Moody's Analytics

RISK PERSPECTIVES

STRESS TESTING: EUROPEAN EDITION

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FEATURED ARTICLES:

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FROM THE EDITOR

Welcome to the first edition of Moody's Analytics Risk Perspectives, a publication created for risk practitioners. In many ways, it is a reflection of our larger goal – to deliver essential insight to the global financial markets. Practitioners can then turn that insight into action, whether it is to maintain regulatory compliance, make smarter, risk-aware decisions, or enhance their business planning.

In this edition, we focus on stress testing in Europe – specifically how banks can leverage stress testing to add value to their business, for regulatory compliance and beyond. The following is a collection of articles that contain actionable information about stress testing.

In the *Rethinking Stress Testing* section, we discuss how banks can view stress testing in a new light so they may fully reap the benefits of their enterprise risk investment. For instance, in the article 'Are Regulatory Stress Tests Just Cost without Value?', we introduce the fact that whilst regulatory compliance is challenging, there are ways in which banks can use stress testing to build long-term value rather than treating it like a check-the-box exercise.

In *Regulatory Spotlight,* we take a fresh look at the underlying causes and lessons learned so far from the various stress testing exercises in Europe and in the US, provide an update on regulations, and address how banks can handle key regulatory compliance challenges. We evaluate the upcoming European Banking Authority (EBA) stress tests and their impact on banks' organisations in 'EU Stress Testing Regulatory Update: What Happens Next?' and also take a look at the AQR in 'Asset Quality Review: Setting the Foundation for a Standard Stress Testing Framework'.

The *Approaches to Implementation* section provides best practices about how to navigate the complexity and uncertainty that still hinders the execution of stress testing and pinpoints key opportunities that banks should embrace. For example, in order to implement a comprehensive, rigorous, and forward-looking stress testing programme, we have created a model, which we detail in the article 'Stress Testing Best Practices: A Seven Steps Model'.

In the *Principles and Practices* section, we highlight effective ways for banks to apply stress testing to their organisations and deal with common pitfalls, such as gathering sufficient data or designing meaningful scenarios. In the 'Stress Testing of Retail Credit Portfolios' article, we divide the stress testing process for retail portfolios into four steps, focusing on key activities and providing details about how to implement each step.

Again, we hope our perspectives on stress testing will help you attain a better understanding of how to approach and thrive in a world of ongoing regulatory, business, and industry demands. I encourage you to take part in this discussion and help us shape the future editions of Risk Perspectives by sharing your feedback on our first issue.

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RISK PERSPECTIVES

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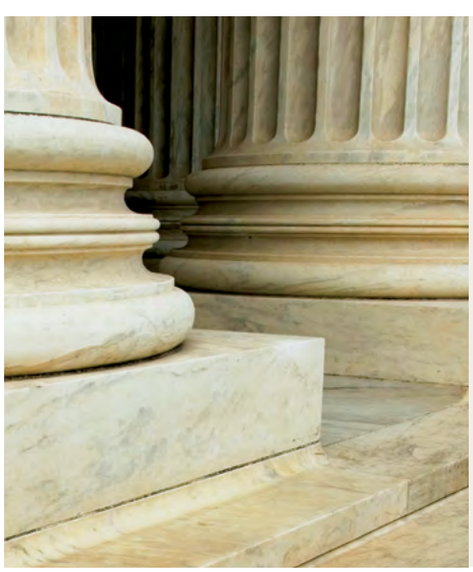

APPROACHES TO IMPLEMENTATION

PRINCIPLES AND PRACTICES

STRESS TESTING CHALLENGES AT A GLANCE

40%

Estimated increase in problem loans under new AQR disclosure standards versus the current IFRS.*

ORGANISATIONAL SILOS

The cost of cleaning data and aggregating results will be very high, especially if the frequency of the stress tests increases.

Breaking the Silos in Stress Testing. Page 14

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Range of people in dedicated teams, depending on bank size, tasked with defining objectives and governance guidelines and ensuring proper coordination among the business, risk, and finance departments.

Stress Testing Best Practices: A Seven Steps Model. Page 50

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What is crucial now in Europe is for the banks to not fail the tests in the coming months under the new supervisory regime of the ECB.

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80%

Amount of potential internal stress testing resources consumed by regulatory stress testing requirements, according to market participants in 2013.

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PROCESSES

Stress testing methods and analytical outcomes need to be consistent with how financial institutions think about risk and reporting, and at the same time meet the regulatory guidelines.

A New Generation of Stress Testing Processes. Page 46

* EBA Consultation Paper. (March 2013). *Supervisory reporting on forbearance and non-performing exposures.*

HIDDEN EXPOSURES

Having an enterprise-wide stress testing framework that acknowledges both traditional stress testing analysis and reverse stress testing is a game changer for financial institutions.
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100

Number of people (or more) involved in the regulatory stress test exercise reported by some banks.
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$25T

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RETHINKING STRESS TESTING

This section discusses how banks can leverage the stress testing exercises to improve their businesses, such as building an integrated and robust framework.

ARE REGULATORY STRESS TESTS JUST COST WITHOUT VALUE?

By Dr. Christian Thun

Dr. Christian Thun
Senior Director, Strategic Business Development (EMEA)

Christian provides deep expertise on credit risk management, Basel II, and portfolio advisory projects and functions as a main contact for regulators and the senior management of financial institutions.

Whilst regulatory compliance is challenging, banks should leverage the stress testing exercises to build long-term value, rather than treating it like a check-the-box exercise.

In an effort to prevent another system-wide failure as experienced in the financial crisis of 2008-2009, banking supervisors and governments around the world tightened regulatory standards – bringing stress testing to the forefront. Many banks have voiced their concern that the ever-increasing data requirements of the tests have little to do with their individual risk profile. Whilst they have to comply and dedicate enormous resources to meet the deadlines, they are asking that, if regulatory stress tests do not fit their business, are they just cost without value?

Stress testing is a powerful risk management tool that offers a unique opportunity to contemplate potential outcomes and actions to take depending on different scenarios. Unfortunately, many banks consider regulatory stress testing a burden and not an opportunity. Whilst there is no doubt regulatory compliance is challenging, there are ways in which banks can use the exercise to build long-term value, rather than treating it like a check-the-box exercise.

STRESS TESTING – A REGULATORY RESPONSE TO THE CRISIS

The eruption of the global financial crisis with the downfall of Lehman Brothers in September of 2008 focused people's attention on tools that, for a long time, often played only a minor role in risk management, including stress testing.

Despite the fact that banks have been using stress testing internally for many years (e.g., to stress market risk factors such as yield curves), the test results had little-to-no influence on the overall business decisions of banks. As a consequence, banks built excessive risk positions without considering how vulnerable they would be if things quickly went wrong.

The risk taking that led the global financial system to being on the verge of collapse spurred regulators around the world to significantly tighten industry rules and guidelines – from increased capital levels and minimum liquidity ratios to maximum leverage ratios – and bring stress testing to the forefront. In many jurisdictions, regular internal stress testing became a mandatory requirement (e.g., through the MaRisk guidelines in Germany). In addition to national regulations, the central supervisory bodies in the United States and European Union (EU) carried out bank-wide stress tests to evaluate the resilience of leading financial institutions to adverse market developments.

The bank-wide stress tests defined standardised scenarios that the banks had to use for their calculations. In its latest stress test in 2011, the EU used a set of baseline and adverse macroeconomic scenarios developed by the EU Commission and the European Central Bank, respectively. The US Federal Reserve Bank (the Fed) provided three different sets of scenarios, including baseline, adverse, and severely adverse scenarios for the Comprehensive Capital Analysis and Review (CCAR) in late 2012.

The complexity increased with each regulatory stress test, as well as the data requirements and reporting obligations for the individual banks. The 2011 EU stress test focused primarily on assessing credit and market risks in adverse economic conditions. Trading and banking book assets were subject to stress at the highest level of consolidation of the banking group. To simplify the calculation, the test was conducted using the assumption of a static balance sheet.

The Fed requirements for BHC capital plans

In contrast to this approach, the Fed asked the top 19 bank holding companies (BHCs) with total consolidated assets of US$50 billion or more in November 2012 to calculate not only the three supervisory scenarios, but also two additional BHC-defined scenarios with a planning horizon of nine consecutive quarters starting in Q4 2012. The resulting capital plan, along with the proposal for planned capital actions, had to be reported by each BHC in early January 2013. In addition, each BHC had to report its estimates of losses, resources available to absorb those losses, balance sheet positions, and capital composition on a quarterly basis over the nine-quarter planning horizon. The Fed also required the banks to submit qualitative information supporting their loss and pre-provision net revenue (PPNR) estimates, including descriptions of the methodologies used to produce the estimates, as well as any other analyses that supported their capital plans.[1]

Banks face enormous challenges

For the 91 banks in the EU, as well as the 19 banks in the US, these regulatory requirements represented huge challenges. The amount of information that was requested, ill-defined regulatory requirements, the common silo architecture, and fragmented risk management approaches in many banks caused inconsistencies, duplicate work, incomplete aggregations, and concerns about the reliability of the overall results. The resources that had to be allocated to perform the calculations and – most importantly – meet the deadlines set by the regulators greatly exceeded the levels of most other major bank-wide projects. Risk professionals had to work extra hours for weeks. Staff had to be pulled from other important projects or their normal daily responsibilities. Several banks reported that in some cases more than 100 people were involved in the regulatory stress test, which illustrates the complexity and resource demands of the exercises.

With ever increasing regulatory requirements, many banks have raised the concern that these stress tests have little to do with a bank's individual risk profile. Instead, they impede a bank's ability to think creatively about their own business and vulnerabilities. Given the resources needed to meet the deadlines and report the results to the regulators, banks have begun to ask for a return on this investment. If a regulatory stress test does not fit a bank's business, is it just cost without added value?

Several banks reported that in some cases more than 100 people were involved in the regulatory stress test, which illustrates the complexity and resource demands of the exercises.

STRESS TESTS ARE VALUABLE BUT BANKS NEED TO INVEST

Contrary to what some banks believe, stress testing is one of the most powerful tools in risk management, yet it is frequently overlooked. A well-functioning, scalable stress testing platform can offer substantial value and returns. Instead of using a rather abstract concept like Value-at-Risk (VaR), stress testing enables risk and business managers to contemplate what could happen to their bank and their risk exposure in situations not captured by the parameters of its current models (e.g., sudden shifts in correlations or default levels). More importantly, it can improve communication between the risk management and business sides of a bank and suggest possible actions for senior management in case an adverse business environment materialises.

With this in mind, the regulatory stress tests without a doubt positively impacted the risk management cultures of many banks. Still, many organisations consider regulatory stress testing more of a burden than an opportunity to learn and improve their internal processes.

Investing in robust stress testing frameworks

The best way forward for many banks is to invest in robust stress testing frameworks that comprise models, data, IT landscape, and processes. The heart of a well-functioning automated stress testing process is a single data repository in which the relevant risk and finance data required for the regulatory stress tests are consolidated and readily available. With the data layer in place, the models, workflow tools, and reporting modules can be layered on top. Once this structure is in place, banks are afforded a scalable and powerful capability – to run and effectively report on a broad array of enterprise-wide stress tests in a timely and cost efficient manner. This capability can offer substantial insight to senior management about their bank's risk profile and potential opportunities.

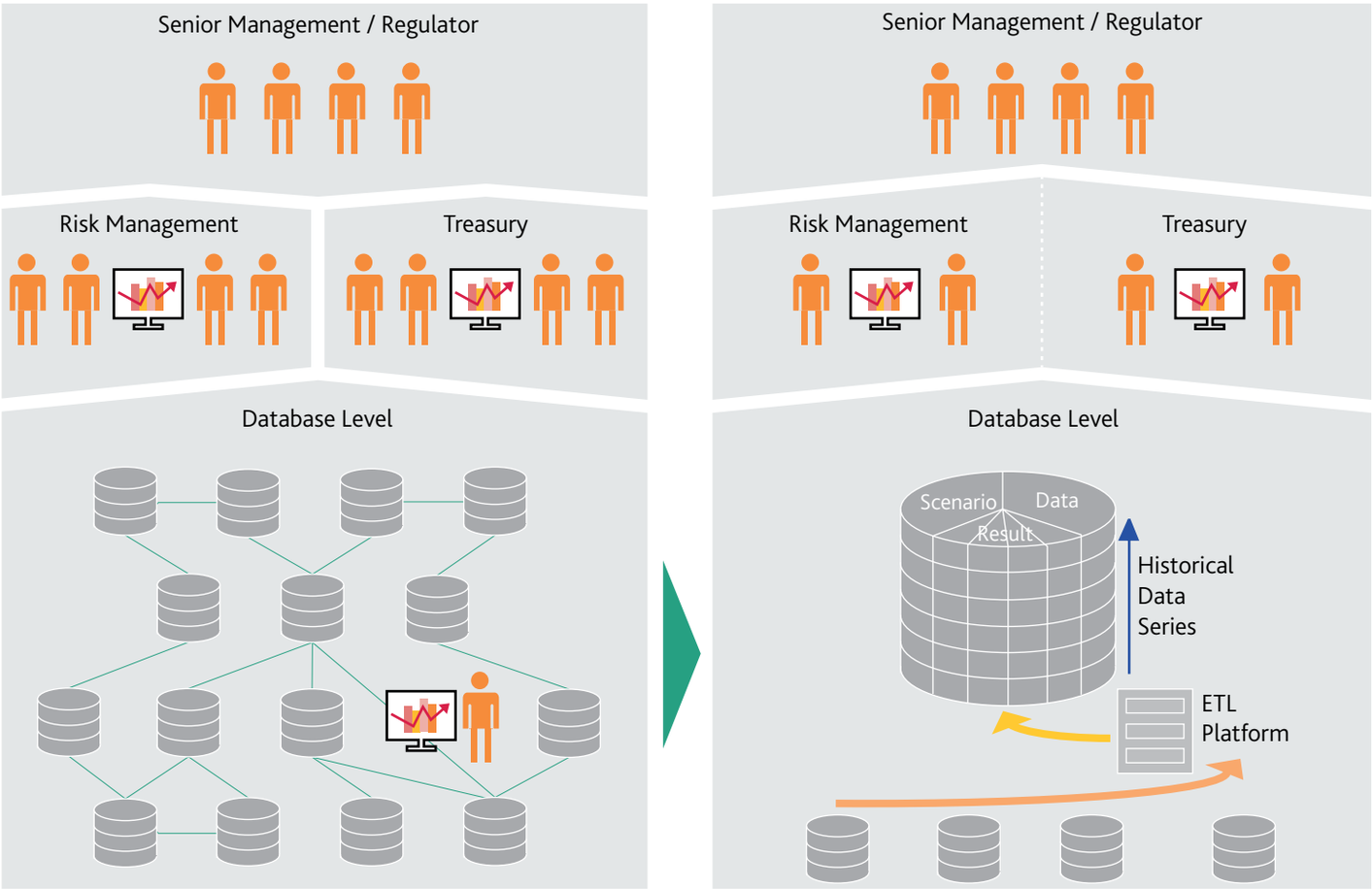
Comparing stress testing processes

Figure 1 compares the typical stress testing process still present in many institutions (on the left) and a leaner, more efficient process (on the right) that is less resource intensive and able to produce results faster.

Typical stress test process

As illustrated on the left, this process can be currently observed in many banks trying to respond to regulatory (or senior management)

Figure 1 Comparison of a typical versus a leaner, more efficient stress testing process



Source: Moody's Analytics

stress test requirements. These banks have to access a wide range of (legacy) systems and databases to collect and consolidate the data needed for stress testing calculations. Even intermediary steps, such as data re-formatting (illustrated by the single person among the databases on the lower left hand side) are needed before the data can be used for the actual calculations. In the risk management department, a larger number of employees (up to 100, as mentioned previously) are charged with the task of performing the calculations. Lastly, within the treasury the extremely arduous task of aggregation and reporting generally takes place before the results can be submitted to senior management and regulators. This complex system is inefficient and costly. Perhaps even more disturbing is the high inherent risk of error prevalent in this ungainly process.

The right side of Figure 1 illustrates the leaner and more controlled framework. The data from sub-systems will be stored via Extract, Transform, Load (ETL) interfaces in a comprehensive data repository. This repository is flexible and contains the necessary data, scenarios, and results to enable those responsible for the stress test to generate the results in a much faster, reliable, and efficient way. Beyond the need to respond to the regulatory stress tests, banks will obviously be in a position to use this framework for their own stress testing.

> The best way forward for many banks is to invest in robust stress testing frameworks that comprise models, data, IT landscapes, and processes.

A leaner, more efficient stress test process

As banks will not be able to avoid the burden of regulatory stress tests, there is no choice but to make the best of it. That means executing the task with minimal resource consumption. Banks will have to invest in infrastructure to establish a process and IT architecture that are robust, repeatable, scalable, and lean.

The requirements set by external regulators are definitely challenging, but there are two ways to master this challenge: automate the process as much as possible and consolidate the data in one single data repository so it is readily available when needed.

With a comprehensive data repository, banks will not only be able to respond to regulatory stress tests with reasonable ease and confidence but, more importantly, they will also build a foundation for their own stress testing – reaping long-term benefits for their investments.

Sources

1 Board of Governors of the Federal Reserve System, Comprehensive Capital Analysis and Review 2013, page 3

BREAKING THE SILOS IN STRESS TESTING

By Nicolas Kunghehian

Nicolas Kunghehian
Director of Business Development (EMEA)

Nicolas provides insiaght on ALM, liquidity, and market risks to help financial institutions define a sound risk management framework.

Integrating different risks in a single framework greatly benefits all financial institutions – leading to better communication, risk assessment, and long-term performance.

It started with the subprime crisis. Defaults in US subprime mortgages impacted the price of some structured instruments, mainly for credit risk reasons. Investors, realising there were significant losses, decided to jettison these increasingly risky securitised instruments. Banks faced the difficulty of raising funds using these special purpose vehicles. As the market became aware of the situation, mainly because too many banks were selling assets to get liquidity, confidence between financial institutions disappeared. At that point, it was impossible to restore confidence in the interbank market. Credit risk in one specific market had been transformed into liquidity risk.

The story is now well known and other risk factors can be added to the whole process, like interest rates. When the interest rates went up in the US, it increased the number of defaults in US subprime mortgages – generally floating rate loans. Risk managers and regulators realised that it was necessary to analyse the combined impact of different risks, especially in a crisis scenario.

Furthermore, in light of the recent credit crisis and the emerging business and regulatory environment coming out of that crisis, many banks are rethinking their traditional operating structures. Banks are realising that their legacy organisation structures need to be closely revisited and some enduring organisational walls will need to come down – either physically or logically – or at least be chipped away in a meaningful way.

This article illustrates that a crisis can occur, or be exacerbated, when risks are managed in different silos in banks. It first defines the different types of risks that can be correlated and provides examples that illustrate how banks should model the different risks together. The second section highlights the benefits of having an integrated process for measuring the risks, not just in the context of stress testing. Finally, it describes the challenges of building such a framework and gives suggestions about how to improve it.

Different types of risks

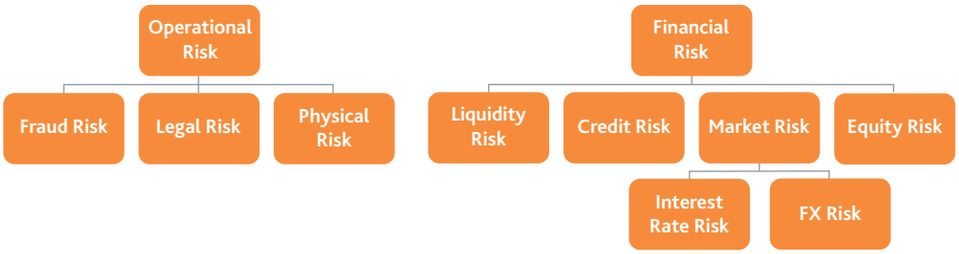
Mapping all the risks that banks face would create an extremely long list. Instead, this article provides examples of the links between some of the most important risks found in banks.

Liquidity and credit risk

'The financial crisis has highlighted the need to better integrate solvency and liquidity stress testing. A sharp rise in their euro and US dollar funding costs, or quantitative rationing, was often the trigger for the failure of banks during the crisis, and for the difficulties that many European banks continue to face'.
(International Monetary Fund, 2013)

Liquidity risk is linked to credit risk. When a loan is not repaid, the impact on the incoming cash flow is straightforward and the treasurer needs to find another source of funding to replace the inflows. Before the crisis in 2008, it impacted a bank's P&L, but it was not a significant problem for a treasurer to find cash in the very liquid

Figure 1 Different types of risks



Source: Moody's Analytics

interbank market. However, after the financial crisis, stress scenarios where it is difficult or even impossible to borrow money from the interbank market have become plausible.

customer decides to prepay because he is selling his house), or a financial option, because interest rates have decreased and a customer wants to renegotiate his loan.

A crisis can occur or be exacerbated when risks are managed in different silos in banks.

Another connection is the impact of credit risk on the reputations of financial institutions. For example, a local bank in a region where the unemployment rate and therefore the number of defaults is high, will find it more difficult to get money from other banks who consider the bank more risky because of the local economy.

Finally, it has been proven that in difficult times, banks tend to lend only to good customers (i.e., lending less globally); thus creating fewer outflows, positively impacting the liquidity risk metrics.

Liquidity and interest rates

ALM teams have always worked on interest rate risk and liquidity risk. Basically, the maturity mismatch between assets and liabilities could be analysed for both risks. Retail banks, for example, tend to lend money with longer maturities for mortgage loans and have short-term resources with non-term deposits. Contractually, all customers could go to their banks and withdraw money from their savings accounts.

For long-term loans, there is generally an implicit option for a customer to prepay their loan. This can be a so-called behavioural option (e.g., a

There is not only a link between interest rate risk and liquidity risk, but also the impact of reputational risk on the two, as the behaviour of customers can be driven by the bank's image. Northern Rock is an interesting example because even with a guarantee of the Bank of England, confidence in it was difficult to restore.

FX and credit risk

When a bank decides to enter a new market, with a different currency, they have two possible options. The first option is to lend money in the local currency. In this case, a bank only has to deal with foreign exchange (FX) risk; that is, their exposure to unanticipated changes in the exchange rate between two currencies. But a bank could also decide to lend money in a more liquid currency (e.g., US dollar or euro). Their customers would benefit from this second option because interest rates are generally lower in euros or US dollars than in less liquid currencies. However, their customers would then be exposed to currency risk as their salaries are generally paid in local currencies. Hence, in the case of a challenging scenario, an increase in the exchange rate could lead to many more defaults than what was initially assessed.

Again, the correlation may be very small in a normal scenario but could become very high in a stress scenario. Therefore, this link must be modelled carefully in the context of a stress testing exercise.

FX and liquidity

FX rates can have a big impact on liquidity. Most of the reports required by the different supervisors now have to be produced per currency, as there is a difference between having cash in a local currency and the US dollar. Even when the exchange rate is indexed on the dollar, some differences can appear when a crisis occurs. It is therefore very important to calculate two metrics in each currency.

Even for liquid currencies it is not always easy to exchange one currency for another. At the end of 2012, French banks discovered that their US dollar funding dried up. Even if they had a sufficient amount of cash in euros, they could not easily find enough US dollars, which led them to decrease their reliance on US funding sources.

THE BENEFITS OF THE INTEGRATION OF RISKS

'Firms that avoided significant losses appear to have a better ability to integrate exposures across businesses for both market and counterparty risk management. Other firms did not appear to have sufficient abilities to identify consolidated, firm-wide, single-factor stress sensitivities and concentrations'.
(Senior Supervisors Group, 2008)

The Senior Supervisors Group's findings should compel every banker to implement an integrated risks framework inside their financial institution. Unfortunately, many bankers still believe their institution will avoid significant losses despite not having an effective framework in place.

Be prepared for new regulations

One of the most important benefits of an integrated framework comes from the ability to efficiently respond to the frequent regulatory exercises that banks are required to perform, like the EBA, IMF, or CCAR. Moreover, regular changes in market practices often drive the supervisors to come up with new ideas, sometimes at the last minute. This challenge can be extended to the internal requirements from senior management. But a common thread among these fluid requests is the need to analyse the relationships among the full suite of risk factors a bank faces.

Despite being mandatory, these regulatory-driven stress testing exercises have not convinced some financial institutions to build a new framework when they have different tools and departments for different types of risks. They generally prefer to stick to their business model, whilst aggregating the data from the different tools. By doing so, they forget that the cost of cleaning data and aggregating results can be very high, especially if the frequency of the stress tests increases. Beyond the tangible costs, there is the high inherent control risk associated with such inefficient and extensive processes, many of which include substantial manual intervention with poor controls.

They forget that the cost of cleaning data and aggregating results can be very high, especially if the frequency of the stress tests increases.

Better understand the risks

The example explaining the link between FX and credit risk is instructive. In some banks, the fact that there are silos (e.g., people in charge of credit risk and others in charge of FX risk), leads to unmonitored – and so unmanaged – risk. The credit risk team could categorise a risk as FX whilst the market risk team could say that it is credit risk.

This illustrates that risk departments will need to better understand all the connections between all the risks – particularly powerful when creating a contingency plan in case a similar scenario occurs.

This also helps build consistent business plans for new strategic investments. For example, before buying another bank or creating a subsidiary in a foreign country, banks can perform simulations to

pinpoint the worst impact of such an investment.

Finally, every team can ensure that the numbers are consistent in the various internal reports when aggregating the data (from credit risk, liquidity risk, FX risk, etc.).

Sharing information

'According to some risk managers, the larger the shock imposed, the less plausible the stress tests or scenarios in the eyes of a business area and senior management'.
(Senior Supervisors Group, 2008)

It seems that the definition of a plausible scenario has changed significantly over time. A sovereign default in Europe was very unlikely five years ago but is now the basis of many stress tests. Using a comprehensive framework not only helps banks better understand why a scenario is plausible, it also makes it more difficult for senior managers (among others) to say that they do not believe that scenario X will lead to consequences Y and Z, as the full framework will be properly documented.

Using the same data, framework, and metrics also enable people to speak the same language. Some treasurers view their risk department as an impediment to effectively doing their job. Risk managers face challenges when explaining to the business lines to what extent one specific transaction could impact the bank. Simply put, business lines were speaking P&L, the credit risk team was speaking Probability of Default (PD)/ Loss Given Default (LGD), and the ALM team was speaking about gaps.

Sharing information and having a common framework fosters communication across an entire organisation, as input data, calculation engines, and reports are based on one platform. Everyone will then have the same level of knowledge about each type of risk. In the end, the strongest benefit is overcoming the barriers between different departments.

Challenges and methodology in practice

A few years ago, measuring different types of risk at the same time was only used to better define a diversification strategy, which mainly pertained to the allocation of economic sectors, countries, and currencies in a single portfolio. For asset managers, this applied to hedge funds, where the risk is not – or minimally – correlated with market prices. Only a few banks managed to implement comprehensive stress tests for two main reasons:

1. Quantifying the impact of the combined risk factors is a difficult task

'Many managers recognise that stress tests themselves should be dynamic – such that they consider new scenarios as business conditions evolve – yet still be stable enough to provide firms with a useful gauge for monitoring the evolution of their risk profile over time'.
(Senior Supervisors Group, 2008)

Methodologies have always been at the heart of risk management. Many quantitative experts write complex models that describe, as precisely as possible, the different risks that a bank can face. This is obviously a difficult task in the case of combined risk factors.

First of all, senior management does not want to know about formulas or models. They are more interested in a global view and do not want to dive into the details. Moreover, liquidity risk issues are completely different than credit risk. For the treasury, liquidity risk is an intraday risk, requiring less complex models and faster – even real-time – observation techniques. Even if modelling is still considered important, infrastructure often receives a larger share of the budget.

Second, stress testing is about a few macroeconomic variables. Most economists only provide frequently used statistics, such as gross domestic product, unemployment rates, consumer price index, equity index, and only two points on the yield curve. A bank must then translate this information to retrieve all the variables needed for every type of risk (e.g., PD, LGD for credit risk, cash flows for liquidity risk, prices for market risk, etc.).

But most importantly, a bank must write an equation that describes the state of their future balance sheet when reacting to multiple scenarios, such as:

- If one of a bank's counterparties defaults, the bank will stop lending to that counterparty
- If the equity prices drop below a given limit, the bank will reduce their exposure to the equity market
- If the liquidity buffer is not sufficient enough, (e.g., the Liquidity Coverage Ratio falls below 100%) the bank could stop lending or buy high quality liquid assets

2. Having the adequate framework to store data, models, and scenarios

'Several firms emphasized the need to improve the applicability of forward-looking scenario analysis to the business practices of the firm. […] System flexibility was cited as crucial, although some firms may not have had sufficiently flexible systems to handle customized scenarios and stress tests'. (Senior Supervisors Group, 2008)

The main types of risk have different risk drivers, time horizons, and metrics, making integrating everything complex. That is why it is necessary to have a framework and a methodology. A framework often does not exist in banks because risk management is typically organised by a silo-based approach. Building a framework leads to internal political discussions, which determine who is in charge and what priority is given to the unified project. Banks implement this type of project when senior management realises that risk appetite can only be defined for the entire balance sheet, not just for a single risk department. In this case, a bank would create a team to define the different needs of each department (risk, finance, treasury, capital management, etc.).

The workflow concept is an important requirement for trading portfolios and is also relevant for balance sheet management. In a world where decisions must be made by the right person at the right moment in the right market, information that travels lightning fast through an organisation is beneficial. This is indeed the case for limit monitoring and the origination process.

Integrating different risks in a single framework greatly benefits all financial institutions – leading to better communication, risk assessment, and long-term performance. Most financial institutions started working on a framework because of regulatory pressure. Senior management, however, also does not want to discover that their institution became bankrupt overnight because the balance sheet of a subsidiary abroad was insufficiently analysed. They now see the real benefits of having a system that can quickly provide the information required to make the right decision at the right time.

Integrated stress testing tools can achieve this goal. Unfortunately, this is not an easy task. The people building a framework must not focus too much on the details. They must acknowledge the limitations and try not to create an ultimate model that will never exist. They must also accept that each person in a bank has a field of expertise and can help in the design of the global framework. This is a team effort which will provide a real-time big picture of their institution under different stressed scenarios. The outcome is for senior management to know all the options to better define their strategy and the risk appetite of their financial institution; thus increasing the long-term profitability of shareholders.

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WHY DOES MY BUSINESS NEED STRESS TESTING BEYOND REGULATORY COMPLIANCE?

By Charles Stewart

Charles Stewart
Senior Director

Drawing on thirty years of financial services experience, Charles helps commercial and corporate banks around the world develop their risk management plans and strategies.

With regulators pushing for investment in stress testing, this is an opportunity for many bankers to change the way the business does its bottom-up planning, monitoring, and control.

Which came first, the chicken or the egg? Did regulators invent stress testing for banks, or has the banking community always undertaken it?

Despite any 'official' answers, there still seems to be an element of debate, or denial, in connection with both questions. People like to pretend there is a degree of uncertainty, and many answers may be correct in some circumstances. Either way, to debate the correctness of a given response is to miss the point.

A lack of preparation

There is no doubt that the crisis that started in 2007, and which evolved into the economic downturn, took banks by surprise. Worse, most financial institutions (the 'egg' for our purposes) were ill-prepared for such a turn of events, and initially had no idea how to react. Each day brought new and unwelcome surprises. With each new revelation, there would be a collective sigh of incredulity from the public at large. In short, banks were unprepared, not just for the specific circumstances of this particular crisis, but also generally for managing an evolving set of stress events.

The regulators (the 'chicken' in this illustration) have targeted this lack of preparedness with their stress testing programmes. Regulators need to assess the impact of different scenarios on the wider economy, as a component of their macro-prudential supervision. They also want to avoid the institution-specific ignorance that prevailed at the heart of the financial crisis. By forcing banks to undertake stress testing, they are raising standards within and across the industry, for both macro- and micro-prudential purposes.

Frustrations over strained resources

The banks' need to allocate the additional resources (human and technical) in order to comply with these regulatory requirements is inevitably a source of resentment. At a time of change and cost constraint, the additional burden is an unwelcome overhead. But when banks reflect on whether such frustration is with the regulators, or whether it is with their own inability to respond, it usually turns out to be largely the latter.

Banks are gradually discovering that these competencies add value for their own purposes. Indeed, stress testing, or at least scenario analysis, is something that has always occurred in banks – just not on a scale or to a level of sophistication that is commensurate with what is now increasingly recognised as necessary. So they are therefore finding that the new, additional capabilities help with both day-to-day management of enterprise risk and also with the planning and monitoring processes.

The 'what ifs…?'

Daily decisions within banks regularly take scenario analysis in to consideration. At the most basic level, credit analysis is all about 'what if…?': What if the client fails? What if the customer loses their job? What if they do not win that critical contract? What if the key employee/

director of a corporate client leaves? Are there enough reserves within this corporate client to allow it to weather a downturn?

At the other extreme, the annual medium-term planning round is about working out the best strategy for capital and resource allocation over the period ahead, in light of what has happened over the last 12 months, and considering different scenarios for what might happen over the next three to five years. All this is a form of stress testing; i.e., considering the outcome for individual situations (whether in respect of customers, business units, or across the enterprise as a whole, and whether for credit risk, liquidity risk, market risk, operational risk, or any of the other risks encountered by a bank) in light of prevailing and anticipated scenarios.

Aggregating scenarios: the real challenge

The key ingredient missing from such routine and traditional stress analysis is 'aggregation'. The real challenge is aggregating scenarios for individual borrowers, liquidity positions, or capital requirements. In short, this is about bottom-up information analysis; taking individual data, combining it with other data, modelling it to transform it into meaningful information, and then further aggregating it for business intelligence purposes.

Banks have long known that such business intelligence would mean the planning process is much better informed. Armed with such insights, the key areas of stress analysis – the quantification of risk appetite, allocation of capital, targeting of an appropriate balance between risk and reward, funding / liquidity planning, asset and liability management, etc. – would all be much more robust.

What is missing and why?

Because the necessary capabilities for all this have been missing, banks have not had, in turn, a robust platform from which to then assess how to manage the consequences of different stress scenarios. Nor have they had the ingredients for defining early warning indicators. So monitoring the evolution of the balance sheet or P&L, and spotting signs of deterioration (or at least change) early enough in the cycle to allow corrective levers to be pulled, has been a process of trial and error.

The reason these competencies have been missing is twofold. On the one hand, the technology – the necessary measures and associated computing power – has only been around for the last ten or fifteen years. On the other hand, there have been (and continue to be) so many other competing pressures for investment spend that, certainly in a period of growth, the business case for other demands on available resources (e.g., customer service, product, or market share) was deemed the priority.

The key ingredient missing from such routine and traditional stress analysis is 'aggregation'. The real challenge is aggregating scenarios for individual borrowers, liquidity positions, or capital requirements.

A window of opportunity for greater stress testing investment

Which is why, with regulators forcing the pace on investment in stress testing, this is an opportunity that many bankers relish: the chance to change the way the business does its bottom-up planning, monitoring, and control, with a clear conscience. In the past, those with a responsibility for risk management within the organisation, from board level downward, might have wished for more resources in order to undertake such bottom-up analysis. Today, with banks being required to deliver on these things for regulatory compliance purposes, there is a window of opportunity for these wishes to come true. This is about the prioritisation of resources. Whilst historically the business benefits of stress testing might have been recognised, now the investment in the necessary competencies can

be legitimately prioritised. Many rightly argue that the banks that implement these capabilities will be arming themselves with clear competitive advantages.

Ultimately, there is one overarching benefit to a greater investment in stress testing capabilities for internal business purposes (as opposed to regulatory compliance purposes). Banks generally exist in order to provide a return to their owners, the shareholders. Shareholders generally require returns that are robust, growing, and sustainable. They also want to have faith in the business management to deliver on these things. That faith is underpinned by transparency of information and by a strong track record. Stress testing for internal management purposes is ultimately about the generation of such business intelligence. It supports transparency and, if acted upon (with the right governance, and with appropriate monitoring and controls so that the consequences of evolving and often unexpected change can be acted upon), ensures that the track record is clearly in evidence.

A changing approach to risk management

To summarise, whilst the banking community has always undertaken forms of stress testing, the recent regulatory emphasis on it as an organisational competency is changing the way banks approach the management of risk across the enterprise. This benefits the banks, their shareholders, and also the wider economy.

As for the case of the chicken and egg, science suggests that it is the egg that came first; it is not possible to genetically modify a living/breathing creature (at least, not without modern science), and therefore the evolution of the chicken into the form currently recognised in nature has to have been through a process of mutation or modification during growth in the egg. And yet the debate will continue…

> With regulators forcing the pace on investment in stress testing, this is an opportunity that many bankers relish: the chance to change the way the business does its bottom-up planning, monitoring, and control, with a clear conscience.

REGULATORY SPOTLIGHT

This section addresses the lessons learned from the stress tests and how upcoming regulatory updates will impact banks, including the AQR.

THE EVOLUTION OF STRESS TESTING IN EUROPE

By Wilfrid Xoual

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Given the history of stress testing, this article examines some of the underlying causes and lessons learned so far from the various exercises, and how that has led to our current situation.

The new context of stress tests

Until the financial crisis of 2008, regulatory stress testing practices in financial institutions were mainly limited to banks following the Internal Rating-Based Approach for Capital Requirements for Credit Risk under Basel II, and as part of the 1995 Market Risk Amendment to the Basel Capital Requirements. Banks were required to stress test their internal rating models under different scenarios like economic downturns, market risk events, or liquidity conditions.

BCBS publication on principles

In its May 2009 publication on the implementation of stress testing principles, the Basel Committee on Banking Supervision (BCBS) described what went wrong with stress testing during the financial crisis. Following banks' failure to provide a proper advanced warning regarding their risk exposures, the BCBS outlined how banks and local regulators should approach stress testing going forward. The BCBS listed several areas to address:

- **'Use of stress testing and integration in risk governance':**
  Though well developed in some banks, stress tests were often conducted separately from other risk assessments and were not included in a global risk framework. Senior management was not involved enough. A global aggregation of stress test results was nonexistent.
- **'Stress testing methodologies':**
  Banks lacked a firm-wide approach and relied too much on models calibrated on historical data.
- **'Scenario selections':**
  Scenarios were not severe enough and missing correlations impacted results. They were often done at a business level and were not related to capital adequacy and liquidity (mostly assessing potential losses).
- **'Stress testing of specific risks and products':**
  New complex products or strategies were not really covered (e.g., structured finance, securitisation, and complex hedging strategies). Counterparty credit risk, liquidity, and contingent risk (e.g., funding constraints, contractual obligations, and reputation) were not really tested.

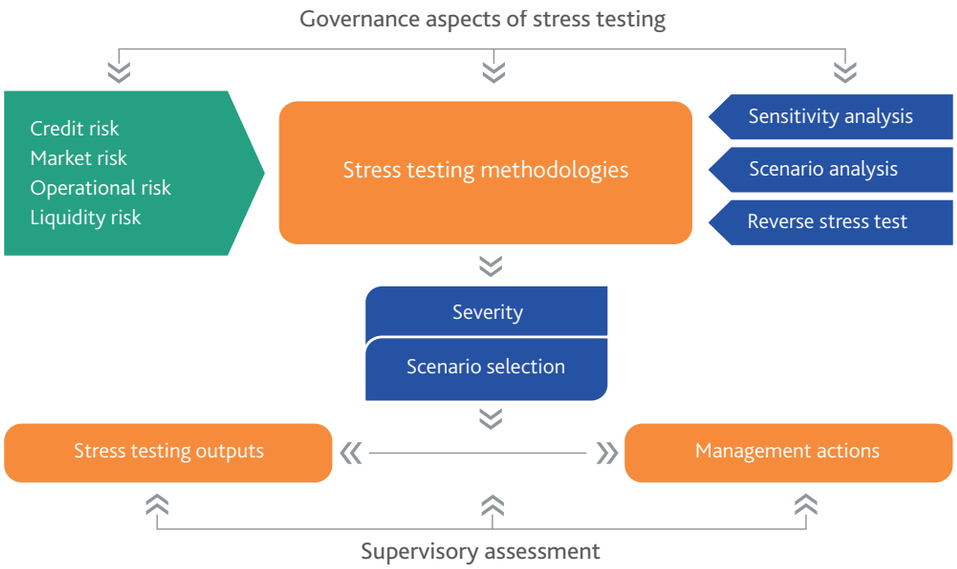
CEBS guidelines on stress tests

The BCBS publication led the Committee of European Banking Supervisors (CEBS) – which eventually became the European Banking Authority (EBA) – to establish a target date for the implementation of these principles. The principles were to be implemented at the local institution-level by mid-2010[1]. They left room for interpretation by local supervisors.

Figure 1, extracted from an EBA presentation, synthesizes the new global 'building blocks' approach advocated by the European regulators.

In its document, the CEBS described 17 guidelines for banks to address these shortfalls. The document also included seven other guidelines dedicated to local regulators, aimed at providing transparency to banks in order to help them

Figure 1 EBA stress testing programme



Source: EBA 2012[2]

understand the reasoning behind the required modification to the stress testing approach.

Transparency and effectiveness across the pond

The US Supervisory Capital Assessment Programme (SCAP) in 2009 was the first of the major regulatory stress testing programmes required of banks after the 2008 financial crisis.

The SCAP test architecture had two new key elements: it created a credible backstop for failing institutions and a new disclosure paradigm. As a result, it provided reassurance that the test was credible and was therefore well received by the market. Ultimately, it was successful in establishing a framework to evaluate systemic risk that was the model for future testing.

During interviews in the beginning of 2013, market participants stated that the amount of regulatory stress testing requirements could represent up to 80% of their resources involved in stress testing internally.

The primary reasons for requiring this stress test were to restore confidence and calm in the financial system by bringing transparency to bank balance sheets in terms of the 'true value' of structured products.

It resulted in the need for 11 out of the 19 participating banks to raise US$75 billion of additional capital. SCAP was successful at reassuring the markets and it also initiated a process in which the 19 participating banks increased their common equity by more than US$300 billion through the end of 2010.

In 2011, the Federal Reserve System (the Fed) initiated for the biggest banks the Comprehensive Capital Analysis and Review (CCAR), which started the next generation of comprehensive regulatory stress tests. This exercise also involves macroeconomic scenario and capital planning.

CCAR is a forward-looking exercise that gives a detailed view on capital and risk for the coming two years. For each quarter, the profit and loss is determined under macroeconomic scenarios defined by the supervisors and the new balance sheet is rebuilt. Most importantly is the requirement that failing banks are not authorised

to pay dividends nor execute shares buybacks. As such, CCAR is strictly adhered to by the banking industry.

EU-wide stress testing campaigns: 2009 to 2011

Whilst the SCAP was underway in the US, European regulators began the task of defining their own set of stress testing parameters coordinated by CEBS. In 2009, CEBS started its first EU-wide stress test. The purpose of this stress test was to assess the EU banking industry in aggregate, leaving the individual bank assessment with each national supervisor. Initially, the results were to remain confidential. In the end, however, the aggregated results were published[3].

The results were not perceived to be transparent enough for investors. Therefore in 2010, the CEBS launched a new 'bottom-up' stress test approach. The Capital Adequacy EU-wide stress testing campaigns covered up to 91 banks and represented 65% of the EU banking system or more than 50% of the overall banking assets from 27 member countries.

The aim was similar to what the successive stress tests campaigns did for the US market. The results seemed promising as the regulatory capital shortfall was only €3.4 billion. However, criticisms surfaced when the European Central Bank and IMF (International Monetary Fund) bailed out Irish banks in November 2010 – banks that had previously passed the stress test. Ultimately, this campaign failed because it was seen as not helping market participants understand real risk exposures within the macroeconomic context of Europe at that time. Critics also felt that it did not answer the basic question of what specific regulatory actions were needed in order to address banks' weaknesses.

The 2011 EBA stress tests were even more transparent, providing market participants with a massive level of detailed information about banks' exposures (more than 3000 data points). Once again, the results seemed accurate (a €2.5 billion shortfall on regulatory capital), but they were also discredited later that year. First, in August 2011, when the IMF's head, Christine Lagarde, was quoted as saying that 'EU banks need urgent recapitalization' estimated at €200 billion. Doubts surfaced a second time in December 2011 when Dexia N.V./S.A, a Franco-Belgian bank that had successfully passed the test, collapsed.

Basel committee on banking supervision peer review

In April 2012, the BCBS, as part of its mandate to assess the implementation of standards across countries and to foster the promotion of good supervisory practices, conducted a peer review of the supervisory authorities' implementation of the principles. One finding of this peer review was that stress tests were being used for a wider range of purposes by supervisors and authorities, such as setting minimum capital requirements, determining explicit capital buffers, and limiting capital distributions by banks.

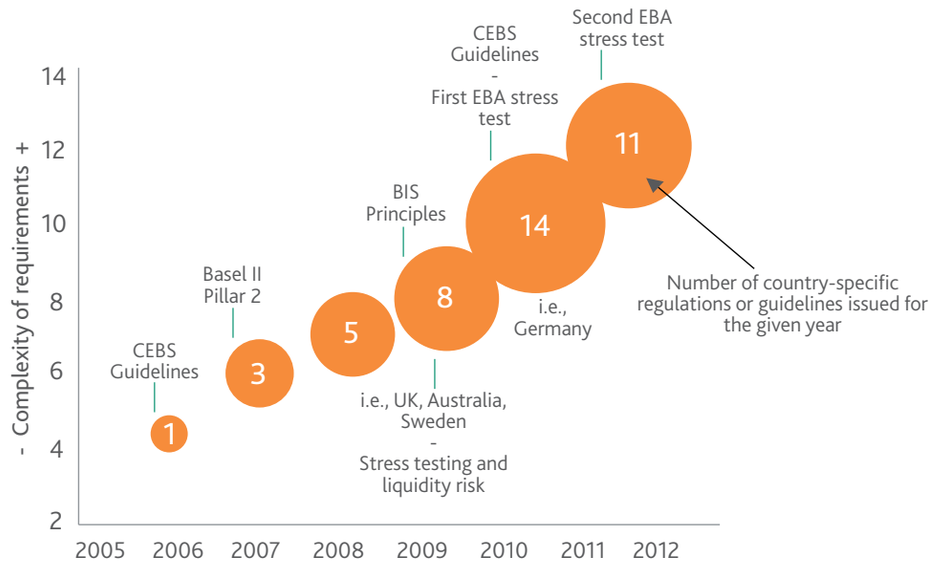
> A regulatory imposed stress test cannot replace individual stress tests that are tailor-made for the specific idiosyncratic risks of individual banks, which is why large banks have significantly reinforced their internal process and improved efficiency in their forward-looking approach.

Furthermore, the stress test results were used (both with and without success) to restore financial stability by reducing opacity in a bank's activities through disclosure, to calm markets, and inspire trust in the banking system of various jurisdictions.

System-wide stress testing exercises

During and following the publication of these 17 global stress testing guidelines, US and European regulators launched system-wide stress testing exercises to assess the potential capital shortfalls in case of a macroeconomic aggravation. Figure 2 illustrates the number of new regulations created following the financial crisis.

Figure 2 Regulatory pressure has increased substantially since 2009 with the emergence of global and local regulations



Source: Moody's Analytics EMEA Market research 2011

During interviews in the beginning of 2013, market participants stated that the amount of regulatory stress testing requirements could represent up to 80% of their resources involved in stress testing internally.

At the same time, they recognised that the new interest and visibility sparked by these system-wide exercises helped to improve the efficiency of the stress testing framework internally, as senior management could not avoid being involved and accountable. An example unearthed during these discussions was that a very large institution had previously discarded supervisory stress tests exercises as a mere 'check-the-box constraint' and suddenly and forcibly had to reconsider its entire risk framework following a bad stress test report from its local regulator.

A regulatory imposed stress test cannot replace individual stress tests that are tailor-made for the specific idiosyncratic risks of individual banks, which is why large banks have significantly reinforced their internal process and improved efficiency in their forward-looking approach.

Prior to the crisis, risk managers in charge of stress testing encountered resistance and difficulty pressing severe stresses into the process as senior management was not receptive. This has definitely changed.

Coping with the new stress test paradigm

With the tremendous increase in the number of regulations and guidelines between 2007 and 2011 and the growing complexity of implementation, banks were required to rapidly adapt their current approach to risk management and their existing level of compliance.

Banks dealt with the regulatory implementation complexity via a segmented approach, based on their size and the degree of intrusiveness by the local regulator pre- and post-crisis. As an example, large UK banks are probably the most advanced in Europe in terms of developing an integrated stress testing framework post-crisis. This includes a liquidity angle due to the size of the banking institutions and the extent of regulator involvement during this period.

Stress testing has become an integrated part of the risk appetite definition process for banks. It moved from a tactical, silo-based risk assessment tool used by business lines and risk managers, to a strategic input into the global business plan of a bank with full visibility from board and executive directors. Yet, due to the broad impact

to many components of the organisational structure of a bank, this strategic transition cannot happen overnight.

How stress tests have changed in the US and Europe

Whilst the concept of a stress test is nothing new, it is clear from an analysis of the historical stress tests conducted from 2009-2012 that stress testing has adapted to the increased need for transparency. The evolution and application of stress testing resulted from lessons learned from each test. Test parameters have had significant implications on the overall success or failure of the tests, such as:

- The purpose and methodology for the tests
- The economic climate
- The severity of scenarios chosen
- The consistency of the framework within the test group
- The certainty of a credible backstop for those banks failing the tests
- The disclosure of this information to the marketplace by regulators

As banks continue to see changes in the regulatory landscape, further refinements to stress test requirements are expected.

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EU STRESS TESTING REGULATORY UPDATE

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What is the impact of upcoming regulatory stress tests on banks' organisations, including those from the EBA and PRA, and data management, modelling, reporting, and automation challenges?

'Stress testing must involve identifying possible events or future changes in economic conditions that could have unfavourable effects on a bank's credit exposures and assessment of the bank's ability to withstand such changes.' (bcbs128, art. 434[1]).

Regulatory requirements to report capital plans under a set of stress scenarios are increasing. As such, financial institutions are required to adapt their internal organisation toward enterprise-wide risk management and capital planning, which involves advanced modelling, data management, and reporting tools. Granularity, consistency, and communication across departments are the key stress testing challenges that financial institutions face in the coming years. Success is contingent upon overcoming these challenges whilst involving senior management.

This process is not without difficulties, as banks must overcome numerous hurdles, such as:

- Gathering the correct data at the transaction level
- Developing the right models to translate macroeconomic scenarios into risk parameters
- Aggregating and reporting the results of the stress testing exercise
- Transforming quantitative results into concrete short-term corrective actions to help senior managers make more informed decisions

Redefining a stress testing approach

As banks adopt and support regulatory stress testing exercises, the benefits of aligning their business needs with the regulators' requirements become clear. For instance, some large banks currently in the process of adapting their processes to meet these requirements are also redefining their approach to stress tests. Up until recently, bank operating models allocated part-time resources to various sections of a stress test exercise. Typically, these resources maintained reporting affiliations to different divisions, teaming up only when a (regulatory) stress test cycle was required. Now, banks are building dedicated teams to cover all aspects of stress testing with the goal of developing a lean, automated, and common set of tools and processes.

Banks will still have to address what they see as the most difficult steps in developing quality idiosyncratic stress tests:

- Defining adequate scenarios
- Accessing the right data
- Properly modelling correlations with risk factors
- Effectively reporting the results

What should we expect in the United Kingdom?

It appears that the UK Prudential Regulation Authority (PRA) is keen to follow the practices of the US Federal Reserve. By the end of this year, UK regulators are expected to ask systemically

important financial institutions (SIFIs) to send regulatory reports in the XML format with granular risk data and provision information on their portfolios. This policy is called the Firm Data Submission Framework (FDSF). PRA will use the data for two purposes: to perform its own stress test and a risk assessment of an individual financial institution and to conduct a global systemic risk analysis of the UK banking sector.

Once a year, each institution will be asked to send 'projections reports' to the regulator, including a five-year forecast, in accordance with various stress scenarios. PRA will then compare the results of each institution to its own assessment and challenge any significant discrepancies. It is expected that institutions will have a year to explain the differences between last year's forecast and the actual results.

This initiative requires that these institutions have data gathering platforms to pull the data with the required granularity and to report it in the XML format. Also, institutions will need to make their stress testing framework more robust to ensure they are validated by supervisors.

The Bank of England Financial Policy Committee has also recommended that the stress testing initiative be extended to the whole UK banking system. *'Looking to 2014 and beyond, the Bank and PRA should develop proposals for regular stress testing of the UK banking system. The purpose of those tests would be to assess the system's capital adequacy. The framework should be able to accommodate any judgements by the Committee on emerging threats to financial stability'.* [2]

The stress tests are forward-looking and *'will play an important part in the PRA's judgements about a firm's financial soundness... Stress tests will not be 'pass/fail' exercises, but will instead be used to assess the balance of risks arising'* .[3]

European Banking Authority stress tests, again?

In the European Union (EU), major banks will first have to support an Asset Quality Review (AQR) toward the end of the year.[4] Although this initiative would typically be led by national regulators, the EBA's aim is to harmonise methodologies, practices, and communications around these exercises. The purpose of this initiative is to classify and valuate assets held by banks to 'dispel concerns over the deterioration of asset quality due to macroeconomic conditions in Europe'.

The timeline of this initiative is highly correlated with European Central Bank's (ECB) Single Supervisor Mechanism (SSM) role. One of the consequences of this AQR initiative is to postpone the EU-wide stress test to 2014. However, to ensure consistency with previous years, the EBA will still provide information on the actual exposures of EU banks. For more information about the AQR, read the article later in this publication, titled: 'Asset Quality Review: Setting the Foundation for a Standard Stress Testing Framework'. Many uncertainties remain in the EBA's 2014 stress test. First, the capital definition of Core Tier 1 could still be the Basel 2.5 risk-weighted asset (RWA) (Tier 1 excluding hybrids) versus a Capital Requirements Directives (CRD) IV definition. Also, it is not clear if the stress testing of regulatory capital will be based on Basel 2.5, Basel III transitional, or Basel III fully phased. Therefore, it is recommended that banks create flexible regulatory capital platforms. Finally, liquidity risk may now be part of the stress testing framework, which of course provides more comprehensive results but also requires more enterprise-wide platforms.

The EBA may request various credit risk metrics sensitivity analyses (not a pass/fail exercise). The EBA may also introduce ceilings and floors

> Now, banks are building dedicated teams to cover all aspects of stress testing with the goal of developing a lean, automated, and common set of tools and processes.

in order to ensure consistency across modelling approaches and jurisdictions.

The impact of regulatory stress testing on banks' organisations

As seen in the US with the CCAR initiative, EU supervisors will now require that financial institutions produce forward-looking stress tests, taking into account all types of risks and forecasts for their portfolios. This will require tremendous organisational changes, as these stress testing exercises will involve the risk management, treasury, and capital planning departments. One solution is that banks have a dedicated department working on stress testing, which could then challenge the risk departments on their systems and models. This stress testing department would act as an internal auditor.

The banks face multiple challenges:

- **Data management**: Financial institutions will need to centralise all the data necessary to support stress testing models, as well as regulatory and internal reporting requirements. This system should also be able to reconcile its data with production systems to ensure result consistency. Therefore, this approach requires an enterprise-wide datamart oriented on risk and financial management. The datamart would be the data source for all risk engines, capital planning, and stress testing tools.
- **Models**: Internal models will be increasingly challenged by supervisors in the stress testing exercises. Banks will need to be able to document and maintain their bottom-up and/or top-down models and be consistent over time.
- **Reporting**: Supervisors will require more and more frequent stress testing and reporting. Financial institutions are required to publish monthly, quarterly, and annual reports in the required format. This in turn requires an automated reporting tool that can produce regulatory reports efficiently, but be flexible enough to audit and adjust those reports. Reconciliation between reports will be paramount. The reporting tools should also be able to keep pace with the regulations. There have been, for instance, several updates per year across jurisdictions (e.g., CCAR in the US) and asset classes.
- **Stress testing automation**: Financial institutions will need software to coordinate and centralise the stress testing process to keep consistent scenario and modelling assumptions across the balance sheet, as well as deploy and maintain a large quantity of models (e.g., periodic recalibration). The stress tests should be automated so banks can run more scenarios (e.g., business-specific scenarios). Finally, properly controlled expert judgment should generally be allowed to overwrite models on specific counterparties when real-life conditions require. Thus, stress testing automation should manage users, through workflow, auditing, and tracking.

The next EU stress testing campaign

Initially planned for this past summer, the new EBA EU-wide stress test has been postponed to allow for an Asset Quality Review to be launched for all banks being transferred to the ECB supervision mid-2014.

This requirement will most certainly reinforce the usage of stress tests by regulators, and will likely push European banks to develop a more robust framework (quantitative and qualitative), as currently seen in the US following the implementation of the Dodd-Frank Annual Stress Test (DFAST) and the third occurrence of the Comprehensive Capital Analysis Review (CCAR).

These ongoing changes represent an increasing challenge for European banks, already overwhelmed by waves of new regulations.

It is recommended that banks create flexible regulatory capital platforms.

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ASSET QUALITY REVIEW:

SETTING THE FOUNDATION FOR A STANDARD STRESS TESTING FRAMEWORK

By Alessio Balduini

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Alessio helps clients address their credit risk regulatory architectures, providing insight about quantitative models, data, and software for risk management.

The AQR will set the foundation for a new global standard for stress testing that will be the immediate next step for the ECB.

Following the EU Parliament's approval, the Single Supervisory Mechanism (SSM) will be introduced with the goal of strengthening the banking system. Many academics and practitioners agree that a single regulatory approach is a pre-condition of market stability, as capital will simply move to less regulated environments without it. Under the proposed scheme, the European Central Bank (ECB) will regulate 80% of all banking assets across the EU.

However, an asset quality review (AQR) of all the banks will need to be performed before the ECB assumes full regulatory responsibility in 2014 and before the stress testing of the 140 banks is carried out.

Factors driving the AQR

This requirement is driven by a few factors. First, there was a stark difference between the Supervisory Capital Assessment Programme (SCAP) test performed by the Fed in 2009 and what the Committee of European Banking Supervisors (CEBS) performed in 2010-11. The latter was initially perceived as insufficient on a number of fronts, such as disclosures of banks' assets, scenarios performed, and capital required. New funding for the capital levels for the banking system was $75 billion in the US and $3.5 billion in the EU. The divergence was even greater considering that 19 of the banks were in the US, whilst there were 91 in the EU. The CEBS's test looked even worse when Irish banks were forced to ask for a lifeline from the ECB to continue to operate within a few months after passing the test.

Next, to overcome its crisis of credibility and re-establish the trust of investors, Ireland had to set up a very granular AQR that had a degree of disclosure similar to what was realised with the SCAP.

Table 1 Asset Quality Reviews

Objective	Review of European banks' balance sheets		
Supervisor in charge and target markets	ECB	17 Euro countries joining the Banking Union (~140 banks)	Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain
	National banking regulators	10 remaining EU members	Bulgaria, Czech Republic, Denmark, Hungary, Latvia, Lithuania, Poland, Romania, Sweden, United Kingdom
Timeline	Expected between Q3 2013 and Q1 2014		

Source: EBA, controlbanking.com, Moody's Analytics

Table 2 Recent Asset Quality Reviews and Portfolios Scrutinised

Country	Timeline	Target	Residential Mortgage	Consumer Loans	CRE	Corporate	SME	Other Retail	Other Corporate
Ireland	Jan-Mar 2011	4 largest banks	✓	✓	✓	✓	✓	✓	
Greece	Aug-Dec 2011	18 banks	✓	✓	✓	✓	✓		✓[1]
Spain	May-Jun 2012	14 largest banks	✓	✓		✓	✓	✓	✓[2]
Cyprus	Sep-Jan 2013	22 banks	✓	✓	✓	✓	✓		
Portugal	Jul-Nov 2011	8 largest domestic banks	Information not available						

Source: The Financial Measures Programme Report, Central Bank of Ireland (March 2011); Diagnostic Assessment of Greek Banks, BlackRock (December 2011); Asset quality review and bottom-up stress test exercise, Oliver Wyman (2012), Independent due diligence of the banking system of Cyprus, PIMCO (March 2013); Financial stability measures of the Economic and Financial Assistance Programme to Portugal, Bank of Portugal (April 2012). Moody's Analytics.

Finally, the European Banking Authority (EBA) Stress Test performed in 2011 examined 90 banks and although the capital level required of the banks was not vastly different from the CEBS's recommendations, the level of granularity and disclosure was much greater and similar to the SCAP-Irish AQR.

A bottom-up approach

In contrast to the EBA's stress test (which remains a top-down approach), the granular AQR, as anticipated by some senior officials, will be bottom-up. This will also reflect a substantial alignment with the more recent AQRs performed in Greece, Spain, Cyprus, and Portugal (see Table 2). The latter's exercises scrutinised those portfolios that faced the greatest credit deterioration during the crisis: e.g., largely corporate commercial real estate, but also mortgages, consumer loans, and small and medium enterprises (SMEs).

The definition of Performing and Non-performing Loans

The major key issue for the AQRs resides in the definition of performing and non-performing loans (NPLs). In the assessment conducted in Spain, the regulator defined three levels, which required provisions of 0%, 15% and 45%, respectively:

1. Performing
2. Sub-standard
3. Non-performing

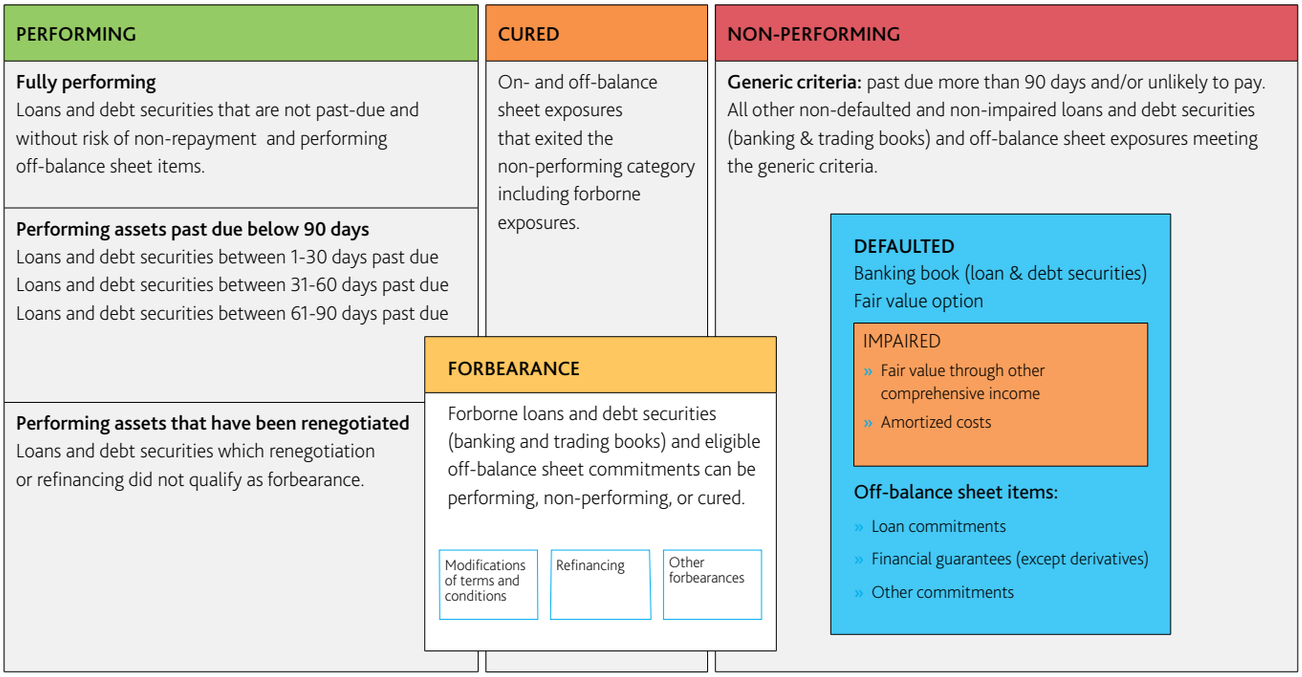
Experts concurred that the three-level granularity could, under stressed scenarios, lead to an excessive amount of migration from one level to the another.

As there is no pan-European standard definition of an NPL, the EBA submitted a consultation paper in March 2013: *Implementing technical standards on supervisory reporting on forbearance and non-performing exposures under article 95 of the draft Capital Requirements Regulation.* The consultation ended on 24 June and the outcome will likely represent the first key regulatory tool to help the ECB guide banks during the AQR.

In the paper, the EBA sought consultation on two definitions and templates (see Figure 1, which is from the draft of the EBA's paper) to define the notions of forbearance and non-performing exposures on one side, and to acquire and store the related data on the other.

> Now, banks are building dedicated teams to cover all aspects of stress testing with the goal of developing a lean, automated, and common set of tools and processes.

Figure 1 EBA Definitions and Templates



Source: EBA Consultation Paper on Draft Implementing Technical Standards on Supervisory reporting on forbearance and non-performing exposures under article 95 of the draft Capital Requirements Directive Regulation (26 March 2013). Final guidelines are expected in Q3 2013. Financial Instruments Directive; UCITS: Undertakings for Collective Investment in Transferable Securities

The latter will have a sizable impact in terms of implementation costs. For example, IT-database systems will have to be modified to adapt to the new definitions and to capture and monitor the data over time. Operations, internal procedures and reporting will also need to be adjusted in line with different levels of provisioning management and the impact on capitals levels.

The AQR and the drafting of definitions and templates will set the foundation for a new global standard for stress testing that will be the immediate next step for the ECB. These standards will also give the ECB's supervisory role much greater credibility when the banking sector and investors need it most.

The AQR and the drafting of definitions and templates will set the foundation for a new global standard for stress testing that will be the immediate next step for the ECB. These standards will also give the ECB's supervisory role much greater credibility when the banking sector and investors need it most.

1 Shipping & Small Business Professional

2 Real estate developers

REGULATORY RADAR

By Sandrine Prioux and María C. Cañamero

The Moody's Analytics Regulatory Radar is a proprietary tool developed to monitor regulations in the immediate and medium term, across market segments and jurisdictions.

This version provides an overview of key rules and regulatory guidelines recently published across Europe in several segments of the financial services industry, including banking, insurance, buy-side, and others.

The radius of the semi-circumference represents the timeline that goes from 2013 at the centre, to 2017 at the outer border. The regulations are grouped by market segments: insurance regulations are positioned on the left inside of the radar, banking regulations are shown at the centre, and buy-side and other regulations are displayed on the right inside of the radar. Flags are used to represent the jurisdiction(s) where the regulation or guideline is to be applied.

Source: Moody's Analytics primary market research and analysis

Legend SII: EU Solvency II; SST: Swiss Solvency Test; BMA: Bermuda Monetary Authority regulation; P2, P3: Pillar 2, Pillar 3 Solvency II; ICAS+: UK Internal Capital Assessment; IFRS: International Financial Reporting Standards; CRDIV: Capital Requirements Directive (Basel 3 EU); AIFM: Alternative Investment Fund Directive; EMIR: European Market Infrastructure Regulation; MIFIR: Markets in Financial Instruments Directive; UCITS: Undertakings for Collective Investment in Transferable Securities

STRESS TESTING DISCLOSURES IN EUROPE

AN INTERVIEW WITH WILFRID XOUAL

Wilfrid Xoual
Senior Director - Head of Business Development (EMEA)

Wilfrid leads a team of experienced industry professionals responsible for helping EMEA financial institutions address their global risk management needs and regulatory issues.

Learn how the next stress testing disclosures will play a critical role in Europe, including a comparison of the US and UK, what banks should disclose and when, and lessons learned.

Why have the disclosures worked in the US and not in Europe?

It's an interesting question. I believe the approach was much more pragmatic in the US, meaningful goals were established and communicated, and outcomes were outlined. Most importantly, a financial backstop was put in place to assist any banks that failed the tests and to support restructuring and recapitalisation. The Fed has also focused on the quality of data underpinning the banks' stress testing and has been running their own models and comparing the results with those of the banks.

The market understood the need to reduce systemic risk and market participants were pleased with the results, despite the fact that some real capital adequacy issues came to light. In the end, banks raised $75 billion of new capital, and systemic risk was significantly reduced.

In Europe, the goal was similar but the complexity of having so many countries and regulators working together, all whilst doing the exercise for the first time during the sovereign crisis, made the process more difficult. Ultimately, the exercise failed to reassure the markets. In the end, with no backstop and a lack of clear objectives, the disclosures created confusion and the desired result was not achieved.

What information should banks disclose and when?

The 'when' question is important. In times of crisis, reassuring the markets is critical. In order to do that, banks need to not only provide information that adds value, but also need to be seen as addressing the issues that market participants view as vital and relevant. Communicating a clear message and providing scenarios can be relatively painful for banks. However, it is important to be explicit and realistic, whilst tackling issues head on. In times of financial stability, providing aggregated results is often sufficient to confirm market expectations. Now that banks are required to be more explicit in their disclosures, the results should be sufficient to confirm market expectations.

What is the impact of the recommendation of the Enhanced Disclosure Task Force?

It is interesting to observe this impact. So far, regulatory pressure has forced banks to develop a stress testing framework, particularly because banks want to simulate pre-regulatory exercises and the impact of adverse scenarios on their regulatory capital ratio. We have observed this trend in discussions with banks and confirmed it through the various surveys Moody's Analytics conducted in the US and Europe.

Right now, banks understand that in order to restore their reputations they need to disclose more information. The role of the Enhanced Disclosure Task Force, sponsored by the FSB (Financial Stability Board), is to help establish some form of industry reporting best practices to help ensure this disclosure occurs. The group is unique in its variety of market participants – rating agencies, banks, investors, analysts –

and together they will define what the banks should be disclosing, preferably in a standardised form. We have been advising our bank clients to closely follow the Task Force's progress and published documents.

How should banks respond to the Task Force's recommendations?

The approach is still flexible. Moody's Analytics has discussed the recommendations with some of the group's members and they are keen to implement the recommendations rapidly, particularly the large banks. At the same time, members want to reassure and stabilise the markets by disclosing relevant and appropriate information, whilst maintaining a level playing field and reducing volatility by avoiding the over-disclosure of sensitive information. This outcome would help banks not only understand the expectations of market participants, but also focus on key business elements that should be addressed to disclose the necessary transparent and granular information.

It seems that we are headed toward a US-type of framework in Europe. In the UK, the Bank of England (BoE) and the Prudential Regulation Authority (PRA) are planning on developing a new recurrent stress testing of the UK banking system, similar to CCAR in the US. The Spanish regulator seems to be inclined to follow a similar approach. Finally, banks will probably lose part of the benefits of having been supervised by their local central bank, so they may expect a tougher stance and stricter application of the regulation.

What are some of the lessons learned about stress test disclosures so far?

Going back to the first question, regarding the comparison between Europe and the US, in my opinion European banks should and could learn a lot from the US. For example, looking at the evolution that took place between the SCAP in 2009 and CCAR sessions up to a few months ago, it is evident that the regulators are using disclosure to orient the market toward their desired outcome, which is greater stability. It is a painful yet necessary exercise.

What is crucial now in Europe is for the banks to not fail the tests in coming months under the new supervisory regime of the ECB.

What does the EBA's delay of stress tests until next year mean for banks? Should they expect any major changes?

The main change is that the European Central Bank (ECB) will take on the role of a single supervisory mechanism (SSM), which is critical in ensuring that any kind of stress testing in the future will be done on reliable balance sheets. The ECB will evaluate the real value of assets and liabilities of all these banks, which is no easy task. What is crucial now in Europe is for the banks to not fail the tests in coming months under the new supervisory regime of the ECB.

It makes sense for the EBA to wait until the SSM is in place, after the evaluation has been done. This would give banks the opportunity to clean up and raise capital before the ECB takes on its new role. It is expected that the ECB will take a strong stance in control and supervision afterwards. This may be difficult to implement but is expected to occur.

In terms of lessons learned, I believe in going back to basics. Without providing clear direction, surprises may occur. This is exactly what has happened in Europe twice already. In 2011, Europe tried to compensate a poorly designed and perceived stress testing exercise by providing too many exposures and information with more than 3000 data points.

This exercise was upsetting for many banks. Although it was used in some cases by analysts to better understand banks' exposures, the volume of information was too high for market participants to use unless they had anticipated that volume of disclosure and had the tools to process it rapidly. Another factor is the need to perform due diligence based on that detailed information. Not all banks had the capabilities to perform the due diligence nor use the information to make more informed decisions.

As for the benefit of disclosure, several academic analyses have been done, based on cumulative abnormal returns, to evaluate the potential impact of the stress tests on banks. It shows that stress test disclosures do add value by reassuring market participants and do raise the value of the banks as it increases returns abnormally, compared to a non-stressed peer group. The benefits cannot be ignored.

What are some of the key stress testing related challenges banks faced in recent months, particularly as they will prepare for the next round of European supervisory stress tests?

In Europe, the complexity of having so many countries trying to cope with the tests at the same time, with the same scenarios, made it very difficult for banks and local regulators. The transformation of the supervisory regime from local regulators controlling their own banks to the wider organisation, the EBA, and soon the ECB, created a lot of frustration. Banks were frustrated not only because the stress testing framework kept evolving whilst banks where trying to produce results, but also because it was difficult to obtain needed clarifications in due time.

Learning from that experience, banks must have the tools and processes that will allow them to adapt seamlessly and follow a moving data and reporting framework. Once again, if the European Banks will have to follow a stress testing pattern similar to what CCAR has imposed on Banks in the US, it is probable that banks will have to gather a massive amount of detailed information to support required simulations and also to feed a central data repository to be used by supervisors to manage financial stability. It is also clear that the CCAR framework is not a set approach but an evolving exercise following market conditions and supervisory trends.

Such an approach is apparently already happening in some countries, like in the UK with the PRA Firm Data Submission Framework (FDSF) for the Systemically Important Financial Institutions (SIFIs).

What role does stress testing play in strategic business planning as a result of the regulatory reform agenda?

In my opinion, the US regulatory reform is a good example of what may happen in Europe. In the US, if a bank fails to pass a stress test, the impact is measured in many areas, such as capital management, business strategy, share buybacks, or compensation. Even the possibility of this outcome motivates shareholders and management to ensure that the tests are done accurately and effectively. I expect that in Europe, banks will follow a similar track.

Banks must have the tools and processes that will allow them to adapt seamlessly and follow a moving data and reporting framework.

SUMMARY OF 2013 COMPREHENSIVE CAPITAL ANALYSIS AND REVIEW AND DODD-FRANK ACT STRESS TESTS

By Thomas Day

Contributors: Cayetano Gea-Carrasco, Michael Fadil, and Anna Krayn

Thomas Day
Senior Director - Regulatory and Risk Solutions

Thomas provides comprehensive risk and advisory solutions to solve complex stress testing, capital planning, and risk management problems for financial organisations worldwide.

This article provides a summary of the 2013 CCAR and Dodd-Frank Act Stress Tests, and compares the results with the 2012 stress tests.

SUMMARY OF DODD-FRANK ACT STRESS TESTS

On 7 March 2013, the US Federal Reserve System released the results of the 2013 Dodd-Frank Act Stress Test (DFAST). As expected, the overall result of the exercise reflects improvement in the capital strength of the industry, with an aggregate Tier 1 common equity of 11.1% versus a 10.1% level for the 2012 stress test results.

In the 2012 stress test results, four banks breached the 5% minimum Tier 1 common equity threshold whilst only one firm – Ally Financial – breached the minimum Tier 1 level in 2013. The post-stress capital levels also improved, with a 7.7% post-stress Tier 1 capital level compared to a 6.3% level in 2012 (see Table 1 below). Overall pre-provision net-revenue (PPNR) levels moved lower year-over-year, with a 2012 level of $294 billion versus a 2013 level of $268 billion. This lower level of earnings strength is attributed to

Table 1 Summary: 2013 versus 2012 Stress Testing Results

	2012	2013
Aggregate Projected Loss	**($534)**	**($462)**
Aggregate PPNR	$294	$268
Other Revenue	$2	$1
Provisions	**($324)**	**($317)**
Securities Losses	**($31)**	**($13)**
Trading and C/P Losses	**($116)**	**($97)**
Other Losses	**($45)**	**($36)**
Aggregate Pre-Tax Net Income	**($220)**	**($194)**
Threshold Breaches	4	1
Tier 1 (beginning)	10.1%	11.1%
Tier 1 (ending)	6.3%	7.7%
Tier 1 Change	-3.8%	-3.4%
THRESHOLD	5	5
Accrual and Trading % of Loss	85.8%	89.5%

Source: Moody's Analytics

lower market interest rates and narrower spreads, a reflection of the continued effort by the Federal Reserve to support broader economic growth through easing monetary policy.

Aggregate portfolio-level loan losses

Regarding aggregate portfolio-level loan losses, the loss rate for 2013 is 7.5% versus an 8.1% level for 2012. The estimated 'severely adverse loss' for the 18 firms comprising the 2013 results was $462 billion, comprised of an estimated $211 billion in consumer loan losses, $97 billion in estimated trading and counterparty losses, $93.4 billion in C&I and CRE losses, and $61 billion in securities and other losses. Notably, over 89% of all losses are driven by the accrual loan portfolio (68%) and potential trading losses (21%).

Loss estimates for loans

Year-over-year, the loss estimates for most loan categories stayed flat or declined, with the notable exception of commercial real estate (CRE) loans. Losses on commercial and industrial (C&I) portfolios declined to 6.8% from 8.2% relative to 2012 results, but remained significantly higher than the historical experience of the banking industry. Though disclosure remained limited, it appeared that the Federal Reserve has adjusted its modelling approach from modelling groups of loans (by industry, credit quality and geography) to a transition path approach specific to given loan type. Within CRE, the loss rate increased from a 5% estimated level in 2012 to a 2013 level of 8%.

Whilst it is difficult to compare loss results due to modelling and economic scenario differences on a year-over-year basis, the rise in expected CRE loss exposure may warrant increased focus for 2013 as US commercial property indices continue to rise and are close to pre-crisis levels. It is also interesting to note that there is a somewhat unintuitive measure coming out of this year's stress test. For the 2013 stress test result, there is a dramatic decline in loss estimates for junior-lien loans and HELOCs. Even whilst first-lien mortgages showed a small increase (20 basis points) in the estimated portfolio loss rate (7.3% to 7.5%), the junior-lien/HELOC portfolio segment showed a full 3.6 percentage point improvement over the 2012 results, moving from 13.2% for 2012 to a much reduced 9.6% level for 2013. With a flat-to-slight increase in first-lien residential mortgage losses, it would be natural to assume a flat-to-higher level of loss for junior lien portfolios and HELOCs. This unintuitive result may, like CRE above, encourage some additional analysis and review to determine the underlying rationale for the significant improvement.

Overall loan balances declined by approximately $99.2 billion year-over-year, with CRE, junior-lien consumer, and HELOC loans leading the decline. Of note, commercial and industrial lending increased at a brisk 8.9% rate even Whilst the loss estimate for this category improved from 8.2% to 6.8%. Given some of the recent market indicators that suggest an increased risk appetite and more aggressive pricing within this segment, evaluating stressed C&I exposure levels at a far more granular level may be prudent for banks experiencing significant growth in this loan category.

$393 billion has been added to Tier 1 common equity since FYE 2008.

Additional notes

It is important to note that the 2012 and 2013 results are not entirely comparable, as both the macroeconomic scenarios and modelling methodologies used for the analysis have changed. This makes it difficult to assess the magnitude of overall improvement in the banks' capital position.

It is also worth noting the disparities between the risk measures submitted by the large banks (for example JP Morgan, Goldman Sachs, and Morgan Stanley) and the Federal Reserve System's (FRS) internal model estimates. For example, Goldman Sachs projected a Tier-1 capital ratio of 8.6% whereas the FRS estimate was 5.8%, under a sharp economic downturn.

Similar differences in the magnitude of impact exist across a number of submissions, indicating material differences in modelling methods and loss and revenue estimates. These disparities highlight the importance of benchmarking results and using multiple, conceptually sound modelling approaches, and the need for model validation that is supported by robust default, recovery, and pre-provision revenue data and analytics.

SUMMARY OF COMPREHENSIVE CAPITAL ANALYSIS AND REVIEW RESULTS

On 14 March the Federal Reserve released the results of its Comprehensive Capital Analysis and Review (CCAR). The CCAR report assesses the quantitative and qualitative aspects of a firm's capital planning and risk measurement processes.

for these banks). This volatility increases during periods of stress; thus affecting the PPNR and their ability to build reserves and capital under those scenarios (versus retail banks with usually more resilient and less volatile earnings for PPNR projection purposes).

Notably, the loss estimates for Goldman Sachs and JPMorgan Chase exhibit significant differences from the Federal Reserve modelled loss estimates. Whilst JPMorgan Chase amended its submission from 7 March 2013 to show increases in loss estimates for residential and junior-lien/HELOC loans, the overall loss estimates of JPMorgan Chase are 62% of the Federal Reserve's estimate. Similarly, Goldman Sachs loss estimates are significantly below the

The Federal Reserve opined that '…all 18 BHCs are on a path to successfully meet the Basel III requirements'.

Capital plan objections

For the 2013 CCAR review, two banks – Ally and BB&T – received objections to their capital plans. This means that the Federal Reserve must pre-approve any capital actions of these two institutions. For Ally the objection was based on both quantitative and qualitative criteria, whilst the objection to the BB&T capital plan was based, in part, on perceived weaknesses in the firm's capital planning process, which includes, in part, erroneous reporting of risk-weighted assets due to the incorrect assessment of unfunded commitments.

Capital plan conditional approval

Beyond the two capital plan objections, Goldman Sachs and JPMorgan Chase received conditional approval for their capital plans. This means that all capital actions can proceed as planned. However, certain process weaknesses require remediation by the end of the third quarter of 2013. Failure to properly address the identified weaknesses could risk possible Federal Reserve objection to the submitted capital plan for each institution. It is worthy to note that PPNR at broker banks is usually driven by the volatility of their trading portfolios (major source of earnings

Federal Reserves' estimates due, in large part, to a significant difference in analytical result. The Federal Reserve estimates over $2 billion in credit losses in a severe stress, whilst Goldman Sachs' internal estimates reflect loss of $300 million, or 15% of the Federal Reserve's estimate. For example, the Goldman Sachs C&I loss rate estimate is 7.3% versus the Federal Reserve's estimate of 49.8%. This difference seems to suggest the need for additional detail.

Concerns exist, given some of the noted differences in loss estimates across several asset classes, particularly around residential mortgage, C&I and CRE, various modelling assumptions, and methodology. It remains unclear whether the challenges derive from the Federal Reserve's or the various banks' modelling assumptions. At this stage, the quality and granularity of data is a big issue when calculating and projecting the PPNR components. This, in turn, may affect the capital projections and the capital plan.

Moody's Analytics estimated C&I loss rates

In December, using Stressed Expected Default Frequency (EDF) measures conditioned on the

Federal Reserve's severely adverse scenario as default probabilities, Moody's Analytics estimated C&I loss rates under a range of loss-given default (LGD) assumptions for pseudo-portfolios of the banks modelled on published default rates. In the aggregate, Moody's Analytics' estimate of 6.7% — using a 50% LGD assumption — was closely aligned with the Fed's 6.8% for C&I loans.

Although one might infer from this that the Federal Reserve used an average LGD of 50% for C&I loans, it is not possible to make such an inference without presupposing that the Federal Reserve's and Moody's Analytics' post-stress default probabilities were similar. However, what may be instructive is the observation that Stressed EDF measures based on the severely adverse scenario for many firms rise in a manner consistent with historical experience . When they rise by more than may appear warranted by the experience of the 2008 financial crisis, it is largely due to the fact that the obligor would enter the Federal Reserve's hypothetical stress scenario from a higher level of credit risk than at the start of the 2008 recession.

C&I loss estimates derived from the banks' models were most closely aligned with Moody's Analytics estimates based on a 40% LGD assumption. The two banks whose C&I loss rate estimates were closest to Moody's Analytics were Goldman Sachs and JP Morgan.

Capital plan review: interesting components

Other interesting components of the 14 March 2013 capital plan review include:

- Many firms are planning significant share buybacks and dividend increases, returning capital to shareholders.
- There are several banks seeking to replace existing common equity with various forms of qualifying Tier 2 capital.
- Two banks – Ally and American Express – took the opportunity to resubmit their capital plans prior to any final Federal Reserve decision on the plan. In American Express' case, the revision was made, in part, due to the Federal Reserve's analysis showing a breach of the 5% common equity threshold, derived in large part from a $3.1 billion difference in the Allowance for Loan and Lease Loss (ALLL) modelling approach.
- Only four banks failed to disclose their own internal loss estimates: Ally, Capital One, Fifth-Third, and SunTrust, highlighting some differences in transparency and disclosure expectations.
- $393 billion has been added to Tier 1 common equity since FYE 2008.
- The Federal Reserve opined that '…all 18 BHCs are on a path to successfully meet the Basel III requirements'.
- There appears to be a need to improve various stress testing processes in order to ensure capital planning '…is conducted in a well-controlled manner'.

APPROACHES TO IMPLEMENTATION

This section examines how to implement a stress testing programme, including new processes, a seven steps model, and a macroeconomic view.

A NEW GENERATION OF STRESS TESTING PROCESSES:

RESPOND TO THE AQR AND 2014 EU-WIDE EXCERCISES

By Cayetano-Gea Carrasco and Isabel Gomez-Vidal
Contributor: David Little

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Cayetano works with financial institutions on credit portfolio management across asset classes, derivatives pricing, CVA/Counterparty Credit Risk analytics, stress testing, and liquidity management.

Isabel Gomez-Vidal
Managing Director, Head of Sales (EMEA)

For more than 16 years, Isabel has helped financial institutions with their credit risk management solutions, including balance sheet management, stress testing, and regulations such as Basel II/III and Solvency II.

Stress testing assesses the system-wide soundness of financial institutions and supports enterprise-wide investment decisions for strategic and capital management planning purposes.

The evolution of the post-crisis financial regulatory reform agenda has positioned stress testing as a key tool in assessing the system-wide safety and soundness of financial institutions. Stress testing is a scenario-contingent analysis of the risk that an institution may face. It helps institutions put in place capital and liquidity contingency measures, develop risk appetite, drive strategic business planning, set risk limits, identify portfolios' vulnerabilities and opportunities in terms of risk-return trade-offs, and determine the optimal timing of strategic and risk management decisions.

Forecasting revenue, expense, portfolio losses, and capital ratios plays an essential part in a stress testing framework. Capital ratios are critical to meeting shareholder and internal stakeholder expectations as they ultimately indicate the solvency of the institution. The forecasts, in turn, affect balance sheet composition, business strategy, and return metrics (e.g., Return on Equity). Therefore, stress testing metrics are usually projected under multiple scenarios as their evolution drives regulatory and risk management decisions.

A US perspective

Stress testing has also become a core regulatory tool to assess the stability of the financial system, enhancing shareholder and market confidence by disclosing the risk tolerance of financial institutions. For example, US bank holding companies have to project loss and income metrics for stress testing reporting and capital planning purposes (Comprehensive Capital Analysis and Review, or CCAR) over nine quarters under a series of forward-looking stress scenarios. The projections consider credit migrations of multiple asset classes, income-related metrics (e.g., via pre-provision net revenue or pre-provision profit for European banks), and they consider all of the bank's portfolios (e.g., retail, commercial and industrial, real estate, etc.). In addition, very granular data, at a loan or facility level, have to be provided to the Federal Reserve on a regular basis. The Fed uses this data to formulate its own analysis at both a system and institution level and to challenge the forecasts submitted by individual institutions.

Why hasn't Europe implemented a CCAR-style stress test?

Whilst the CCAR has been proven to work in the US and has become an example that could be used by regulatory institutions around the world, a similar framework in Europe has not been possible yet given the following:

- A lack of a harmonised framework and set of definitions to accurately assess, quantify, and compare loss projections across institutions under different jurisdictions, as well as a lack of agreement over which regime should be used for stress testing purposes (e.g., Basel III fully deployed or transitional, etc.).
- The need for political consensus on how to deploy the European funds - for example, how to use the European Stability Mechanism, or

ESM, to recapitalise banks that may fall below reasonable capital levels under the stress testing exercise.

» The existence of multiple regulators across jurisdictions and countries with inconsistent regulatory rules, which, combined with a lack of a single regulator with enforcement powers, makes a true euro zone banking union less feasible.

The AQR and the 2014 stress tests

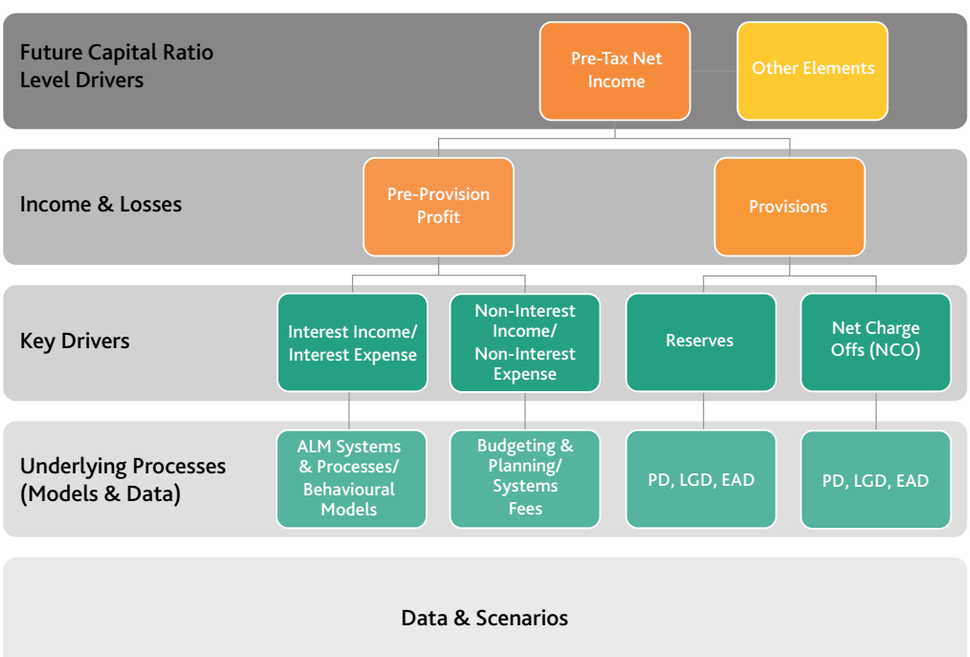
Whilst there is still much work to do, the European authorities and financial institutions have been successfully working on these challenges and taking the appropriate steps during the last few months.

For example, the European Banking Authority (EBA) has released a consultative document providing a single definition of non-performing and forbearance loans across the euro zone banks. This document levels the reporting playing field for a very detailed exercise that is expected to shed light on the quality of the balance sheets at European banks (the Asset Quality Review, or AQR) by 2014.

A stress test is also planned in the euro zone in 2014 after the AQR. In addition, other European regulators have already announced a similar exercise for banks under their supervision (e.g., the UK will run a CCAR-style stress test for UK banks in 2014) and similar deployment timelines. At this stage, an ongoing stress testing process that is part of the supervisory framework will be necessary to monitor the health of European financial institutions' balance sheets and provide credible information about bank and financial system risk to the market on a regular basis. A single, point-in-time exercise is not enough.

A standard set of definitions similar to those suggested by the EBA are also important to successfully compare risk (e.g., risk-weighted assets, or RWA) and stress testing metrics across jurisdictions in the euro zone. Therefore, for consistency, the definitions used during the AQR will likely be the same for the stress testing that

Figure 1 Integration and consistency between finance and risk metrics are the key to an effective stress testing process



Source: Moody's Analytics

will be administered by the EBA in 2014. This, in turn, may affect reclassifications of some portfolios and changes in the reported quality versus accounting rules-based reporting (i.e., International Financial Reporting Standards, or IFRS). As a consequence, capital – already a scarce resource – may be significantly impacted at European financial institutions.

Finally, the European Central Bank is expected to act as the lead regulator (single supervisor and responsible for the Single Supervisory Mechanism, SSM) by the end of 2014, which will facilitate having a unified supervisory body in the euro zone and harmonise decision-making and legislation. The European Parliament has also set the basis for consensus on the uses of the ESM so a credible capital backstop plan can be deployed to recapitalise those institutions that may fail, or be close to a certain threshold, during stress testing.

> An ongoing stress testing process that is part of the supervisory framework will be necessary to monitor the health of European financial institutions' balance sheets and provide credible information about bank and financial system risk to the market on a regular basis. A single, point-in-time exercise is not enough.

Overcome challenges with stress testing frameworks

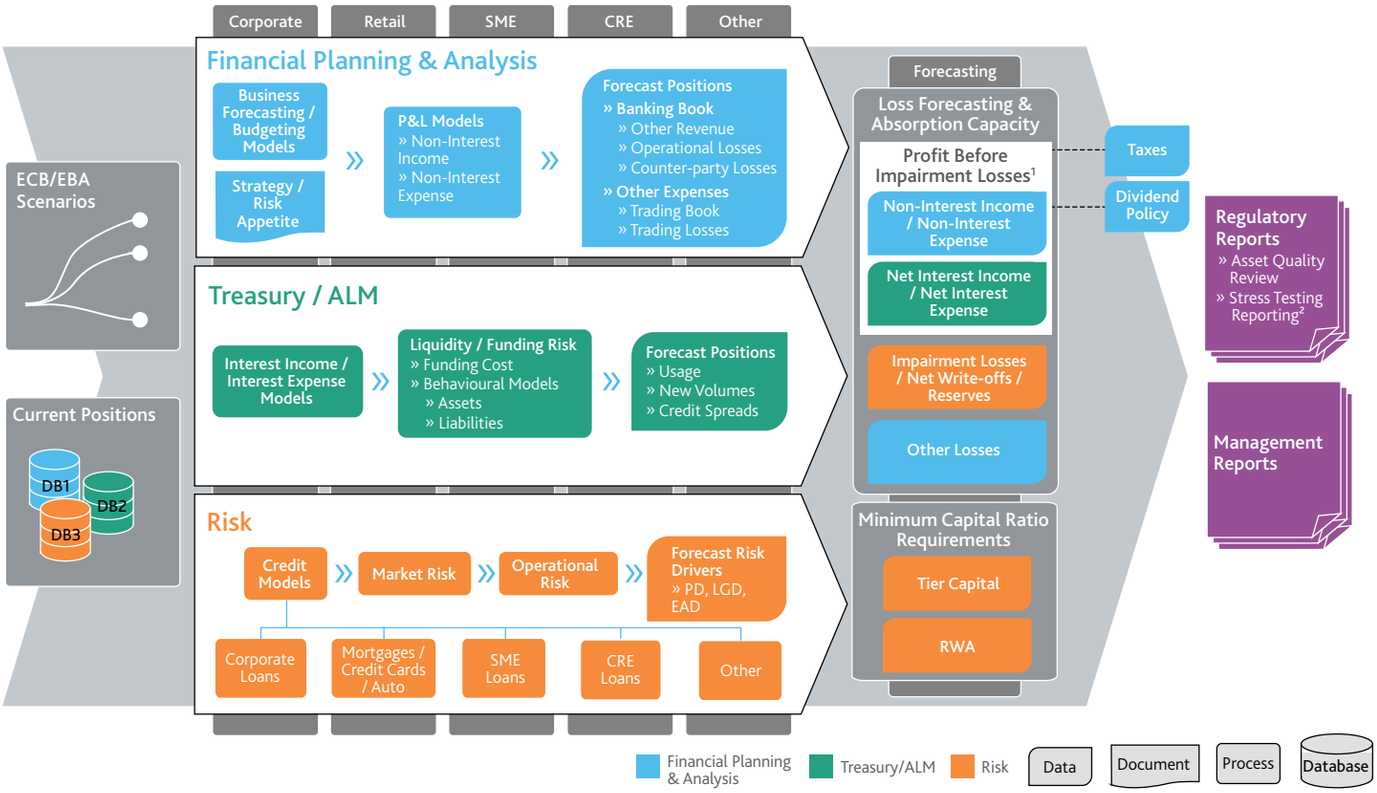
Financial institutions in the euro zone are also starting to enhance their stress testing frameworks to overcome limitations in traditional silo-based stress testing approaches and limitations in loan or facility-level data for bottom-up, granular modelling analysis. Banks are updating their architecture and stress testing processes to streamline the stress testing calculation and reporting, and are also updating the underwriting processes to proactively manage the quality of loans at origination.

Moving toward a realistic, granular, and ongoing stress testing framework, however, brings some key challenges to European financial institutions that must be overcome to successfully analyse the balance sheet resilience under different scenarios and provide reasonable results that can be leveraged from a business perspective.

The challenges are consistent across regions and institutions, but the priorities are different depending on the current state:

- There is a lack of consistency between the accounting rules and the regulatory guidelines proposed by the regulators for stress testing purposes. Although this is not an issue given that the objectives of both are different and they will not substitute for each other, a reconciliation framework should be in place at institutions to understand the differences in terms of results. At this stage, stress testing methods and analytical outcomes need to be consistent with how financial institutions think about risk and reporting, and at the same time meet the regulatory guidelines.
- Achieving modelling consistency across risk and finance metrics for stress testing and balance sheet forecasting is complex. For example, forecasting conditional new business (including conditional credit spreads) and being consistent at the same time with the credit loss estimation implies a substantial amount of new analytical work. At this stage, the ability to perform side-by-side comparison analysis (e.g., bottom-up versus top-down) provides powerful tools to challenge the business units and understand the business dynamics in the context of stress testing.
- Balance sheet forecasting and monitoring of key performance metrics require the integration of financial planning, treasury, credit, risk management, capital planning and reporting, as well as the linkage to liquidity management. This cannot be done with the current infrastructure at most financial institutions and requires a new generation of architecture and software platforms that not only can streamline and automate the stress testing and balance sheet forecasting calculation, but also can deploy and maintain

Figure 2 The Stress Testing Challenge



1 Also called Pre-Provision Profit.
2 No reporting guidelines have been published yet.

Source: Moody's Analytics

Figure 2 illustrates how stress testing represents a unique challenge, in terms of integrating data, models, platforms, and reporting across an organisation. Successful firm-wide stress testing frameworks need to overcome silo-based approaches by integrating the views of a bank's Finance, Risk and Business units to deliver automated and streamlined calculations and facilitate reporting.

a large number of models and incorporate auditing and tracking capabilities. At this stage, the scalability of these platforms is the key to maximising the return on investment and considering future requirements as methodologies and regulatory guidelines are continuously evolving.

Assuming that the AQR, the euro zone, and UK stress tests and the SSM happen according to plan over the next 18 months, European banks should expect that they will be required to make some changes to the way they currently do business. From reassessing the granularity and/or approach to their loss modeling to enhancing their coordination across finance, risk, and business units to automating and streamlining the required reporting for stress testing, banks will face modeling, data, and infrastructure challenges.

Effectively addressing these stress testing challenges, though, will enable bank boards and senior management to make better-informed decisions, proactively create contingency and resolution plans, make forward-looking strategic decisions for risk mitigation in the event of actual stressed conditions, and help in understanding the evolving nature of risk in the banking business (e.g., economic cycle, mergers, acquisitions, etc.). All of this can be viewed at a group level or on a very granular basis and consistently across multiple portfolios, risk types, and jurisdictions. In the end, a thoughtful, repeatable, and consistent stress testing framework should lead to a more sound, lower-risk banking system with more efficient banks.

STRESS TESTING BEST PRACTICES:

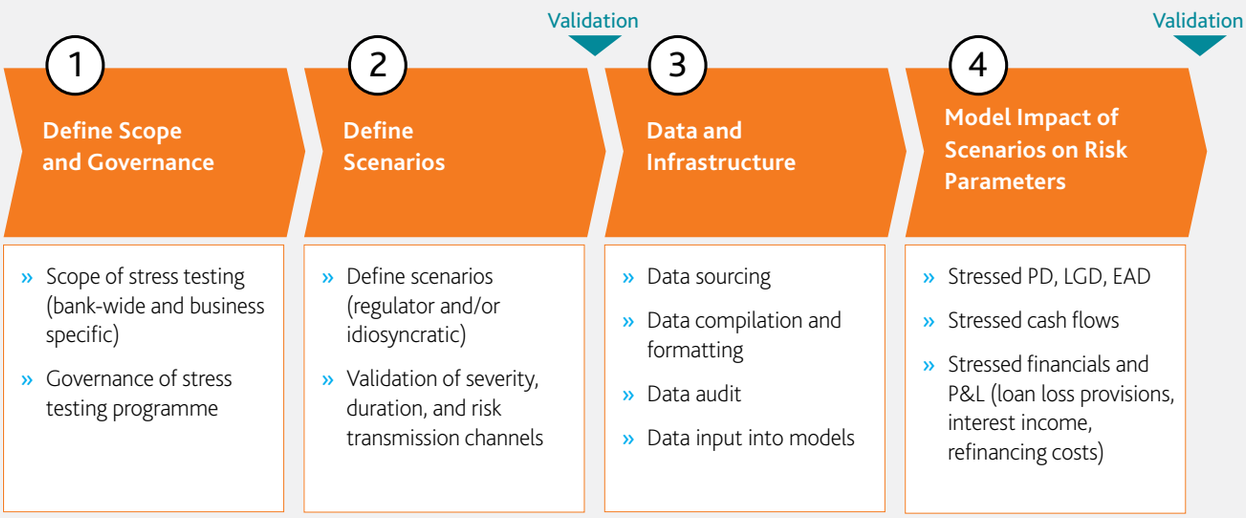
A SEVEN STEPS MODEL

By Dr. Christian Thun, Sandrine Prioux, and Maria C. Cañamero
Contributors: Charles Stewart and Nicolas Kunghehian

Implementing stress testing practices across the various bank divisions is a complex process. In order to address the need for an implementation framework, Moody's Analytics has created a Seven Steps Model.

The model represents a collection of principles and best practices developed through extensive interviews with many of the stakeholders in our client institutions. It also represents a process to implement a comprehensive, rigorous, and forward-looking stress testing programme.

Moody's Analytics has created a Seven Steps Model to help implement stress testing best practices across various bank divisions.



The findings are summarised in this article's chart, which highlights key activities for each step in the process. Each step is detailed to further pinpoint opportunities for effectively integrating stress testing in a firm.

Step 1: Define scope and governance

Organisational silos, still dominant at many banks, make efficient enterprise-wide stress testing an ongoing challenge. However, banks should establish dedicated teams tasked with defining objectives and governance guidelines and ensuring proper coordination among the business, risk, and finance departments. Such teams often range in size from three to twenty people (based on bank size). Some teams report to the Chief Risk Officer (CRO), others to the Chief Financial Officer (CFO); in both structures, a direct relationship to the board is critical.

Step 2: Define scenarios using a multidisciplinary approach

Many banks use committees to define and review stress scenarios and to reinforce participation across the institutional boundaries. Some organisations have created departments focused on the sole task of developing and managing enterprise stress testing. Such groups typically use external scenarios (such as macroeconomic shocks) as benchmarks that assist in developing specific internal scenarios. Moody's Analytics recommends this as a best practice. Defining scenarios that are useful to business lines, as well as the risk and finance functions, require the effective participation and cooperation of multiple teams and specialists.

Additionally, embedding risk culture in decision-making across business units and functions, whilst essential, remains a challenge for many banks.

Step 3: Data and infrastructure

Institutions continue to struggle with data quality, availability, and comprehensiveness despite significant investments in both capabilities and infrastructure in recent years. Legacy systems and silos that were developed during the course of Basel II implementation hinder the flexibility required for effective stress testing. Shifting and uncertain regulatory demands also complicate progress in this area. Therefore, a flexible platform for aggregating the balance sheet data that integrates information from across the organisation is crucial.

Steps 4 & 5: Calculate stressed key performance indicators (KPIs)

Once the data is captured and centralised, the next step is to layer on macroeconomic scenarios. Modelling the impact of macroeconomic scenarios on institutional cash flows (e.g., income or economic capital) requires both significant information and a strong understanding of the business drivers.

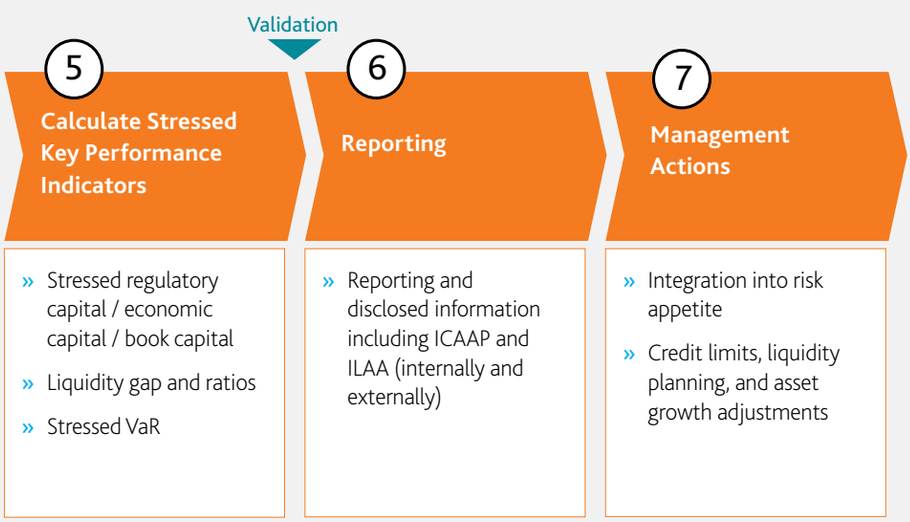
Step 6: Reporting

Requirements for stress testing come from a variety of external and internal sources. These include national and supranational regulators, the board of directors, various committee and governance structures, as well as business line management. These requirements will grow and evolve over time, making effective reporting consume an increasing amount of both time and resources.

Reporting tools that address regulatory requirements that can also be leveraged for business purposes will offer significant benefits and should be considered a best practice. At the same time, the lack of common standards for reporting means the size, degree of detail required, and structure of reports will vary widely, so flexibility and the ability to adapt to changing requirements are critical capabilities.

Step 7: Action based on fully engaged senior management

Ultimately, stress testing must be part of both the business planning process and the institution's day-to-day risk management practice.



Quantitative measures – such as probability of default (PD), exposure at default (EAD), and loss given default (LGD) – are of particular interest to senior management as they link stress testing directly to performance. Common implementation challenges include lack of internal skills and data, shortage of relevant resources, time constraints, and a dearth of skilled personnel. Best practices include developing internal models using dedicated quantitative teams, as well as using third-party models and services to accelerate the process, decrease internal workloads, and fill gaps in key skills and capabilities.

Adjustments to asset-liability composition should align with management of concentration risk. Monitoring sensitive limits should provide useful input to risk appetite discussions. Yet 80% of surveyed financial institutions fail to integrate stress testing into the senior decision-making process. Best practices in this area remain a work in progress.

In conclusion, investing in efficient tools, processes, and systems should help banks turn what is perceived as a labour-intensive, mainly regulatory exercise into an effective tool for business planning and risk management. Easier compliance with regulation and increased transparency in the marketplace should coincide with more confident decision-making.

IS REVERSE STRESS TESTING A GAME CHANGER?

By Cayetano-Gea Carrasco and Mikael Nyberg

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Cayetano works with financial institutions on credit portfolio management across asset classes, derivatives pricing, CVA/Counterparty Credit Risk analytics, stress testing, and liquidity management.

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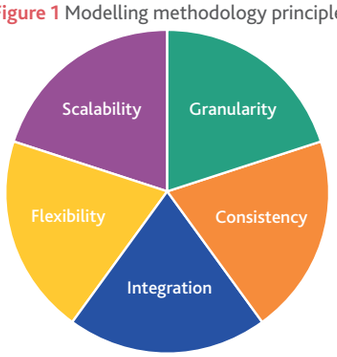
This article outlines the steps to perform reverse stress testing, which explores tail risks and reveals hidden vulnerabilities and scenarios not reflected through traditional stress testing analysis.

Regulators have advocated for the use of reverse stress testing to supplement stress testing by exploring tail risks and revealing hidden vulnerabilities and scenarios that are not reflected through traditional stress testing analysis. This article outlines the steps required to perform such analysis to meet regulatory expectations.

Why reverse stress testing?

Reverse stress testing analysis offers a unique opportunity for financial institutions to better understand their business and focus management's attention on the areas where weakness could turn out to be potentially harmful to the entire organisation. A reverse stress test explicitly identifies and assesses only the tail risk scenarios most likely to render business models unviable, that can cause the institution to default. This is a core difference when compared with traditional stress testing methodologies, where stress scenarios are chosen based on expert knowledge or historical evidence a priori.

Figure 1 Modelling methodology principles



Source: Moody's Analytics

Modelling flow

Although an accurate modelling methodology able to characterise an institution's business model and portfolio compositions is critical to identify and analyse hidden vulnerabilities within an reverse stress testing framework, the regulatory bodies have not provided methodological guidelines. However, the following principles should apply when developing one:

- **Granularity:** Able to drill down to individual factors that may affect the business lines or products.
- **Consistency:** Consistent with overall stress testing methodology and regulatory guidelines.
- **Integration:** Integrated within the enterprise risk management function and architecture.
- **Flexibility:** Fully customisable to the business model of the institution.
- **Scalability:** Accommodate future requirements in terms of asset coverage, portfolios, geographies, or regulatory guidelines.

From a workflow and data management perspective, as a best practice, institutions should develop centralised, enterprise-wide stress testing and reverse stress infrastructures that strive to integrate data, analytics, and reporting. All information critical to calculating, managing, reporting, and monitoring the stress and reverse stress testing results should be easily and cost-effectively available.

From a regulatory compliance perspective, institutions' enterprise risk management platform should be able to generate pre-configured stress testing and reverse stress testing reports by different regulatory jurisdictions. The institutions should also maintain the analysis history for trend analysis, auditing, and benchmarking across several dimensions and for each legal entity of the institution.

From an operational perspective, the institutions' enterprise risk management platform should allow banks to drill down into each scenario to see the detailed underlying factors' composition during the reverse stress testing calculation process.

From a reporting perspective, the platform should perform side-by-side comparison analysis between the stress testing and reverse stress testing results across jurisdictions, strategies, or portfolios.

To be effective, the reverse stress testing exercise should finalise an enterprise-wide contingency plan framework to address vulnerabilities before the changes hit and ensure the survival of the institution under those events.

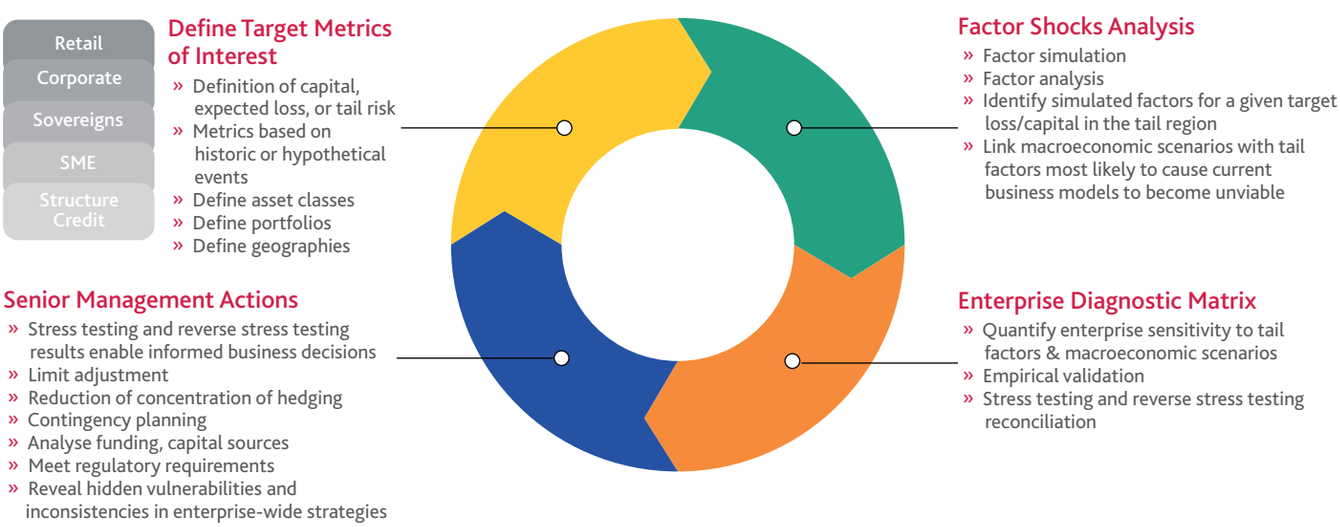
A bottom-up modelling approach

Institutions should address the reverse stress testing analysis using a bottom-up modelling approach. The advantage of this approach is that it avoids solving inversion problems arising from maximisation-based models and at the same time accounts for all the risk dependencies during the simulation through the factors' correlation structure and migration dynamics. On the other hand, top-down approaches are usually not suitable for reverse stress testing analysis since the factors' realisations are aggregated and cannot be decomposed at an individual level.

Once the modelling flow and enterprise risk management architecture has been set at the institution, the reverse stress test analysis should start by specifying a target loss level, business line or sub-portfolio subject to the analysis. The analysis should then identify the macroeconomic shocks, scenarios, and tail risk factors driving those losses.

Subsequently, the connections with a portfolio's performance, strategic events (merger, acquisition, new portfolio composition, etc.), and business model weaknesses (insolvency, bankruptcy, etc.) should be analysed as well. Therefore, the analysis would identify hidden

Figure 2 Provides a high-level view of the reverse stress testing modelling flow



Source: Moody's Analytics

vulnerabilities that may have not been detected during the stress testing analysis.

There are six main recommended stages when performing a bottom-up reverse stress testing analysis at the enterprise-wide level.

Stage 1: Define metrics and target survival values

The first stage involves defining the appropriate loss level (e.g., confidence level) for the metric of interest for the financial institution (e.g., capital ratio, solvency ratio, etc.). The horizon for the analysis should be consistent with the requirements to fulfill the capital requirements under the corresponding regulatory jurisdiction and guidelines (e.g., one year under Basel III).

Stage 2: Perform tail risk factor analysis

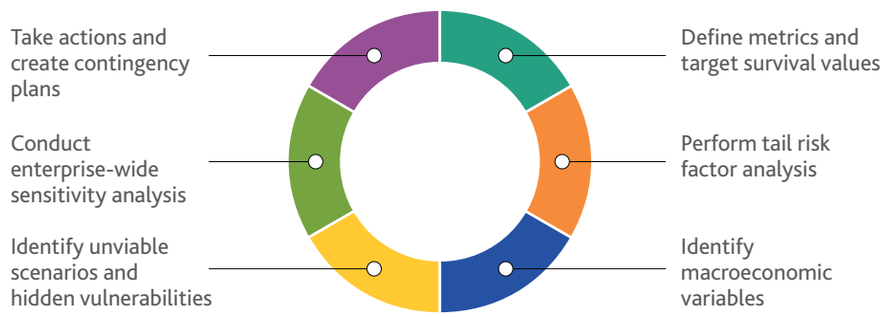
The second stage is to identify the factor draws and their combinations that had the most impact on the portfolio tail region through a quantitative discovery process. The factors and the loss associated with the portfolio in the tail region as well as which instruments, counterparties, countries, and industries react most to these states are also known at this step. The correlation structure affecting the institution's balance sheet composition should be taken into account in the analysis as well.

For example, Figure 4 shows the factors that will make the institution unviable for a sample institution's portfolio for a given target tail risk probability of 10 basis points (or equivalent, a target confidence level of 99.9%). In this specific case, the SME portfolio is the most reactive factor that causes the institution to default.

Stage 3: Identify macroeconomic variables

Once the most reactive factors have been identified from Stage 2, a sensitivity analysis is performed to measure the impact of these factors on an institution's business model. This analysis is designed to uncover the severity of the scenarios needed for the financial institution to fail, or losses to exceed the given level of capital in Stage 1.

Figure 3 Recommended stages: bottom-up reverse stress testing analysis



Source: Moody's Analytics

Stage 4: Identify unviable scenarios and hidden vulnerabilities

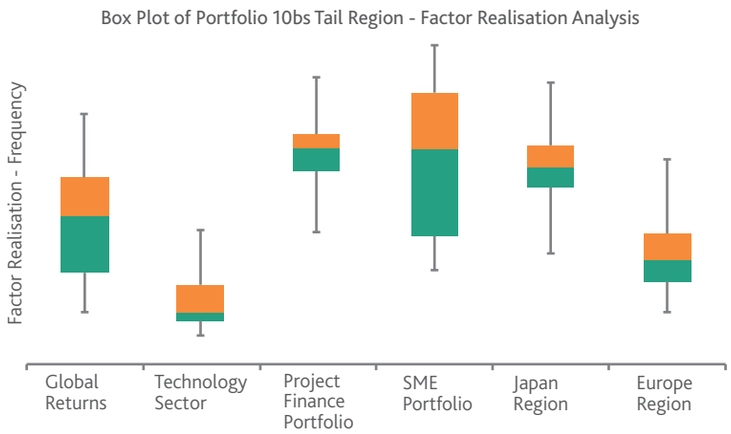
Factors from Stage 3 are ranked and mapped to macroeconomic variables and scenarios analysed during the simulation. In detail, for each simulated trial and each analysed sector a unique vector (ϕ) determines the relevant macroeconomic variables (MV) and their weights (w) at counterparty level:

Stage 5: Conduct enterprise-wide sensitivity analysis

Macroeconomic variables from Stage 4 are mapped to macroeconomic variables from the stress testing analysis, thus identifying hidden vulnerabilities and overlapping effects.

$$\varphi = \sum_{i=1}^{N} w_i MV_i \;\; where \sum_{i}^{N} w_i = 1$$

Figure 4 Analysing factors' realisations across tail events for reverse stress testing purposes



Source: Moody's Analytics

Stage 6: Take actions and create contingency plans

Finally, to be effective, the analysis should identify how resilient a bank's business model is for different solvency and capitalisation rates. An enterprise-wide risk management diagnostic matrix should present the information, sensitivity analysis, and facilitate analysing the results for regulatory reporting and decision-making initiatives.

Having an enterprise-wide stress testing framework that acknowledges both traditional stress testing analysis and reverse stress testing is a game changer for financial institutions. Reverse stress testing addresses tail risk analysis by starting from a known stress test outcome and then asking what events could lead to such an outcome for the financial institution, revealing hidden vulnerabilities in the portfolio and in the firm's stress testing framework that may not be detected during the stress testing analysis. Therefore, a robust and consistent portfolio bottom-up modelling approach is key to avoiding under or over-estimation of risk for assuring flexible risk management policies and increasing the return for the shareholders.

We have introduced a modelling framework that allows financial institutions to understand and identify the enterprise-wide risks under adverse conditions that may have serious implications for their solvency. The framework can be used to provide guidance and perform analysis in order to reveal hidden vulnerabilities and tail risks for several key metrics.

> From a workflow and data management perspective, as a best practice, institutions should develop centralised, enterprise-wide stress testing and reverse stress infrastructures that strive to integrate data, analytics, and reporting.

A MACROECONOMIC VIEW ON STRESS TESTING

By Dr. Juan M. Licari and Dr. José Suárez-Lledó

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José is Director of the Economic and Consumer Credit Analytics team, responsible for the research and implementation of risk management solutions with banks and investment firms worldwide.

This article discusses how developing deterministic scenarios form a macroeconomic view on stress testing that helps to uncover system or enterprise-wide vulnerabilities and assist banks in making more informed business decisions.

Macroeconomic scenarios

Both regulators and practitioners are progressively shifting their attention toward the role of deterministic scenarios in forecasting and stress testing. These scenarios are relevant in that they unveil threats to the economy as a system (in the case of the regulator) and to a business (in the case of practitioners). Developing these scenarios requires sensible macroeconomic models that, beyond capturing well-known relationships, are also able to incorporate a number of important elements, such as the right correlations across variables and feedback loops, the ability to capture how these change under stress, and the capacity to generate internally consistent paths for the variables.

Our approach

Macroeconomic modelling that achieves these objectives triangulates three types of models:

1. Dynamic Stochastic General Equilibrium (DSGE) models to incorporate economic theory through rational optimisation of the agents in the economy
2. Structural Vector AutoRegressive models (SVARs) to allow for forecasts that are more data driven and not so much constrained by a particular theory
3. Large-scale Structural Econometric models to generate projections for a larger set of more granular variables

In the context of models that are currently operational, a certain degree of accuracy can be achieved for only a limited number of macroeconomic variables. Therefore, the scenarios rely on two workhorse models used by most central banks and some governments for the modelling of a limited set of key variables (GDP, unemployment, monetary policy rates, interest rates, inflation, house prices, etc.), and that are more suitable for the analysis of short-term shocks. For a larger set of more granular variables (production indexes by sectors, sub-national level series, etc.), a large-scale econometric model is employed. The paths for the key variables from the two smaller models are input into the larger model to generate series for more than 200 variables.

Dynamic Stochastic General Equilibrium models

One of the two pillar models belongs to the Dynamic Stochastic General Equilibrium (DSGE) family. These models incorporate rational optimisation by establishing how the various agents in the economy make decisions and react to shocks. This structure is taken from economic theory. Households are assumed to try to maximise their expected lifetime utility with a degree of risk aversion. In doing so, they consider their budget constraint where their savings and consumption are financed by their labour income, accumulated debt, and possibly returns to savings and government transfers. The production side of the economy is represented by firms deciding

how much technology and capacity to use and how much labour to rent in order to maximise profits and return to their stock. Monetary and fiscal authorities will design monetary and fiscal policies aiming at maximising the welfare of the agents and at achieving the best possible allocation of resources.

Structural Vector AutoRegressive models

Because the DSGE framework basically imposes a structure to the data, another class of models is also considered that, whilst still incorporating some economic theory to help identify the reaction to shocks, are much more data driven. They are known as Structural Vector AutoRegressive (SVAR) models and are basically a system of equations that approximates the relationships of a number of economic drivers with their lags, as well as the cross correlations of the variables amongst themselves.

SVARs model the endogenous economic variables as a function of their own lags and the lags of other variables so that they are free from the simultaneous equations bias. Both models are estimated with Bayesian and likelihood techniques. Proponents of the Real Business Cycle literature are among the main supporters of the DSGE models (Thomas Sargent, Nobel 2011, Edward Prescott, Nobel 2004, Robert Lucas Nobel 1995, etc.). On the other hand, SVARs belong to the econometrics arena pioneered by Christopher A. Sims (Nobel 2011) and others.

Large Scale Macroeconometric models

The third model is a large scale macroeconometric model, in the fashion of those designed by Lawrence Klein (Nobel 1980). This model looks at the aggregate supply-aggregate demand relationships. Whilst it may not fall in line with recent theoretical developments, it is highly useful, as it is capable of generating projections for a large number of variables. The final forecasts and alternative scenarios will be a weighted average of the forecasts from the different models.

MODELLING SCENARIOS

Now that the models are in place, what scenarios are worth looking at and what shocks should be modelled? A pure brute force approach would be to just look at an extreme percentile of the distribution of simulations that could be run with the models. A more sensible approach is to think of a relevant narrative and then pin the simulation path that would correspond to that narrative. For example, consider a scenario based on a credit crunch, which would also feature the money market rate increasing to 6% in the second quarter of the scenario. In that case, it would make sense to retrieve the simulation presenting that level and timing of the money market rate.

> Developing deterministic scenarios in forecasting and stress testing to reveal threats to the economy requires three macroeconomic scenarios: one that incorporates economic theory, another with forecasts that are more data driven, and a third that generates projections for a larger set of more granular variables.

It is important to note that because Moody's Analytics models are internally consistent systems of equations, when a specific path for one variable is selected the corresponding path for all other variables would also be pinned down. This general equilibrium view of the world is in contrast with partial equilibrium frameworks that model some economic factors in isolation, disregarding how they might be impacted by the feedback loops from other drivers that could be involved in the scenario initially triggered by that economic factor.

Satellite models for market risk parameters

The purpose of the test, whether for pure forecasting accuracy or stress testing, will bear important implications for the type of models that are considered when modelling financial variables. Some core financial variables are modelled within the macroeconomic systems to encapsulate the mutual influence between the

macro side of the economy and the financial and banking sectors. All other market risk metrics are derived in satellite models that feed from the relevant outputs from the macro models that are taken as drivers. Examples of these satellite systems are models for implied volatilities (equity indexes, commodities, interest rates, exchange rates, etc.), corporate and sovereign CDS, interest rates swap curves, and credit migration matrices.

A methodology that leverages the correlated structure of most financial variables

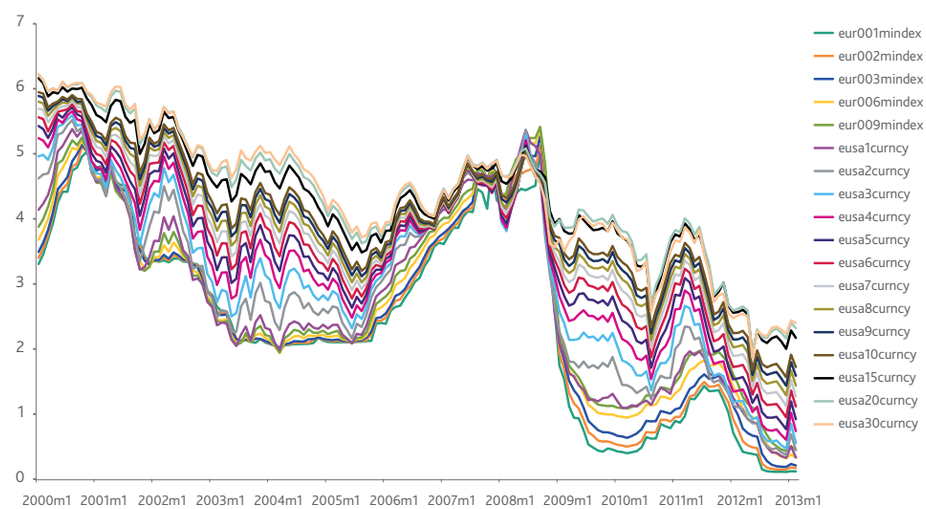
The equity indexes of different countries exhibit a considerable degree of co-movement. Such is also the case of the cross-section of maturities in an interest rate curve and other metrics. This feature makes a very favourable case for the use of techniques that reduce the dimension of the initial set of variables to a lower number of series (factors) that can still account for most of the behaviour of the original dataset. In particular, we use Principal Component Analysis (PCA) because it generates independent factors, which are very convenient for reverse stress testing (RST) as we will discuss later (for more information about Reverse Stress Testing in this magazine, please see the article: 'Is Reverse Stress Testing a Game Changer?'). PCA 'diagonalizes' the correlation matrix of the dataset, thus extracting independent vectors (factors) that span the whole dataset. From these vectors, only the first few factors that span most of the data are taken.

INTEREST RATES

Consider a stress testing exercise on the Interest Rate Swap curve. As part of performing a sensible stress testing exercise, the two important features of the data are modelled: the dynamics of the spread across maturities and the alignment of certain swap rate tenor points to their corresponding yield tenor points. From the panel dataset consisting of the spectrum of maturities over time, two main factors via PCA are extracted[1]. In turn, a model for these two factors as a function of the economic drivers in order to stress the curve is defined.

The first factor is referred to as the 'Level' of the curve, as it indicates an average level of the interest rates at any moment in time. The second factor is known as the 'Slope' of the curve since it reflects to some extent the differences between the long end and short end of the curve. The level is interpreted to represent the medium term inflation expectations and it appears to be related to the monetary policy rate (or the three-month money market rate[2]) and the ten-year

Figure 1 Euro Swap Rates (Maturities: 1M – 360M)



Source: Moody's Analytics

Figure 2 Interest Rate Swap Curves - Level and Slope Factors

Source: Moody's Analytics

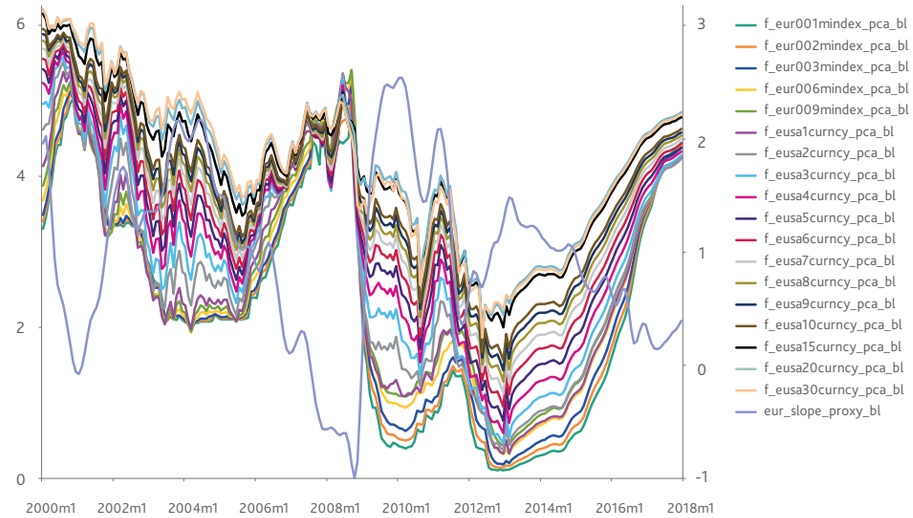
government yield. The slope factor is seen as the reactions of the curve to short-term shocks or fluctuations in the economy and it is associated with the term premium (approximated by the difference between the ten-year government yield and the three-month yield or money market rate) and with fluctuations in GDP growth.

Developing deterministic scenarios in forecasting and stress testing to reveal threats to the economy requires three macroeconomic scenarios: one that incorporates economic theory, another with forecasts that are more data driven, and a third that generates projections for a larger set of more granular variables. When modelling the scenarios, a more sensible approach is to think of a relevant narrative and then pin the simulation path that would correspond to that narrative, rather than look at an extreme percentile of the distribution of simulations that could be run with the models. All together, they form a macroeconomic view on stress testing that will help to uncover system or enterprise-wide vulnerabilities and assist banks in making more informed business decisions.

Figure 3 Representative equations of the models tested

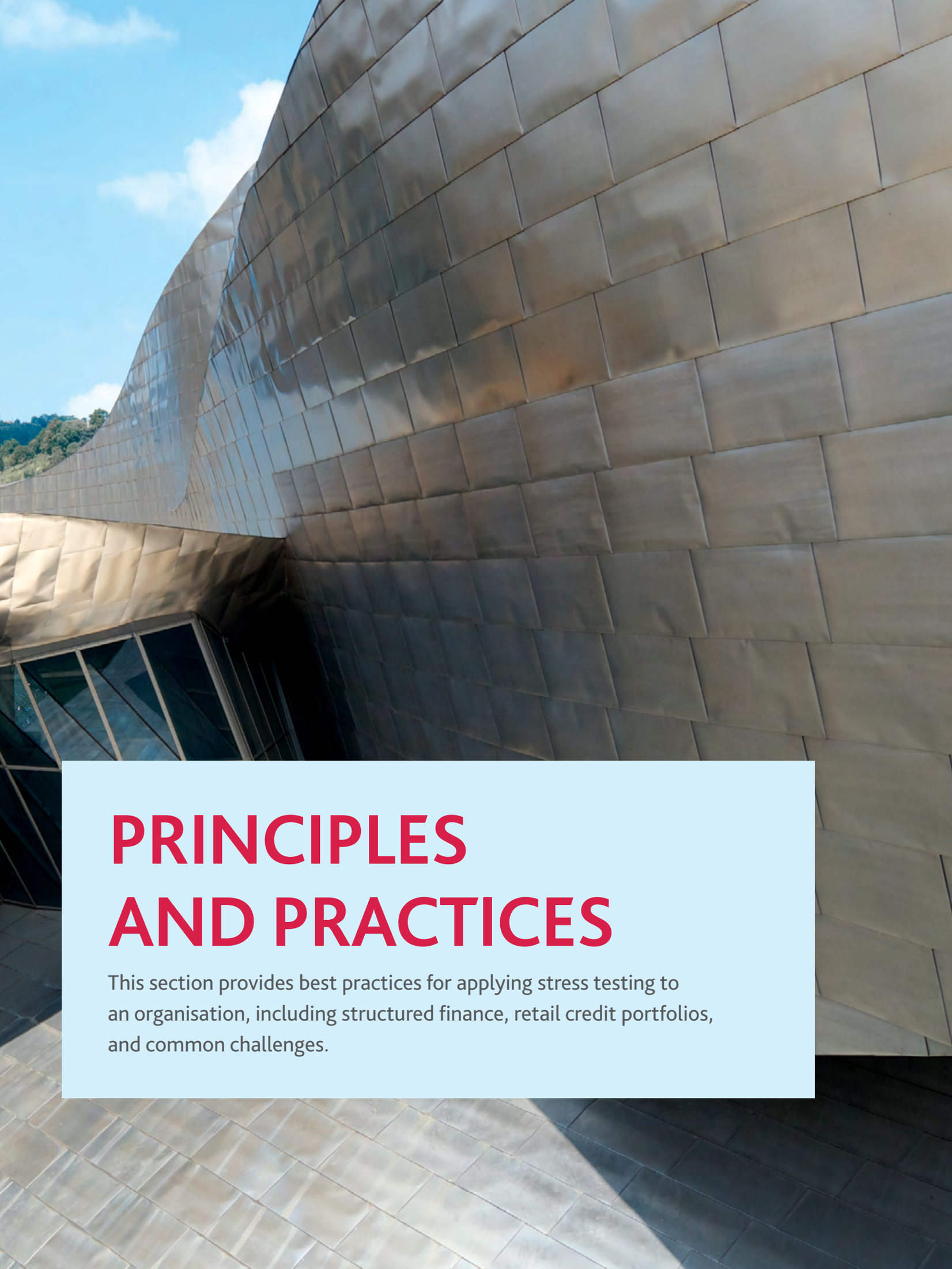
$$L_t = \beta_0 L_{t-1} + \beta_1 money\ rate_t + \beta_2 10yr\ yield_t + \varepsilon_t$$

$$S_t = \varphi_0 S_{t-1} + \varphi_1 GDP_t + \varphi_2 (term\ premium_t) + \epsilon_t$$



1 For some years, models of the term structure have been working with three factors. Whilst the third factor may add extra accuracy, most recent models are already focusing on only two factors. After all, in most cases two factors account for over 98% of the behaviour of the dataset. For stress testing purposes, two factors seem to be sufficient.

2 Sometimes the monetary policy rate stays flat for prolonged periods whilst the money market rate continues to give an idea of the fluctuations in the market



PRINCIPLES AND PRACTICES

This section provides best practices for applying stress testing to an organisation, including structured finance, retail credit portfolios, and common challenges.

CHALLENGES AND PITFALLS OF STRESS TESTING

By Dr. Christian Thun

Dr. Christian Thun
Senior Director, Strategic Business Development (EMEA)

Christian provides deep expertise on credit risk management, Basel II, and portfolio advisory projects and functions as a main contact for regulators and the senior management of financial institutions.

This article describes stress testing challenges and pitfalls and offers ways to successfully overcome them to comply with the new regulatory guidelines and to establish internal frameworks.

Banks around the world have devoted considerable time and resources to comply with the new regulatory guidelines and to establish internal frameworks so that they can perform stress tests for different types of risk, asset classes, and business lines. To successfully embed such a framework for stress testing, banks need to establish an enterprise-wide process that encompasses multiple steps involving a variety of employees, departments, and data sources. The management of such a process is challenging and its complex nature makes it prone to pitfalls and errors. This article describes some of these challenges and pitfalls and offers ways to deal with them.

At the beginning of every meaningful stress test, financial institutions need to decide what they need to stress, how they will conduct the test, who will be in charge, and what they want to achieve with the results. A stress test has to meet business objectives, such as setting trade limits or capital allocations, or defining the organisation's risk appetite, which can differ from regulatory requirements.

Deciding what needs to be stressed and how

Many banks are still having problems with this initial step. To decide what needs to be stressed, banks often align their efforts with regulatory requirements or market best practices, rather than deriving them from an internal business and risk analysis perspective.

An obstacle to such an integrated, bank-wide perspective is often the organisational setup that evolved over the last decade. Banks aligned their risk management functions with the key risk categories according to Basel II, leading to a silo organisation in risk management that focuses separately on credit, market, operational, concentration, and liquidity risk. Such a setup has made efficient bank-wide or cross-risk stress testing, as well as its planning and coordination, unnecessarily difficult.

Looking at the methods for stress testing that have evolved over the years, two main methods have arisen: sensitivity tests and scenario analyses. Sensitivity tests assume that only one risk factor, such as a shift in the yield curve, changes significantly. Sensitivity tests are rather simple in nature and relatively straightforward to implement, but lack plausibility because they do not take into account interdependencies between risk factors. As a result, the scenario analysis has become common practice to stress different risk categories. Scenario analysis examines the impact on a risk factor, such as probability of default, resulting from simultaneous changes in macroeconomic variables, such as inflation or GDP, allowing for a more realistic assessment of risk.

Designing meaningful scenarios

The most common pitfall is the design of meaningful scenarios that are severe but plausible at the same time. Depending on the scenario, the results of the stress test may significantly misrepresent the risks to which a bank is actually

exposed, because the scenario may not be severe enough or plausible, or because it does not address important aspects. The unforeseen problems at Franco-Belgian bank Dexia in October 2011 after it had passed the stress test of the European Banking Authority three months earlier and the sudden problems of Ireland's banks in November 2010 after they had passed the EU stress test just four months earlier are both good illustrations of this kind of misrepresentation.

The biggest obstacles in scenario design are the lack of sufficient data and the inability of a human test designer to create a variety of scenarios that do not just stress the obvious and ignore the potential effect of unforeseen events.

Developing a stress scenario to estimate the potential impact of catastrophic but low-likelihood events to a bank's portfolio is difficult even for experienced risk managers. Despite a risk manager's efforts, this kind of thought experiment is prone to two major pitfalls: ignoring plausible scenarios and considering implausible ones. Human creativity is influenced by experience, which leads risk managers to ignore plausible stress scenarios simply because they have not occurred yet. If a risk manager's imagination is geared toward implausible scenarios – for example, an asteroid hitting the earth – the key purpose of the stress test, to enable better decision making, is jeopardised. What kinds of useful options will the management of a bank derive from the alarming results of a highly implausible stress scenario? How should it approach reverse stress testing that asks for the kinds of plausible circumstances that could make a bank's business model unviable? Interestingly, given the myriad factors that could make a bank's business unviable, senior management and risk managers tend to consider a big idiosyncratic shock, rather than more likely scenarios, in their reverse stress testing.

Gathering sufficient data

The most immediate challenge many banks face, is a lack of data. In particular, information from periods of severe stress is rare – information that would form the basis for a scenario, as well as help discern the linkage between macroeconomic variables and risk drivers. Given the interdependencies between macroeconomic variables such as GDP, unemployment, inflation, and oil prices, having sufficient data available to understand and properly model behaviour under stress is critical. A lack of sufficient data will eventually lead to a weak and unstable linkage between any scenario and relevant risk factors, yielding an outcome that may set values at implausible levels. Given that the focus of stress testing is on the tails of the distribution, a lack of data will limit the usefulness of the stress test. If additional data are not available and assumptions have to be made, those responsible for the scenario design or stress test should run the test using different assumptions to better grasp the potential margins of error.

> An obstacle to such an integrated, bank-wide perspective is often the organisational setup that evolved over the last decade.

Even institutions that have enough granular information face data quality problems resulting from insufficient internal IT architecture, inconsistent data and processes, and non-accountability of those responsible for the input or audit of the information quality. Another increasingly important aspect is speed. If the results of a stress test should be relevant for a business decision, they will need to be available within days, if not hours, after the process has started. It is not uncommon that weeks can pass before the results of a stress test are available to senior management. In today's dynamic and volatile markets, to be in a position to consider contingency plans for the business only after several weeks have passed is at the very least a competitive disadvantage.

Linking a scenario with drivers of credit risk such as Expected Default Frequency (EDF™) or Loss Given Default (LGD), and subsequently

the economic capital required to protect a loan portfolio from unexpected losses, is another area of common pitfalls. The behaviour of risk drivers such as EDF or LGD under stress is usually modelled assuming non-linear relationships but proper parameterisation of the linkage function may suffer from a lack of data or intuition. Similarly, the calculation of economic capital under stress will only yield meaningful results if the bank is able to understand the dynamics of asset correlations during periods of economic stress. Banks often rely on changes in equity correlations as a proxy to capture these dynamics simply because data is readily available for these and they are easier to measure. However, empirical evidence has shown that equity correlations tend to be too low for financial firms, as well as for utilities and low-credit-quality firms. These deviations will lead to significant underestimation of the amount of required economic capital during stress periods.

The biggest obstacles in scenario design are the lack of sufficient data and the inability of a human test designer to create a variety of scenarios that do not just stress the obvious and ignore the potential effect of unforeseen events.

Communicating the results into action

All efforts to create a meaningful stress test will be useless if one key aspect is left out: communication. Internal communication is just as important, if not more so, as the external communication in the form of regulator-prescribed formats. The stress test has to be easily communicated. It has to be understood by risk managers as well as senior management, and has to illustrate and quantify the vulnerabilities of an organisation's current business model, as well as the transmission mechanism from scenario assumptions to potential portfolio impact.

Ultimately, the results of a stress test will affect the decision-making process. Stress test results need to be benchmarked against the risk appetite of an organisation and lead to a critical review of its current risk profile. Senior management has to prepare plans for early intervention, such as raising funds, suspending dividends to shareholders, limiting or even eliminating certain business activities, requiring more frequent reporting, replacing responsible managers – even closing a business line if it can no longer continue in a viable fashion. Senior management's engagement at this point is critical to endorsing any necessary action plans. Unfortunately, incorporating into a company's strategic business planning the results of a hypothetical stress test scenario that may never materialise is a challenge on its own.

Although much has been achieved in the last three to four years and the banks' stress test frameworks are very different from their pre-crisis versions, risk managers still face and must address numerous challenges and pitfalls before they can turn stress testing into the powerful instrument it can be.

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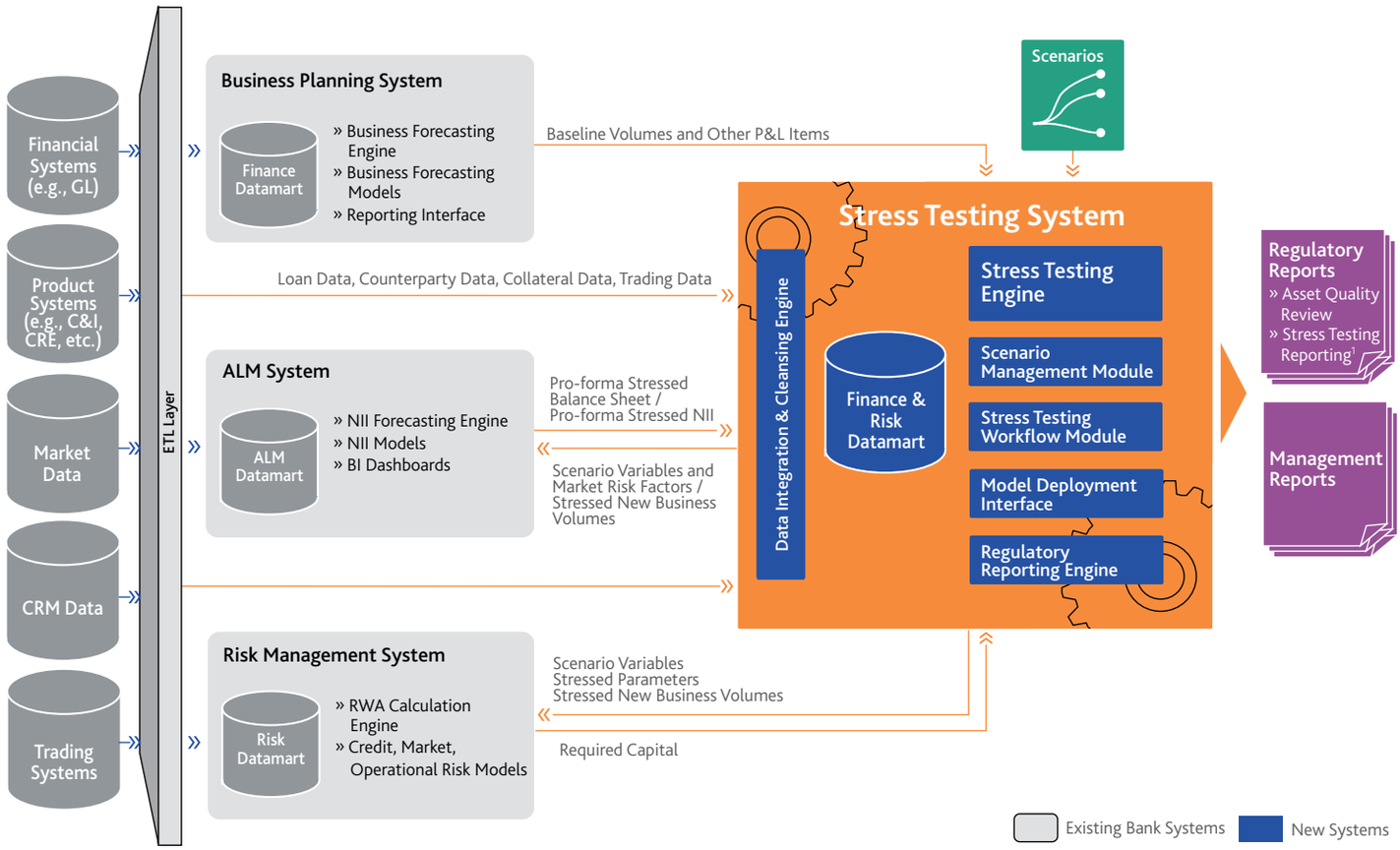
TARGET ARCHITECTURE FOR STRESS TESTING

By Alex Kang and María C. Cañamero

The Target Architecture for Stress Testing diagram illustrates the building blocks of a sound enterprise-wide stress testing system. The architecture highlights the need for a solution that will facilitate systems and models integration, data flow coordination, and automated reporting.

Figure 1 Target architecture for stress testing



Source: Moody's Analytics

1 No reporting guidelines have been published yet.

Below is a brief description of six key elements of the architecture:

1. **Data integration and cleansing engine, and finance and risk datamart**
   This data management platform is designed to provide the infrastructure needed to implement a world-class stress testing framework by managing and centralising all data required for the Asset Quality Review and stress testing.
2. **Stress testing engine**
   The stress testing engine enables bankers to perform the calculations required to forecast expected losses, impairments, and other income and losses indicators under stress conditions.
3. **Scenario management module**
   This module enables bankers to define custom scenarios and leverage pre-defined macroeconomic scenarios, including regulatory scenarios.
4. **Stress testing workflow module**
   This module includes automated software and reporting tools designed to streamline the Asset Quality Review and enterprise-wide stress testing process.
5. **Model deployment interface**
   This interface enables bankers to deploy the models required to conduct stress tests.
6. **Regulatory reporting engine**
   Regulatory reporting tools streamline and facilitate regulatory and business reporting by capturing, consolidating, and reporting the data. Ideally, the tools are based on templates that reflect the requirements of each local supervisor.

STRESS TESTING OF RETAIL CREDIT PORTFOLIOS

By Dr. Juan Licari and Dr. José Suárez-Lledó

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Senior Director, Head of the Economics and Consumer Credit Analytics

Juan and his team are responsible for generating alternative macroeconomic forecasts for Europe and for building econometric tools to model credit risk phenomena.

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In this article, we divide the stress testing process for retail portfolios into four steps, highlighting key activities and providing details about how to implement each step.

Practitioners apply various methods of portfolio analysis to the evaluations of the credit risk of retail debt. This article divides the stress testing process for retail portfolios into four steps, highlighting key activities and providing details about how to implement each step.

It also discusses how Moody's Analytics leverages on panel-data and time-series econometrics in order to (i) understand the dynamic behaviour of the bank's risk drivers and their interactions/feedback-effects, (ii) quantify their sensitivities to changes in the macro economy, and (iii) produce forward-looking projections that are consistent with one another and with the shape of the future economic cycle.

RETAIL CREDIT METHODOLOGIES – STRESS TESTING PROCESS STEPS

Based on our experience, the stress testing process for retail portfolios can be segmented into four key steps:

1. Data collection
2. Modelling development
3. Model validation
4. Model forecasting/stress testing

All steps carry full documentation as to any assumptions or data manipulation that has been considered. The key estimation and validation results should be fully documented to ensure complete transparency and to achieve a smooth knowledge transfer process.

Step 1 – Data collection: Historical data needs to be collected for as many years as possible across asset classes and geographies.

1. **Endogenous variables:** The models will need observed performance for the endogenous variables across time and across asset classes, geographies, and industries/sectors.
   - Examples of these risk parameters are: defaults, severity of losses, and prepayments.
   - Additional performance metrics, such as early arrears, can also add value to the modelling effort (these metrics can serve as early warning indicators for defaults). Examples of these are: 30-59-day, 60-89-day, 90-plus-day, etc.

2. **Portfolio characteristics:** In order to understand and quantify the quality of the underlying assets in a bank's portfolio, the modeller needs information about the characteristics of the admission policy profile for loans and lines of credit, interest rate/pricing information for assets and liabilities, term/maturity of the exposures, etc.
   - Examples of these are: region and industry breakdown, interest rates, loan-types, LTVs (loan-to-values), and credit scoring distributions. These will act as right-hand-side or control variables.

3. **Macroeconomic data:** The second subset of right-hand-side variables will consist of macro and sector-specific data. Banks should have an

extensive macro data warehouse with historic and forecast variables across countries, sub-national regions, and industries. An analyst typically leverages this extensive dataset to test for the strongest (and consistent) correlations between the endogenous and macro variables.

Examples of retail credit data structures are:

- **Segment-vintage-time data (SVTD):** SVTD is the most common template for the performance data. The portfolio is grouped by segments (mainly business-driven sub-portfolios), vintages (monthly, quarterly, or even annual cohorts, depending on the size of the portfolio), and time (monthly or quarterly observations on the performance of segments and cohorts). Panel-data and dynamic panel-data techniques are brought forward to model these portfolios.
- **The key performance components become:** (a) segment quality (rank-ordering of sub-portfolios, channel distributions, customer groups, or others), (b) life cycle or seasoning of the cohorts (nonlinear relationship between performance and age of the accounts), (c) vintage quality/risk (rank-ordering of cohorts according to acquisition and other policies), and (d) exposure of the accounts to the underlying economic cycle.
- **Vintage-time data:** A special case of the previous type is when there is a single segment/group, but the vintage and time dimensions remain relevant. For these portfolios, the modeller can identify the life cycle, vintage quality, and time components.
- **Segment-time data:** There are cases in which the vintage decomposition is neither feasible nor desired. Some portfolios are grouped into segments (according to business decisions or risk categories) and the metric to be modelled (for example, delinquency or default rate) is observed over time. This process becomes a standard (balanced) panel-data model. A platform should be equipped with all the standard econometric tools to handle these models. Techniques such as pooled-OLS, random and fixed effects, or Arellano-Bond estimators can be tested on these portfolios.
- **Time data:** Time-series tools can be leveraged to handle portfolios whose performance is measured through several time-series variables. Multi-variate time-series techniques such as vector autoregressive estimations can be implemented to capture the dynamic behaviour or credit portfolios. Value at Risk (VAR) and structural VAR tools are widely used in econometrics for forecasting and simulation purposes. Similarly, AutoRegressive Integrated Moving Average (ARIMA) and Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) methods can also be tested.
- **Account/loan level data:** Credit behaviour can be modelled at an individual account level, providing forecasted values for each account/loan. The detailed nature of this data lends itself towards binary outcome models (for instance, a binomial regression on a default indicator). Variables for this approach could include segment, vintage, age, and time variables. The segment splits could be any field dividing the accounts at origination such as product, region, or risk. The age variable relates to the time period since the point modelling started. Examples include time since origination or time since charge-off. The vintage and time variables can be either numeric fields modelling these aspects or alternatively macroeconomic and business data to represent these components. An example of business data that could be utilised for modelling the vintage aspect is an application score.

The modellers can run equations using time-series, cross section, and panel-data techniques. Several estimation methods are available: OLS, MLE, GLM, GMM, Pooled-OLS, fixed or random effects, Arellano-Bond, quantile techniques, probit and logit, VAR, ARIMA, GARCH, etc.

Step 2 – Model development

The objective in this phase is to explain as much of the variability of risk parameters (endogenous variables) as possible, making use of (i) internal/portfolio drivers and (ii) macroeconomic and other external factors. The specific estimation method (model) will depend on the nature of the historical data collected.

There are three alternative model structures depending on the depth and aggregation of the historic data:

1. Fully aggregated model: in case there is only aggregate, market data for this asset class as a whole
2. Segmented data: in case there is a need to collect more granular performance data with dimensions across banks countries/regions and/or sectors/industries
3. Loan-specific data: in case there is performance data at the loan or customer level

Note that modellers can always aggregate up from a granular segmentation into an aggregate model; that is, go from (3) to (2) or (1) or from (2) to (1).

The modelling specifications for the three alternatives are:

Step 2.1 – Modelling, Case 1: Aggregate performance

If the dataset that is put together contains observed performance for the endogenous variables across time, with no other dimension (no country or industry breakdown, no loan-specific segmentation, etc.), the modeller can make use of multi-variate time series techniques, such as VAR and S-VAR (structural VAR). This point is illustrated by concentrating on three left-hand-side variables (represented together as the vector y_t: PD (or default metric), LGD (or severity/recovery metric), and prepayment risk. These can be modelled simultaneously, against their lags and against a list of internal and external drivers (x_t^1 represents a vector of internal drivers or portfolio characteristics, x_t^2 stands for a vector of macroeconomic factors):

$$y_t = (default_t, severity_t, prepayment_t) = f(y_{t-1}, y_{t-2}, \ldots, y_{t-N}; x_t^1, x_t^2) \quad (A.1)$$

This aggregate model will produce dynamic forecasts for y_t consistent with the assumptions specified for the economic series (embedded in $(x_{t+1}^2, x_{t+2}^2, \ldots, x_{t+M}^2)$. By changing the future values of the macro series, the model will produce alternative shapes for the vectors. Sensitivity and scenario analyses can be applied to this model by changing the future values of different sets of macro drivers. Standard impulse-response exercises can be carried out, as is common practice in time series analysis. An important feature of the proposed methodology is that it can allow for interactions between the three vectors; that is, prepayment and credit risk are not modelled independently.

Note that the economic series were taken as exogenous, and the future paths of y_t do not affect the shape of the economic cycle; there are no feedback effects between credit performance and the economy. Models in line with equation (A.1) can work very well for cases in which the modeller can isolate the economy from the outcome of the risk parameters. Cases where the sector/industry are modelled are not systemically important. Alternatively, if we are interested in analysing the effects of some macroeconomic shock to an asset class or a sector that is systemically important (key to the underlying performance of the economy), the system (A.1) needs to be generalised to incorporate some macroeconomic variables into the left-hand side of the equation.

$$(\tilde{x}_t^2, y_t) = f(\tilde{x}_{t-1}^2, \tilde{x}_{t-2}^2, \ldots \tilde{x}_{t-N}^2, y_{t-1}, y_{t-2}, \ldots, y_{t-N}; x_t^1, \bar{x}_t^2) \quad (A.2)$$

The vector of macroeconomic data has been split into endogenous ($\tilde{x}_t^2$) and exogenous ($\bar{x}_t^2$) subgroups. For systemically important asset classes or models, the effects of, say, a very high PD outcome, will influence the performance of the economy and vice versa. There is now a clear and transparent feedback effect that should be present in a market-wide stress testing framework.

Step 2.2 – Modelling, Case 2: Segmented data

If the dataset contains an observed performance for the three vectors over time and across banks, industries/sectors or countries, the dynamic panel-data techniques can now be used. The estimation equation looks like (A.1) but with an

This segment is referred to as 'j'. Equations (A.1) and (A.2) become:

$$y_{j,t} = (default_{j,t}, severity_{j,t}, prepayment_{j,t}) = f(y_{j,t-1}, y_{j,t-2}, \ldots, y_{j,t-N}; x^1_{j,t}, x^2_{j,t}) \quad \text{(B.1)}$$

$$(\bar{x}^2_{j,t}, y_{j,t}) = f(\bar{x}^2_{j,t-1}, \bar{x}^2_{j,t-2}, \ldots \bar{x}^2_{j,t-N}, y_{j,t-1}, y_{j,t-2}, \ldots, y_{j,t-N}; x^1_{j,t}, \bar{x}^2_{j,t}) \quad \text{(B.2)}$$

additional dimension coming from the country, industry/sector, and/or bank to which it belongs.

This version of the model will produce values for the endogenous variables across all segments 'j', $y_{j,t}$. Aggregating over all possible segments will provide us with a metric similar to the one described in (A.1). In other words, the aggregate model from (1) is simply a special case of the segmented equation (but with a single segment). As was the case with the previous estimation method, dynamic panel-data tools will allow us to run sensitivity and scenario analyses, perform impulse-response exercises, and test the shape of the three vectors under different economic assumptions.

Equation (A.2) extends the notion of systemically important segments to allow for interaction between macro factors and portfolio performance. With more granular specifications, the systemic importance of the model is less relevant. And this point is a key weakness of loan-level and other very granular modelling techniques when it comes to be applied to market-wide stress testing exercises. They lack the systemic dimension and will take macro factors as given, exogenously.

Step 2.3 – Modelling, Case 3: Account or client-level performance

If the data that is collected is granular enough to have loan-specific performance, the structure of the equation is that of a discrete-choice model. Several techniques can be tested on these equations (Probit, Logit, Censored-regressions) depending on the exact nature of the historic data. To illustrate the structure of a generic loan-specific equation, consider 'i' as the index for a specific loan that belongs to industry or country 'j' observed at a point in time 't', as represented in equation (c).

$$y_{i,j,t} = (default_{i,j,t}, severity_{i,j,t}, prepayment_{i,j,t}) = f(y_{i,j,t-1}, y_{i,j,t-2}, y_{i,j,t-N}; x^1_{i,j,t}, x^2_{i,j,t}) = \quad \text{(C)}$$

The output of a model like (C) can also be aggregated up into segment predictions, in line with (B.1) or even (A.1) if the aggregation is done on all dimensions (but 't').

Step 3 – Model validation

The modelling development phase concludes with strict in- and out-of-sample validation exercises. Forecasting performance and model robustness are tested, and the results are fully documented. Below is a summary of some of the validation tests that are recommended:

i. In-sample fit and residual analysis.
   Goodness of fit is studied for all equations to ensure a model presents no estimation bias or asymmetries. Several statistics help a modeller understand the goodness of fit of the model (R2, Adj R2, RMSE, likelihood-if normality was tested, etc.). Understanding correlation patterns for residuals is also important. It also helps identify and control for outliers.
ii. Out-of-sample accuracy.
   It is standard to work with holdout samples in order to (a) re-estimate the equations using this subsample and (b) compare the model predictions against actual history. The closer the model gets to observed values the better. This forecasting accuracy is analysed through mean-squared-errors and mean-absolute-errors. The holdout sample period can vary from six to 12 months, sometimes even 24 months (if there is a long historic sample to re-estimate the model).
iii. Model robustness.
   With the holdout samples described above, the modeller should also be interested in

Pool performance time series (e.g., CPR, CDR, LGD, Vectors) $= f$

Table 1 Example of a Dynamic Panel-Data Equation, in Line with Equation (B)

Pool- and loan-level components
» Attributes (e.g., LTV, FICO, collateral type) define quality across pools » Early delinquencies also serve as proxies for underlying pool quality » Economic conditions at origination matter for pool quality » Econometric technique accounts for other unobserved effects

Business cycle exposure component
» Explicit connection between pool performance and macroeconomic drivers (e.g., home prices, unemployment rate, GDP, disposable income, refinancing)

Lifecycle component
» Takes into account the shape of the performance curve over a pool's life » Nonlinear model against 'deal age'

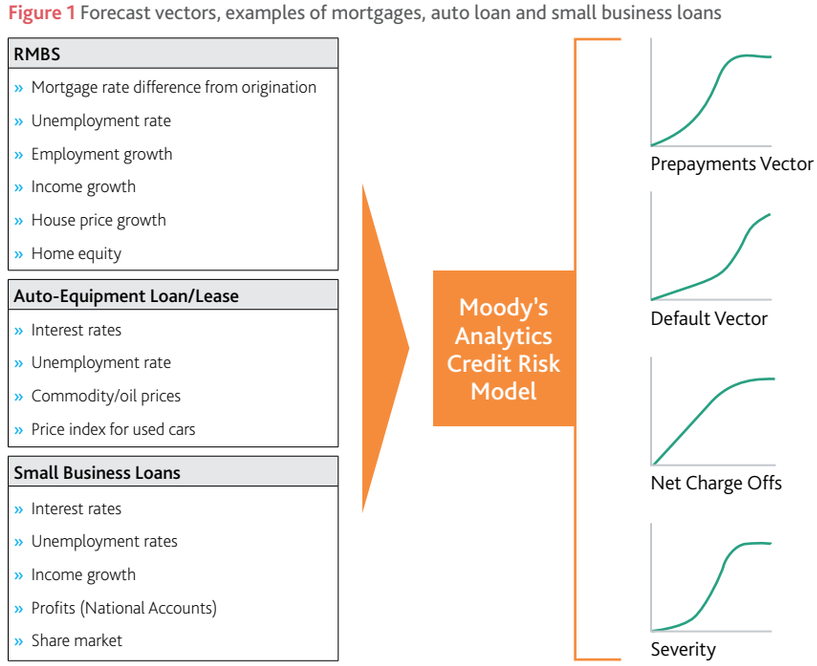
Source: Moody's Analytics

testing how stable and robust their models are. The modeller needs to compare the estimation outputs of the full vs. holdout samples, looking for cases where some parameters change their signs or lose predictive power.

Step 4 – Generating stressed predictions

After the model has been developed and validated, the equation can finally be used to produce outputs; that is, predicted vectors for defaults, severities, and prepayments. Alternative assumptions on the future values of the macroeconomic series (reflected in $x^2_{t+1}, x^2_{t+2}, \ldots, x^2_{t+M}$) will produce alternative shapes for the endogenous variables. With the estimated functional form for the model equation, the modeller will be able to shock the

Figure 1 Forecast vectors, examples of mortgages, auto loan and small business loans



Source: Moody's Analytics

macro drivers with alternative assumptions and generate predicted values for all left-hand-side variables.

STRESS TESTING FRAMEWORK FOR RETAIL PORTFOLIOS

Techniques used for the stress testing of retail exposures

Moody's Analytics leverages panel-data and time-series econometrics in order to (i) understand the dynamic behaviour of the bank's risk drivers and their interactions and feedback effects, (ii) quantify their sensitivities to changes in the macro economy, and (iii) produce forward-looking projections that are consistent with one another and with the shape of the future economic cycle.

The choice of a specific technique depends upon data availability and its structure. Techniques can typically be categorised in the following types:

1. Very granular performance data (e.g., loan-level information)
2. An intermediate, segmented data set (e.g., sub-portfolio data segmented across countries and across risk levels)
3. An aggregated set of time-series (for portfolios and sub-portfolios across regions).

Type 1 datasets allow modellers to develop granular, bottom-up stress testing set-ups. A top-down approach is typically applied to datasets in line with Type 3. In many instances, an intermediate approach such as Type 2 is the optimal choice.

Example of a mortgage portfolio – segmented by cohorts

In order to reduce the number of variables in the model but maintain the explanatory power that age provides, a cubic spline function is applied to capture the nonlinear relationship between defaults and months-in-book. After identifying the life cycle component, the risk heterogeneity or defaults across vintages and seasonality of default rates over time are modelled.

After controlling for these components (age, quality, and seasonality), the modeller should

Figure 2 Stress Testing Equations – Macro Drivers of a Mortgage Portfolio

Group	Variables	30 day delinquency	60 day delinquency	90+ day delinquency	CDR	Foreclosure	Repossession	LGD	Net Charge-off	CPR	Principal
Origination conditions	LTV				X			X			
	WAC									X	
	Master Trust	X		X	X			X			
	Country		X		X	X	X	X	X	X	X
	Product Line	X		X		X	X	X	X	X	X
	Loan Type	X		X							
Current Economic Conditions	Home Prices			X	X			X			
	GDP										X
	Unemployment Rate	X	X	X	X	X	X		X		
Current Economic Conditions	Home Prices (HP)				t	t	t		t	t	
	10-Year Bond Rate									t	
	Unemployment Rate	t	t	t	t	t	t		t		
	GDP		t	t							
	Employment										t
Pipeline connections	60 day delinquency			t, t-3	t-3	t-3	t-3				
	90 day delinquency				t, t-3				t-3		
Other Variables	Lifecycle * Economic		X								
	Country * Economic							X			
Lifecycle	Number of knots	4	4	4	4	4	3	4	4	4	4

Source: Moody's Analytics

consider the effects of external, macro drivers. With economic factors included, the modeller can run macro stress testing exercises.

RETAIL CREDIT METHODOLOGIES – ALTERNATIVE ESTIMATION METHODS

The toolkit of estimation methods that can be leveraged for stress testing purposes is quite comprehensive. This section lists examples of alternative methodologies whose applications will depend on the nature and availability of data.

Standard OLS estimations

The OLS estimation fits a model of a dependent variable on independent variables using linear regression, optimised on the ordinary least squares method. Note that although the estimation is done on a linear equation, the modeller can still apply nonlinear transformations to dependent and independent variables before running the estimation (for example, logistic or logarithmic mappings).

Quantile regressions

The QREG command fits quantile (including median) regression models, also known as least-absolute-value models (LAV or MAD) and minimum L1-norm models. There is an option associated with quantile regression for modifying the asymmetry parameter. This is a parameter in quantile regression that weights the possibly distinct costs of under-prediction and over-prediction. With this parameter set to 0.5, positive and negative errors are weighted equally. When the asymmetry parameter is 0.5, our best predictor is the median; it does not give as much weight to outliers. When the asymmetry parameter is 0.7, the loss is asymmetric; large positive errors are more heavily penalized then negative errors.

XTREG Regression (FE, RE, and MLE option)

The XTREG command is a regression technique that allows FE (fixed effects), RE (random effects) and MLE (maximum likelihood estimation) options. The MLE option maximises the log-likelihood function. The FE option allows the regression to use a fixed effects estimator, whilst the RE option allows the regression to use a random effects estimator.

Discrete choice models (PROBIT and LOGIT commands)

Discrete choice models are appropriate where there is dichotomy in the required dependent variable. These models can be utilised if loan-specific data are provided (i.e., modelling a default indicator) or, alternatively, a vintage-level indicator (default rate > 3%, for instance).

- **PROBIT:** The probit command fits a maximum-likelihood probit model (binary regression).
- **LOGIT:** The logit command fits a maximum-likelihood logit model (logistic regression).

Vector AutoRegressive techniques

The VAR model fits a multivariate time-series regression of each dependent variable on lags of itself and on lags of all other dependent variables. VAR also fits a variant of models known as the VARX model, which also includes exogenous variables.

AutoRegressive Integrated Moving-Average Modelling

ARIMA fits a model of dependent variable on independent variables where the disturbances are allowed to follow a linear autoregressive moving-average, or ARMA, specification. The dependent and independent variables may be differenced or seasonally differenced to any degree. When independent variables are included in the specification, such models are often called ARMAX models. When independent variables are not specified, they reduce to Box-Jenkins ARIMA models in the dependent variable.

Arellano-bond estimation

Linear dynamic panel-data models include p lags of the dependent variable as covariates and contain unobserved panel-level effects, fixed or random. By construction, the unobserved panel-level effects are correlated with the lagged dependent variables, making standard estimators inconsistent. Arellano and Bond (1991) derived a consistent generalised method of moments, or GMM, estimator for the parameters of this

model; XTABOND implements this estimator. This estimator is designed for datasets with many panels and few periods, and it requires that there be no autocorrelation in the idiosyncratic errors.

Application: technical description of the vintage model

For a given segment, say $i = 1, \cdots, N$, we have aggregate data on a set of sequential vintages observed over subsequent time periods. A vintage indicator is defined as: $v = 1, \cdots, V$. And the time indicator is the standard: $t = 1, \cdots, T$.

The point here is that vintage is a time-series concept: the February 2006 vintage followed the January 2006 vintage. Thus, a time dimension is running in two different directions. In other words, there is a cross section of a time series of time series, as opposed to just the cross section of time series that is in standard panel datasets.

These types of data are commonly analysed in consumer credit. One has a vintage of loans that all originated at a specific time in a specific segment. Modelling the nonlinear life cycle of the loans using spline functions is favoured, and then incorporating two additional components called 'vintage quality' and 'prevailing conditions,' which are constant within vintage and time, respectively.

This model is estimated by OLS, pooled-OLD, GLS, MLE, GMM or similar unbalanced dynamic panel data-specific approaches (pooled-OLS, fixed effects, random effects, etc.). Careful attention is paid to functional form to ensure that predicted delinquency or default rates remain bounded between zero and unity.

The basic model is thus of the form: $y_{ivt} = \mu_i + x'_{it}\beta + z'_{iv}\gamma + r'_{ivt}\phi + f_i(t - v) + u_{ivt}$

Where x_t is a set of variables that help define the macroeconomic conditions or the internal policy variables that the segment/sector i faces at time t, and z_{iv} are variables that define the conditions (including macroeconomic factors and internal policy variables) that pertained at the time each vintage was formed. The μ_i variables are region-based fixed effects. One can also have variables that vary over both vintage and time, contained in r_{ivt}. These variables, which describe how the economy of segment/sector i has altered since origination, often prove to be very useful. The function $f_i(t - v)$ is a nonlinear baseline life cycle that might also be a function of macroeconomic or internal factors; $t - v$ is just the age of the vintage at time t.

Figure 3 Home Prices Assumptions

Figure 4 Geographic Heterogeneity of Mortgage Defaults

Figure 5 Mortgage Default Rates – Baseline Forecasts

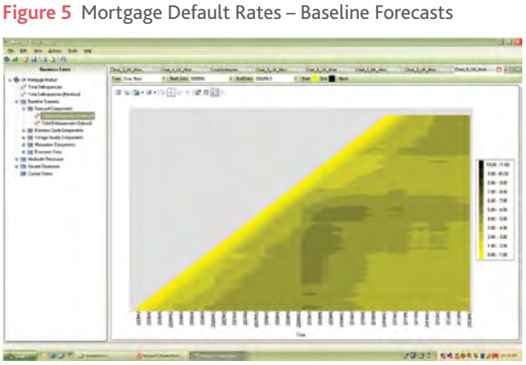
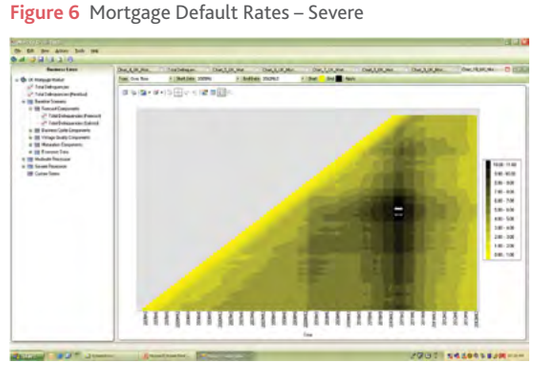


Figure 6 Mortgage Default Rates – Severe



THE CHALLENGES OF STRESS TESTING STRUCTURED FINANCE IN EUROPE

By Stephen Clarke and Andrew Jacobs

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Stress Testing structured finance transactions presents unique challenges due to large and diverse portfolios of underlying assets, limitations on data availability, and the idiosyncrasies and complexities of the structures and associated risks.

Stress testing European structured finance portfolios presents a unique challenge: nowhere is tail-risk analysis more critical yet more difficult to do properly. As we have witnessed over the past decade, structured finance transactions tend to carry myriad risks, therefore requiring complicated analyses. In response, banks tend to separate structured finance securities from less esoteric asset classes, both organisationally and analytically. However, when a bank conducts stress testing, it must consistently apply stresses to all its positions regardless of asset class. This article addresses some of the challenges banks face in stressing their structured finance positions within the context of a larger enterprise-wide stress testing exercise.

An inherently involved and complex process

Looking at a structured finance portfolio as a whole can yield useful generalisations around projected performance. For example, dropping home prices are on average going to negatively affect the credit risk of RMBS tranches. However, unlike corporate bonds, for example, it is not possible to know intuitively how a change in a given macroeconomic statistic will affect a single position. Depending on the deal structure, it is possible that severe economic scenarios could improve the relative performance of some tranches and cause significant losses to others. You cannot determine the impact on structured finance tranches without running the cash flows on the underlying properties and loans and then moving those cash flows through the deal's waterfall. And yet, running the cash flows opens up a whole new set of problems, including challenges in maintaining quality data and building the underlying asset models.

Dealing with data

Using a consistent method to stress test across asset classes implies the ability to reliably convert forecasts on a potentially large set of macroeconomic factors into performance projections on each of a bank's positions. In the world of structured finance, this ideally means crafting projections at the underlying loan-level. Loan-level data, especially in European deals, can be frustratingly scarce, which contributes to a dearth of granular structured finance asset models. Despite concerted efforts of both regulators and the market to increase loan-level data availability in Europe, the lack of history in these newly created datasets makes robust and predictive model building difficult.

Whilst lower coverage for loan-level data makes it hard, if not sometimes impossible, to develop reliable account-level models, the paucity of data also means that any successful stress testing model must simultaneously and consistently support alternate methodologies. For example, a bank with whole loan mortgages and RMBS on its books may stress whole loans through an account-level asset model, whereas the

RMBS position can only be analyzed through an aggregation model on the underlying collateral. Despite using separate models, stressed results between the whole loan and RMBS books must be consistent. Most often, missing loan-level data forces a pool-level analysis where historical performance of a given pool, its comparables, and aggregate industry and national metrics inform the projections. Mechanisms should be in place to reconcile results from the loan-level and pool-level models.

Identifying and addressing hidden risks

Complexities in structured finance models in Europe are not limited to the underlying assets. Because of the preponderance of cross-currency transactions, currency swaps are common and swaps of any kind could introduce many risks, including counterparty risk. In so-called normal economic environments, counterparty risk can be overshadowed by credit risk and extension risk, as two examples, but it strongly came to the forefront during the credit crisis when protective swaps failed to deliver in times of need. Indeed, counterparty risk tends to become problematic in particularly difficult economic environments, or tail-risk scenarios, which are precisely what stress testing is designed to address. Properly tracking counterparty risk within the context of structured finance securities is especially challenging given the lack of unique identifiers and standard reporting templates for derivative transactions in securitizations. Investors need to scour performance reports and deal with documents carefully to understand their counterparty exposure.

Developing an industrial-strength, scalable platform

Even if a given bank has access to a model for stress testing that features consistent implementation of structured finance analysis, that bank cannot simply run the stress test once and move on. Stress testing is meant to be an ongoing process and, therefore, any competent stress testing solution must be streamlined and user-friendly. Furthermore, the platform must be extensible and diligently supported in order for the bank to keep up with the ever-changing regulatory environment. In cases where some banks hold thousands of structured finance positions, building an efficient technology infrastructure to run a variety of stress tests in a consistent and timely manner is a challenge that must be addressed.

Stress testing with a mixed portfolio that includes structured finance securities can be a daunting task. From complicated legal structures and non-standard reporting of underlying collateral to properly incorporating macroeconomic factors, some banks may struggle to convince regulators that their structured finance testing is up to the same standards as the stress testing on their more vanilla positions. This is why it is critical to leverage a platform that provides cohesion across asset classes, strong fundamental analysis, consistent assumptions, model design, and ongoing support. Consistency across all portfolio assets is an imperative to stress testing best practices.

> Loan-level data, especially in European deals, can be frustratingly scarce, which contributes to a dearth of granular structured finance asset models.

STRESS AND SCENARIO TESTING:

HOW INSURERS COMPARE WITH BANKS

By Brian Heale

Contributor: Brian Robinson

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Brian provides technology solutions to the global insurance industry, as well as an in depth knowledge of the life and pensions business and enterprise technology.

In this article, we compare the bank and insurance industries, to not only highlight how they are being brought closer together, but also to gain a new perspective on stress testing practices.

Although the business models are fundamentally different, there are parallels between the challenges of stress testing for both banks and insurers. This article compares the two industries, highlighting their differences and similarities to not only call out how these once separate entities are being brought closer together, but also to gain a new perspective on stress testing practices. Furthermore, many banks in Europe actually own insurance companies so it will be interesting to watch how they deal with the differences in the future.

The liability profiles for different types of insurers place different requirements on the assets they hold, which is reflected in their stress testing approaches. Property and casualty (P&C) insurers are more focused on ensuring liquidity to pay claims should those arise sooner than anticipated, whilst life insurers are more concerned with matching returns to their future obligations. Consequently P&C insurers tend to adopt an investment strategy based on fixed income assets with few equity/growth assets. Life insurer investment focuses more on growth and hedging-type assets. This differences in risk profiles places different emphasis on the factors each would look at from a stress perspective.

Stress and scenario testing have been a long-standing practice in the insurance sector but recently its importance has grown significantly, driven by the introduction of regulations such as Solvency II, local regulatory requirements, and increased market awareness of the benefits of stress testing.

Senior management's acceptance of stress testing as an internal risk management tool has further promoted the concept of stress testing to insurers. Similar to their bank counterparts, insurers face various 'shocks', some of which are correlated with the business and financial cycle. Stress testing is a valuable tool for regulators to ascertain whether insurers are financially flexible enough to absorb losses that could occur in various adverse real-world scenarios.

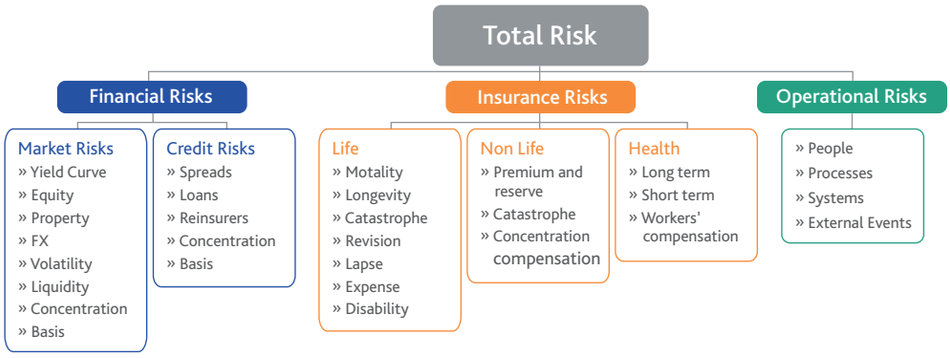
STRESS TESTING PRACTICES: DIFFERENCES BETWEEN INSURERS AND BANKS

Despite the shared need to meet regulatory requirements, there are four key differences between the stress testing practices of insurers versus other financial institutions.

Difference 1: In addition to financial and operational risk, insurers must consider the impact of insurance risk

The key risk exposures of insurers include not only financial and operational risk, but also insurance risk (highlighted in orange in Figure 1). Although insurers primarily underwrite insurance risk, they are exposed to financial risks due to the interaction between their assets (premiums invested to cover liabilities) and liabilities[1]. The addition of insurance risk adds a layer of complexity when developing aggregated stress tests and consolidated reporting across the organisation.

Figure 1 Insurers: key risk exposure



Source: Moody's Analytics

It is worth noting that many insurers also consider additional risk types, such as strategic, reputational, commercial (e.g., new market entrants, competition from different sectors), regulatory (e.g., change in regulations), model, operational, and group risk.

Difference 2: Insurers consider additional stresses to assess the impact of insurance risk

It can be argued that insurance stress tests are structured in a similar manner to those prevalent in the banking world because many of the financial risks the two sectors face are broadly similar. However, to accommodate the additional risks, insurers are required to develop additional stress tests to effectively study the impact on their portfolio.

The insurance business is split into two fundamental lines of business: life (long-term business, such as term, endowment, and universal life) and non-life (short-term business, such as automobile, home, and aviation). Risks such as catastrophe (natural disasters, hurricanes, flood, etc.), mortality, and lapse are significant for insurers but are largely irrelevant for banks. Life insurance is essentially a long-term business, with some policies having a term of 50 years or more.

Table 1 Example insurance stresses

Example Life Stresses	
Mortality Risk	An insurer assesses the impact of changes in mortality (level or trend) on their long-term liabilities. For example, annuity providers may be concerned about improvements in mortality (e.g., due to medical enhancements). If people live longer, then annuity providers will need to pay claims for longer. Thus, they will want to assess the sensitivity of their liabilities to long-term mortality improvements, also known as longevity risk. Alternatively, an insurer may write term assurance business that pays out a claim on death during the term of the contract. In this case, an insurer will be concerned about an increase in mortality. An insurer will want to check the sensitivity of their liabilities to both events (e.g., a pandemic causes a sudden spike in claims) or increases in longer term mortality.
Lapse Risk	Lapses occur when a policyholder terminates their policy before the end of the contract term. There are two sides to lapse risk: » For some policies, the longer the policyholder maintains their policy the more profits an insurer expects to make (e.g., Unit Linked Contracts). Thus, if more policyholders lapse than an insurer expects, there may be a negative impact on the future profit stream. » However, some policies are effectively loss-making for insurers (e.g., contracts with valuable financial guarantees that are 'in the money'). For these policies, the risk is that fewer policyholders lapse than expected.
Example Non-Life Stresses	
Catastrophe Risks	Non-life insurers exposed to catastrophe risk (e.g., hurricane, flood, and storms) are concerned with both the likelihood of a catastrophe and the corresponding loss should such an event occur. Thus, they will be interested in the sensitivity of both the likelihood of such an event happening and the associated loss on their balance sheet.

Table 1 provides some examples of unique life insurance stresses that do not typically apply to banks. These are a few examples of the different kinds of activities of insurers should take into account in the stress test framework and scenario design.

Difference 3: Insurers are subject to insurance-specific regulations, such as Solvency II and ORSA

Insurance is highly regulated and stress testing is a well-established practice. For example, in the UK the Individual Capital Assessment (ICA) regime has been around for many years. Today in Europe, there is the broader regulatory driver of Solvency II, as well as initiatives driven by local regulators, such as the Prudential Regulatory Authority (PRA) in the UK and the Federal Financial Supervisory Authority in Germany. The Own Risk Solvency Assessment (ORSA) requires insurers to stress their material risks and carry out scenario analysis to assess the robustness of their balance sheet both now and in the future.

Solvency II

Solvency II requires that an insurer's balance sheet is stressed under the Standard Formula approach to assess the Solvency Capital Requirement (SCR). The European Insurance and Occupational Pensions Authority (EIOPA) prescribes details of the parameters of those shocks (examples in Table 2).

ORSA and stress tests

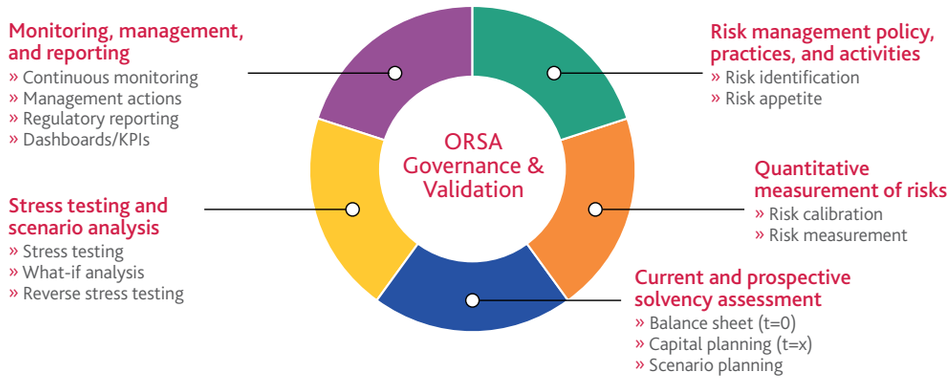
The ORSA is a set of processes designed to help insurers understand their own risks and support decision-making and strategic analysis. To effectively manage their risk, insurers must understand their risk profile and use stress testing and scenario analysis to assess the robustness of the balance sheet and capital calculation. Figure 2 highlights the ORSA process and stress testing, and scenario analysis is a major component.

The ORSA principles have been adopted beyond Europe – for example the National Association of Insurance Commissioners (NAIC) in the US is introducing ORSA, as has the FSB in South Africa. The Netherlands are currently undertaking an ORSA dry-run process. Thus ORSA is slowly moving toward universal acceptance in insurance. A key aspect of the ORSA is that it requires the projection of an insurer's balance sheet over a multi-year time horizon based on a number of scenarios. Insurers typically adopt a small number (e.g., 6-7) of business planning scenarios for use in their ORSA.

Table 2 Example insurance stresses

Example Shock Parameters	
Interest rate shock	Instantaneous upward or downward shock on the term structure of interest rate: » Upward: 25% - 70% by maturity year » Downward: 30% - 75% by maturity year
Lapse shock	» Permanent lapse increase: 50%, cap at 100% lapse rate » Permanent lapse decrease: 50%, absolute change cap at 20%, » Mass lapse: 30% for policies with surrender strain, 70% for non-retail business
Longevity shock	» Permanent mortality increase for each age: 15%
Global and other equities shock	The standard shocks applied to both classes, -39% and -49% respectively, are calibrated in accordance with a Value-at-Risk (VaR) over a one-year horizon at a 99.5% confidence level. In order to consider equity market cycles, a symmetric adjustment (Dampener Effect) of 10 percentage points is applied to standard shocks. Thus, each year, the prudential regulator will fix a shock level ranging from -29% to -49% for 'Global' equities, and from -39% to -59% for 'other' equities.

Figure 2 ORSA process and stress testing



Source: Moody's Analytics

Difference 4: Applying macroeconomic scenarios to the insurance business requires adaptations to the model

In order to test the impact of event-driven and alternative economic scenarios on a given insurance portfolio, macroeconomic scenarios may be used over the business planning horizon. However, care is required in using banking stresses and/or scenarios. Figure 3 illustrates how the two main types of macroeconomic scenarios over the business planning horizon fit in the insurance business.

STRESS TESTING PRACTICES: SIMILARITIES BETWEEN INSURERS AND BANKS

The major differences in stress testing between banks and insurers have previously been outlined, primarily relating to insurance risk and the different natures of the businesses. However, there are also similarities faced by the two sectors in the implementation of their stress testing exercises.

Similarity 1: insurers are becoming lending institutions, making them vulnerable to systemic risk

By entering the lending business, insurers are building similar portfolios to financial lending institutions. Many are increasingly looking into investing in alternative credit assets (such as infrastructure and corporate loans or CDS writing), which provide a better yield than long-term bonds and critically also match their long-term liabilities. Examples of insurers that are moving into the lending business which historically have been considered the domain of the banks, include AXA, L&G, and Ageas. Ageas established a US $1.3 billion corporate loan business in 2010 and AXA plans to lend €10 billion over the next five years. It is worth noting that insurers hold total assets of over $25 trillion and could become significant lenders in the coming years.

The move away from traditional insurance underwriting activities may make insurers more vulnerable to financial market developments and more likely to amplify systemic risk. Ultimately, this makes credit risk more relevant.

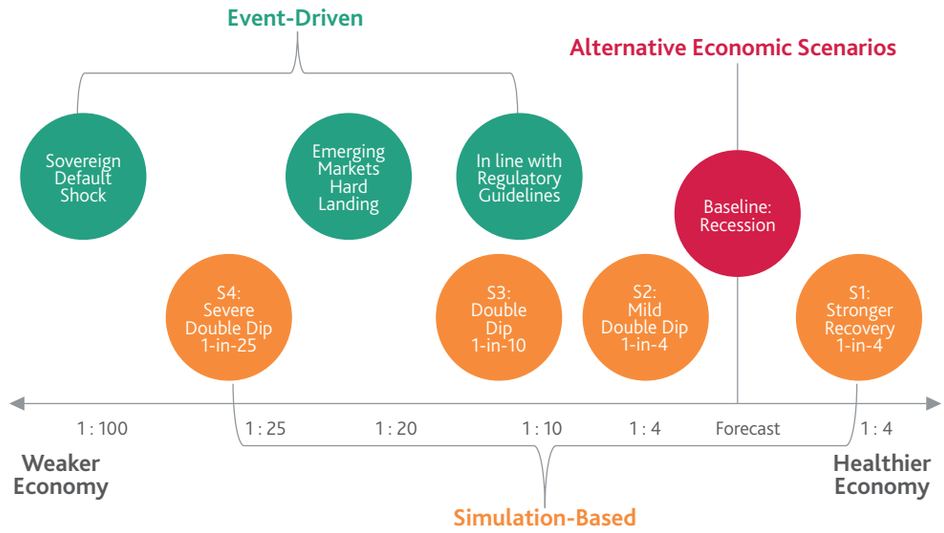
Interaction of assets and liabilities

- Life insurers aim to manage their exposure to financial risks by matching their expected long-term liability cash flows with corresponding assets.
- In contrast, investment banking has a much greater short-term focus. However, it should be noted that banks may also have long-term loans (mortgages), with the main difference being that banks finance long-term assets (loans) with short-term financing (deposits) whilst insurers have long-term liabilities (policies) to be financed by premiums.

Similarity 2: Stress and scenario testing exercises similar in design and purpose

The base stress test framework and governance will be broadly the same. This is highlighted in Figure 5, which could equally apply to either organisation.

Figure 3 Macroeconomic scenarios over a business planning horizon



Source: Moody's Analytics

Many of the macroeconomic scenarios will be similar, as both insurers and banks operate in the same economic environments. Some of the calibrations may vary to reflect unique insurance needs, but the principles are common. Whilst Basel II/III sets out the regulatory requirements for stress testing in banks, the insurance equivalent, Solvency II, does have certain stresses unique to insurance that are broadly based on the Basel regime.

Similarity 3: Regulators are considering applying certain bank stress tests to SIFI insurance companies

Is applying a bank stress test model to insurers overkill? As discussed, there are some similarities in stress testing between banks and insurers. However, it would be a mistake to apply banking requirement to insurers.

A good example of the differences between insurers and banks recently occurred in the US where the Federal Reserve Board was insisting on applying bank-like stress tests to MetLife, who they regarded as a systemically important financial institution (SIFI), along with several other large US insurers. The American Council of Life Insurers (ACLI) expressed concern about this approach, arguing that a bank model is too overbearing for an insurer. The ACLI said that insurance companies face risks that are in many instances unique to their business model.

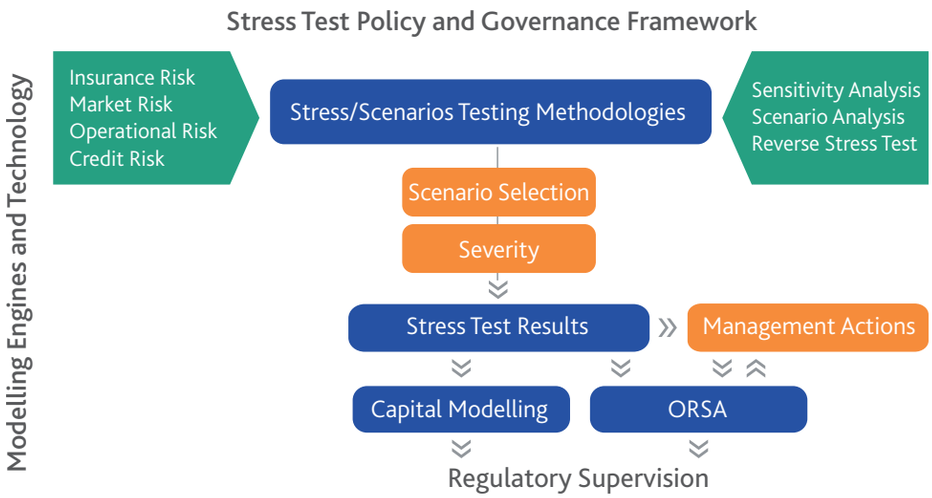
This view was reinforced by John Nadel of Sterne Agee and Leach, Inc., New York, who recently said, 'I don't believe the Fed intends to force insurance companies into the bank stress test model and metrics without at least some adjustments to reflect some of the key differences in their business models (duration of liabilities, lower liquidity risk, etc.).

The consensus was that the stress test, as currently designed for banks, 'is flawed when applied to non-bank institutions.' The key points emphasised were:

> Many banks in Europe actually own insurance companies so it will be interesting to watch how they deal with the differences in the future.

- Traditional core activities of life insurance companies do not present a systemic risk to the financial stability of the United States, and that the risk measured should be the risk that matters.
- Stress testing scenarios for insurers caught under Fed supervision should de-emphasise

Figure 4 Stress test policy and governance framework



Source: Moody's Analytics

shocks arising from traditional banking activities because risks arising from traditional banking activities, such as commercial and consumer lending, are likely to be of comparatively less importance to companies like insurers.

» Insurance companies face risks that are in many instances unique to their business model.

Perhaps this is best summarised by the ACLI, who recently wrote to the Fed to argue that the Fed's proposed rules do not appropriately distinguish between bank holding companies and nonbank financial companies that are designated as systemically important under section 113 of the Dodd-Frank Act (Non-bank Covered Companies). Additionally risk assessment should be tailored to life insurers, not hit with the same regulatory cudgel.

Whilst the above relates specifically to the US it is not inconceivable that other regulators may consider a similar approach.

Similarity 4: Implementing stress testing throughout the organisation is a challenge

One of the major challenges insurers face in stress and scenario testing is that the structure of multi-national/regional insurers means that stress testing has to be operational at both the group and subsidiary ('solo') level. The risks and considerations are very different for a small solo operation when compared to the group. For example, the solo will have to reflect local market factors and regulatory constraints. In essence, the group scenarios have to reflect the risks of the whole group, the interaction of those risks, and operate in multiple economic environments.

As an example of the complexities involved, one very large European multi-national has over 140 solos to consolidate at the group level.

Another factor is that often larger insurers will have grown by acquisition and thus have inherited a range of solos, each of which has its own actuarial modelling engines, technologies, and capabilities. Equally, local regulators each have their unique requirements on stress and scenario testing that almost certainly are different from the regulatory regime in which the group resides.

Perhaps the biggest challenge is in actually operating and monitoring a consistent stress testing process across a diverse group. This raises the key question of whether all stress testing should be undertaken by group based on data and inputs provided by the solo or, alternatively, solo stress testing is undertaken at the local level and effectively consolidated at group. There is no one answer to this question and approaches vary.

Stress testing in insurance has some parallels to banks but differs in a number of crucial ways. The main difference is that although insurers are exposed to financial risks, typically their largest exposure relates to insurance risks, which are less relevant for banks. Thus, insurers need to ensure that these insurance risks are covered as part of any stress and scenario testing.

Specifically, life insurance is a long-term business where contracts may have terms of 50 years or more. Thus, the time horizon of risks (e.g., long-term trends in mortality improvements) can be different from banks. Also, the interaction of assets and liabilities is very important for life insurers as part of any stress testing approach; whereas banks tend to focus on assets, particularly credit risk.

Regardless of these differences, stress and scenario testing is as important a tool for insurers as banks from both a regulatory and management perspective and should be an ongoing process built into the day-to-day operations of the insurer. Commenting on the volatility in the market to the *Financial Times* in August 2008, David Viniar, a Financial Officer of Goldman Sachs, said 'We are seeing things that were 25-standard deviation moves, several days in a row.'

TEN OBSERVATIONS ON STRESS TESTING AND SCENARIO ANALYSIS IN INSURANCE

Stresses and scenarios should:

1. Cover all key risks an insurer is exposed to, including financial and insurance risks
2. Be dynamic and look to the future and compare historical results with forward-looking views
3. Encompass different events and degrees of severity, including what are considered to be severe but plausible events (not always that easy when considering catastrophe and terrorist risk)
4. Include a time horizon that reflects the characteristics of the business
5. Examine the full range of relevant variables – wider than key financial indicators – including strategic goals and idiosyncratic factors
6. Consider if a scenario is one that would have a materially larger impact on an insurer than its peer companies
7. Incorporate 'real-world' events and not just financial risks
8. Generate clear outputs which are used to inform and support decision making and senior management discussion of results
9. Comprise a range of qualitative and quantitative factors which could materially impact a firm. They should strike a sensible balance between sophistication/complexity and tractability for senior management
10. Utilize both micro and macroeconomic drivers

1 An insurer is fundamentally in the business of underwriting risks – typically it accepts risks from individuals (or entities) and pools them together to spread the risk. Basically, the insurer underwrites the risk in return for a premium (which it invests) and issues a policy to the policyholder, which is in essence its liability. The liability relates to the possibility that it may pay out a claim or cash sum at maturity.

IS STRESS TESTING WORTH THE INVESTMENT?

By Alessio Balduini

Alessio Balduini
Managing Director, Stress Testing and Asset Quality Review Coordinator (EMEA)

Alessio helps clients address their credit risk regulatory architectures, providing insight about quantitative models, data, and software for risk management.

Given the complexity and level of investment involved, risk practitioners have asked if stress testing is worth the effort. However, stress testing has become a key risk management tool.

Risk practitioners have asked whether or not stress testing is worth the investment. More precisely, is it likely that the attention to this topic will fade after the current regulatory push? Will all banks sufficiently support their stress testing capabilities to embrace the implementation of an effective process?

Throughout this publication, we have taken a closer look at the opportunities and challenges of stress testing in Europe – from an overview of the current dynamic and regulatory updates to implementation and best practices. And although we are years into the resource-siphoning scramble to stay compliant with regulations, there is still much more to do.

In a previous article, Christian Thun addressed the question 'Are regulatory stress tests just cost without value?' Some banks may believe this to be the case, especially if the ever-increasing data requirements of the tests have little to do with a bank's individual risk profile.

Complying with regulation has never been easy; yet in a very short period of time, stress testing has become both a central regulatory necessity and a key risk management tool. It's a unique opportunity to contemplate potential outcomes and actions to take depending on different scenarios. However, there are still institutions that opt for a superficial approach, which may expose them to structural weaknesses in a few years.

Regulators are serious about stress testing

Regulators are taking stress testing seriously, as reflected in the increase in the level of attention being dedicated to it. The regulatory requirements have also evolved rapidly to become even more complex and place more demands on banks, as described in the 'Evolution of Stress Testing in Europe', in an effort to restore confidence and calm in the financial system by bringing transparency to bank balance sheets. With that as the context, we looked ahead to what changes will impact the industry in 'Regulatory Updates'.

We note three factors that support this view:

1. The introduction of the European Central Bank (ECB) as a unique euro zone supervisor and its decision to run an asset quality review of the balance sheet of every bank, which adds a much higher degree of credibility.
2. Regulatory teams focused specifically on stress testing have been seconded to the ECB from local regulators, giving the Central Bank access to trained resources in a short period of time.
3. Data analysis from the EBA will be performed at a more rapid pace and with increased capacity, as a result of recent investments in their data technology platforms.

Keeping an eye on the US

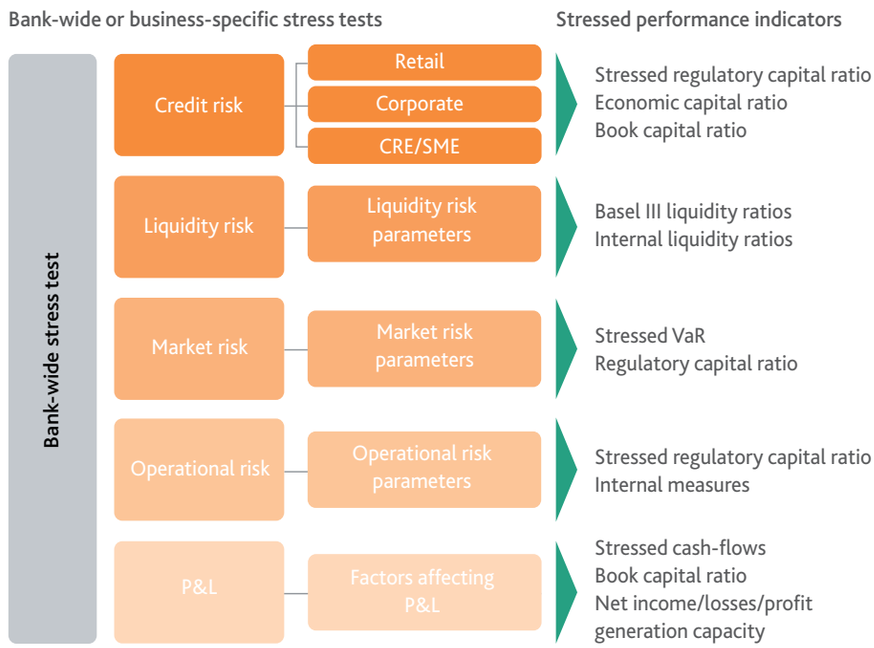
More banks are also following the Comprehensive Capital Analysis and Review (CCAR), driven by some of their activities based in the US. The Prudential Regulatory Authority in the UK has also indicated that it 'would move towards a US-style system'. All of these factors reinforce our impression that a granular bottom-up driven exercise will take place rather than a top-down approach in most of the asset classes.

Basel II's Internal Rating Systems, Probability of Default, and portfolio models. The board members of banks or CEOs are able to easily grasp the idea of stress testing and understand the relevance of GDP figures, unemployment, or oil prices on their exposures.

Beyond banking

The relevance of stress testing extends beyond the banking sector. Treasurers of large corporate firms are moving outside their usual comfort zone of buy-and-hold strategies and are including stress testing practices in their risk management frameworks. In fact, they are facing the same issues as banks do from their boards (see our article 'Stress and Scenario Testing: How Insurers Compare with Banks'). They also want to have high profile discussions around risk appetite and are seeking answers to simple questions such as 'what would happen if…?' or 'what should we do if…?'

Figure 1 Types of risk and finance indicators currently stressed



Source: Moody's Analytics

For more information on the US activities, please see Thomas Day's article 'A Summary of the CCAR and Dodd Frank Act Stress Tests'.

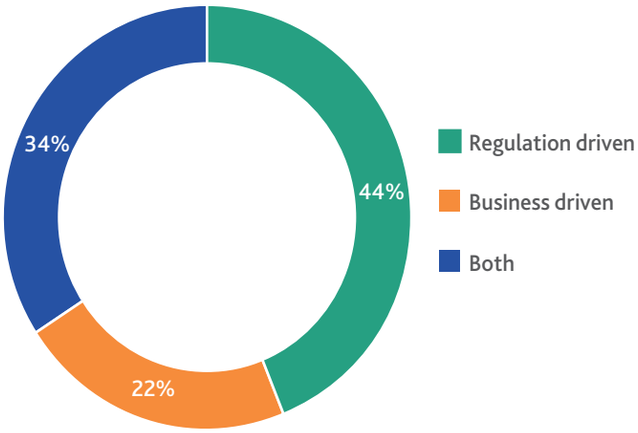
Obtaining a clearer view of a stress testing framework

After years of planning, working on organisational structures, and methodology discussions, top banks now have a clearer view of what they need to do to implement a stress testing framework.

Stress testing has probably taken less time than Basel II to weave itself into banking culture, but its concept is relatively easier to understand than

As these questions are changing the sponsorship dynamics, decisions to implement the stress testing framework are no longer only driven by

Figure 2 Main drivers for stress testing (% of survey participants)



Source: Moody's Analytics Stress Testing Survey 2011

requirements from regulators, but also driven by business or a combination of both (see Figure 2).

A need for more comprehensive services

On another front, as the demand for stress testing services grows, the quality of supporting services from consultants, products, and software providers will need to become more comprehensive. Software providers have always been active on various fronts (e.g., data, analytics, and software), but it took at least a year to get a comprehensive solution, which includes data inputs and models for various types of risks and asset classes from a variety of different sources. The challenge is to have systems that will be able to integrate risk, mostly from credit exposures and finance, which are components that have not historically shared the same IT and analytical platform.

Banks around the world have devoted considerable time and resources to comply with the new regulatory guidelines and to establish internal frameworks so that they can perform stress tests for different types of risk, asset classes, and business lines. Considering all the collective inputs, stress testing is definitely here to stay beyond the recent regulatory push and is well worth the cost of the initial investment, despite the challenges of implementing the framework. Overall, it is a matter of choosing between the opacity of the past or moving towards transparency and innovation.

> All of these factors reinforce our impression that a granular bottom-up driven exercise will take place rather than a top-down approach in most of the asset classes.

SUBJECT MATTER EXPERTS

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Director of Business Development (EMEA)

Nicolas is responsible for providing thought leadership on ALM, liquidity, and market risks for the EMEA region to help financial institutions define a sound risk management framework.

Nicolas worked as ALM and risk manager in two French Banks for more than six years before joining Fermat in 2005, which was acquired by Moody's Analytics in late 2008. Nicolas holds a mathematics and economics degree from the Ecole Polytechnique and a finance and statistics degree from the Ecole Nationale de la Statistique et de l'Administration Economique.

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SUBJECT MATTER EXPERTS

Eric Leman

Associate Director, Solution Specialist

Eric has more than ten years experience helping organisations make more informed credit and risk management decisions.

He has served as a Solution Specialist of banking compliance and risk management since 2010 – specifically Basel II Capital Adequacy (Credit Risk, Market Risk), Asset and Liability Management, Value at Risk, and Credit Risk Monitoring. Prior to that, he worked in Moody's Analytics Implementation Services.

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Dr. José Suárez-Lledó

Director, Economic and Consumer Credit Analytics

José is a Director in the Economic and Consumer Credit Analytics team, responsible for the research and implementation of Moody's Analytics risk management solutions and managing projects with major banks and investment firms globally.

He is directly involved in modeling, forecasting, and stress testing, including retail and corporate credit portfolios, key market risk indicators, structured finance, rating migrations against different macroeconomic scenarios, and designing macroeconomic models that generate scenarios. José is also a frequent speaker at credit risk events.

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Dr. Juan Licari

Senior Director of Economic and Consumer Credit Analytics

Juan and his team are responsible for generating alternative macroeconomic forecasts for Europe and for building econometric tools to model credit risk phenomena. His team develops and implements risk solutions that explicitly connect credit data to the underlying economic cycle, allowing portfolio managers to plan for alternative macroeconomic scenarios. These solutions are leveraged into stress testing and reverse stress testing practices.

Juan communicates the team's research and methodologies to the market and often speaks at credit events and economic conferences worldwide. He holds a PhD and an MA in economics from the University of Pennsylvania and graduated summa cum laude from the National University of Cordoba in Argentina.

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Alain Maure

Director, Head of Risk Management Solutions (EMEA)

Alain leads the software and risk management solutions team for EMEA. He joined Moody's Analytics in 2003, when Fermat, his former company, was acquired. He has more than 15 years experience providing financial and risk management expertise to major financial institutions around the world. Alain was previously a quantitative equity analyst in investment banking in London. He has degrees in mathematics from the Ecole Centrale de Lille and a postgraduate diploma in finance.

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Mikael Nyberg

Managing Director, Advisory Services

Mikael leads the Advisory Services group, which provides consulting, product training and implementation services for Moody's Analytics portfolio, credit risk measurement and valuation products. Mikael has extensive experience in risk management for the financial industry, having worked on over 300 projects helping institutions around the world with their portfolio credit risk. He lead the development of quantitative risk modeling techniques to enhance portfolio performance, meet current regulatory requirements, and anticipate future stress scenarios.

His educational background includes BSc (ECON) in Finance and Accounting from the London School of Economics and a MBA from IESE in Barcelona.

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Charles Stewart

Senior Director

Calling on 30 years of risk management experience, Charles helps organisations make more informed credit and risk management decisions. Charles joined Moody's KMV in early 2006 from Barclays Bank PLC, where he worked in various capacities during his 28-year career there.

Drawing on his knowledge of both theory and also the realities of day-to-day practice, Charles has used his extensive risk management experience and his familiarity with many of the challenges associated with commercial and corporate banking to help financial institutions around the world with the development of their risk management planning and strategies.

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Dr. Christian Thun

Senior Director, Strategic Business Development (EMEA)

Christian is responsible for providing thought leadership on credit risk management and strategic business development in the EMEA region and functions as a main contact for regulators and senior management of financial institutions.

With more than 15 years experience, Christian has worked with numerous financial institutions in the EMEA region on Basel II implementation, risk management, stress testing and portfolio advisory projects, and in the process has became an internationally-known expert on credit risk management.

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Wilfrid Xoual

Senior Director, Head of Business Development (EMEA)

Wilfrid leads a team of experienced industry professionals responsible for helping EMEA financial institutions address their global risk management needs and regulatory issues. Wilfrid was the former COO EMEA of Fermat, purchased by Moody's Analytics in Q4 2008.

Previously, he served as the Managing Director for PayZone in France and Spain, and after seven years in the fields of strategy and management consulting, he held management positions in several multinational firms, such as Dow Jones Telerate, Cendant, and Diners Club.

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Is a loan level capital allocation and risk management tool providing stressed PDs, LGDs, and prepayments for RMBS, auto ABS, mortgage and auto loans under the Fed's CCAR scenarios and custom scenarios.

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WSA Platform

Is a risk and portfolio management tool used for stress testing structured finance transactions. Moody's Analytics maintains a global structured finance deal library. WSA integrates macroeconomic, credit models, pool, and loan level performance data to forecast cashflows, PD's, LGDs, and prepayments.

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Provides a comprehensive view of global economic conditions and trends. Our database covers more than 180 countries with more than 260 million time series from the best national and private sources, as well as key multinational data sets.

Moody's Analytics Credit Research Database (CRD)

Is the world's largest and cleanest database of private firm financial statements and defaults, built in partnership with over 45 leading financial institutions around the world.

Exposure at Default (EAD) Data

Is derived from a subset of the CRD Database and is compiled of 10+ years of usage data for estimating and calculating EAD. The EAD database contains quarterly usage and Loan Equivalency Ratio data for both defaulted and non-defaulted private firms since 2000.

PD Time Series Information

Offers time series of observed default rates and calculated PDs, covering more than two economic cycles. This data is collected and calculated for both public and private firms.

Credit Migration Data

Enables users to construct detailed credit migration (transition) matrices. This detailed private firm data allows users to be more granular with segmentations across industry, region, and asset size using several different PD rating calculation methodologies.

Credit Cycle Adjustment Data

Combines financial statement ratio information of private firms with credit cycle factors in the public equity markets to derive a dynamic, through-the-cycle PD measure.

Structured Finance Data

Offers loan, pool and bond level performance data for RMBS, CMBS, ABS and CDOs. SF Data can be used for bottom-up mortgage stress testing model creation and calibration. SSFA data and calculations are also available.

Default and Recovery Database

Allows users to look at how default experience varies at different points in the economic cycle, and which factors made default experience in each economic cycle unique. The data includes detailed rating histories, 30-day post default pricing, and three views into ultimate recovery.

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Contact Alessio Balduini to join the Stress Testing group:
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ABOUT US

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More information is available at moodysanalytics.com.

GLOSSARY OF TERMS

ACLI	American Council of Life Insurers
ALM	Asset and Liability Management
AQR	Asset Quality Review
ARMA	Autoregressive Moving-Average
BCBS	Basel Committee on Banking Supervision
BHC	Bank Holding Company
CCAR	Comprehensive Capital Analysis and Review
CDS	Credit Default Swap
CEBS	Committee of European Banking Supervisors
CFO	Chief Financial Officer
CRD	Capital Requirements Directives
CRO	Chief Risk Officer
DFAST	Dodd-Frank Act Stress Test
DSGE	Dynamic Stochastic General Equilibrium
EAD	Exposure at Default
EBA	European Banking Authority
ECB	European Central Bank
EIPOA	European Insurance and Occupational Pensions Authority
ETL	Extract, Transform, Load
FDSF	Firm Data Submission Framework
FE	Fixed Effects
FSB	Financial Stability Board
FX	Foreign Exchange
GDP	Gross Domestic Product
GLS	Generalised Least Squares
GMM	Generalised Method Moments
IMF	International Monetary Fund
KPI	Key Performance Indicators
LCR	Liquidity Coverage Ratio
LGD	Loss Given Default
MLE	Maximum Likelihood Estimation
NAIC	National Association of Insurance Commissioners
NPL	Non-Performing Loans
NSFR	Net Stable Funding Ratio
OLS	Ordinary Least Squares
ORSA	Own Risk Solvency Assessment
P&L	Profit and Loss
PCA	Principal Component Analysis
PD	Probability of Default
PPNR	Pre-Provision Net Revenue
PRA	Prudential Regulation Authority (UK)
Qreg	Quantile Regressions
RE	Random Effects
RST	Reverse Stress Testing
RWA	Risk Weighted Asset
SCAP	Supervisory Capital Assessment Programme (US)
SCR	Solvency Capital Requirement
SIFI	Systemically Important Financial Institution
SSM	Single Supervisory Mechanism
SVAR	Structural Vector Autoregressive
VaR	Value-at-Risk
XML	Extensible Markup Language

Loan classification and restructureing

Loan Loss Estimation

CREDIT RISK

Reverse

EBA

NPLs

Stress Testing

Capital requirements

Interest rates

SUCCESS

Building an Integrated Framework

Breaking Silos

Integration

SCAP

Modelling methodology

Improve Risk Management

Regulation

Bottom-up stress test

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