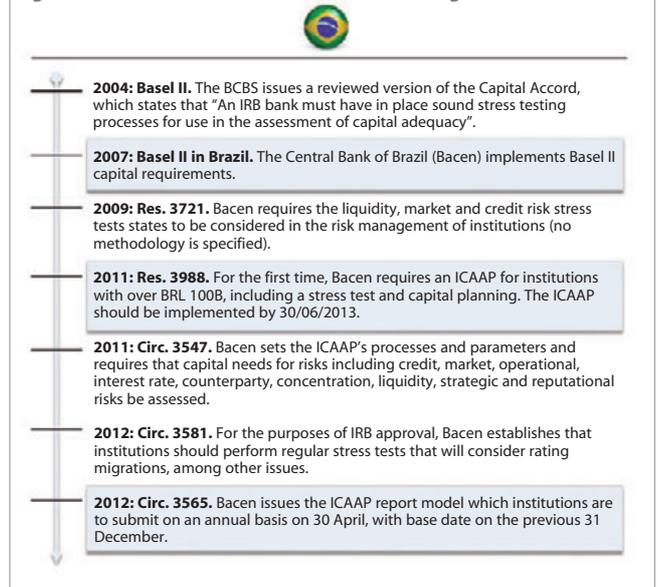
Basel, the ICAAP among them, but this did not materialize into regular and unified reports for the supervisor. In 2009, however, the Dodd-Frank Act added the requirement that institutions with over USD 10 billion in assets should execute and report internal stress tests on an annual basis, while systemic institutions should do it every six months.

This led the supervisory agencies to publish two final rules on internal stress tests in 2012, which capture the terms of the Dodd-Frank Act and require a five-year projection of financial statements and a comprehensive report that must be published by the institutions themselves.

- ▶ Brazil (Figure 5): even though the Central Bank of Brazil (BACEN) adopted Basel II in 2007 as did other Latin American countries, the effective transposition of the ICAAP and the stress test has been made progressively through circulars and resolutions in the last few years and it is still going on. In 2011, it imposed an ICAAP on institutions with over BRL 100 billion in assets for the first time²⁰, including a stress test and a capital plan. Also in 2011, it specified²¹ that the ICAAP should cover all relevant risks, including credit, market, operational, interest rate, counterparty, liquidity, strategic and reputational risks.

The concrete ICAAP report model was published²² in 2012 and consists of a template institutions will have to fill in with the quantitative (capital, methodology, validation) and qualitative (description of governance, auditing, risk appetite, etc.) aspects from their capital adequacy assessment, as well as a three-year capital plan and an action plan in the event of insufficient capital.

Figure 5. Main Pillar 2 and internal stress testing milestones in Brazil



In sum, as it can be appreciated in the comparative chart of Figure 6, the ICAAP regulations show uneven progress across countries. This is reflected by requirements that are aligned in terms of purpose, but have different degrees of specificity regarding methodology and the need to publish the results.

²⁰ Resolução 3.988 from the Central Bank of Brazil.

²¹ Circular 3.547 from the Central Bank of Brazil.

²² Circular 3.565 from the Central Bank of Brazil.

Figure 6. Summary on internal stress testing characteristics in Spain, the USA and Brazil

Aspect	 SPAIN	 UNITED STATES	 BRAZIL
Minimum scenarios	Two: baseline and adverse, as set by the institution	Three set by the supervisor: base, adverse and highly adverse, plus at least one additional set by the institution	Two: base and adverse, as set by the institution
Frequency	Annual	Annual (in general) or every six months (systemic institutions)	Annual, plus a special ICAAP on 30/09/2013
Projection time horizon	3 years	9 quarters	3 years
Reporting	IAC and Estado IAC01	FR Y-14 and others	Relatório ICAAP Circ. 3.565
Publicly disclosed	No	Yes (summarized)	Not described
Data synergies with supervisory stress testing	No, the 2012 supervisory stress test was performed under a different information request	Yes, the CCAR was carried out using the same information as institutions	No, the supervisory stress test is performed under supervisory information since 2002



Principles for sound stress testing practices and supervision

In 2009, the Basel Committee issued “Principles for sound stress testing practices and supervision”, which includes a series of principles for the proper management of stress tests.

The main issues covered by these principles in relation to financial institutions’ practices are summarized below.

Principles for financial institutions (principles 1 to 15)

1 to 6. Use of stress testing and integration in risk management

Stress tests must be part of the corporate culture of the institution and their results must have an impact on risk management and business decision making. The institution must have a stress test program that promotes the identification and control of risks, provides a risk perspective complementary to other internal tools and improves the management of capital and liquidity. Senior management involvement is critical in ensuring the appropriate use of stress testing.

The institution shall have rigorous policies and procedures governing the stress test program, including a sound infrastructure flexible enough to be adapted to the different stress tests and covering a wide range of techniques and perspectives. The efficiency and soundness of the stress test program must be assessed regularly and independently.

7 to 10. Stress testing methodology and scenario selection

Stress tests must cover a series of risks and business areas. The institution must be able to effectively include all tests carried out to provide a complete picture of its risks.

Stress testing programs must cover different scenarios –including future scenarios- that offer a range of severity levels and include events that can threaten the institution’s viability.

As part of the stress test program, the institution must take into account simultaneous pressures on financing and in asset markets, as well as the impact of a reduction in market liquidity on exposure valuation.

11 to 15. Specific areas of focus

The effectiveness of risk mitigation techniques should be systematically challenged. The institution should enhance its stress testing methodologies to capture the effect of reputational risk and should consider the high degree of leverage of certain exposures as a risk factor.

The institution should include in its stress tests all relevant information related to its underlying asset portfolios, its dependence on market conditions, contractual agreements and effects related to the level of subordination of specific tranches.

Guidelines on stress testing

In 2010, the Committee of European Banking Supervisors (CEBS), later integrated into the European Banking Authority (EBA), published the “Revised guidelines on stress testing (GL32)”, which provided guidelines for the appropriate management of stress tests in financial institutions in line with the principles stated by the Basel Committee (2009).

The main issues addressed by these guidelines in relation to financial institutions’ practices are summarized below.

Guidelines for financial institutions (guidelines 1 to 17)

1 to 5. Governance aspects of stress testing and use

Management has ultimate responsibility for the overall stress testing program of the institution and its engagement is essential for effective stress testing.

The stress testing program should be an integral part of an institution’s risk management framework and inform decision making at all appropriate management levels. The institution should have allocated resources and written policies to facilitate the implementation of stress testing and should regularly review its stress testing program and assess its effectiveness and usefulness in management.

6 to 13. Stress testing methodologies

The institution should perform sensitivity analysis on specific portfolios or risks, identify appropriate mechanisms for translating scenarios into internal risk parameters and perform scenario analysis (including the occurrence of simultaneous events) as part of its stress testing program. Stress tests should be based on exceptional but plausible events, covering a wide range of scenarios with different severities including scenarios which reflect a severe economic downturn.

The whole risk interaction system should be considered in the scenarios. Moreover, the institution should complete its stress testing framework with reverse stress tests as one of its risk management tools.

Stress testing should be conducted on a firm-wide basis covering a range of risks in order to deliver a complete picture.

14 to 15. Output of stress testing programs and intervention actions

The institution should present results in relation to its regulatory capital, available resources, balance sheet and P&L account, and should identify management actions aimed at ensuring its ongoing solvency in adverse scenarios.

16 to 17. Stress tests and ICAAP

The institution should evaluate the reliability of its capital planning based on stress test results. According to the ICAAP, stress tests should be consistent with an institution’s risk appetite and contain credible mitigating actions.

Guidelines on internal stress tests

Though the regulation is explicit about the mandatory nature of stress tests, the Basel ICAAP regulation and that of the different countries does not specify the exact nature of internal stress tests and it is left to the institutions to determine how to apply it, with some more or less specific guidelines added to the rule or issued as separate guidelines and, in some countries, with several minimum scenarios that must be considered.

These local stress testing guidelines are frequently based on Basel publications and, in the case of Europe, on EBA publications, which have issued related recommendations in the past years.

Also, the Basel Committee on Banking Supervision issued some principles²³ for sound stress testing and supervision in 2009, to address the fact that the mechanisms in place until then had been insufficient to prevent the crisis. These principles, though specific and relatively comprehensive in scope, remained as guidelines and provided 15 recommendations for banks and six for supervisors.

At the same time, Basel III introduced the liquidity risk stress test²⁴ for the first time through two ratios (LCR and NSFR) which consider adverse scenarios in their definition²⁵. These requirements, which will gradually become mandatory between 2015 and 2019, regulate the execution of some aspects of stress testing in very specific fields.

In 2010, the EBA (back then the ECBS²⁶) published detailed guidelines²⁷ on stress testing, based on a building blocks approach (Figure 7) and providing indicative specifications for each risk: market, securitizations, credit, counterparty,

operational, liquidity, interest rate and concentration. There has not been significant progress in this area since the creation of the EBA.

Thus, the overall regulatory situation regarding internal stress testing varies across countries, ranging from mandatory to recommended implementation, providing relatively detailed guidelines but leaving each institution to decide the precise way in which stress testing is to be implemented.

Stress test in management

In parallel to progress on the ICAAP and regulatory guidelines (and partly driven by them), financial institutions have been developing their stress testing frameworks with the aim of introducing a prospective element in the management and strategic decision-making process.

Specifically, the main purposes for which the more advanced institutions are using their stress testing frameworks can be grouped into three lines (Figure 8):

- ▶ Business planning, by identifying potential obstacles the business plan might face and analyzing the assumptions on which it is based, to define the strategies needed in order to add strength and rigor to the plan.

²³ Principles for Sound Stress Testing Practices and Supervision. BSCB, 2009

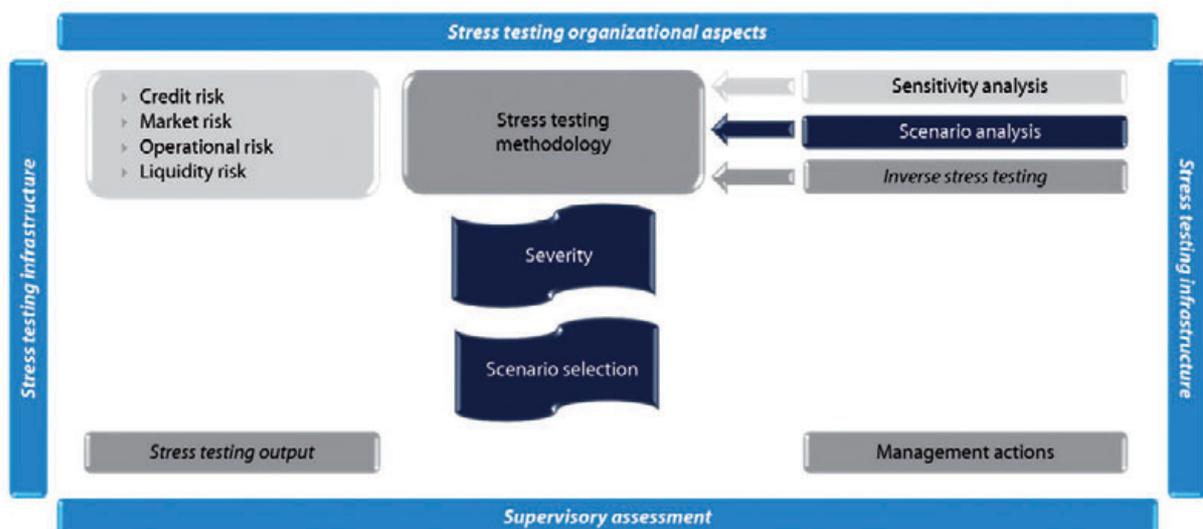
²⁴ Basel III: International framework for liquidity risk measurement, standards and monitoring. BCBS, 2010.

²⁵ These ratios and their implications are detailed in "Liquidity risk: regulatory framework and impact on management". Management Solutions, 2012.

²⁶ The former European Committee on Banking Supervision (ECBS) joined the European Banking Authority (EBA) in 2011, the latter assuming its publications retrospectively.

²⁷ ECBS Revised Guidelines on Stress Testing (GL32). ECBS, 2010.

Figure 7. EBA/ECBS stress testing approach through a building blocks system



Source: EBA/CEBS (2010).

- ▶ Capital planning, through the analysis of the institution's capital adequacy in different scenarios and enabling the definition of specific action plans to solve those scenarios in which solvency requirements are not met.
- ▶ Risk management, for which stress testing is a central tool, both from the point of view of compliance with regulatory requirements and, from a management perspective, to define and monitor the institution's risk appetite framework.

To achieve these goals, stress testing should be fully integrated in management systems, which represents a challenge for financial institutions in many ways, including:

- ▶ Involving senior management in the definition of the stress testing framework, in managing the institution in accordance with stress test results and in disseminating these results across the organization.
- ▶ Assessment of stress test results, as well as their use in management, by experts from different areas (Risks, Business, Finance, etc.).
- ▶ Linking the institution's objectives to stress test results through high level metrics which are stressed (such as results, risk weighted assets (RWA) or the common equity ratio).
- ▶ Continually monitoring stress test results are aligned with the institution's defined risk appetite and implementing corrective actions in the event of deviations.



Credit risk stress testing methodology (1/2)

Although there will still be some time until a consensus is reached on the optimal stress testing methodology, some practices are becoming increasingly frequent in the case of credit risk. The following provides a brief example of the phases and methodology usually involved in the calculation of the expected loss under an already defined stress scenario.

1. Projecting the probability of default under the stress scenario

A conventional and widely applied approach to projecting the probability of default (PD) is to model historical sensitivity to macroeconomic factors using econometric models.

Thus, from the internal default data observed in each portfolio, the following (possibly autoregressive) relationship is established:

$$f(Y_t) = \beta_0 + \sum \beta_i X_i + \sum \varphi_j f(Y_{t-j}) + \varepsilon$$

where f is a transformation of the dependent variable (the default rate), for which either a logistic or a Gaussian is normally used as the identity function; the X_i are the regressors (macro factors), β_i and φ are the estimators; and ε is the error.

This shape is fully equivalent to partitioning into a systemic component, expressed through observable macro factors, and an idiosyncratic one, usually encoded into a non-observable latent factor.

Once this expression has been estimated, default rates (Y_{t+1}) are projected into the future and transformed into systemic shocks (distance to default) using Merton's method:

$$Z_{t+1} = \frac{N^{-1}(\mu) - N^{-1}(Y_{t+1})\sqrt{1-\rho}}{\sqrt{\rho}}$$

where ρ is the asset correlation (regulatory or extracted from the historical default series), and μ is the historical default rate average.

Finally, these systemic shocks are applied to the transaction or client cycle-adjusted PD (k) using Vasicek's conditioning function, to obtain next year's projection for PD:

$$PD_{k,t+1} = N\left(\frac{N^{-1}(PD_{TTC_k}) - \sqrt{\rho}Z_{t+1}}{\sqrt{1-\rho}}\right)$$

where PD_{TTC_k} is the through-the-cycle adjusted PD for each transaction or client.

Figure 8. Main uses of stress testing in management



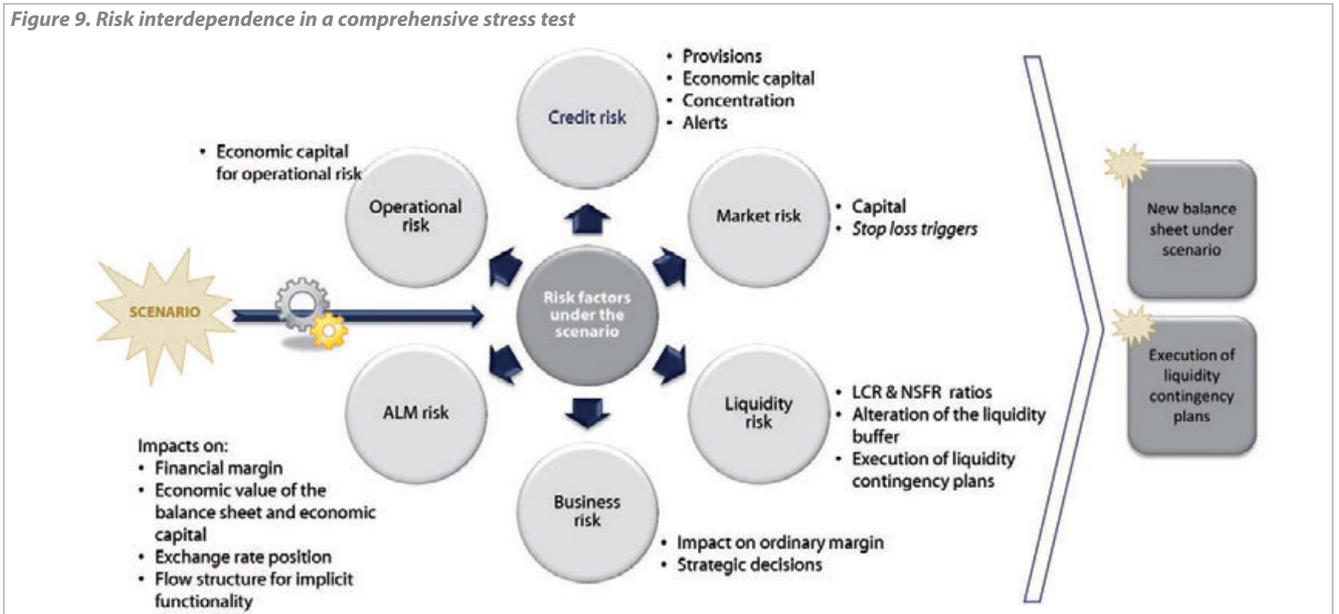
- ▶ The balance between severity and plausibility in the adverse scenarios used.
- ▶ Deciding on the binding nature of the stress test results for business decisions: setting of limits, incentives, policies and procedures, etc.
- ▶ Embedding stress testing in the institution's corporate culture, which is particularly complex because it involves managing the institution by considering events that are unlikely to occur.

applied to all risk factors and ultimately to the balance sheet and income statement (Figure 9).

In this regard, although the more advanced institutions already have stress testing frameworks covering various risks and their interrelations, achieving a comprehensive approach of this kind is still a challenge for most of them. The most common situation is the existence of a stress testing framework which is different for each risk, with little or no communication with other risks, and decentralized across different areas, which makes it difficult to consider trade-offs and interdependence between risks.

An added difficulty is that a stress testing framework should be comprehensive and consistently reflect risk interdependence. To do this, the defined scenarios need to be simultaneously

Figure 9. Risk interdependence in a comprehensive stress test



One of the consequences of this is that some stress tests are much more developed than others at most institutions. In particular, credit risk has been given special attention in Europe in the last two years, due not only to its significance as the main risk institutions are exposed to, but also in response to the supervisory stress testing exercises, to be discussed in the following section. These exercises have on the one hand contributed to unify practice and, on the other, have caused financial institutions to react by speeding up the development of internal stress testing tools for estimating expected loss and capital, partly as an element of comparison against the published supervisory stress tests.

In conclusion, financial institutions are rapidly evolving their internal stress testing frameworks, with different degrees of attention being paid to the various risks and some differences as to their level of centralization. In addition, their integration in the institution's management process is becoming more pronounced, and involves incorporating stress testing as a central tool to define and monitor the institution's risk appetite.



Credit risk stress testing methodology (2/2)

2. Projecting severity (LGD) under the stress scenario

For severity, an option is to take advantage of the mechanism used for IRB calculation of downturn LGD (DLGD), which is already stressed by nature, modify the downturn scenario to match the projected scenario and recalculate. Another frequently used alternative is to project LGD through a breakdown by recovery process outcome:

$$LGD_t = \sum P(\Omega_i)_t \cdot LGD_t | \Omega_i$$

where $P(\Omega_i)_t$ is the probability that the recovery process ends as $\Omega_i = \{\text{cure, restructuring, default, etc.}\}$; and $LGD_t | \Omega_i$ is LGD conditional to that outcome, all this for a given period (t).

Its simplest form usually takes $\Omega_1 = \text{friendly outcome}$, i.e. exit from default and return to normal situation, which has a very low LGD associated, thus $P(\Omega_1)_t \cdot LGD_t | \Omega_1 \cong 0$ and $\Omega_2 = \text{non friendly outcome}$ (including defaulted, unrecoverable, foreclosure, etc.), which has a much higher LGD associated.

LGD is therefore frequently modeled as:

$$LGD_t = P(\Omega_2)_t \cdot LGD_t | \Omega_2$$

for which both the probability that the outcome will not be friendly and the LGD for this type of outcome are expressed as a (possibly autoregressive) econometric function of macro factors, based on historical observation of the probability series and LGD:

$$P(\Omega_2)_t = \beta_0 + \sum \beta_i X_i + \sum \varphi_j P(\Omega_2)_{t-j} + \varepsilon$$

where X_i are the regressors (macro factors); β_i and φ_i are the estimators; and ε is the error.

Thus, the relationship between macro factors and outcome probabilities and their associated LGDs is estimated, and immediate projected into the future by substituting the regressors with the corresponding expected values in order to obtain the projected LGD.

This procedure is repeated for each significant portfolio bucket for which there is sufficient historical information available (e.g. mortgages with LTV < 80%, developers with secured land, etc.). Since in IRB banks LGD is usually identical for all transactions k that have a series of features in common (those defining the bucket), it can be assumed that $LGD_{k,t} = LGD_t$.

3. Loss projection under the stress scenario

Finally, the loss stressed for n years for each transaction or client k based on PD and LGD projected under the defined scenario is simply:

$$L_k = EAD_k \cdot \sum_{t=1}^n \left[\left(\prod_{\tau=1}^{t-1} (1 - PD_{k,\tau}) \right) \cdot PD_{k,t} \cdot LGD_{k,t} \right]$$

which implicitly presupposes a static portfolio and the conservative consideration of default as an absorbing state (i.e. there is no way out of it). Portfolio changes (new contracts, maturities, early repayments, etc.) are usually modeled as multiplicative factors applied directly to EAD.

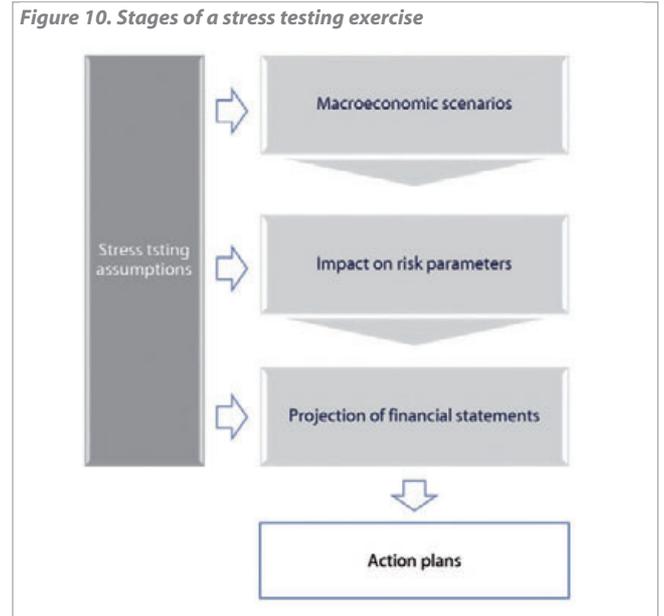
Methodological aspects

In regards to their methodological structure, most internal stress tests are created according to a common scheme (Figure 10):

1. **Scenarios:** first, several scenarios are defined that include macroeconomic assumptions over the time horizon defined for the test. They include at least a baseline scenario that is likely to occur, and an adverse scenario which is unlikely but possible.
2. **Models:** then, these scenarios are impacted on risk factors by using econometric models built from internal historical data from the institution. In the case of credit risk, these factors include the probability of default (PD), loss given default (LGD) and exposure at default (EAD), and the expected loss as a consequence. Regarding liquidity risk, liquidity coverage ratio (LCR), net stable funding ratio (NSFR) the survival period, etc. are also included.
3. **Projections:** the institution's financial statement projections are generated based on the impact of risk factors and other assumptions (such as the projection of the portfolio's growth, the hypothesis on the distribution of dividends, etc.).
4. **Outcomes:** finally, a decision is made on whether the institution is sound enough (solvency, liquidity, etc.) to absorb the impact of the considered scenario, and if not immediate contingency action plans are defined to solve it.

Even if this is the common scheme in stress testing exercises, each institution has its own methodology with specific

Figure 10. Stages of a stress testing exercise



characteristics to show the reality of its risks and adapt to the internal information available. These characteristics appear both in the definition of the exercise and throughout the process. They are critical in defining the methodology especially when applying expert adjustments based on the judgement of analysts, which are sometimes hardly justified meaning their use must be reduced to the minimum necessary.

For further information on the econometric modeling methodology for risk parameter stress tests (with a special focus on credit risk), please see *"Analysis of default based on macroeconomic factors"*²⁸.

²⁸ *Analysis of default based on macroeconomic factors*, Management Solutions, 2009.



Challenges and open issues in stress test methodology

The methodology to perform stress tests is still an open issue and analysts are far from reaching a consensus partly because of the methodological complexities it involves, inevitably related to data quality and availability.

Some of the main challenges and open issues quantitative analysts deal with when performing a stress test modeling exercise are briefly listed below:

1. Consistency and reliability of scenarios: the macroeconomic scenarios defined are also subject to errors of unknown extent, to which stress test models are sensitive (by construction). Moreover, variables defining the scenarios may not capture all the relevant factors for a given institution.
2. Capital definition: the capital definition used is not homogeneous across countries; for instance, in the EBA exercise, certain instruments did not count as capital (generic provisions in particular, of great relevance in Spain).
3. Consistency with the IRB methodology: in the case of non-IRB institutions, there are no internal risk parameters to support the stress test, or parameters not approved by the supervisor are used. In the case of IRB institutions, internal estimations may differ or even be inconsistent with the parameters used in the stress test (e.g. the LGD of the base scenario may be higher than the downturn LGD). In both cases, the parameter calculation methodology may show relevant differences between institutions.
4. Complete cycle information: the historical information on which model estimations are based should ideally cover a full economic cycle; however, information is rarely so in-depth or its quality is poor in the outer years. Furthermore, the end date of the current cycle is not defined, nor is it defined whether it is legitimate to expect that the sensitivities calculated in the previous cycle can be applied to the next cycle.
5. Asset correlation: there is conflict as to which methodologies should be used to calculate the asset correlation internally, both in terms of their soundness and the quantity and quality of data necessary to perform them. This frequently leads to using regulatory correlations (Basel), which were calibrated in 2001 and of which no update or data used for their estimation has been published.
6. PD and LGD correlation: incorporating the PD and LGD correlation into the stress test (as into the economic capital) poses methodological difficulties arising from the fact that both parameters are usually estimated independently when in practice they are not, which usually leads to disregarding this correlation.
7. LGD time lag: the fact that recovery processes usually last between one and two years on average and that the longest ones last between three and five years has two effects: on the one hand, processes are less sensitive to a macroeconomic shock during the most common time horizon in a stress test (three years); on the other hand, when explaining the LGD variation with macrofactors, a relationship with advanced factors (neither contemporary nor delayed) is observed, which is explained by the fact that the greatest increase in LGD occurs between one and two years after the shock.
8. Spurious relationships: when building econometric models that relate risk parameters with macro- factors, spurious relationships frequently appear due to bias in the data or to insufficient macro-variables; for instance, a decrease in LGD observed in recent years (actually due to bias because longer recovery processes, which are obviously worse, have not finished yet) is directly and spuriously related to a drop in housing prices.
9. Optionality: the optionality implicit in some products, such as prepayment in mortgages or the possibility to have mortgage line funds available, is not usually modeled through macro-factors, which makes the impact of macro-defined scenarios incomplete.
10. Portfolio growth: similarly, the usual way to model portfolio growth is by applying a flat rate per product or segment which is disconnected from macro-factors, thereby making the sensitivity to scenarios incomplete.
11. Refinancing: in some countries, refinancing has spread as an instrument to postpone or minimize default, which undermines the real default rates. This situation is frequently corrected by applying expert haircuts that are hard to justify, to which the final outcome is very sensitive.
12. Volatility of projections: despite econometric models being designed to present outcomes and estimators with a confidence interval that reflects uncertainty (the model error), results are usually published as an exact final figure, omitting their confidence interval, something that can create a false impression of accuracy of the predictions.
13. Backtest: stress test predictions are not usually backtested against the reality that later occurred, a fact that does not contribute to reinforce the credibility of exercises. Moreover, it is not clear that this backtest can be conducted soundly, since losses and capital show a “self-fulfilling prophecy” behavior: when it is known that an institution needs additional capital, the institution is forced to recapitalize in order to cover this need; therefore, a subsequent backtest will show that the institution did not have that need as the capital deficit announced will not appear a year later.
14. Expert adjustment: the lack of data availability, quality and consistency frequently requires resorting to expert adjustments, which have relatively little basis in reality. Finding a balance between granularity and soundness is essential, keeping the use of these adjustments to a minimum as they make the exercise less robust and credible.

Supervisory stress tests



As was mentioned in the previous section, beyond the development of internal stress testing frameworks by financial institutions, it has become common practice in recent years for supervisors themselves to conduct stress tests both on the financial system as a whole and individually on institutions, frequently within the framework of the SREP process under Basel's Pillar II.

The main purpose of these tests is to assess the loss-absorbing capacity of the system and of individual institutions in the face of worsening macroeconomic conditions. This requires an analysis to determine whether financial institutions' own resources are adequate to withstand the adverse scenarios considered and, if not, quantify the capital needed to ensure they do.

After summarizing a few key thoughts on the subject, this section will briefly describe the supervisory stress test regulatory background, then it will comment on several open

issues and relevant challenges relating to its execution and, finally, it will describe some of the main exercises performed in the past years in four different geographical areas.

Main reflections

Regulators and supervisors are performing stress tests on the financial system and on the institutions within their jurisdiction to a new level, going beyond regulations and using results to make decisions on the recapitalization or the intervention of institutions. In the context of the economic crisis, their ultimate goal is to recover confidence in the financial system, as their goals clearly state. To this end, they are embarked on an unprecedented exercise of transparency towards the market.

However, stress tests are not without criticism and pose challenges and open issues, such as a uniform definition of capital, the reasonableness of scenarios and the justification of

assumptions. Also, specific regulations on supervisory stress tests still lack maturity, so these exercises are expected to be developed further and in greater depth in the years to come.

Regulatory background

The SREP

As it is the case with internal stress testing and the ICAAP, international regulations on supervisory stress tests originate in the Basel Capital Accord. In fact, much of the regulation issued since then has linked both types of stress testing, placing the supervisor as the final evaluator of the institutions' solvency.

So, the backbone of Basel's SREP process is that supervisors should evaluate banks' internal capital adequacy assessments and strategies, as well as their ability to monitor and ensure compliance with the regulatory capital ratios.

In parallel with the ICAAP, the SREP has been adopted and incorporated into national regulations at a different pace and with different results, particularly in regards to the level of detail with which each supervisor approaches the performance of stress tests within their area of jurisdiction.

The adoption of Basel's Pillar II in different geographies has already been addressed in the previous section. However, to increase the focus on the SREP, the following observations on its development in Spain, the U.S. and Brazil are mentioned:

- ▶ Spain: the Bank of Spain bases the SREP process on the IAC report submitted by institutions on an annual basis, and analyzes the institutions' current and projected solvency through its review. However, it does not carry out an independent and regular supervisory stress test like other countries do.

Nonetheless, Spanish institutions have been subject to European stress tests carried out by the EBA in 2010 and 2011, which will be later detailed. They also went through stress tests conducted by the Bank of Spain and the Ministry of Economic Affairs (to be detailed later as well), under the restructuring process framework of the Spanish financial system.

None of the tests has been strictly regulated, but the EBA has announced that it will perform a new stress test during 2013-2014 and, in addition, the approval of a new Regulation²⁹ is in the pipeline. Under this regulation, the European Central Bank will assume the role as the single supervisor in Europe, which will include conducting stress

tests on financial institutions in the European Union, among other functions.

- ▶ The United States: In 2009, the Dodd-Frank Act required institutions considered to be systemic to undergo supervisory stress tests on an annual basis, in addition to the internal stress tests described in the previous section.

This led to the performance of the SCAP³⁰ (2009) and the CCAR³¹ (2011 onwards) annual supervisory stress test exercises, which will be later analyzed in detail. It also led the Federal Reserve to issue a regulation on supervisory stress testing in 2012. This regulation captures the Dodd-Frank Act requirements through a test known as DFAST (Dodd-Frank Act Stress Test), which must be performed on systemic institutions on an annual basis.

- ▶ Brazil: as in other countries, the SREP process in Brazil is focused on the review of capital adequacy reports issued by the institutions. Additionally, a semi-annual supervisory stress test has been carried out by the Bacen since before 2002 (thus, preceding the SREP). The Bacen's results are published in the aggregate in its Relatório de Estabilidade Financeira. This stress test has become increasingly sophisticated in the last few years, and has explicitly included a separate liquidity stress test since 2009.

As in other Latin American countries, the Brazilian financial system underwent an independent supervisory stress test in 2012 under the IMF and World Bank's FSAP³² program, as it will be detailed later on.

In conclusion, regulations governing the SREP and the supervisory stress tests in the aforementioned countries show overall progress in line with those governing the ICAAP, with the notable exception of the United States, which moved ahead in this regard in 2012.

²⁹ Proposal for a Regulation by the Council to confer the European Central Bank specific functions regarding the prudential supervision of credit institutions.

³⁰ *Supervisory Capital Assessment Program*.

³¹ *Comprehensive Capital Analysis Review*, which is based on an internal stress test conducted by the institutions and is completed with a stress test by the supervisor.

³² *Financial Sector Assessment Program*, from the IMF and the World Bank.

Guidelines for supervisory stress testing

Just as the Basel regulations simultaneously incorporated ICAAP and SREP, thereby establishing the need to conduct both internal and supervisory assessments on capital, the guidelines published by the Basel Committee³³ and the EBA³⁴ (described in the previous section) also covered several principles specifically targeted at the supervisors.

Although fewer in number than those targeting institutions, these principles have received more attention from the financial industry. Indeed, in 2012 the Basel Committee reviewed³⁵ the degree of compliance with the principles it had drawn up three years earlier, which specifically focused on the performance of supervisors, and concluded that there were large differences in the degree of real implementation of these principles across countries, and this would possibly require increased monitoring and further guidelines in the future.

Description and impact of major exercises

In recent years, many supranational and national authorities have conducted stress tests on the entire financial system with different objectives, scope, impact and consequences.

This section summarizes a comparative analysis of various supervisory stress tests in order to identify key similarities and differences between them, and their impact on the firms analyzed.

For this purpose, four stress testing exercises that were conducted in different geographical areas in recent years have been selected for their representativeness:

- ▶ Europe (2010-13): in order to increase confidence in the European banking sector, in 2011 the EBA conducted a stress test, based on a previous CEBS exercise carried out in 2010, with a view to publicly assess the loss absorption capacity of institutions. The results of this test, however, were not binding, partly due to difficulties in reaching a unified definition of capital across the various participating countries. The EBA will conduct a new stress test in 2013-14.
- ▶ Spain (2012): as part of a program that was agreed by national and European authorities, in 2012 solvency stress testing was conducted on each separate institution and an assessment of the industry's assets was performed. The aim was to restore the credibility of the Spanish banking system, increase transparency and work towards a healthier, more profitable and solvent system that would ultimately drive economic growth through improved credit provision.
- ▶ United States (2009-13): SCAP 2009 was a pioneering stress testing exercise in that it analyzed each institution separately, and also in the publication of results. The SCAP was followed by several CCARs from 2011 onwards, which consolidated the implementation of these exercises in the United States on a regular basis, and by DFAST, targeted at systemic institutions, from 2013.
- ▶ Brazil (2012): A number of stress tests have been performed in Latin American countries in the past few years. Brazil, in particular, has conducted stress testing exercises every six months on the entire financial system since 2002. These tests, whose overall results are published in the Financial Stability Report, have become increasingly sophisticated and have incorporated liquidity risk in recent years. In spite of this, and as happened in other Latin American countries, in 2012 the Brazilian financial system underwent an additional, independent stress test, conducted in the aggregate as part of the IMF and World Bank's financial sector assessment program (FSAP), which will be discussed later in this section. Although the exercise was not binding, it showed the strength of the Brazilian financial system as a whole in the short and medium term.

These four stress testing exercises have been compared by examining the context, objectives, participants, main methodological aspects and results of each exercise, as well as the impact each had on the institutions and financial system within the test's geographical scope of implementation.



³³ *Principles for stress testing implementation and oversight*. BCBS, 2009

³⁴ *CEBS Revised Guidelines on Stress Testing (GL32)*. CEBS, 2010.

³⁵ *Peer review of supervisory authorities' implementation of stress testing principles*. BCBS, 2012.

In light of this comparison, one can appreciate a series of common trends and significant issues across tests, some of which are especially noteworthy:

- ▶ Among the stated objectives of all exercises, emphasis is made on increasing the level of confidence in the financial system through the identification of potential weaknesses and vulnerabilities. In this regard, although bank recapitalization is a consequence of several of these exercises, stress tests are serving primarily as transparency exercises vis-à-vis the market, rather than as precision exercises on the future situation of the institutions.
- ▶ In line with this, the trend is to include a growing percentage of financial sector assets (up to 90% in the case of Spain), to ensure that the exercise reviews the system as thoroughly as possible.
- ▶ There is a clear trend towards the implementation of stress tests by individual entity (rather than for the system as a whole) using a bottom-up approach (from granular portfolio information, as opposed to top-down, where aggregate data are used). In emerging countries, these exercises are conducted on an aggregate basis and complemented with IMF and World Bank international stress testing programs.
- ▶ While credit risk is central to all stress testing exercises, there are differences as to the emphasis on other risks, which some supervisors (such as the United States) are increasingly taking into account. Market risk is only partially analyzed in several of them, but liquidity risk, for example, is not addressed at all, except in the IMF and World Bank tests (e.g. Brazil) on a highly aggregated basis. It is expected that, with the introduction of the Basel III metrics on liquidity, this risk will progressively be included in stress testing. While sovereign risk and its potential impact of contagion on other neighboring countries was present in contexts such as that of the EBA exercise, it is not usually considered in the tests either.
- ▶ Regarding methodology, the degree of transparency existing in other areas has not yet been achieved, as some key assumptions are still not justified, and the details released would not allow it to be audited or replicated by third-parties even if the data were available. Consequently, there is still some distance to go before a consensus is reached between countries on the stress test methodology to be used.
- ▶ As for the results, the trend is for them to be publicly available, include a high level of detail and be increasingly binding. Although FSAP exercises (as Brazil's) and the one carried out in Europe were used as guidance, those conducted in the United States and Spain resulted in the recapitalization of several entities by public or private means.



BANK FOR INTERNATIONAL SETTLEMENTS

Principles for sound stress testing practices and supervision

In 2009, the Basel Committee issued “*Principles for sound stress testing practices and supervision*”, which includes a series of principles for the proper management of stress tests.

The main issues covered by these principles in relation to supervisory practices are summarized below.

Principles for supervisors (principles 16 to 21)

In line with Pillar 2 requirements under Basel II, supervisors should examine stress test results as part of a review of both the institution's internal capital assessment and risk management process.

In particular, supervisors should consider the results in order to assess capital adequacy and liquidity and should require that corrective action be taken by the Administration if deficiencies in the stress testing program are identified or if the stress test results are not being properly taken into account in the decision making process.

Supervisors should regularly and thoroughly assess the institutions' stress testing programs and may require them to perform sensitivity analysis on certain portfolios or parameters, or to use specific scenarios.

Supervisors should engage in constructive dialogue with other public institutions and authorities to identify systemic vulnerabilities. They should also ensure that they have the capabilities and skills required to properly assess a stress testing program.



Guidelines on stress testing

In 2010, the Committee of European Banking Supervisors (CEBS), later integrated into the European Banking Authority (EBA), published the “*Revised guidelines on stress testing (GL32)*”, which provided guidelines for the appropriate management of stress tests in financial institutions in line with the principles stated by the Basel Committee (2009).

The main issues addressed by these guidelines in relation to supervisory practices are summarized below.

Guidelines for supervisors (guidelines 18 to 21)

Supervisors should review stress test results in order to assess both the resilience of institutions in the event of adverse economic conditions and their ability to hold a sufficient level of capital and liquidity. They should also assess and challenge the scope, severity, assumptions and proposed mitigation measures of the stress tests.

Also, supervisors should regularly review the institutions' stress testing programs in terms of scenario selection, methodology, infrastructure and the use of tests.

For international institutions, agreements between the different supervisors should be reached to ensure the coordination of supervisory activities. Stress tests should be conducted globally, so that results reflect the impact of each scenario on the group as a whole.

- ▶ With regard to the minimum capital thresholds required to pass the tests, economic developments and worsening financial conditions have increasingly raised the level of capital that institutions must hold, commensurate with systematically harsher scenarios and assumptions.
- ▶ Finally, the national and supranational authorities conducting the stress tests do not publish any subsequent analysis on the degree of accuracy of the loss predictions, which shows there is some room for improvement towards consolidating the credibility and transparency of these exercises.

In short, supervisory stress testing is a growing and evolving practice which is rapidly expanding but still has some distance to go before a level of maturity is reached, especially in terms of scope (the risks considered) and methodology.

The observed exercises show that this practice is gaining ground mainly as an exercise in transparency by banks and countries towards the market. It is expected that this trend will intensify in the coming years, making regulatory stress tests more comprehensive, detailed and transparent, and converging towards a unified practice that will make it possible to compare firms from different countries under the same analysis methodology.

Comparison summary

The comparative table (Figure 11) summarizes the main features of the four exercises considered.

Europe: results of the EBA stress test (2010-11)

The result of the stress test exercise conducted by the EBA in 2011 was a capital shortfall of Euro 2.5 billion in the adverse scenario. Of the 91 European institutions tested eight were

below the level of capital required, of which five were Spanish, although it should be considered that:

- ▶ Spain contributed a larger number of institutions to the analysis (covering 93% of its financial system's assets). If the selection criteria had been kept within the target set by the EBA (50% representation), all institutions would have passed the test.
- ▶ For reasons of uniformity, the EBA did not consider the use of some mitigating elements when determining the ratio of capital of institutions. Thus, of the five Spanish institutions which did not reach the target capital level, four would have passed the 5% threshold if the generic provisions had been taken into account, and no entity would have fallen short if the EBA had also included the bonds mandatorily convertible into ordinary shares under the criteria set by Royal Decree-Law 2/2011 regarding the definition of capital.

As a result, and in view of the above, the Spanish authorities considered this stress test as an element to be included in the overall strategic framework for restructuring the Spanish banking sector, as part of which the capital requirement had already been raised to between 8% and 10% depending on the type of bank, which was later unified at 9%.

Besides the five Spanish banks, three other European banks (two Greek and one Austrian) showed a ratio below the 5% required in the adverse scenario. One of them underwent a recapitalization that same year, while the other two rejected the EBA result, claiming that some transactions (mergers and sales) that had taken place while the stress test was being conducted and had significantly increased their capital ratio had not been taken into consideration.



Figure 11. Summarized comparison between supervisory stress tests

	 EUROPE	 SPAIN	 UNITED STATES	 BRAZIL
Year	2010-13	2012	2009-13	2012
Goal	Increase confidence through transparency and address some weaknesses highlighted in the CEBS 2010 stress test.	Restore the credibility of The Spanish banking system, increase transparency and achieve a healthier, more profitable and solvent system.	Reduce uncertainty and restore confidence in the financial system following the onset of the crisis and the failure of several financial institutions.	Identify and analyze financial sector vulnerabilities within the FSAP program.
Participants	Organizer: EBA. In cooperation with: <ul style="list-style-type: none"> ▶ National Supervisory Authorities. ▶ European Systemic Risk Board. ▶ European Central Bank. ▶ European Commission. 	Organizers: Bank of Spain and Ministry of Economic Affairs. In cooperation with: <ul style="list-style-type: none"> ▶ European Central Bank. ▶ European Commission. ▶ European Banking Authority. ▶ International Monetary Fund. ▶ Independent consultants. 	Organizer: Federal Reserve System (Fed). In cooperation with: <ul style="list-style-type: none"> ▶ Board of Governors of the Federal Reserve System. ▶ Federal Deposit Insurance Corporation. ▶ Office of the Comptroller of the Currency (OCC). 	Organizers: IMF, World Bank and Central Bank of Brazil.
Institutions tested	91 European financial institutions (representing 65% of the financial system's assets).	14 financial groups (representing 90% of the financial system's assets).	19 financial institutions (representing 2/3 of the financial system).	The whole of the Brazilian banking system.
Scenarios	Two scenarios: base and adverse.	Two scenarios: base and adverse	Two scenarios: base and adverse.	Three scenarios: global recession, reversal of capital flows and a terms-of-trade shock.
Scope	Credit, market and sovereign risk.	Credit risk.	Credit, counterparty and market risk.	Credit, market, interest rate, liquidity and contagion risk.
Time horizon	2 years: 2011-2012.	3 years: 2012-2014.	2 years: 2009-2010.	5 years: 2012-2016.
Target capital	Core capital: 5%.	Core capital by scenario: <ul style="list-style-type: none"> ▶ Baseline: 9%. ▶ Adverse: 6%. 	Tier 1 capital: 6%. Core capital: 4%.	N/A.
Results	Under the adverse scenario: <ul style="list-style-type: none"> ▶ Failed the test: 8 out of 91. ▶ Capital shortfall: Euro 2.5 billion. 	Under the adverse scenario: <ul style="list-style-type: none"> ▶ Failed the test: 7 out of 14. ▶ Capital shortfall: Euro 57.3 billion. 	Under the adverse scenario: <ul style="list-style-type: none"> ▶ Failed the test: 10 out of 19. ▶ Capital shortfall: USD 185 billion. 	<ul style="list-style-type: none"> ▶ Brazil's banks showed the ability to cope with a global recession scenario. ▶ The large banks comfortably passed the liquidity tests.

Thus, while the macroeconomic environment and the results of the stress testing exercise themselves did not promote a substantial change in the perception of investors, whose main concern was sovereign risk could be aggravated by the situation of Greece and subsequent contagion effect, the EBA stress test of 2011 was considered effective to the extent that it helped to make the situation of the main European banks more transparent.

Spain: results of the Spanish banking system stress test (2012)

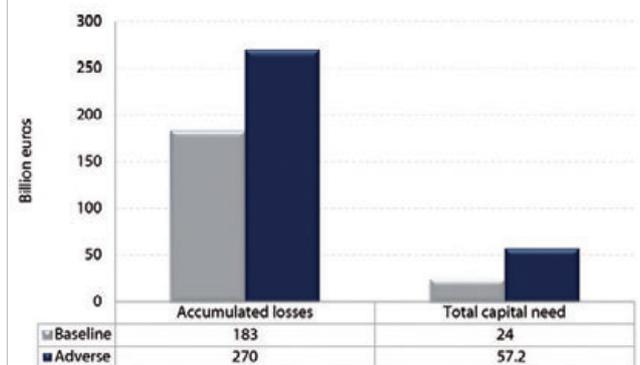
The result of the first top-down exercise, in June 2012, showed the system’s recapitalization requirements were between Euro 16 and 26 billion under the baseline scenario, and between Euro 51 and 62 billion under the adverse scenario.

An individualized and detailed analysis of each bank during the bottom-up exercise carried out in September 2012, confirmed the results of the top-down approach, showing capital needs of Euro 24 billion under the baseline scenario and Euro 57.3 billion under the adverse scenario (Figure 12).

Participating banks were classified into four groups for the purposes of the stress testing exercise (Figure 13):

- ▶ Group 0, composed of those banks whose capital exceeded the minimum level required under the adverse scenario, therefore not requiring the adoption of any measures.
- ▶ Group 1, composed of Banks in which the FROB³⁶ already had a majority holding.

Figure 12. Results of the bottom-up stress testing exercise conducted on the Spanish banking system

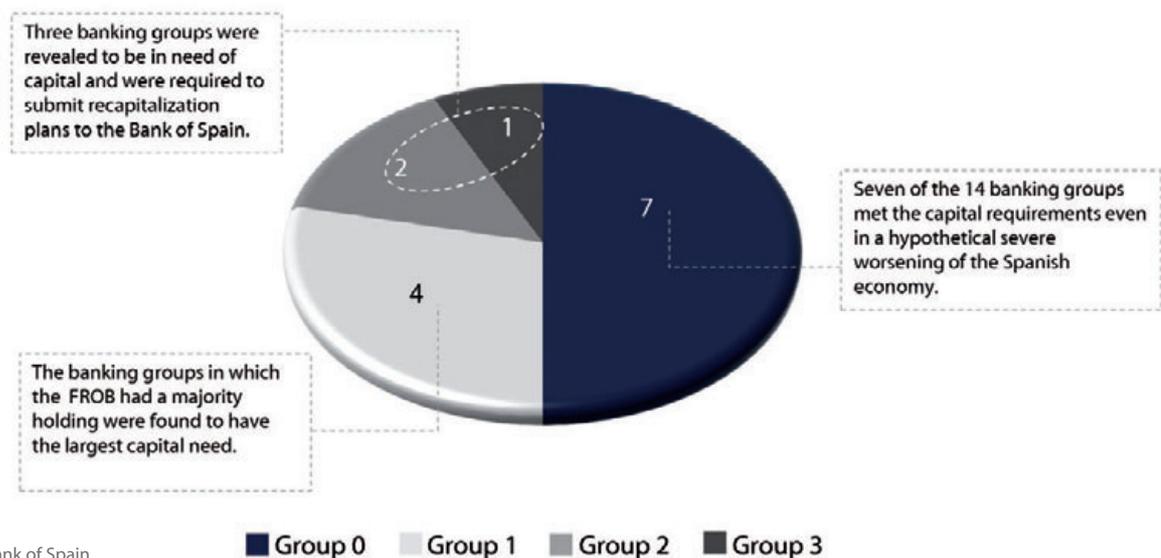


Source: Bank of Spain.

- ▶ Group 2, composed of banks with a capital shortfall identified by the stress test and whose recapitalization plan showed they were unable to meet this shortfall privately without State aid.
- ▶ Group 3, composed of Banks with a capital shortfall identified by the stress test under the adverse scenario, but whose recapitalization plans showed they would be able to meet this shortfall without help from the State.

³⁶ Fund for Orderly Bank Restructuring, whose aim is to manage Spanish credit institution restructuring and resolution processes.

Figure 13. Results of the bottom-up exercise under an adverse scenario, conducted on each institution



Source: Bank of Spain.



Europe – EBA stress test (2010-11)

i. Context and purpose

The 2009 SCAP exercise in the U.S. acted as a spark that led the CEBS to conduct the first public European-wide stress test in 2010.

In 2011, the EBA absorbed the CEBS and conducted a similar exercise on a number of European institutions, attempting to mitigate some weaknesses that had been identified in the previous analysis, with a three-fold objective:

- Help increase confidence in the European banking sector, in an economic context marked by financial market concerns about the Greek situation and its contagion to other eurozone countries.
- Assess the loss absorption capacity of the European financial system.
- Increase transparency vis-à-vis investors, analysts and other financial market participants, by publicly disclosing detailed information about the status and level of solvency of major European institutions.

To this end, the EBA changed the CEBS stress test in three key areas: redefined the minimum capital requirement, unified criteria across participating countries and published a greater amount of information on the results.

ii. Participants

Stress test governance

The EBA had primary responsibility for conducting this stress test on European banks, in cooperation with national supervisory authorities, who would report the information required on the institutions to the EBA, and with the European Systemic Risk Board (ESRB), the European Central Bank and the European Commission, who determined the macroeconomic scenarios and the test's assumptions.

Institutions tested

The EBA determined that the institutions to be tested should represent at least 50% of banking sector assets in each country; the final figure was 65%, and covered 91 institutions.

Spain was the country that had the highest number of institutions tested: 27 out of 91 participating banks, accounting for 93% of assets in Spain's financial system. This difference in representation within the Industry was due to the Bank of Spain's determination to increase transparency and confidence in a system that was immersed in a restructuring and consolidation process.

iii. Methodology highlights

Scenarios considered

The stress test was conducted to estimate the resilience of the institutions under a baseline scenario and an adverse scenario, both over a two-year horizon. The adverse scenario involved sudden changes and simulated economic impacts focused primarily on

credit and market risk. A third impact was added to test the banking industry's ability to cope in the event of a sovereign debt crisis. The severity of some of the macroeconomic scenarios described was remarkable.

Scope and assumptions

The overall approach and main assumptions of this stress test were as follows:

1. The stress horizon for the estimation of capital needs was 2011-2012.
2. The exercise considered impacts associated with credit and market risk, as well as sovereign risk under the adverse scenario. Liquidity risk was excluded.
3. The analysis was conducted on static balance sheets, assuming both zero growth and that the business structures of the institutions being tested would remain the same.
4. All regulatory changes occurring during the analysis period would be considered and included in the models, provided they could compromise the level of solvency of the banking sector.

Data (input)

The data used in the analysis was provided by the institutions involved in response to the EBA's request.

Methodology

The stress test was conducted in five steps from a methodology standpoint:

1. Macroeconomic scenario definition; the probability of occurrence of the adverse scenario for the EU was defined to be under 1% in 2011 and under 4% in 2012.
2. Estimation of impairment and losses (based on PD, LGD and EAD) under both scenarios, and of the impairment of the trading portfolio and of sovereign exposures.
3. Estimation of the institutions' available resources to cope with expected losses under the described scenarios, taking into account both the provisions and the profit generation capacity.
4. Assessment of the impact and of the level of capital the institutions would be required to hold after the stress event, which was set at 5% of core tier 1 capital.
5. Definition of mechanisms that would ensure the institutions holding insufficient capital could withstand this impact. In Spain, these measures were guaranteed through the FROB.

Results showed that half of the 14 banks were classified into Group 0, while four of the remaining institutions were already participated by the FROB (Group 1) and three would have to submit their plans for recapitalization as they did not meet the minimum capital requirement, and were yet to be classified into either Group 2 or 3.

During the second quarter of 2012, the institutions in the last two groups designed their recapitalization plans, which were approved by the Bank of Spain later that year. These plans involved:

- ▶ Recapitalization and portfolio sale by one of the institutions, which was thus able to meet the capital needs identified in the stress testing exercise by its own means (Group 3).
- ▶ Requesting assistance from the FROB for the remaining banks (classified as Group 2) for an amount below that which was required according to the stress test results, thanks to the implementation of specific mitigation measures such as:
 - Transferring troubled assets to the asset management company (Sareb) created for this purpose.
 - Holders of subordinated debt and preference shares would take losses.
 - Including the disposal of assets and of other capital gains in the restructuring plans.
 - Downsizing of staff and the branch network.

United States: results of the SCAP, CCAR and DFAST stress tests (2009-2013)

The results of the SCAP 2009 exercise showed that, under an adverse scenario, the combined losses of all 19 institutions in the period from 2009 to 2010 could amount to USD 600 billion. Most of these estimated losses (USD 455 billion approximately) came from mortgages and consumer loans.

After deducting the available resources estimated under the same scenario, banks would need a total of USD 185 billion to meet the capital requirement set by the supervisors. The results by institution showed that:

- ▶ These USD 185 billion came from 10 of the 19 institutions tested, which meant that 9 banks had sufficient resources to meet the established requirement.
- ▶ Most of this USD 185 billion corresponded to a core capital shortfall. Most entities had enough tier 1 capital to absorb losses under the adverse scenario, but their structure meant that 10 of them could not meet the 4% core capital requirement.

Banks whose capital was below the minimum requirement and were not able to raise capital on the public debt market, had to issue convertible preferred stock to the U.S. Treasury in an amount sufficient to meet the required ratio.





Spain: Spanish banking sector assessment (2012)

i. Context and purpose

The Spanish financial system is undergoing a restructuring and consolidation process aimed at reducing pressure from the markets and, consequently, the lack of confidence in bank solvency.

In this context, and as part of the scheme agreed by the the national and the European authorities¹, at the beginning of 2012 it was decided that it was necessary to estimate the capital adequacy of banks and assess the industry's assets, with the aim of restoring the credibility of the Spanish banking system, increase transparency and achieve a healthier, more profitable and solvent system that would ultimately drive economic growth through the recovery of credit flows.

To this end, a stress test was carried out throughout 2012, in two stages:

- A first exercise conducted in the aggregate (using a top-down approach), which sought to arrive at an initial overall capital amount for the system as a whole.
- A second exercise, more refined, to determine the capital needs of each bank using granular information from their loan portfolios (bottom-up approach).

The agreed scheme would be supplemented by a plan to recapitalize and restructure the banks identified as less viable and transfer specific real estate assets of entities in need of state aid to an asset management company or "bad bank".

ii. Participants

Stress test governance and responsibility

The project was led by the Bank of Spain in cooperation with the Ministry of Economic Affairs, and external consultants were engaged to carry out the test.

In order to monitor and ensure the transparency and quality of the stress tests, two expert committees composed of Spanish authorities (Bank of Spain, Ministry of Economic Affairs and FROB) and International bodies (European Central Bank, European Commission, European Banking Authority and the International Monetary Fund) were created.

Institutions tested

A total of 14 financial institutions², representing 90% of total assets in the Spanish banking system participated in the exercise.

iii. Methodology highlights

Scenarios considered

Both the top-down exercise and the subsequent disaggregated approach by institution were conducted under a baseline scenario which incorporated conservative assumptions, more likely to occur, and an adverse scenario representing a very unfavorable macroeconomic context and therefore characterized by more conservative assumptions that would be unlikely to materialize. They were defined based on the main macroeconomic variables (GDP, CPI, unemployment, house and land prices, etc.

Scope and assumptions

These stress tests were also based on the following assumptions:

1. The exercise focused on credit risk impacts. It therefore excluded the effects of liquidity, interest rate, structural and market risk.
2. The time horizon for estimating capital needs was 2012-2014.
3. The stressed portfolios consisted mainly of private sector resident loans, including real estate assets.

Data (input)

The bottom-up³ exercise was conducted using data from Bank of Spain sources, internal data provided by the institutions tested and information provided by auditors and appraisal companies. The analyses were complemented by assumptions based on information provided by the consultants who carried out the test.

Methodology

Based on the information described above, the stress test conducted to determine the individual capital needs of each institution was articulated around three notions:

1. Expected losses for credit risk: each of the main parameters used in credit risk measurement (PD, LGD and CCF), was stressed to a specific degree, as were the losses from foreclosed assets.
2. Loss absorption capacity: in addition, the ability of each entity to absorb losses through the available means, such as provisions, excess capital or profit generation capacity was quantified.
3. The potential impact on capital and, consequently, the level of solvency: the corresponding loss absorption capacity excess or shortfall over the expected losses made it possible to estimate the impact on capital and thus the level of solvency of each entity. The capital ratio requirement (using the tier 1 core ratio) was set at 6% for the adverse scenario and 9% for the baseline scenario.

¹ See *Memorandum of Understanding on financial sector policy conditions*. European Commission, 2012.

² Santander Group (incl. Banesto), BBVA (incl. Unnim), CaixaBank (incl. Banca Cívica), Kutxabank, Sabadell (incl. CAM), Bankinter, Unicaja-CEISS, Libercaja (Ibercaja, Caja3 and Liberbank), BMN, Banco Popular (incl. Banco Pastor), Banco de Valencia, NCG Banco, CatalunyaBank and Bankia-BFA.

³ Provided hereinafter are the detailed methodological aspects of the bottom-up exercise. The approach used for the top-down exercise is not considered substantially different from that used for the bottom-up exercise, despite the fact that there were some differences between them. In both cases, the data shown are subject to the availability of public information.

The stress testing exercise carried out by the U.S. supervisor, and the subsequent efforts by firms to raise their Tier 1 ratio, was considered effective to the extent that it helped to show the recapitalization needs of the U.S. financial system in the event of a crisis and achieved the goal of strengthening investor confidence in the banking sector.

The SCAP exercise was followed in the U.S. by the CCAR exercise, which has been conducted every year since 2011 and embodies the Supervisory Review and Evaluation Process (SREP) envisaged in Basel's Pillar 2, and by the DFAST exercise conducted since 2013, which embodies the requirements set in 2009 by the Dodd-Frank Act.

Finally, the positive result of the SCAP helped to extend this type of testing to other banking systems, such as the exercises carried out by the CEBS and the EBA in Europe in 2010 and 2011.

Brazil: results of the Financial Sector Assessment Program (2012)

The independent stress test carried out in 2012 by the IMF and the World Bank in Brazil, similar to that conducted in other emerging countries by these organizations, confirmed the aggregated stress test results that Bacen had been publishing since 2002 and highlighted the robustness of Brazil's banking systems, showing the following:

- ▶ Most Brazilian Banks could withstand extreme shocks, including a global recession scenario. Faced with such a scenario, the system's capital ratio would remain above the minimum regulatory requirement, with only a group of small banks temporarily falling below this ratio.

- ▶ The aggregated result showed a capital shortfall of $\frac{1}{4}$ percentage point of GDP. Using IRB approximations, only a small group of firms would temporarily have a capital ratio below the regulatory minimum.
- ▶ Concentration risk was moderate, as were market risk and interest rate risk. The failure of one or more firms would mainly affect 20 small banks, but not the larger entities. Exchange rate risk was considered low and no bank failures were predicted in the event the main currencies were to depreciate by 50%. Interest rate risk, though high, was considered to be still manageable.
- ▶ All large banks passed the liquidity test. Small and medium firms that were highly dependent on wholesale funding showed greater, though contained, vulnerability to these problems.
- ▶ The risk of direct contagion proved to be limited: a single bank failure would trigger a maximum loss of 0.8% of the system's assets. However, the risk of indirect contagion was more significant: a failing bank would cause severe early withdrawal of deposits and substantial asset impairment, although the level of available reserves would provide a sufficient buffer in the event this liquidity shock were to occur.

The results of this stress testing exercise on Brazil's financial sector as part of the IMF and World Bank FSAP program revealed that, although Brazilian banks showed strong resilience to the more severe scenarios, in the long term they could be affected by the global context of economic uncertainty.

Moreover, the examination concluded that Brazil's oversight system "is sophisticated, risk-based and comprehensive, combines local inspections with remote monitoring, crosses data from different databases, and uses a vast array of statistical methods"³⁷.

Finally, despite these positive results, the IMF warned that in the last decade, Brazil's credit boom and high interest rates had triggered "pockets of vulnerability" in some sectors that may hinder their economic growth in the long-term and affect the robustness of the banking system.



³⁷ Relatório de Estabilidade Financeira – Resultados do FSAP. Central Bank of Brazil (Sept. 2012).



United States – SCAP, CCAR and DFAST (2009-13)

i. Context and purpose

The onset of the economic crisis in 2007 led the U.S. central authorities to intervene in order to provide liquidity to the financial system. This situation, aggravated in 2008 by the failure of several banks, including Lehman Brothers, intensified the need to restore confidence in the banking system, whose investors began to show reluctance to assume the underlying risks as they lacked sufficient information.

Within this context and in an unprecedented move, in 2009 the U.S. Federal Reserve System (Fed) announced the need to put all financial institutions through a stress test which came to be known as SCAP (Supervisory Capital Assessment Program), which would allow the Fed to assess banking sector resilience by estimating the minimum capital buffer required to cope with a worsening crisis. Also, the Fed believed it was important to make the stress test results public in order to provide investors with an informed view on the overall state of the system and on each individual institution.

Until then, the results of a similar test had never been published as, although these tests were already commonly used by banks internally, they had never served a public purpose. Thus, stress tests were given a whole new dimension, and their efficacy would be measured by their ability to reduce uncertainty and restore confidence in the financial system.

As the SCAP was followed by the CCAR (Comprehensive Capital Analysis and Review) from 2011 onwards, these tests came to be performed on a regular basis. The DFAST (Dodd-Frank Act Stress Test), which was later implemented, showed a significant increase in the number of entities that passed the test.

ii. Participants

Stress test governance

The tests were conducted by the main U.S. federal banking regulatory agencies: The Board of Governors of the Federal Reserve System, Federal Reserve Banks, Federal Deposit Insurance Corporation and Office of the Comptroller of the Currency.

Several economic analysis firms also participated in scenario definition.

Tested institutions

The institutions tested were those with assets exceeding USD 100 billion. Thus, the stress test was conducted on 19 financial institutions¹ which together accounted for two-thirds of assets in the U.S. financial system.

iii. Methodology highlights

Scenarios considered

The stress tests were based on two scenarios:

1. Baseline or reference scenario, intended to provide a consensus view on the depth and duration of the recession.

2. Adverse scenario, representing the possibility of the economic situation becoming significantly weaker and extending over a longer period of time under the baseline scenario.

In both cases, the scenarios were defined using the main macroeconomic variables: GDP, unemployment rate and housing prices.

The CCAR, which was developed later (2011), incorporates more variables and provides a third scenario (severely adverse scenario), describing a post-war like recession situation, and requires institutions to define at least one internal scenario reflecting a severe impact on their business model.

Scope and assumptions

The SCAP stress test was supported on the following assumptions:

1. The exercise focused on credit risk loss estimates. Only those institutions with a trading portfolio exceeding USD 100 billion in assets had to provide additional loss estimates for counterparty and market risk.
2. The time horizon for the stress test was 2009-2010.
3. The exercise focused not only on the quantification of the amount of capital required, but also on its composition: 6% of tier 1 capital and 4% of core capital under the adverse scenario.

Data (input)

The data used in the analysis came from two main sources: that provided by the participating institutions themselves and that resulting from models developed by the supervisor, which were used to set the value ranges and indices required to unify the results.

Methodology

The process combined the internal forecasts of institutions with estimates generated by the supervisory teams. Thus, the stress test was structured in five phases²:

1. Data submission from the banks to the supervisory authorities.
2. Internal estimation of losses and available resources.
3. Supervisory review of the data received and estimation of losses and available resources through independent techniques.
4. Final review and adjustment to ensure consistency across institutions.
5. Estimation of capital needs under the adverse scenario.

¹Bank of America, JPMorgan Chase, Citigroup, Wells Fargo, Goldman Sachs, Morgan Stanley, Metropolitan Life Insurance Company, PNC Financial Services, U.S. Bancorp, The Bank of New York Mellon, GMAC, SunTrust Banks, Capital One, BB&T, Regions Financial Corporation, State Street Corporation, American Express, Fifth Third Bank and KeyCorp.

²For further detail, please refer to *The Supervisory Capital Assessment Program: Design and Implementation*. Board of Governors of the Federal Reserve System, 2009.

Challenges and open questions

Supervisory stress tests have developed naturally in response to the current climate with the ultimate aim of restoring confidence in the resilience of the banking system. To this end, stress test results are public and thus represent an exercise in transparency towards the markets by banks and supervisors, which has an intrinsic value that goes beyond the specific outcome of the tests.

This transparency is usually reinforced when parties other than banks and the supervisor are involved in the stress testing exercise, as they provide expert judgment, advice on methodology and credibility to the tests. Some of these participants include supranational bodies (e.g. the EBA, the IMF and the Basel Committee), national authorities other than the supervisor (e.g. Ministry of Economic Affairs), as well as independent consultants and auditors, asset valuation companies, banking associations and the academic world.

However, these stress tests are not exempt from criticism in several areas and there are open-ended questions and challenges as to their definition and implementation, including most notably the following:

- ▶ The definition of capital, which is not always uniform, particularly when entities from different countries are analyzed simultaneously; this was the case with the EBA exercises, in which there were some discrepancies with local supervisors regarding the consideration of certain instruments, such as generic provisions, as part of core capital.
- ▶ The transparency of the methodology and the assumptions used, as they are not always published in as much detail as the final results.
- ▶ The nature of the assumptions built into the methodology, since high impact and not always sufficiently justified expert judgements are sometimes included.
- ▶ The alignment of the methodology, inputs and stressors with tests conducted in other countries, which is not always analyzed as evidenced by the fact that comparative studies in this regard are rarely published.
- ▶ The difference in scope between the different exercises, as in some cases the system is encompassed almost entirely, while in others the scope is restricted to the largest institutions in a geographical area.
- ▶ The macroeconomic scenarios used, which are sometimes judged to be too severe, and whose realization receives little attention after the exercise.
- ▶ The lack of critical analysis on previous exercises ascertaining whether stress tests are indeed highly reliable, and therefore it is reasonable to trust them to take action such as bank intervention, recapitalization or dissolution based on their results, or whether their level of accuracy is debatable.

The following sections are specifically intended to shed some light on the last three issues, providing a comparative analysis of stress tests conducted in different countries, in addition to a retrospective analysis (backtest) on the degree of success of one of these stress testing exercises.





Brazil: Financial Sector Assessment Program (2012)

i. Context and purpose

The Financial Sector Assessment Program (FSAP), developed jointly by the World Bank and the International Monetary Fund, was launched in 1999 in order to provide national and international authorities with an assessment of the strengths and weaknesses of financial systems, to warn countries of potential vulnerabilities in the financial sector and help them design appropriate action in each particular case.

Although systemic risk was considered to be low in 2012, Brazil's financial system was exposed to the effects of international market volatility. For this reason, that same year the Brazilian banking system underwent an FSAP that examined the macroeconomic factors that affected the system's performance and identified possible needs for development and reform. This exercise will be briefly described in this section.

ii. Participants

Stress test governance

The 2012 Brazilian FSAP was conducted by the World Bank and the International Monetary Fund, in close cooperation with experts from the Central Bank of Brazil (Bacen), whose work focused on the review and evaluation of the process and the results.

Institutions tested

The stress tests set within the context of the financial sector assessment program were conducted on the Brazilian banking system as a whole. The results were reported on an aggregated level, without providing detailed information by institution.

iii. Methodology highlights

Scenarios considered

Scenarios were based on the main macroeconomic variables. There were three:

1. The first scenario simulated a period of global recession, characterized by a GDP decline of 2.5 standard deviations from baseline growth over a two year period.
2. The second scenario represented a reversal of capital flows. In this scenario, the exchange and interest rate shocks were equivalent to twice the changes observed during the global financial crisis.
3. In the third scenario, the terms-of-trade shock corresponded to the highest current account deficit observed in the previous 20 years.

Scope and assumptions

Some of the main assumptions of the stress test were:

- The program focused on credit, market, interest rate, liquidity and contagion risk, and did not cover the specific risks of individual banks, such as operational, legal or fraud risk.
- The time horizon over which banking system resilience would be assessed spanned a period of five years: 2012-2016.

Data (input)

The stress test was conducted using data provided by the individual banks, in addition to benchmark analyses undertaken by the supervisor.

Methodology

Stress testing was conducted in four methodological steps:

- Credit Risk estimation: macroeconomic scenarios were translated into financial stress elements through models to estimate credit risk losses by means of probability of default (PD) and exposure at default (EAD), and to quantify the banks' ability to generate profits. Potential losses (LGD) were estimated on the basis of PD behavior.
- Estimating the level of solvency: using 2011 data from all banks that were analyzed, a balance sheet approach was used to assess the institutions' ability to cope with both a prolonged macroeconomic shock and the introduction of Basel III. Concentration and market risks were assessed based on single-factor shocks under each scenario.
- Estimating liquidity risk: the liquidity tests conducted were equivalent to retail deposit outflows of 15 percent, interbank deposit outflows of 20-90 percent and cuts in other sources of funding of 70-95 percent over a 21-day period. Liquid assets were also subject to haircuts based on their quality and maturity. Liquidity risk was assessed through a ratio used by Bacen, that compares liquidity inflows (unencumbered liquid assets plus scheduled cash inflows) with potential liquidity outflows (deposit losses plus scheduled outflows).
- Estimating contagion risk: Bacen and the IMF used network models to simulate the impact of a bank's default on all interbank exposures, and the potential direct and indirect contagion effects .

Retrospective analysis of an exercise: Backtesting a stress-test



An important aspect of supervisory stress testing in the financial industry on which there has been very little analysis, whether or not these tests are conducted within the SREP framework, is the level of accuracy of their predictions in terms of both the macroeconomic scenarios used in their definition and the capital and loss projections outcome.

Although these exercises have already been conducted for several years in some geographical areas, and despite the fact that their results are often used to determine the need to recapitalize or even liquidate the institutions, national and supranational authorities conducting these tests do not publish retrospective analyses of their reliability in statistical terms.

This section provides a retrospective analysis, or backtest, of the degree of accuracy of a supervisory and public stress test, undertaken by the EBA in 2011. This exercise was selected for two reasons: first, the two-year time horizon set for the

exercise (2011 and 2012) had ended, and as a result the data to be used for comparison was already available. Second, it was the most comprehensive stress test conducted in terms of the level of detail of the published results, as it involved a break-down of the institutions' projected income statements.

For uniformity reasons, this analysis only covers the Spanish banks tested as part of the EBA exercise, as they were all analyzed under the same macroeconomic scenarios, thus avoiding the distortion caused by any differences in criteria that may be implicit in the definition of the different country scenarios. Also, all Spanish banks are subject to the same regulations regarding the definition of capital and provisions, which also contributes to avoid the bias that was attributed to the EBA exercise for this reason.

The backtest was conducted in sequential steps, by analyzing the degree of accuracy of each element in the stress test methodology process: macroeconomic scenarios planned,

projected losses and projected capital. This approach seeks to assess the reliability of all elements in the stress test, since it is their orderly combination that makes it possible to reach conclusions on the exercise as a whole (as shown in Figure 14).

After an executive summary on the main conclusions reached and the information used, the analysis is structured into four sections that respond to four objectives:

- ▶ Backtest on scenarios: analyze the degree of accuracy of the macroeconomic scenarios used in the stress test and examine the impact this level of accuracy will have on the subsequent phases of the exercise.
- ▶ Backtest on losses: assess whether the difference between the expected losses under the stress test and the losses that actually occurred are significant, and examine the consequences.
- ▶ Backtest on capital: examine whether the difference between the EBA's capital projections and the capital reported by the institutions at the end of each year are significant, and evaluate the implications.
- ▶ Qualitative backtest: ascertain whether the outcome expected under the stress test exercise has materialized, by looking at which institutions needed to receive state aid, undertake restructuring or be intervened further along in the process to guarantee their solvency.

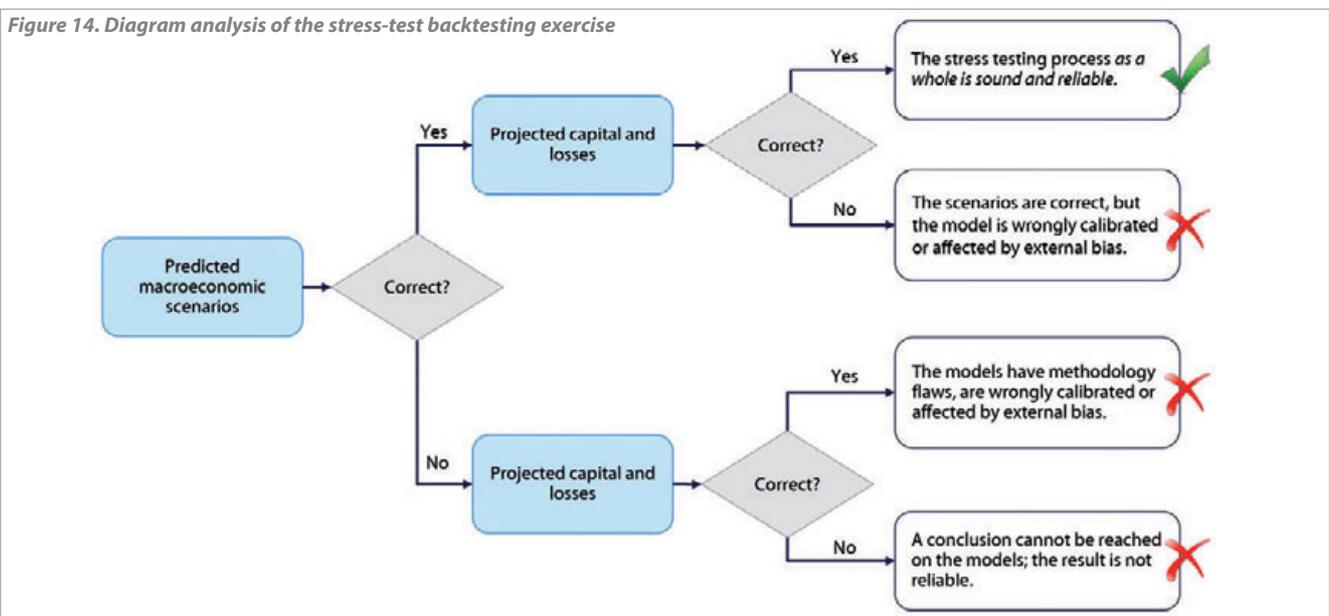
Main findings

It can be concluded from the analysis that the stress test conducted by the EBA was not able to correctly predict the scenarios, losses or capital for the 22 Spanish financial institutions tested, with a level of error that remained moderate in 2011 and was amplified in 2012. The analysis also reveals that the error was not homogeneous: the EBA overestimated the losses in 2011 and underestimated them in 2012.

In spite of the above, the exercise ranked the institutions logically in the sense that those assigned worse ratings received capital injections, were taken over or intervened, even though this might have been the result of a "self-fulfilling prophecy": the publication of the outcome might have contributed to eroding trust in the "failed" banks, which in turn helped to trigger a bank rescue scenario.

In any case, beyond the specific results, the EBA's stress test was a far-reaching exercise in transparency in which most Spanish banks participated at the request of the Bank of Spain. This transparency later played a key role in the restructuring of the financial system.

Figure 14. Diagram analysis of the stress-test backtesting exercise



Data used in the analysis

In order to backtest the macroeconomic scenarios, six of the most important variables defining these scenarios were analyzed: GDP, unemployment rate, inflation, short-term interest rates (based on Euribor) and housing and land price changes. The information used to compare the EBA forecasts was sourced from the European Commission, since the scenarios designed by the EBA were based on this source³⁸.

The stress test results on the Spanish banks, published by the EBA on 15 July 2011, were used to backtest capital and losses, and these results were compared against their 2011 and 2012 annual and quarterly reports. The information used had the following characteristics:

- ▶ Institutions: the analysis covered 24³⁹ Spanish banks representing 93% of all assets in the Spanish banking system.
- ▶ Variables: the variables selected for the analysis were the ratio of losses (provision for credit losses and other impaired assets) to interest margin and core capital ratio, adjusting the series to make them comparable to those used by the EBA.
- ▶ Time horizon: years 2011 and 2012.

Finally, as several of the 24 banks that took the stress tests in 2011 have since undergone merger, acquisition or intervention processes, it was necessary to add their data together in order to obtain a comparable basis for analysis.

Backtest on scenarios

The macroeconomic scenarios in the EBA's stress test were expected to develop as follows (Figure 15):

- ▶ Baseline scenario: GDP growth was expected during 2011 and 2012, with a slight recovery in employment, low inflation during the analysis window, a decline in housing and land prices, and a slight increase in interest rates.
- ▶ Adverse scenario: a GDP decrease of 1.7 and 2.8 percentage points below the baseline scenario was expected for both periods, with a slow rise in unemployment, a context of low prices, reaching deflation in 2012; a sudden drop in housing prices of 7 and 8 percentage points below the baseline scenario, and in land prices of up to 15 percentage points below the baseline scenario, and an increase in interest rates.

An individual analysis of each macroeconomic variable shows that, overall, the observed reality was close to the scenarios set by the EBA in 2011, but in 2012 it was worse than the adverse provisions, with significant deviations in several variables.

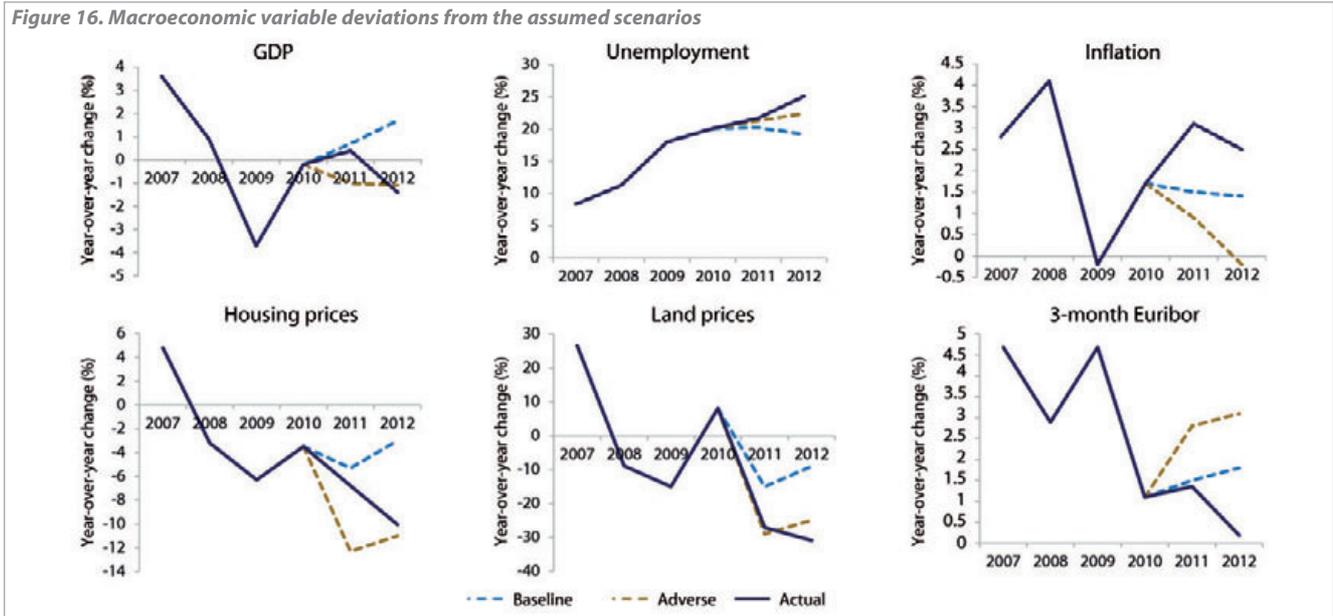
³⁸ Except for housing and land prices; since the reference used by the EBA is not known, data published by the Bank of Spain were used for these variables.
³⁹ The number of banks varies between 24 and 21 from one exercise to another depending on the availability and quality of information.

Figure 15. Macroeconomic scenarios predicted and actual data

Variable	Actual Data			Baseline scenario		Adverse scenario	
	2010	2011	2012	2011	2012	2011	2012
GDP	-0.2	0.4	-1.4	0.7	1.7	-1	-1.1
Unemployment	20.1	21.7	25.1	20.2	19.2	21.3	22.4
Inflation	1.7	3.1	2.5	1.5	1.4	0.9	-0.2
Free-market housing prices	-3.5	-6.8	-10.1	-5.3	-3.0	-12.3	-11.0
Land prices	8.1	-27.1	-30.9	-15	-9	-29	-24.9
3-month Euribor	1.1	1.4	0.2	1.5	1.8	2.8	3.1

Source: EBA, European Commission and Bank of Spain.

Figure 16. Macroeconomic variable deviations from the assumed scenarios



Some of the highlights from the analysis are (Figure 16):

- ▶ In the case of GDP, the gap between the baseline scenario and the adverse scenario was rather wide, reaching 2.8 percentage points in 2012. When comparing expected GDP evolution with actual performance, it can be seen that, despite predictions being fairly accurate in relation to the 2011 baseline scenario, the actual GDP decline in 2012 exceeded expectations under the adverse scenario.
- ▶ In the case of unemployment, while the baseline scenario described a slow decline, the adverse scenario projected an upward trend to a level of 22.4%, representing a 3.2 percentage point gap. The actual 2012 data was much worse than expected: at 25.1%, it was 5.9 percentage points above the baseline scenario and 2.7 percentage points above the adverse scenario.
- ▶ Expected inflation followed a downward trend in both scenarios. While it remained low in the baseline scenario, in the adverse scenario it even led to a deflationary period. Actual inflation was significantly higher than expected, reaching 3.1 and 2.5 percent in 2011 and 2012, respectively.
- ▶ Housing price forecasts described a 7 and 8 percentage point gap between the baseline and adverse scenarios in 2011 and 2012 respectively, showing a price decrease in 2011 and a slight recovery in 2012. While the actual price level was somewhere between the values set for both scenarios, it fell steadily (did not recover) to a level which deviated from the adverse scenario by just 0.1 percentage points in 2012.
- ▶ As for land prices, both scenarios predicted a downward trend, with a slight recovery in 2012. In this case, the actual decline observed was in line with the adverse scenario described for 2011, but surpassed adverse scenario expectations for 2012.
- ▶ Finally, when it came to the Euribor, both the baseline and the adverse scenarios described increasing values for both 2011 and 2012, 1.3 percentage points apart in both cases. While actual performance was close to the baseline scenario for 2011, the downward deviation from both 2012 scenarios was significant (1.6 and a 2.9 percentage points) both in trend and value terms.



Although the actual behavior of macroeconomic variables was close to the baseline scenario for 2011 (and mostly remained between the baseline and the adverse scenarios) in 2012 it was significantly worse than the adverse scenario and expected trends were reversed for many variables.

This means that the level of error in the loss and capital projections will be high and difficult to quantify. However, since the projections did not alter the trends predicted by the baseline and adverse scenarios, it could be deduced that these errors are not due to methodological flaws in the models, but to an inadequate definition of scenarios.

In this regard, the following exercises will attempt to determine whether actual expected losses and capital were closer to the baseline scenario in 2011 and significantly worse in 2012, as would be expected, or whether the behavior was different, which would constitute grounds for challenging the reliability of the models in addition to questioning the scenarios.

Backtest on losses

To backtest the losses incurred, the amount of the "Impairment losses on financial and non-financial assets" predicted by the EBA for each bank was compared with the actual loss on the provision for credit losses and impairment of other assets published by the institutions themselves in their annual and quarterly reports for 2011 and 2012. To obtain a uniform value across entities, the amount of the loss was divided by the interest margin predicted by the EBA or published by the banks themselves in each case.

The charts in Figures 17 and 18 illustrate the comparison between actual value and predictions for this ratio under the baseline and adverse scenarios.

In 2011, actual results were better than predicted under the baseline scenario for 69% of banks in the analysis, which reveals the first inconsistency in the loss projection model, since, as determined in the previous section, the macroeconomic reality generally remained between the baseline and adverse scenario expectations.

Moreover, at least four entities reported losses higher than those predicted in the adverse scenario, therefore, in 40% of cases out of the total number of institutions on which data was available ⁴⁰, actual results were not within the range expected by the EBA.

This may be due to the fact that there were some impacts the EBA could not foresee:

- ▶ Asset sales by several institutions in order to free provisions and thus reduce the related losses.
- ▶ The liquidity scheme offered by the European Central Bank during this period, giving banks the possibility to obtain funds at interest rates that were lower than those offered in the market, which lessened their interest burden and improved their margins.

In 2012, by contrast, loss ratios showed a significant upward deviation with respect to the EBA provisions. These ratios were also significantly worse than those observed in 2011,

Figure 17. Expected and observed ratio of impairment losses to net interest income for the institutions tested in 2011

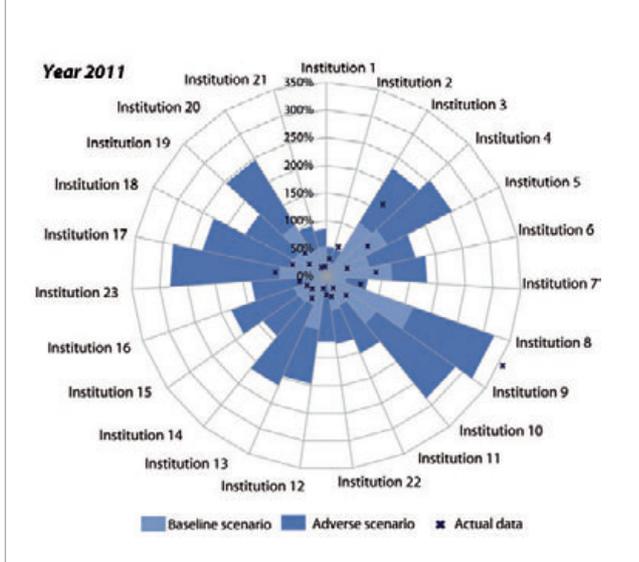
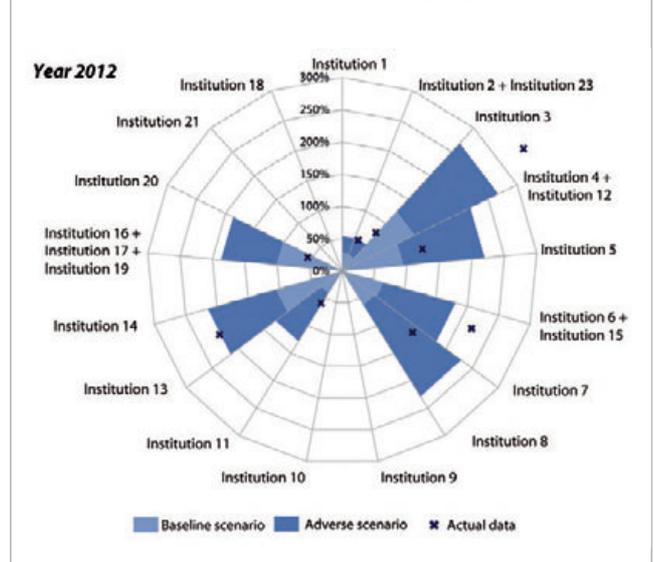


Figure 18. Expected and observed ratio of impairment losses to net interest income for the institutions tested in 2012



⁴⁰ At the time the document was compiled, the actual data observed in 2012 was not available for all institutions under analysis.

probably due to the worsening economic environment and the measures adopted by the Government during that year, as part of which banks were required to modify their loan-loss provision schemes by including specific allowances according to the type of funding and substantially increasing the provisions for land and real estate development-related assets.

To sum up this backtest, it is safe to say that stress models failed to correctly predict losses, since there are significant differences between the predicted and the actual values for most institutions in 2011, which were magnified in 2012. Also, an analysis of trends reveals that the EBA overestimated the loss in 2011, despite the fact that the macroeconomic reality was in line with predictions for that year, and underestimated the loss in 2012. This leads to questioning the calibration of the model's sensitivity to macroeconomic factors, and the ability of the exercises to incorporate inorganic transactions (e.g. sale of portfolios) as well as regulatory changes during the prediction window.

Backtest on capital

To compare the capital ratio in the baseline and adverse scenarios with the actual results, the amount of core capital disclosed by the banks in their 2011 and 2012 annual reports was compared with the same ratio as reported by the EBA, incorporating some concepts⁴¹ which, though accepted by the Bank of Spain, were not considered in the stress testing exercise for the sake of uniformity across countries.

The charts in Figures 19 and 20 illustrate the deviations observed between capital ratio predictions and actual values in the baseline and adverse scenarios.



Actual results for 2011 show significantly improved capital ratios compared to those described in the adverse scenario, and these ratios continue to improve to levels that largely exceed baseline scenario forecasts for 2012. Thus, while in 2011 one third of institutions had ratios that exceeded the limit set in the baseline scenario for that year, the percentage for 2012 went up to 50%⁴².

⁴¹ Essentially stating that ratios should include generic provisions and other items such as bonds convertible into shares.

⁴² The percentage was estimated taking into account only those institutions whose 2012 data was updated at the time the document was compiled.

Figure 19: Expected and observed core capital ratio for the institutions tested in 2011

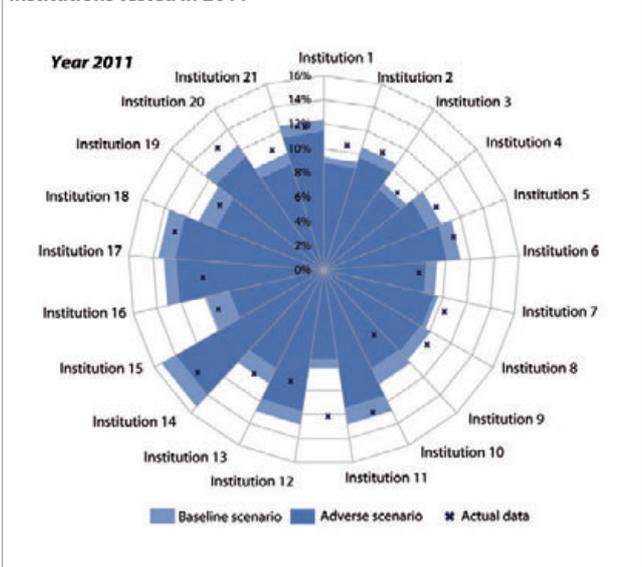
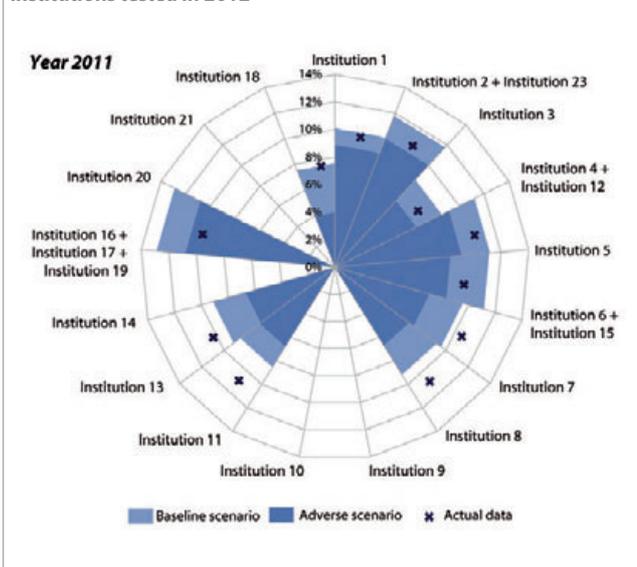


Figure 20: Expected and observed core capital ratio for the institutions tested in 2012



This may be due to regulatory changes that took place during the EBA stress test and were therefore not considered for the exercise. In particular, Royal Legislative Decree 2/2011 on Strengthening the Financial System, established a solvency requirement of 8% or 10% for all Spanish institutions. Following its publication, most savings banks were transformed into banks and strengthening measures were adopted, some of the most significant being the “cleaning up” of the balance sheet by selling specific portfolios, and the restructuring plans in which many of the institutions in the group under analysis were immersed.

From the backtest performed on capital, it can be concluded that, to the extent that the EBA stress test could not consider regulatory changes or changes to assumptions occurred during the prediction window, the results were inevitably biased and deviated significantly from forecasts. This is not necessarily due to error in the mathematical model embedded in the stress test, but does challenge the overall ability of the stress test to predict the capital levels of the institutions.

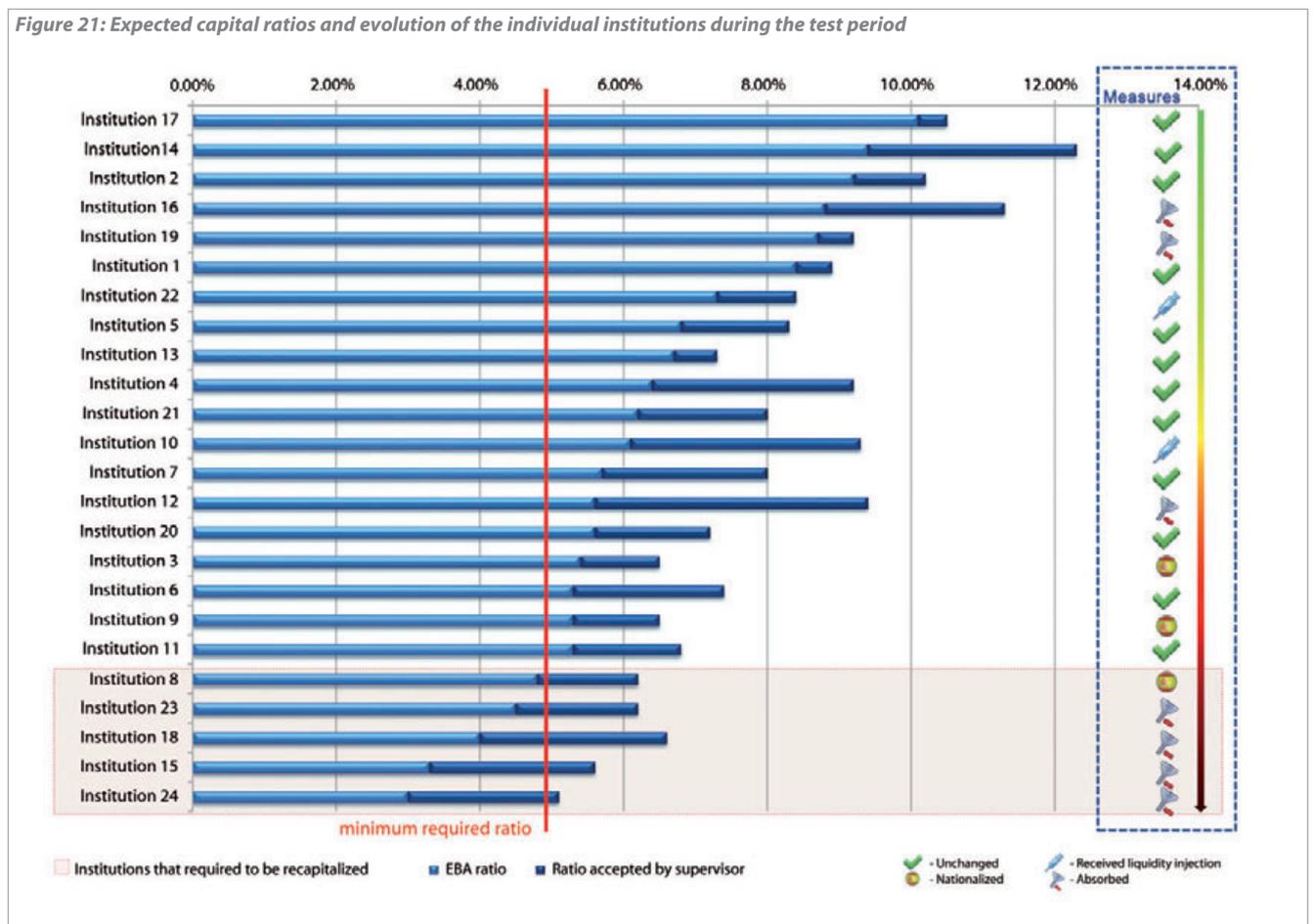
Qualitative backtest

Beyond the specific levels of capital and losses expected and observed for each institution, the question arises whether the stress test analyzed was able to correctly rank the institutions in the sense that those that obtained the worst results (that were rated as “failed”) actually needed aid or intervention for their survival at a later stage.

Figure 21 shows the EBA ranking compared to the actual performance of the banks analyzed.

Banks were classified into four categories depending on whether (1) the institution in question was absorbed by another, (2) the institution was nationalized, (3) the institution received a capital injection by the Bank of Spain, or (4) the institution required no action and remained unchanged during 2011 and 2012.

As can be seen, there appears to be a strong relationship between the ranking of banks based on the the EBA stress test results and the measures that were subsequently adopted. In particular:





- ▶ Four out of the five institutions that were found to require capital according to the limit set by the EBA, ultimately went through restructuring and merger processes involving other institutions within the Spanish banking system restructuring framework, and the fifth was nationalized.
- ▶ Three out of the seven institutions whose ratios were between 5% and 6% (close to the minimum required) were nationalized or taken over by other banks.
- ▶ Finally, of the 12 institutions whose ratios were above 6%, two-thirds did not require any of the above measures, and in many cases absorbed the institutions with greater capital needs.

From the above, it can be concluded that there is a significant link between the rating obtained in the stress test and the actual performance of the institutions assessed. However, it should be noted, particularly in regards to the qualitative backtest, that there was possibly a "self-fulfilling" prophecy effect in the sense that negative evaluations might have led to increasing distrust and in the worst cases even trigger the institution's collapse.

In this regard, given the economic context in which the analysis was conducted in Spain, the EBA stress test should be understood as an important piece in the strategy for restructuring the Spanish financial system, whose results (especially the qualitative ones) influenced the subsequent unfolding of events, which somewhat limits the possibility of a bias-free backtest.

Finally, aside from considerations regarding the accuracy of the numerical results on capital and losses provided by the stress test models, the EBA exercise was first and foremost an exercise in transparency towards markets, driven by the Bank of Spain and by the institutions themselves, and in this sense, a step forward that would have a significant impact on the overall financial system restructuring process.



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Design and Layout

Marketing and Communication Department
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